Service Manual

Generator Set

QSX15-G9 Engine with PowerCommand® 2.3 Control

DFEJ (Spec P)
DFEK (Spec P)

English
Original Instructions 12-2019 A063S746 (Issue 1)

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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 and batteries.

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 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 Safety Precautions

1.2.1.1 General Safety Precautions

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

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

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

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

⚠ WARNING

Toxic Hazard

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

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

⚠ WARNING

Electrical Generating Equipment

Incorrect operation can cause severe personal injury or death.

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

⚠ WARNING

Toxic Gases

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

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

⚠ WARNING

Combustible Liquid

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

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

⚠ WARNING

High Noise Level

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

Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Electrical Generating Equipment

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

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

⚠ WARNING

Toxic Hazard

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

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

⚠ WARNING

Combustible Liquid

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

Do not use combustible liquids like ether.

⚠ WARNING

Automated Machinery

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

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

⚠ WARNING

Fire Hazard

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

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

⚠ WARNING

Fire Hazard

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

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

⚠ WARNING

Fall Hazard

Falls can result in severe personal injury or death.

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

⚠ WARNING

Fire Hazard

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

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

⚠ WARNING

Pressurized System

Pressurized systems can rupture/leak which can result in severe personal injury or death.

Use appropriate lock out/tag out safety procedures to isolate from all energy sources before performing any service tasks. Use PPE.

⚠ WARNING

Confined Areas

Confined spaces or areas with restricted access or potential to entrap can cause severe personal injury or death.

Use appropriate lock out/tag out safety procedures to isolate from all energy sources. Use PPE. Follow site specific lone worker protocols/permits to work.

⚠ CAUTION

Manual Handling Heavy Objects

Handling heavy objects can cause severe personal injury.

Use appropriate lifting equipment and perform tasks with two people where doing so would make completion of the task safe.

⚠ CAUTION

Power Tools and Hand Tools

Tools can cause cuts, abrasions, bruising, puncture injuries.

Only trained and experienced personnel should use power tools and hand tools. Use PPE.

⚠ CAUTION

Sharp Edges and Sharp Points

Projecting corners/parts may cause cuts, abrasions and other personal injury.

Use PPE. Be aware of sharp edges and corners/sharp points. Cover/protect them.

NOTICE

Keep multi-type ABC fire extinguishers close by. 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 the applicable region.)

NOTICE

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

NOTICE

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

NOTICE

Remove fuel from subbase fuel tank before conducting any hot work.

1.3 Generator Set Safety Code

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

⚠ WARNING

Electrical Generating Equipment

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

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

1.3.1 Moving Parts Can Cause Severe Personal Injury or Death

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

1.3.2 Generator Set Operating Areas

⚠ WARNING

Ejected Debris

Debris ejected during destructive failure can cause serious injury or death by impact, severing or stabbing.

Do not to stand alongside the engine or alternator while the generator set is running.

- Operators must not stand alongside the engine or alternator while the generator set is running, unless the risks of doing so have been assessed and adequate mitigation steps have been taken.
- If there are operation/maintenance procedures that require spending time alongside the generator set when it is running, take every precaution to perform these tasks safely. Keep time spent performing these tasks to a minimum.
- Be aware of the product environment. Other equipment may be in operation or energized in the surrounding area.

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

⚠ WARNING

Electric Shock Hazard

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

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

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

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

Guidelines to follow when working on energized electrical systems:

NOTICE

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

NOTICE

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

In summary:

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

1.4.1 AC Supply and Isolation

NOTICE

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

NOTICE

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

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

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

1.4.2 AC Disconnect Sources

⚠ WARNING

Hazardous Voltage

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

The equipment may have more than one source of electrical energy. Disconnecting one source without disconnecting the others presents a shock hazard. Before starting work, disconnect the equipment, and verify that all sources of electrical energy have been removed.

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, 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 distributor for more information.

1.6 Exhaust Gases Are Deadly

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

1.6.1 Exhaust Precautions

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

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Toxic Gases

Inhalation of exhaust gases can cause asphyxiation and death.

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

⚠ WARNING

Fire Hazard

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

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

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

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

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

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

1.7 Decommissioning and Disassembly

NOTICE

Decommissioning and disassembly of the generator set at the end of its working life must comply with local guidelines and legislation for disposal/recycling of components and contaminated fluids. This procedure must only be carried out by suitably trained and experienced service personnel. For more information contact your authorized distributor.

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2 Introduction

⚠ WARNING

Hazardous Voltage

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

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

⚠ WARNING

Electrical Generating Equipment

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

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

2.1 About This Manual

This manual provides troubleshooting and repair information for the Generator Sets listed on the front cover. Additional Engine and alternator service and maintenance instructions are contained within the applicable engine and alternator service manuals. Operating and basic maintenance instructions are in the applicable Generator Set Operator Manual.

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

This manual contains basic (generic) wiring diagrams and schematics that are included to help in troubleshooting. The wiring diagrams and schematics that are maintained with the unit should be updated when modifications are made to the unit.

Read **Chapter 1 on page 1** and carefully observe all instructions and precautions in this manual.

2.2 Test Equipment

To perform the test procedures in this manual, the following test equipment must be available

- True RMS meter for accurate measurement of small AC and DC voltages.
- Grounding wrist strap to prevent circuit board damage due to electrostatic discharge (ESD).
- Battery Hydrometer
- Jumper Leads
- Tachometer or Frequency Meter
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter
- PCC Service Tool Kit (Harness Tool and Sensor Tool)

- InPower Service Tool (PC based Generator Set Service Tool)

2.3 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	LED	Light-emitting Diode
AMP	AMP, Inc., part of Tyco Electronics	LTS	Long Term Storage
ANSI	American National Standards Institute	LVRT	Low Voltage Ride Through
ASOV	Automatic Shut Off Valve	MFM	Multifunction Monitor
ASTM	American Society for Testing and Materials (ASTM International)	Mil Std	Military Standard
ATS	Automatic Transfer Switch	MLD	Masterless Load Demand
AVR	Automatic Voltage Regulator	NC	Normally Closed
AWG	American Wire Gauge	NC	Not Connected
CAN	Controlled Area Network	NFPA	National Fire Protection Agency
CB	Circuit Breaker	NO	Normally Open
CE	Conformité Européenne	NWF	Network Failure
CFM	Cubic Feet per Minute	OEM	Original Equipment Manufacturer
CGT	Cummins Generator Technologies	OOR	Out of Range
CMM	Cubic Meters per Minute	OORH / ORH	Out of Range High
CT	Current Transformer	OORL / ORL	Out of Range Low
D-AVR	Digital Automatic Voltage Regulator	PB	Push Button
DC	Direct Current	PCC	PowerCommand® Control
DEF	Diesel Exhaust Fluid	PGI	Power Generation Interface
DPF	Diesel Particulate Filter	PGN	Parameter Group Number
ECM	Engine Control Module	PI	Proportional/Integral
ECS	Engine Control System	PID	Proportional / Integral / Derivative
EMI	Electromagnetic interference	PLC	Programmable Logic Controller
EN	European Standard	PMG	Permanent Magnet Generator
EPS	Engine Protection System	PPE	Personal Protective Equipment
E-Stop	Emergency Stop	PT	Potential Transformer
FAE	Full Authority Electronic	PTC	Power Transfer Control
FMI	Failure Mode Identifier	PWM	Pulse-width Modulation

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
FRT	Fault Ride Through	RFI	Radio Frequency Interference
FSO	Fuel Shutoff	RH	Relative Humidity
Genset	Generator Set	RMS	Root Mean Square
GCP	Generator Control Panel	RTU	Remote Terminal Unit
GND	Ground	SAE	Society of Automotive Engineers
LCT	Low Coolant Temperature	SCR	Selective Catalytic Reduction
HMI	Human-machine Interface	SPN	Suspect Parameter Number
IC	Integrated Circuit	SWL	Safe Working Load
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
		VPS	Valve Proving System

2.4 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 DFEJ and DFEK with PC 2.3 (A063S745)
- Operator Manual for DFEJ and DFEK with PC 3.3 (A063S749)
- Operator Manual for DFEJ and DFEK with PC 3.3 MLD (A063S752)
- Installation Manual for DFEJ and DFEK with PC 2.3, 3.3, and 3.3 MLD (A063S744)
- Service Manual for DFEJ and DFEK with PC 2.3 (A063S746)
- Service Manual for DFEJ and DFEK with PC 3.3 and 3.3 MLD (A063S750)
- Controller Service Manual for PC 2.3 (0900-0666)
- Controller Service Manual for PC 3.3 and PC 3.3 MLD (0900-0670)
- Engine Operation & Maintenance Manual for QSX15 Engine (5504567)
- Alternator Service Manual for HC Alternator (0900-9904)
- Specification and Data Sheet
- *Application Manual T-030: Liquid Cooled Generator Sets*
- Parts Manual for DFEJ and DFEK with QSX15 Engine (A040G238)

- Standard Repair Times - CH Family (A034H046)
- Global Commercial Warranty Statement (A028U870)

2.5 After Sales Services

Cummins offers a full range of maintenance and warranty services.

2.5.1 Maintenance

⚠ WARNING
Electrical Generating Equipment
Incorrect operation and maintenance can result in severe personal injury or death.
Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

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

2.5.2 Warranty

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

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

Extended warranty coverage is also available.

For further warranty details, contact your authorized service provider.

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

2.5.2.1 Warranty Limitations

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

3 Specifications

3.1 Generator Set Specifications

TABLE 1. GENERATOR SET SPECIFICATIONS

MODELS	**DFEJ Spec P**	**DFEK Spec P**
Engine		
Cummins Diesel Series	QSX15 (60 Hz)	QSX15 (60 Hz)
Generator kW Rating (Standby)	450	500
Generator kW Rating (Prime)	410	455
Engine Fuel Connection		
Inlet/Outlet Thread Size	Refer to generator set outline drawing supplied	
Maximum Weight (Wet)		
Fuel		
Fuel Pump Flow Rate	56 gph (212 L/hr)	56 gph (212 L/hr)
Maximum Fuel Inlet Restriction	8 in. Hg (203 mm Hg)	
Maximum Fuel Return Restriction	8 in. Hg (203 mm Hg)	
Air		
Maximum Air Cleaner Restriction	25 in. Water Gauge	
Exhaust		
Outlet Size	6 in. NPT Male STD (A299)/ASA Flange (A355) or Slip-on (A298) Optional	
Exhaust Flow at Rated Load (Standby)	3190 cfm	3430 cfm
Exhaust Flow at Rated Load (Standby)	90.3 m^3/min	97.2 m^3/min
Exhaust Flow at Rated Load (Prime)	2990 cfm	3220 cfm
Exhaust Flow at Rated Load (Prime)	84.4 m^3/min	91 m^3/min
Exhaust Temperature (Standby)	880 °F	893 °F
Exhaust Temperature (Standby)	470 °C	478 °C
Exhaust Temperature (Prime)	866 °F	880 °F
Exhaust Temperature (Prime)	464 °C	471 °C
Maximum Allowable Back Pressure	41 in. H2O (10.2 kPa)	
Electrical System		
Starting Voltage	24 Volts DC	
Battery(s)	Two or Four 12 Volt	

Battery Group Number	2x 4D or 4x Group 34 or 4x Group 24	
CCA (minimum) Cold Soak	1425A at 0 °F to 32 °F (-18 °C to 0 °C)	
Cooling System		
Ambient design	104 °F (40 °C)	
Coolant Capacity with Standard Set-mounted Radiator	15.3 Gal (57.9 L)	
Lubricating System		
Oil Capacity with Filters	88 qt (83.3 L)	

3.2 Engine Fuel Consumption

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

Model	DFEJ	DFEK
Engine	**QSX15-G9**	**QSX15-G9**
Engine Performance Data at 60Hz[1]	115	127
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 3. FUEL CONSUMPTION (GAL/HR) AT 1800 RPM (60 HZ)

Model	DFEJ	DFEK
Engine	**QSX15-G9**	**QSX15-G9**
Engine Performance Data at 60Hz[1]	30.5	33.6
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.		

3.3 Derating Factors

TABLE 4. DFEJ DERATING FACTOR

Application	Derating Factor
Prime	Generator set may be operated up to 2682 m (8800 ft) at 40 °C (104 °F) without derate. For sustained operation above these conditions derate by 3.2% per 300 m (1000ft) and 16.6% per 10 °C (18 F).
Standby	Generator set may be operated up to 2926 m (9600 ft) at 40 °C (104 °F) without derate. For sustained operation above these conditions derate by 3.0% per 300 m (1000ft) and 9.5% per 10 °C (18 F).

TABLE 5. DFEK DERATING FACTOR

Application	Derating Factor
Prime	Generator set may be operated up to 1585 m (5200 ft) at 40 °C (104 °F) without derate. For sustained operation above these conditions derate by 3.2% per 300 m (1000ft) and 16.6% per 10 C (18 °F).
Standby	Generator set may be operated up to 1524 m (5000 ft) at 40 °C (104 °F) without derate. For sustained operation above these conditions derate by 3.0% per 300 m (1000ft) and 9.5% per 10 C (18 °F).

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4 Periodic Maintenance Schedule

4.1 Periodic Maintenance Schedule

4.1.1 Air Intake Maintenance Schedule

TABLE 6. AIR INTAKE MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 250 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**				
Check air cleaner restriction indicator (where fitted): If the service indicator shows red, replace air cleaner elements and reset the air cleaner service indicator.	■						
Check air intake system for leaks: Visually inspect the air intake system for signs of wear or damage. Check audibly when the generator set is running. To replace, contact your authorized distributor.	■						
Clean air cleaner housing.				■			

4.1.2 Control Maintenance Schedule

TABLE 7. CONTROL MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 500 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**				
Check operation of Control Panel: Check display (the system will perform a control panel test on initial activation). To replace, contact your authorized distributor.	■						
Check operation of Emergency Stop Button: With the generator set running, press the Emergency Stop button. Check all systems, before resetting the fault.		■					

4.1.3 Cooling Maintenance Schedule

TABLE 8. COOLING MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 250 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**				
Check coolant level of radiator(s) (water jacket & LTA): If low, top up to coolant system specifications level, with Cummins recommended coolant mix.	■						
Check cooling fan blades: Visually inspect the fan blades through the guarding for signs of wear or damage. To replace, contact your authorized distributor.	■						
Check drive belt, condition and tension: Visually check belt for evidence of wear or slippage. To replace, contact your authorized distributor.	■						
Check coolant lines and radiator hoses for leaks, wear, and cracks: Visually check for leaks, worn or damages hoses. To replace, contact your authorized distributor.	■		■				
Check radiator air flow: Visually inspect the radiator through the guarding for blockage, build up of debris, signs of wear or damage. To clean or replace, contact your authorized distributor.	■						
Check anti-freeze and DCA concentration	■						
Clean radiator core.			■[1]				
Re-grease bearings			■				
Check aftercooler core.						■	
Check water pump.						■	
Change coolant filter.			■				
Check coolant heater.			■				
Fan drive idler arm and fan belt tensioner check.					■		
Replace cooling system coolant.							■
■[1] – Cleaning schedule may be reduced depending on operating conditions/environment. Contact your authorized distributor.							

TABLE 9. ENGINE MAINTENANCE

MAINTENANCE ITEMS Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first	Daily 8 Hours	6 Months 250 Hours	12 Months 1500 Hours	2 Years 6000 Hours	5 Years 10000 Hours
Task	**Operator Task**	**Service Technician Task**			
Check fuel lines and hoses: Visually check for leaks, worn or damages hoses. To replace, contact your authorized distributor.	■[1]				
Check engine oil level: If low, top up to engine specifications level, with recommended oil.	■				
Drain water from fuel system primary filter/water separator: Drain one cup, or more, of fuel to remove water and sediment. See procedure in this chapter.	■				
Crankcase breather tube/collector. Check for condensed oil. Drain and dispose of in accordance with local legislation.	■				
Fuel Filter, Remote Mounted (if fitted): Drain one cup, or more, of fuel to remove water and sediment. Check system.	■				
Check charge alternator: Check visually and audibly when the generator set is running. To replace, contact your authorized distributor.	■				
Check engine coolant heater: Check coolant heater has power and is running. To replace, contact your authorized distributor.	■				
Crankcase Breather Tube - Check		■			
Lubricating Oil and Filters - Change		■			
Supplemental Coolant Additive (SCA) and Antifreeze Concentration - Check		■			
Fuel Filter (Spin-On Type) - Change		■			
Coolant Filter - Replace			■		
Coolant Filter Head - Inspect for reuse			■		
Cooling Fan Belt Tensioner - Check			■		
Air Leaks, Air Intake and Exhaust Systems - Check			■		
Air Cleaner Restriction - Check			■		
Engine Wiring Harness - Check			■		
Radiator Hoses - Maintenance Check				■	

MAINTENANCE ITEMS Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first	Daily 8 Hours	6 Months 250 Hours	12 Months 1500 Hours	2 Years 6000 Hours	5 Years 10000 Hours
Task	**Operator Task**	**Service Technician Task**			
Crankcase Breather Tube - Check				■	
Cold Weather Starting Aids - Check				■	
Engine Steam Cleaning - Clean				■	
Engine Mounting Bolts - Check				■	
Vibration Damper, Viscous - Inspect for reuse				■	
Overhead Set - Adjust				■	
Crankcase Breather (Internal) - Replace				■	
Air Compressor Discharge Lines - check					■
Fan Hub Belt Driven - Replace					■
■[1] – Check before starting and again with the generator set running.					

NOTICE

For specific engine maintenance schedules and procedures, reference the literature particular to the ESN (Engine Serial Number) available on QSOL (QuickServe OnLine).

4.1.5 Exhaust Maintenance Schedule

TABLE 10. EXHAUST MAINTENANCE

MAINTENANCE ITEMS Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first	Daily 8 Hours	Weekly 50 Hours	6 Months 250 Hours	12 Months 250 Hours	1500 Hours 12 Months	2000 Hours	2 Years 6000 Hours
Task	**Operator Task**		**Service Technician Task**				
Check all exhaust components, and hardware (fittings, clamps, fasteners, etc.): Visually inspect the exhaust system for signs of wear or damage. Check audibly when the generator set is running. To replace, contact your authorized distributor.	■						
Check exhaust condensation trap: Drain condensation into a suitable container. Dispose of fluids in accordance with local legislation.	■						

4.1.6 Generator Set Maintenance Schedule

TABLE 11. GENERATOR SET MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 250 Hours**	**12 Months 1000 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Check fuel level in tank: If low, add fuel (A full tank reduces condensation.)	■							
Check bedframe/enclosure fluid containment (where fitted): Drain as necessary. Clean all contaminated areas. Dispose of fluids in accordance with local legislation.	■							
Inspect Engine/Alternator Flexible Rubber Coupling					■			
Check generator set enclosure: Visually check enclosure, walk around inspection of generator set. Make sure no inlets/outlets are covered/restricted, service access doors are operational and safety systems are in place and operational. To replace damaged parts, contact your authorized distributor.	■							
Check batteries: Check connections are secure and battery area is free from tools and other items.		■				■		
Check battery electrolyte level.				■				
Check electrical connections (battery, starter motor and alternator connections).				■		■		

4.1.7 Generator Set Maintenance Schedule

TABLE 12. GENERATOR SET MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 250 Hours**	**12 Months 1000 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Check fuel level in tank: If low, add fuel (A full tank reduces condensation.)	■							
Check bedframe/enclosure fluid containment (where fitted): Drain as necessary. Clean all contaminated areas. Dispose of fluids in accordance with local legislation.	■							
Inspect Engine/Alternator Flexible Rubber Coupling					■			
Check generator set enclosure: Visually check enclosure, walk around inspection of generator set. Make sure no inlets/outlets are covered/restricted, service access doors are operational and safety systems are in place and operational. To replace damaged parts, contact your authorized distributor.	■							
Check batteries: Check connections are secure and battery area is free from tools and other items.		■				■		
Check battery electrolyte level.				■				
Check electrical connections (battery, starter motor and alternator connections).				■		■		

TABLE 13. ALTERNATOR SERVICE SCHEDULE

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Replace	SERVICE LEVEL: Commission	SERVICE LEVEL: Post Commission / 250 hrs / 0.5 year	SERVICE LEVEL: Level 1 / 1000 hrs / 1 year	SERVICE LEVEL: Level 2 / 10,000 hrs / 2 years	SERVICE LEVEL: Level 3 / 30,000 hrs / 5 years
Alternator	Alternator rating		X				X				
	Bedplate arrangement		X				X				
	Coupling arrangement		X				X			*	X
	Environmental conditions and cleanliness		X				X	X	X	X	X
	Ambient temperature (inside & outside)			X			X	X	X	X	X
	Complete machine - damage, loose parts & earth bonds		X				X	X	X	X	X
	Guards, screens, warning and safety labels		X				X	X	X	X	X
	Maintenance access		X				X				
	Electrical nominal operating conditions & excitation	X		X			X	X	X	X	X
	Vibration*	X		X			X	X	X	X	X
Windings	Condition of windings		X				X	X	X	X	X
	Insulation resistance of all windings (PI test for MV/HV)			X			X	*	*	X	X
	Insulation resistance of rotor, exciter and PMG			X				X	X		
	Temperature sensors	X		X			X	X	X	X	X
	Customer settings for temperature sensors		X				X				

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Replace	SERVICE LEVEL: Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Bearings	Condition of bearings		X				X							X	
Bearings	Grease exhaust & trap				X			X		X		X		X	
Bearings	Grease in re-greasable bearing(s)	X				X		every 4000 to 4500 hours / 6 months							
Bearings	Sealed bearing(s)		X					every 4000 to 4500 hours							
Bearings	Re-greasable & sealed bearing(s)					X						*		X	
Bearings	Temperature sensors	X		X			X	X		X		X		X	
Bearings	Customer settings for temperature sensors		X				X								
Terminal Box	All alternator/customer connections and cabling		X				X	X		X		X		X	
Controls & Auxiliaries	Initial AVR & PFC set up	X		X			X								
Controls & Auxiliaries	AVR & PFC settings	X		X				X		X		X		X	
Controls & Auxiliaries	Customer connection of auxiliaries			X			X			X		X		X	
Controls & Auxiliaries	Function of auxiliaries			X			X	X		X		X		X	
Controls & Auxiliaries	Synchronization settings		X				X								
Controls & Auxiliaries	Synchronization	X		X			X	X		X		X		X	
Controls & Auxiliaries	Anti condensation heater					X						*		X	
Rectifier	Diodes and varistors		X				X	X		X		X			
Rectifier	Diodes and varistors					X								X	
Cooling	Air inlet temperature	X		X			X	X		X		X		X	
Cooling	Air flow (rate & direction)	X	X				X								
Cooling	Condition of fan		X				X	X		X		X		X	
Cooling	Condition of air filter (where fitted)			X			X	X		X		X		X	
Cooling	Air filters (where fitted)				X	X				*		*		*	

* For stand-alone alternator only.

4.2 Generator Set Long Term Storage

4.2.1 Required Materials

- Tectyl™ 915W40 or equivalent engine preservative oil that meets military specification MIL-PRF-21260, type P-10, Grade 2, SAE 30
- Tectyl™ 511-M, or equivalent rust preventative compound that meets military specification MIL-C-16173C, type P-2, Grade 1 or 2
- Daubert Chemical NoxRust No. 518 or equivalent preservative oil that meets military specification MIL-L-644, type P-9
- Moisture indicating silica desiccant gel packs
- Heavy paper or plastic and tape
- Corrosion inhibiting plastic such as Zerust

NOTICE

Do not leave Bio-Free diesel fuel in the fuel system longer than 6 months.

NOTICE

Do NOT leave diesel fuel containing bio components in the fuel system during storage. Fuel properties degradation may cause damages and lead to premature failure of fuel system components.

4.2.2 Procedure

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

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

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

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

⚠ WARNING

High Noise Level

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

Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

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

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

Failure to follow these instructions may invalidate the warranty and may result in reduced reliability. Please contact your local factory representative for more details.

1. Follow the proper starting procedure to start the generator set.
2. Bring the generator set to rated speed with no load.
3. Operate the generator set until the coolant temperature reaches 160° F (70° C).
4. Follow the proper procedure to turn off the generator set.
5. Follow the necessary lock-out-tag-out procedures to ensure the generator does not start.
6. Drain the engine oil from the oil sump.
7. Install the drain plug and fill the engine to the high mark with the Tectyl™ 915W40, or equivalent engine preservative oil.
8. Disconnect the inlet fuel line to the engine fuel filter.
9. Disconnect the injector fuel return line.

NOTICE

Refer to the fuel consumption specifications to determine the amount of fuel required to run the engine for 25 minutes.

10. Put both fuel lines in the container of bio-free diesel fuel.
11. Follow the proper starting procedure to start the generator set.
12. Once the engine is operating smoothly, transfer the fuel supply line to the container of the Daubert Chemical NoxRust No. 518 or equivalent preservative oil outlined in the ***Required Materials Section.***
13. Operate the generator at idle for 25 minutes to ensure the engine preservative oil and the fuel system preservative is fully distributed.

NOTICE

Dispose of the mixed fuel in accordance with local regulations.

14. Follow the proper procedure to turn off the generator set.
15. Follow the necessary lock-out-tag-out procedures to ensure the generator set does not start.

16. Re-connect both fuel lines.
17. Drain the preservative oil from the engine oil pan sump, oil filter and fuel filters.
18. Install the drain plug in the oil sump. The sump can remain empty until the engine is ready to put in a service application.
19. Remove the intake and exhaust manifolds.
20. Spray Tectyl™ 511-M or equivalent into the intake and exhaust ports in the cylinder heads and in the manifolds.

NOTICE
Do NOT spray Tectyl™ 511-M or equivalent preservative oil on the intake manifold or any fuel system components as this may permanently damage sensors or valves.

21. Brush or spray Tectyl™ 511-M or equivalent on all the exposed surfaces that are not painted. Preservative oil should not be applied to any plastic, rubber or similar surfaces. Make sure to coat the flywheel, flywheel housing and all other unpainted machined surfaces with this preservative oil.
22. Remove the rocker lever covers.
23. Spray Tectyl™ 511-M or equivalent onto the rocker levers, valve stems, springs, valve guides, crossheads and push rods.
24. Install the covers.
25. Remove camshaft inspection covers.
26. Spray Tectyl™ 511-M or equivalent onto the camshaft.
27. Install the covers.
28. For components containing exposed bearings that are not easily accessible (e.g. fan hubs), remove the component to aid access. Brush or spray Tectyl™ 511-M or equivalent on all surfaces that are not painted and refit the component.
29. Remove any external drive belts to prevent localized stretching and deformation.
30. If the generator set will remain in storage for 24 months or more, the cooling system must be drained.

NOTICE
If the storage period will be less than 24 months, and if it meets Cummins coolant specifications for anti-freeze with anti-corrosion inhibitor, then it is not necessary to drain the coolant.

NOTICE
The engine cooling system must be drained and flushed with a suitable solvent or a hot, lightweight mineral oil after each 24-month period.

31. Place a warning tag on the generator stating "**Engine Does NOT Contain Oil**" and "**Do NOT Operate.**"
32. Store the generator set in a clean, dry, vibration free and climate controlled area.
33. Place silicon gel packs in the following areas.
    - Generator control panel
    - Intake manifold

- Exhaust manifold

4.2.3 Additional Steps

NOTICE
For two bearing alternators, decouple the alternator from the engine. For single bearing machines, do not decouple.

NOTICE
Do not rotate the engine during long term storage.

NOTICE
If the two bearing alternator is decoupled, rotate only the alternator 6 complete revolutions every 4 weeks. For single bearing machines, do not rotate

- Leave the alternator anti-condensation heaters in operation. If power to the heaters is unavailable, then place multiple silica desiccant gel packs in the core of the alternator at both ends of the rotor and in the terminal box.
- Place multiple silica desiccant gel packs on the outside of the generator at, or near the following areas:
  - Intake/exhaust manifolds
  - Generator set control panel
  - ECM's
  - Alternator entrance box

NOTICE
The amount of silica desiccant gel packs required and the replacement interval for the silica gel packs will vary based on manufacturer and the environment the generator is exposed to. Follow manufacturer guidelines for replacement intervals and to determine the amount needed. Moisture indicating gel packs will better determine when the replacements need to occur. Inspect the silica gel packs once a month.

- If necessary, disconnect the generator set batteries. Follow the manufacturer's storage procedures to store the batteries.
- Cover all openings with heavy paper or plastic and tape to prevent dirt and moisture from entering the engine/alternator.
- Place a warning tag on the generator set stating there are silica desiccant gel packs at the locations placed.
- Wrap the generator set in a corrosion inhibiting plastic such as Zerust.

4.2.4 Returning the Generator Set to Service

1. Remove the protective paper and plastic coverings.
2. Remove all silica desiccant gel packs.

3. For alternators with re-greasable bearings:
    - If the alternator has been rotated during the storage period and has been in storage between 6 and 24 months, re-grease the bearings during the first run. Follow the recommended re-greasing procedure found in the specific alternator service manual.
    - If the alternator has not been rotated during the storage period and has been in storage for a period longer than 12 months, replace the bearings. Follow the recommended re-replacement procedure found in the specific alternator service manual.
4. For alternators with sealed for life bearings:
    - If the alternator has been rotated during the storage period and has been in storage for a period longer than 24 months, replace the bearings. Follow the recommended replacement procedure found in the specific alternator service manual.
    - If the alternator has not been rotated during the storage period and has been in storage for a period longer than 12 months, replace the bearings. Follow the recommended replacement procedure found in the specific alternator service manual.
5. For two bearing machines, recouple the alternator to the engine if necessary.
6. For the alternator, carry out the "pre-running" checks as detailed in the specific alternator model service manual to determine the condition of the windings.
7. Flush the engine preservative oil out of the engine by removing the plug from the main engine oil rifle and pumping a hot, lightweight mineral oil through it. Make sure that the engine crankshaft is barred at least 3 to 4 revolutions during this flushing procedure.
8. Drain all the mineral oil that was used to flush the engine clean and the engine preservative oil.
9. Install the drain plugs.
10. If necessary fill or flush/fill the cooling system:
    - If the generator set has been in storage for less than 24 months and if the cooling system was drained, fill the cooling system with new coolant.
    - If the generator set has been in storage for 24 months or more, the cooling system must be drained and flushed with a suitable solvent or a hot, lightweight mineral oil.
    - If the generator set has been in storage for less than 24 months and the cooling system has an extended life coolant with a rust inhibitor, then drain and fill the cooling system with new coolant.
11. Fill and install new oil, fuel and coolant filters.
12. Fill the oil pan sump.
13. If necessary, re-connect the generator set batteries.
14. Prime the lubricating system using the main oil rifles of the engine.
15. Reinstall any belts that were removed.

NOTICE
The engine may run unstable until the fuel system is completely primed, or until the preservative fluid is completely flushed out of the fuel system.

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5 Troubleshooting

5.1 Locking the Generator Set Out of Service

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

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

5.1.1 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.

5.2 Troubleshooting - General

5.2.1 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.

5.2.2 Safety Considerations

⚠ WARNING

Hazardous Voltage

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

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

⚠ WARNING

Combustible Gases

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

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

⚠ WARNING

Automated Machinery

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

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

Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review the safety precautions in the Important Safety Instructions section.

High voltages are present when the generator set is running. Do not open the generator set output box while the generator set is running.

NOTICE

Disconnect the battery charger from the AC source before disconnecting the battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the generator set.

When troubleshooting a generator set that is shut down, make certain the generator set cannot be accidentally restarted as follows:

1. Make sure the generator set is in the Off mode.
2. Turn off or remove AC power from the battery charger.

3. Using an insulated wrench, remove the negative (−) battery cable from the generator set starting battery.

5.2.3 InPower Service Tool

The InPower™ service tool can be used in troubleshooting to perform tests, verify control inputs and outputs, and test protective functions. Refer to the InPower User's Guide, provided with the InPower software for test procedures.

InPower, when used improperly, can cause symptoms like warnings and shutdowns that appear to be a defective base board. When these problems occur, always verify that a self-test or fault simulation (override) have not been left enabled with InPower. If you do not have InPower, or the enabled fault simulation(s) cannot be found using InPower, disconnect battery power to disable the test or override condition.

Make sure that parameter adjustments and time delays, related to the fault condition, have been appropriately set for the application. It may be necessary to write the initial capture file to the device or update the calibration file.

Updating a calibration file requires the InPower Pro version. Confirm that the installed calibration part number matches the serial plate information.

NOTICE
Using the wrong calibration file can result in equipment damage. Do not swap base boards from another generator set model.

Some features are not available until the hardware for that feature is installed and InPower Pro is used to update (enable) that feature. Confirm that the feature is installed and enabled prior to troubleshooting the base board for symptoms related to a feature.

5.2.4 Network Applications and Customer Inputs

In applications with networks and remote customer inputs, the generator set may start unexpectedly or fail to crank as a result of these inputs. These symptoms may appear to be caused by the base board. Verify that the remote input is not causing the symptom or isolate the control from these inputs before troubleshooting the control.

5.2.5 Test Equipment

To perform the test procedures in this manual, the following test equipment must be available:

- True RMS digital multi-meter for accurate measurement of resistance, AC voltage (0-1000 VAC), and DC voltage.
- Current probe(s).
- Battery hydrometer.
- Jumper leads.
- Tachometer.
- Megger or insulation resistance meter.
- InPower service tool (PC-based service tool)
- InSite Tool
- Newest InPower InCal files (calibration for control) from the InCal web site (**power.cummins.com** under “Services", “Software Updates", “InCal Quick Links").

- PC-based service tool connector (Cummins Part number 0541-1199).
- Inline 4 / Inline 5 adapter or newer (Cummins Part number 0491-8416).
- Inline 4 / Inline 5 drivers (available via kit or online at **cummins.com/parts-and-service/electronic-service-tools/inline**).
- Basic electrical test lead set, with very small probe tips. Fluke test leads “TL80A" (part number 0541-1627) are recommended.
- 316289800 - Pressure/Temperature sensor breakout cable
- 382477400 - Pressure sensor breakout cable
- 382477600 - Pressure sensor breakout cable
- 316475200 - DanfossTM pressure sensor breakout cable TM pressure sensor breakout cable
- 382275800 - Male Deutsch/AMP/Metri-Pack test lead
- 382291700 - Female Deutsch/AMP/Metri-Pack test lead
- 382481200 - Deutsch socket pin test lead
- 382481100 - Deutsch pin test lead

5.2.6 Voltage/Continuity Testing

Voltage and continuity tests are required in the following tables. In some cases, it is necessary to remove a plug to complete the test.

The following corrective actions will mention when it is necessary to remove a plug for testing. In other cases, the plug must not be removed for testing. When plug removal is not mentioned, testing must be performed by inserting a narrow meter probe into the back of the plug.

5.2.7 CT Ratio Calculator

InPower has a built-in CT ratio calculator which allow you to determine the required CT size and CT ratio.

The following generator set information is required to calculate the CT ratio:

- Generator set power ratings
- Frequency range
- Nominal frequency
- Nominal voltage Limits
- Secondary CT ratio value

Follow these steps to use the CT ratio calculator in InPower.

1. Connect to the PCC and highlight any of the folders under the PCC connection (such as Advanced Status). Right click on the folder, and click on Genset OEM Setup...

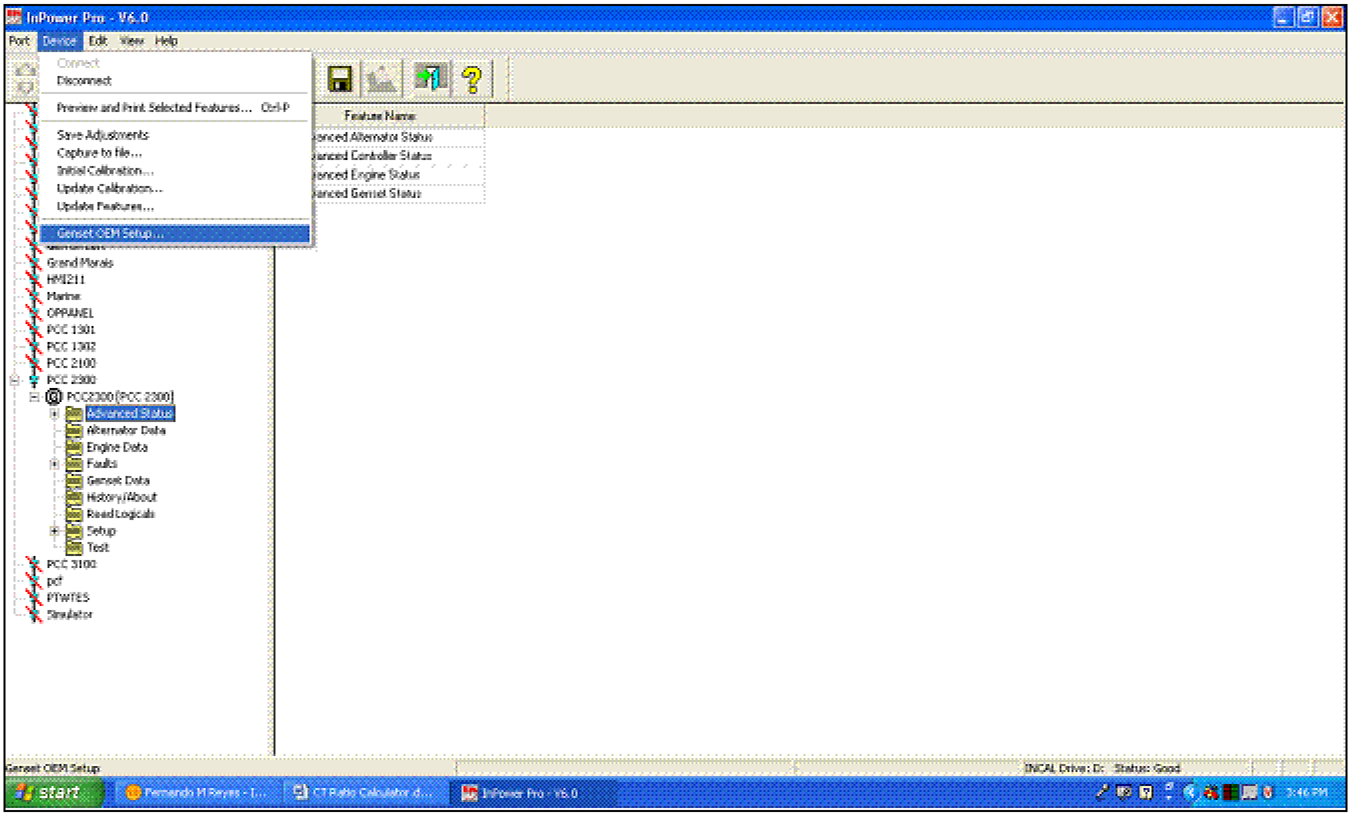


FIGURE 1. INPOWER - GENSET OEM SETUP SELECTION

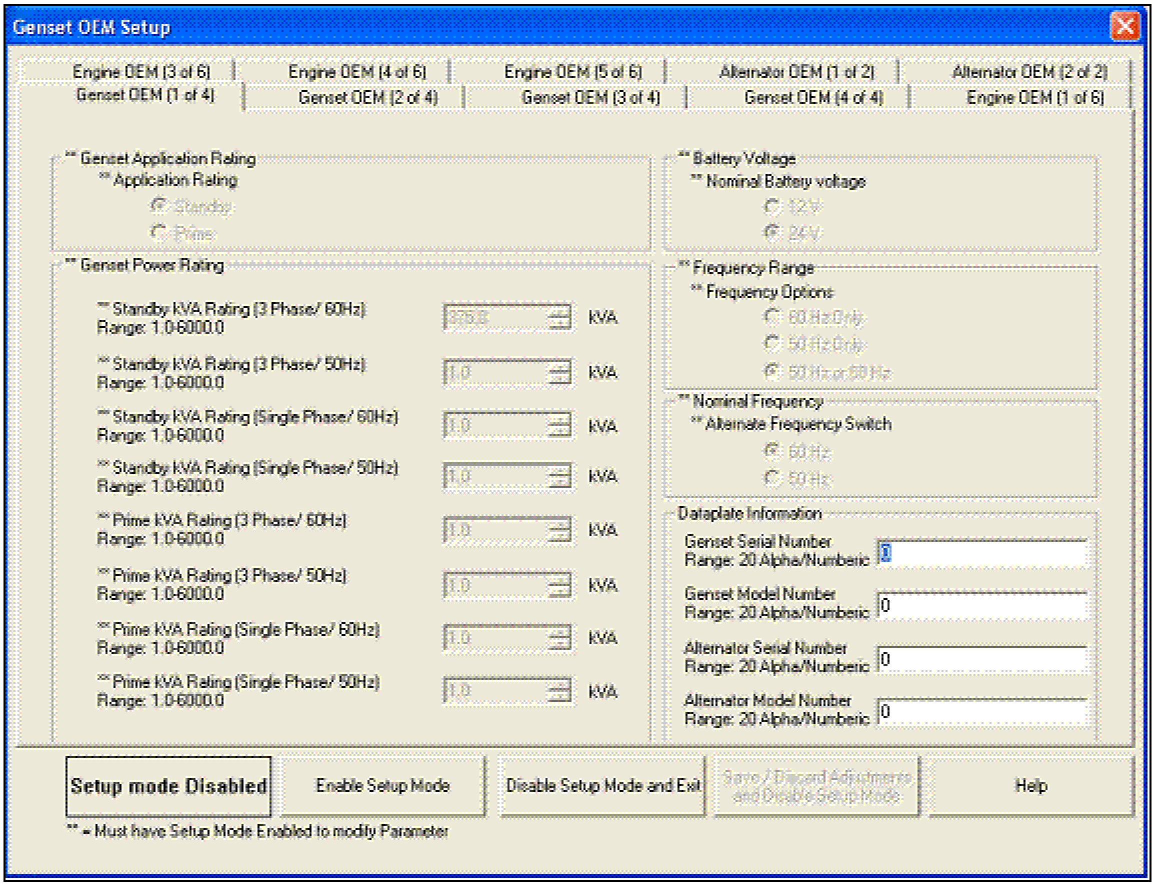


FIGURE 2. GENSET OEM SETUP WINDOW

2. Click on Enable Setup Mode in order to enable the menu.
3. Enter the generator set information under Genset Power Ratings, Frequency Range, and Nominal Frequency.
4. Click on Save/Discard Adjustments and Disable Setup Mode in order to save the generator set settings. This step is required.

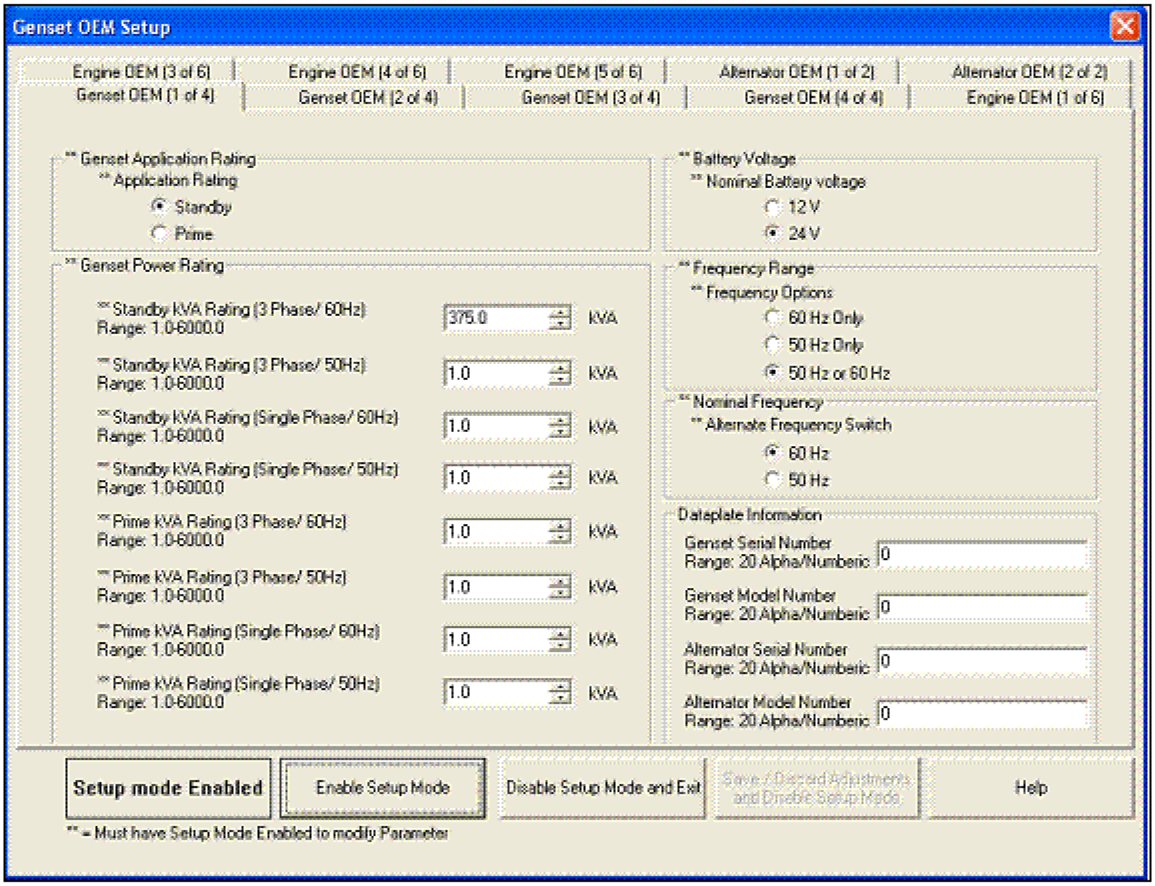


FIGURE 3. GENSET OEM SETUP WINDOW - ENABLE SETUP MODE

5. Open the Genset OEM Setup again.
6. Click on the Alternator OEM (1 of 2) tab to display the settings below.

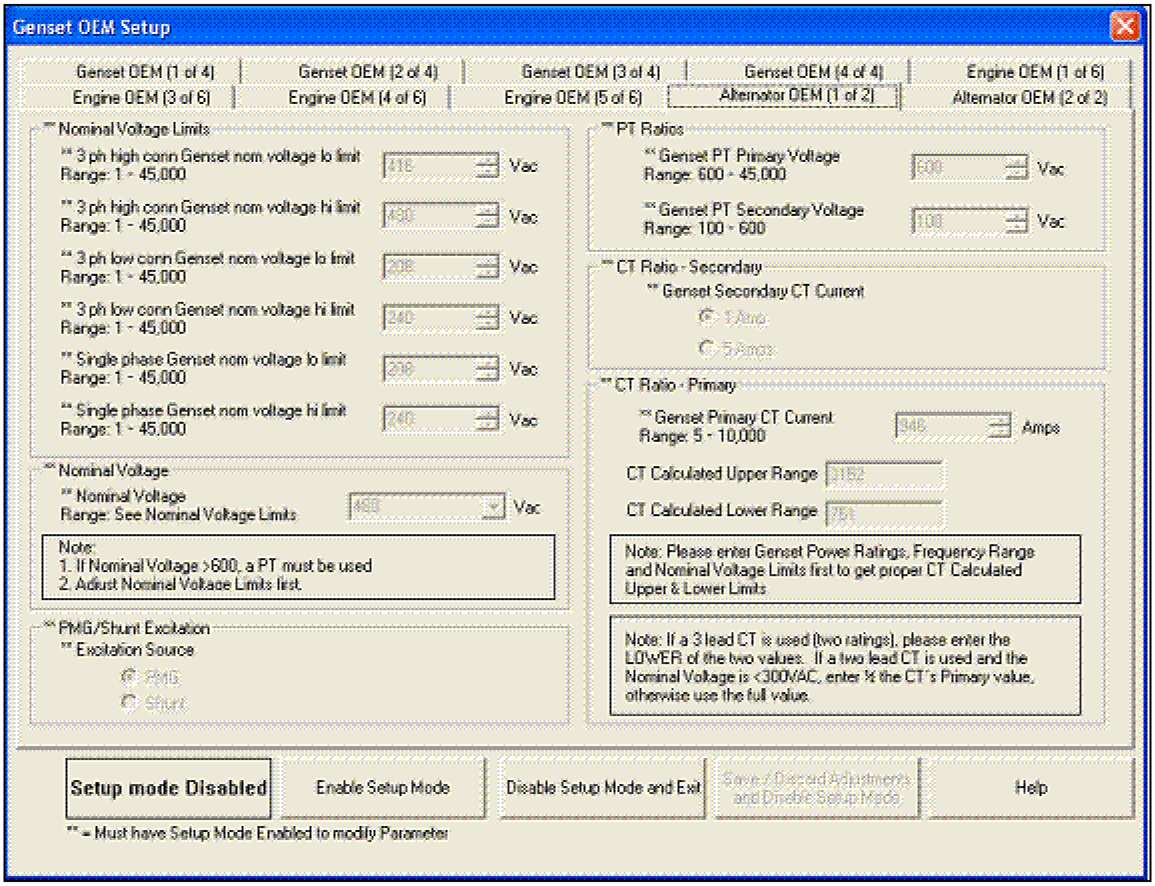


FIGURE 4. GENSET OEM SETUP WINDOW - OEM (1 OF 2)

7. Click on Enable Setup Mode in order to enable the menu.

8. Enter the generator set information under Nominal Voltage Limits and CT Ratio –Secondary. After all the information is entered, InPower will calculate the required Genset Primary CT Ratio limits. The primary CT Ratio needs to be between the CT Calculated Upper Range and the CT Calculated Lower Range.

   The CTs and the CT ratio setting in the PCC require a primary CT ratio between the CT Calculated Upper Range and the CT Calculated Lower Range.

   The alternator CT ratio is required to have a secondary CT Ratio equal to the setting under the CT Ratio – Secondary.

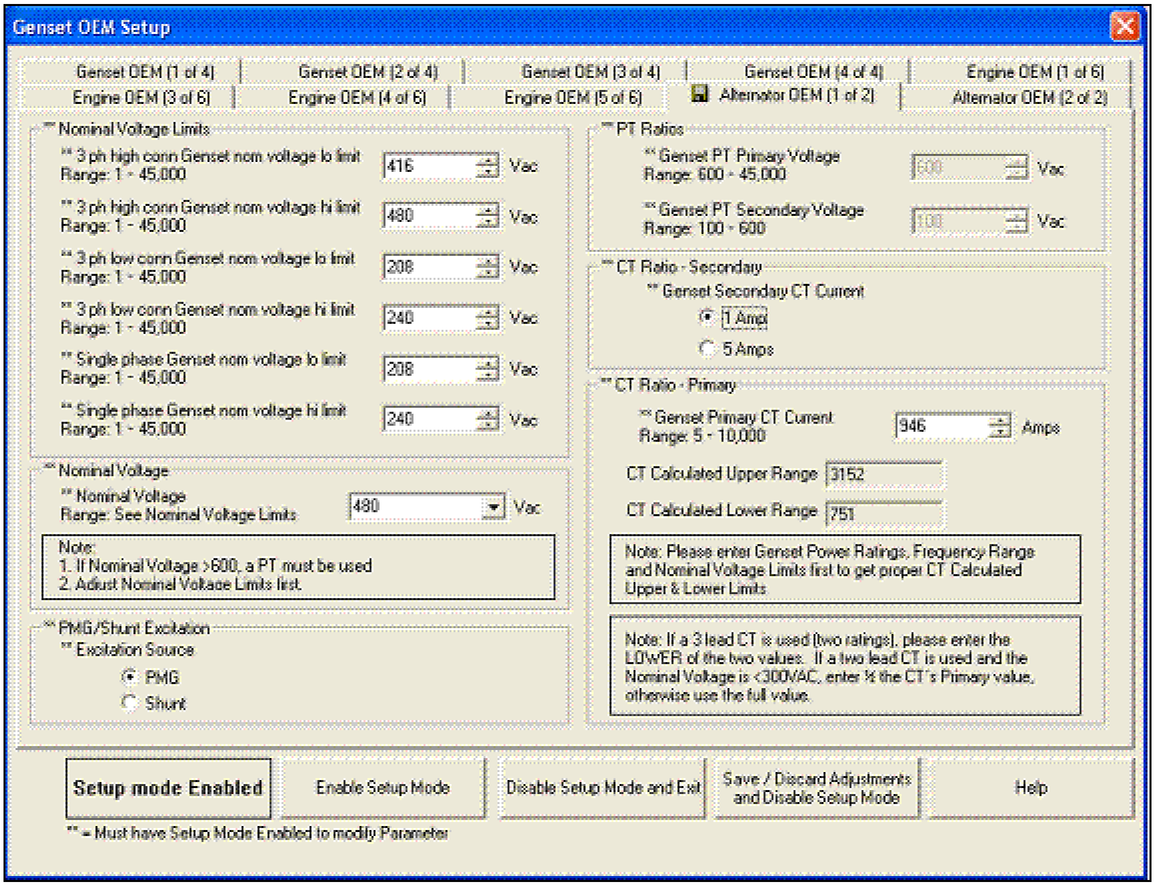


FIGURE 5. OEM (1 OF 2) NOMINAL VOLTAGES

9. To exit the setup mode and save changes, click on Save / Discard Adjustments and Disable Setup Mode.

   To exit the setup mode without saving changes, click on Disable Setup Mode and Exit. Then, click on Discard when the Save Adjustments Screen pops up.

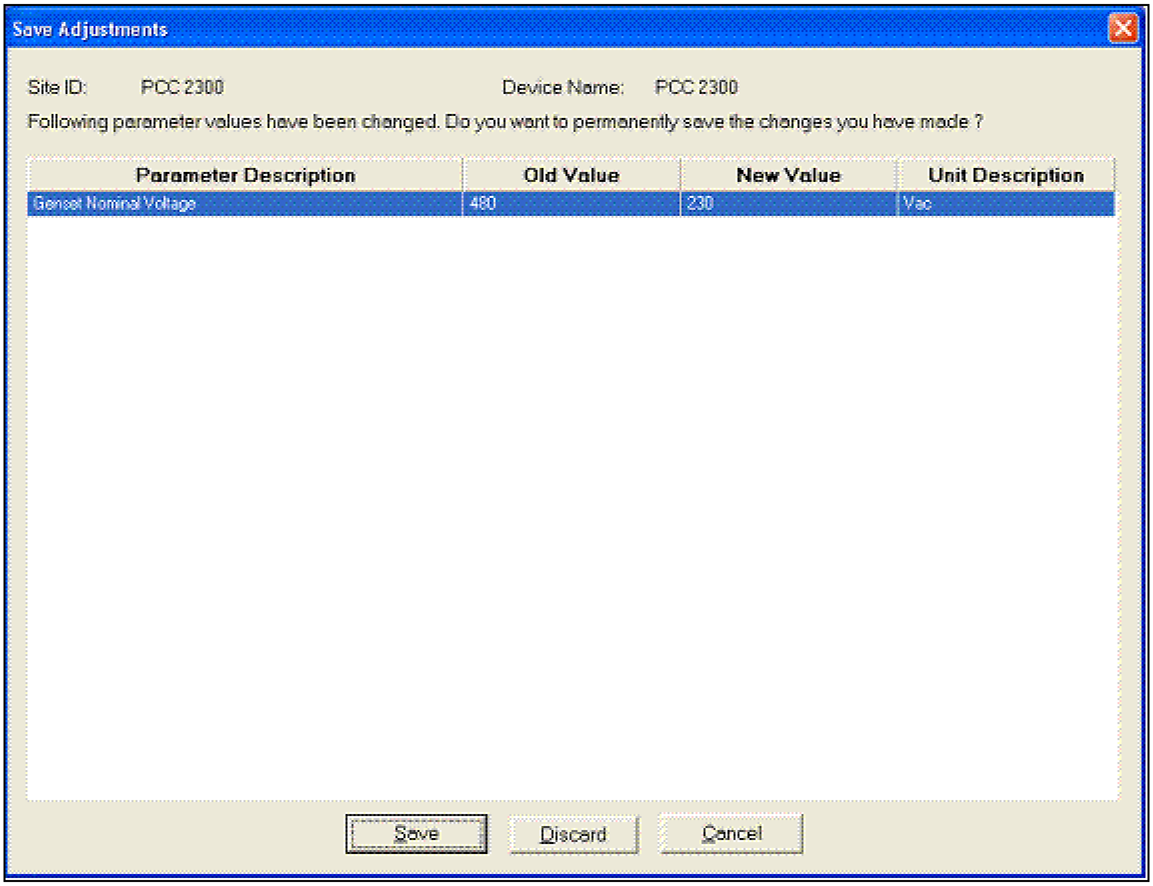


FIGURE 6. SAVE ADJUSTMENTS WINDOW

5.2.8 Reading Fault Codes

When a fault occurs, the graphical display on the HMI will display the fault code/message.

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.

5.2.9 Troubleshooting Procedures

The following list of troubleshooting procedures are a guide to help you evaluate problems with the generator set. You can save time if you read through the manual ahead of time and understand the system.

NOTICE

Always set the generator set to off mode before disconnecting or connecting harness connectors. Otherwise, disconnecting the harness connectors can result in voltage spikes high enough to damage the DC control circuits of the set.

NOTICE

Electrostatic discharge will damage circuit boards. Always wear a wrist strap when handling circuit boards or when disconnecting or connecting harness connectors. See the *Circuit Board Removal/Replacement* procedure in the controller Service Manual.

NOTICE
The troubleshooting procedures for ECM-related faults and engine-related faults are in the engine service manual.

NOTICE
Each fault code “warning" can be changed to a “shutdown" using InPower. Default settings are used in this manual. It is recommended that all changes to settings be recorded at each site to aid in the troubleshooting of the generator set.

If you are troubleshooting a fault that does not appear in the graphical display, look at the SA field in the Faults screens to identify the source of the fault. If this field is blank, the PCC is the source of this fault.

Try to think through the problem. Go over what was done during the last service call. The problem could be as simple as a loose wire, an opened fuse, or a tripped circuit breaker.

This section contains the following information:

- How to troubleshoot a local/remote failure to crank problem when the control panel does not indicate any fault condition.
- How to troubleshoot engine problems that are not within the detectable range of the PC control.
- How to troubleshoot a Check Engine lamp fault for generator sets that contain the low emissions option.
- Descriptions of each status, warning, and shutdown code; warning and shutdown limits where applicable; and basic corrective actions, such as checking fluid levels, control reset functions, battery connections, etc.
- Detailed troubleshooting procedures. In the following list of troubleshooting procedures, the fault codes are arranged in numeric order.

5.2.10 Fault Reset Signal

This signal may come from any of these sources:

- PCC Fault Reset connection (typically, the Reset button on the Operator Panel)
- Reset button on the Operator Panel
- Modbus networks
- PC-based service tool, such as InPower

This signal becomes active for one second when any of these sources changes from inactive to active. Then, the signal remains inactive until any of these sources changes from inactive to active again.

5.2.11 Delayed Shutdown

The PCC provides advance warning of an impending shutdown if all of these conditions are met:

- *Delayed Shutdown Enable* is set to Enable.
- The ECM is set to enable Battle Short mode (Core 2 ECMs only).
- A non-critical shutdown fault occurs, and there are no critical shutdown faults.

When these conditions are met, the PCC generates warning fault 1124 (Delayed Shutdown) and waits *Delayed Shutdown Time Delay* before it initiates the stop sequence.

5.3 Troubleshooting Fault Codes

5.3.1 Types of Events/Faults

The PCC generates these types of events/faults.

5.3.2 Event/Fault List Definition

Faults and events that appear in the table that do not have a troubleshooting procedure in this manual are engine driven faults/events. To troubleshoot these faults, consult the engine Service manual, engine Troubleshooting and Repair manual, and/or QuickServe OnLine.

5.3.3 Events

The PCC generates events to notify external devices when certain conditions are met. The PCC may send notifications any of these ways:

- Configurable outputs.
- PCCNet devices (For example, events might control a LED or a configurable output on a PCCNet device.)

It is up to the external devices to respond to an event when they are notified about one. Events do not appear in any screen in the Operator Panel.

5.3.4 Warning Faults

The PCC generates warning faults to warn the operator when unsafe conditions are occurring.

When the PCC generates a warning fault, the warning fault becomes active. However, active warning faults have no effect on generator set operation. The generator set can start, continue running, and stop as usual.

Active warning faults appear in the Warning Faults screen. In addition, the PCC provides these indications as long as there is an active warning fault:

- The Warning LED on the Operator Panel is on.
- Event 1540 (Common Warning) is active.
- Event 1483 (Common Alarm) is active.

Follow these steps to clear a warning fault.

1. Correct the condition(s) that caused the fault.
2. Activate the fault reset signal.

Faults that have been cleared appear in the Fault History screen.

5.3.5 Derate Events

Derate events are warning faults in which the PCC also requests a reduction in the kW output level of the generator set.

If a derate event is active, *Derate Request* (This Parameter is not available in the Operator Panel, refer to parameters table) is the percentage of the current kW output level the PCC would like to have removed. Each derate event has this percentage associated with it. If two or more derate events are active at the same time, the PCC considers only the maximum percentage requested by each derate event. The PCC does not add the percentages together. For example, if one derate event requests a 10% reduction and a second derate event requests a 20% reduction, *Derate Request (This Parameter is not available in the Operator Panel, refer to parameters table)* is 20%, not 30%.

The PCC is running in Load Govern paralleling state, the PCC requests that *Genset % Standby Total kW* be no more than 100% - *Derate Request (This Parameter is not available in the Operator Panel, refer to parameters table)*. This becomes a limitation for *Load Govern kW Target*.

If the PCC is not running in Load Govern paralleling state, the PCC generates warning fault 1464 (Load Dump Fault). If *Load Dump/Configurable Output #11 Output Function Pointer* is set to Default, the Load Dump connection is active. The PCC does not do anything else to reduce the kW output level. It is up to external devices to reduce the load.

If *LBNG Genset Enable* is set to Enable, the PCC recognizes derate requests from the engine control module (ECM) only if all of these conditions are met.

- *LBNG Derate Enable* is set to Enable.
- The AUX101's Derate Authorization connection is active.

5.3.6 Shutdown Faults

The PCC generates shutdown faults to prevent damage to the generator set. The PCC shuts down the generator set immediately.

When the PCC generates a shutdown fault, the shutdown fault becomes active. The PCC initiates a Shutdown Without Cooldown sequence.

Active shutdown faults appear in the Shutdown Faults screen. In addition, the PCC provides these indications as long as there is an active shutdown fault:

- The Shutdown LED on the Operator Panel is on.
- Event 1541 (Common Shutdown) is active.
- Event 1483 (Common Alarm) is active.

You cannot start the generator set until you clear the shutdown fault. Follow these steps to clear a shutdown fault.

1. Correct the condition(s) that caused the fault.
2. Make sure the emergency stop buttons are inactive, and change the PCC to Off mode.

NOTICE
If Remote Fault Reset Enabled is set to Enable, you can also clear shutdown faults in Auto mode. In this case, change the PCC to Auto mode , and make sure the exercise signal and the remote start signal are inactive. The PCC generates event 2941 (Remote Shutdown Fault Reset Occurrence) when shutdown faults are reset in Auto mode.

3. Activate the fault reset signal.

Faults that have been cleared appear in the Fault History screen.

5.3.6.1 Shutdown with Cooldown Faults

Shutdown with cooldown faults are shutdown faults in which the PCC has time to cool down the generator set.

When the PCC generates a shutdown with cooldown fault, the shutdown with cooldown fault becomes active. If the PCC is running in Load Govern paralleling state, it initiates a Manual Stop sequence and starts running the load govern kW ramp unload process. If the PCC is not running in Load Govern paralleling state, it initiates a Controlled Shutdown sequence. When the stop sequence has finished, the PCC generates shutdown fault 1336 (Cooldown Complete).

If a shutdown with cooldown fault is active and the engine speed is greater than zero, warning fault 1132 (Controlled Shutdown) is active. You can assign this event/fault to a configurable output, so that the PCC notifies an external device that is going to shut down the generator set.

In other ways, shutdown with cooldown faults are the same as shutdown faults.

5.3.6.2 Critical Shutdown Faults vs. Non-critical Shutdown Faults

The PCC always shuts down the generator set when a critical shutdown fault is generated. Non-critical shutdown faults do not prevent the PCC from starting or running the generator set when Battle Short mode is active. The PCC also responds to critical shutdown faults and non-critical shutdown faults differently if Delayed Shutdown is set up.

NOTICE
This discussion applies to shutdown with cooldown faults as well as shutdown faults.

The table below identifies the critical shutdown faults.

TABLE 14. CRITICAL SHUTDOWN FAULTS

Event/Fault Code	Description
115	Eng Crank Sensor Error
234	Crankshaft Speed High
236	Both Engine Speed Signals Lost
359	Fail To Start
781	CAN Data Link Failure
1245	Engine Shutdown Fault
1247	Unannounced Engine Shutdown
1336	Cooldown Complete
1433	Local Emergency Stop
1434	Remote Emergency Stop
1438	Fail To Crank
1992	Crankshaft Sensor High
2335	AC Voltage Sensing Lost (Excitation Fault)
2914	Genset AC Meter Failed

All other shutdown faults are non-critical shutdown faults. The PCC still provides the usual indications that a shutdown fault has occurred, even if it overrides a non-critical shutdown fault.

5.3.7 Fault Codes

This table identifies the faults codes and events that the PCC can generate depending on its configuration.

NOTICE

InPower can be used to raise the response/severity of an event or fault. For example, an event can be changed to a warning fault or a warning fault to a shutdown fault. The response/severity of an event or fault (except event/fault 1452 (Genset Breaker Fail to Close)) cannot be set lower than its default value, and the severity cannot be changed of any fault or event with an asterisk (**).

Codes marked with * are generator related fault codes. For all other codes for the possible cause, failure and diagnosis refer to the relevant engine service manual.

TABLE 15. FAULT CODES

Code	Event/Lamp	Displayed Message
111	Shutdown	Internal ECM Failure
115	Shutdown	Eng Crank Sensor Error
118	Warning	Fuel Pressure OOR High
119	Warning	Fuel Pressure Sensor OOR Low
121	Shutdown	Loss of Speed Sense
122	Warning	Manifold 1 Press High
123	Warning	Manifold 1 Press Low
124	Warning	Manifold 1 Press High
135	Warning	High Oil Rifle 1 Pressure
141	Warning	Low Oil Rifle 1 Pressure
143	Warning	Low Oil Rifle Pressure
144	Warning	High Coolant 1 Temp
145	Warning	Low Coolant 1 Temp
146	Warning	Pre-High Engine Coolant Temperature
151	Shutdown	High Coolant Temp
153	Warning	High Intake Manf 1 Temp
154	Warning	low Intake Manf 1 Temp
155	Shutdown	High Intake Manf 1 Temp
187	Warning	Sensor Supply 2 Low
195	Warning	High Coolant 1 Level
196	Warning	Low Coolant 1 Level
197*	Warning	Low Coolant Level
212	Warning	High Oil 1 Temperature
213	Warning	Low Oil 1 Temperature
214	Shutdown	High Oil 1 Temp
219	Warning	Eng Oil Level Remote Reservoir: Least Severe Level

Code	Event/Lamp	Displayed Message
221	Warning	Air Pressure Sensor High
222	Warning	Air Pressure Sensor Low
223	Warning	Oil Burn Valve Sol Low
224	Warning	Oil Burn Valve Sol High
227	Warning	Sensor Supply 2 Low
228	Shutdown	Low Coolant Pressure
231	Warning	High Coolant Pressure
232	Warning	Low Coolant Pressure
233	Warning	HT Coolant Pressure Moderate Low
234*	Shutdown	Crankshaft Speed High
235*	Shutdown	Low Coolant Level
236*	Shutdown	Both Engine Speed Signals Lost
238	Warning	Sensor Supply 3 Low
239	Warning	Main Supply High
245	Warning	Fan Control Low
254	Shutdown	FSO PWM High Control Error
255	Warning	FSO PWM Low Control Error
259	Warning	Engine Fuel Shutoff Valve Stuck Open
261	Warning	High Fuel Temperature
263	Warning	High Fuel 1 Temperature
265	Warning	Low Fuel 1 Temperature
266	Shutdown	High Fuel Temperature
271	Warning	Low Fuel Pump Press
272	Warning	High Fuel Pump Press
277	Warning	Fuel Control Valve Out of Adj
281	Warning	Cylinder Press Imbalance
284	Warning	Eng Speed/Position Sensor: Voltage Below Normal
285	Warning	CAN Mux PGN Rate Error
286	Warning	CAN Mux Calibration Error
287	Warning	CAN Mux Accel Data Error
295	Warning	Key On Air Pressure Error
311	Warning	ACT1 FF Shorted HS TO LS Error
312	Warning	ACT5 Shorted HS TO LS Error
313	Warning	ACT3 RF Shorted HS TO LS Error

Code	Event/Lamp	Displayed Message
314	Warning	ACT6 Shorted HS TO LS Error
315	Warning	ACT2 FT Shorted HS TO LS_Error
319	Warning	RTC PWR Intr: Data Erratic Intermittent or Wrong
321	Warning	ACT4 RT Shorted HS TO LS Error
322	Warning	Inj 1 Solenoid Low Curr
323	Warning	Inj 5 Solenoid Low Curr
324	Warning	Inj 3 Solenoid Low Curr
325	Warning	Inj 6 Solenoid Low Curr
331	Warning	Inj 2 Solenoid Low Curr
332	Warning	Inj 4 Solenoid Low Curr
341	Warning	Engine Control Module Data Lost
342	Shutdown	Calibration Code Fail
343	Warning	ECM Hardware Failure
351	Warning	Injector Supply Failure
352	Warning	Sensor Supply 1 Low
359*	Shutdown	Fail to Start
378	Warning	Elect Fuel Inj Cntrl Valve Ckt: Curr Below Normal
379	Warning	Elect Fuel Inj Cntrl Valve Ckt: Curr Above Normal
386	Warning	Sensor Supply 1 High
394	Warning	Eng Timing Actuator Driver: Curr Below Normal
395	Warning	Eng Timing Actuator Driver: Curr Above Normal
396	Warning	Fuel Cntl Valve Solenoid Driver 2 Sensor Ckt: OC
397	Warning	Fuel Cntl Valve Solenoid Driver 2 -
398	Warning	Eng Timing Actuator Driver 2 Circuit: OC
399	Warning	Eng Timing Actuator Driver 2: Grounded Ckt
415	Shutdown	Low Oil Rifle Press
418	Warning	High H2O in Fuel
419	Warning	Intake Manifold Pres Bank Imbalance: Data Erratic
421*	Warning	High Oil Temperature
422	Warning	Coolant Level Data Error
425	Warning	Oil Temperature Error
426*	Event	J1939 Datalink: Data Erratic/Intermittent/Wrong
427*	Warning	CAN Data Link Degraded
433	Warning	Intake Manifold Press Sensor Ckt: Data Erratic

Code	Event/Lamp	Displayed Message
435	Warning	Oil Pressure Switch Error
441*	Warning	Low Battery 1 Voltage
442*	Warning	High Battery 1 Voltage
449	Shutdown	Inj Metering 1 Press High
451	Warning	Inj Metering 1 Press High
452	Warning	Inj Metering 1 Press Low
482	Warning	Fuel Press Low: Valid But Below Normal: Mod Severe
488*	Warning	High Intake Manf 1 Temp
496	Warning	Eng Speed Sensor 2 Supply Volt: Root Cause Unknown
546	Warning	Fuel Delivery Press High
547	Warning	Fuel Delivery Press Low
553	Warning	APC Pressure High
554	Warning	APC Pressure Error
556	Shutdown	Crankcase Pressure High
559	Warning	Inj Metering 1 Press Low
611*	Warning	Engine Hot Shut Down
686	Warning	Turbo 1 Speed Incorrect
689	Warning	Crankshaft Speed Error
697	Warning	ECM Temperature High
698	Warning	ECM Temperature Low
731	Warning	Crankshaft Mech Misalign
757	Warning	All Persistent Data Lost Error
778	Warning	EPS Backup Lost Sync Error
781*	Shutdown	CAN Data Link Failure
782	Warning	SAE J1939 Data Link 2 Engine Network No Data Received – Condition Exists
783	Shutdown	Intake Manf 1 Rate Error
1117	Warning	Power Lost With Ignition On
1121*	Warning	Fail To Disconnect
1122*	Event	Rated To Idle Delay
1123*	Shutdown	Shutdown After Battle Short (Shutdown)
1124*	Warning	Delayed Shutdown
1131*	Warning	Battle Short Active
1132*	Warning	Controlled Shutdown

Code	Event/Lamp	Displayed Message
1139	Warning	UFD Injector 1 Error
1141	Warning	UFD Injector 2 Error
1142	Warning	UFD Injector 3 Error
1143	Warning	UFD Injector 4 Error
1144	Warning	UFD Injector 5 Error
1145	Warning	UFD Injector 6 Error
1219*	Warning	Utility Breaker Tripped
1223*	Warning	Utility Frequency
1224*	Warning	Genset Overvoltage
1225*	Warning	Genset Undervoltage
1226*	Warning	Genset Frequency
1243*	Warning	Engine Derated
1244*	Shutdown	Engine Normal Shutdown
1245*	Shutdown	Engine Shutdown Fault
1246*	Warning	Unknown Engine Fault
1247*	Shutdown	Unannounced Engine Shutdown
1248*	Warning	Engine Warning
1256	Warning	Ctrl Mod ID In State Error
1257	Shutdown	Ctrl Mod ID In State Fail
1312*	Event	Configurable Input # 2
1317*	Event	Configurable Input # 13
1318*	Event	Configurable Input # 14
1322*	Warning	kW Load Setpoint OOR High
1323*	Warning	kW Load Setpoint OOR Low
1324*	Warning	kVAR Load Setpoint OOR High
1325*	Warning	kVAR Load Setpoint OOR Low
1328*	Warning	Genset Breaker Tripped
1336*	Shutdown	Cooldown Complete
1357	Warning	Oil Remote Level Low
1363	Warning	Intake Manf 1 Press Low
1367	Warning	High Prefilter Oil Press
1368	Warning	Low Prefilter Oil Press
1376	Warning	Camshaft Speed Error
1411	Warning	High Out Freq Adjust Pot

Code	Event/Lamp	Displayed Message
1412	Warning	High Droop Adjust Pot
1416*	Warning	Fail To Shutdown
1417*	Warning	Power Down Failure
1418	Warning	High Gain Adjust Pot
1427	Warning	Overspeed Relay Error
1428	Warning	LOP Relay Error
1429	Warning	HET Relay Error
1431	Warning	Pre-LOP Relay Error
1432	Warning	Pre-HET Relay Error
1433*	Shutdown	Local Emergency Stop
1434*	Shutdown	Remote Emergency Stop
1435*	Warning	Low Coolant Temperature
1438*	Shutdown	Fail To Crank
1439*	Warning	Low Day Tank Fuel Switch
1441*	Warning	Low Fuel Level
1442*	Warning	Weak Battery
1443*	Shutdown	Dead Battery
1444*	Warning	Overload
1445*	Shutdown	Short Circuit
1446*	Shutdown	High AC Voltage
1447*	Shutdown	Low AC Voltage
1448*	Shutdown	Under Frequency
1449*	Warning	Over Frequency
1451*	Warning	Gen/Bus Voltages Out of Calibration
1452*	Warning	Genset Breaker Fail To Close
1453*	Warning	Genset Breaker Fail To Open
1454*	Warning	Genset Breaker Position Contact
1455*	Warning	Utility Breaker Position Contact
1456*	Warning	Bus Out Of Synchronizer Range
1457*	Warning	Fail To Synchronize
1458*	Warning	Sync Phase Rotation Mismatch Overfrequency
1459*	Shutdown	Reverse Power
1461*	Shutdown	Loss of Field (Reverse kVAR)
1463**	Event	Not In Auto

Code	Event/Lamp	Displayed Message
1464**	Warning	Load Dump Fault
1465**	Event	Ready To Load
1469*	Warning	Speed/Hz Mismatch
1471*	Warning	Over Current
1472*	Shutdown	Over Current
1475*	Warning	First Start Backup
1483*	Event	Common Alarm
1517	Shutdown	Failed Module Shutdown
1518	Warning	Failed Module Warning
1519	Warning	At Least One Module Has: Least Severe Fault
1540*	Event	Common Warning
1541*	Event	Common Shutdown
1548	Warning	Inj 7 Solenoid Low Curr
1549	Warning	Inj 8 Solenoid Low Curr
1551	Warning	Inj 7 Solenoid Low Curr
1552	Warning	Inj 7 Solenoid Low Curr
1553	Warning	Inj 7 Solenoid Low Curr
1554	Warning	Inj 7 Solenoid Low Curr
1555	Warning	Inj 7 Solenoid Low Curr
1556	Warning	Inj 7 Solenoid Low Curr
1557	Warning	Inj 7 Solenoid Low Curr
1573*	Event	Configurable Input #1
1597	Warning	ECM Device/Component
1622	Warning	Inj 9 Solenoid Low Curr
1689*	Warning	Real Time Clock Power
1695	Warning	Sensor Supply 5 High
1696	Warning	Sensor Supply 5 Low
1794*	Shutdown with Cooldown	Fire Detected
1843	Warning	Crankcase Press High
1844	Warning	Crankcase Press Low
1845	Warning	H2O In Fuel Sens High
1846	Warning	H2O In Fuel Sens Low
1847*	Shutdown w/Cooldown	Eng Coolant Temp - Shutdown w/Cool

Code	Event/Lamp	Displayed Message
1852*	Warning	Pre-High H2O In Fuel
1853*	Warning	Annunciator Input 1 Fault
1854*	Warning	Annunciator Input 2 Fault
1855*	Warning	Annunciator Input 3 Fault
1866	Warning	EGR DP Autozero Error
1891	Warning	Change Oil
1893	Warning	CAN EGR Valve Comm
1894	Warning	CAN VGT Comm Error
1895	Warning	EGA DL Mismatch Error
1896	Warning	EGR DL Valve Stuck
1899	Warning	Low EGR Dif Pressure
1911	Warning	Inj Metering 1 Press High
1912*	Warning	Utility Loss Of Phase
1913*	Warning	Genset Loss Of Phase
1914*	Warning	Utility Phase Rotation
1915*	Warning	Genset Phase Rotation
1916*	Event	Sync Check OK
1917*	Warning	Fuel Level High
1918*	Shutdown	Fuel Level Low
1933	Warning	High EGR Data Link Volt
1934	Warning	Low EGR Data Link Volt
1935	Warning	EGR DL Cmd Source Err
1942	Warning	THD AZ Error
1944*	Warning	HMI 113 Out Config Error
1961	Warning	High EGR DL EDU Temp
1974	Warning	Crankcase Press High
1978*	Warning	Speed Bias OOR Hi
1979*	Warning	Speed Bias OOR Lo
1992*	Shutdown	Crankcase Sensor High
1999*	Warning	Maximum Parallel Time
2185	Warning	Sensor Supply 4 High
2186	Warning	Sensor Supply 4 Low
2215	Warning	Fuel Pump Press Low
2249	Warning	APC 2 Pressure Low

Code	Event/Lamp	Displayed Message
2261	Warning	Fuel Pump Press High
2262	Warning	Fuel Pump Press Low
2265	Warning	High Fuel Lift Pump Volt
2266	Warning	Low Fuel Lift Pump Volt
2272	Warning	EGR DL POS Sensor Error
2273	Warning	EGR Delta P OOR High Error
2274	Warning	EGR Delta P OOR Low Error
2292	Warning	APC Flow high
2293	Warning	APC Flow Low
2311	Warning	EFI Control Valve Fail
2328*	Event	Utility Available
2331*	Warning	Utility Undervoltage
2332*	Event	Utility Connected
2333*	Event	Genset Connected
2335*	Shutdown	AC Voltage Sensing Lost (Excitation Fault)
2336*	Shutdown	Bad Checksum
2342*	Warning	Too Long In Idle
2349	Warning	EGR DL Motor Open Error
2351	Warning	EGR DL Motor Short Error
2357	Warning	EGR DL Motor Lock Error
2358*	Warning	Utility Overvoltage
2359	Warning	EGR Delta P IR High Error
2375	Warning	EGR Orifice TMPTR OOR High Error
2376	Warning	EGR Orifice TMPTR OOR Low Error
2377	Warning	High Fan Control Voltage
2396*	Warning	Utility Breaker Fail To Close
2397*	Warning	Utility Breaker Fail To Open
2448	Warning	Coolant Level Moderately Low
2539*	Warning	High Voltage Bias
2541*	Warning	Low Voltage Bias
2544	Shutdown w/Cooldown	Over Temperature (ECM Internal temperature Data valid but above normal operational range Most severe level)
2545*	Warning	Keysw Reset Required
2555	Warning	Low GHC 1 Voltage

Code	Event/Lamp	Displayed Message
2556	Warning	High GHC 1 Voltage
2619*	Warning	Aux101 0 Input 1 Fault
2621*	Warning	Aux101 0 Input 2 Fault
2622*	Warning	Aux101 0 Input 3 Fault
2623*	Warning	Aux101 0 Input 4 Fault
2624*	Warning	Aux101 0 Input 5 Fault
2625*	Warning	Aux101 0 Input 6 Fault
2626*	Warning	Aux101 0 Input 7 Fault
2627*	Warning	Aux101 0 Input 8 Fault
2628	Warning	Aux102 0 Expansion Input 9 Fault
2629	Warning	Aux102 0 Expansion Input 10 Fault
2631	Warning	Aux102 0 Expansion Input 11 Fault
2632	Warning	Aux102 0 Expansion Input 12 Fault
2653*	Warning	Exhaust St 2 Temp High
2657*	Warning	Exhaust St 1 Temp High
2661	Shutdown	At Least One Unacknowledged Most Severe Fault 0 Condition Exists
2662	Warning	At Least One acknowledged: Most Severe Fault
2677*	Shutdown	Fail to Stop (Shutdown)
2678*	Warning	Charging Alternator Fail
2693*	Warning	Speed Bias OOR
2694*	Warning	Alternator RTD OOR
2727	Warning	Critical CEN Not Accessible Error
2729*	Warning	IO Module Lost
2731*	Shutdown	IO Module Lost
2738	Warning	Ether INJ Low CTRL Error
2739	Warning	Ether INJ High CTRL Error
2774	Warning	EGR DP Clogged Tubes Error
2779*	Event	Utility Unloaded Event
2814*	Shutdown	Genset CT Ratio Low
2815*	Warning	Genset CT Ratio High
2816*	Shutdown	Genset PT Ratio Low
2817*	Warning	Genset PT Ratio High
2818*	Warning	Bus PT Ratio Low
2819*	Warning	Bus PT Ratio High

Code	Event/Lamp	Displayed Message
2821*	Warning	Utility PT Ratio Low
2822*	Warning	Utility PT Ratio High
2882*	Warning	Aux101 1 Input 1 Fault
2883*	Warning	Aux101 1 Input 2 Fault
2884*	Warning	Aux101 1 Input 3 Fault
2885*	Warning	Aux101 1 Input 4 Fault
2886*	Warning	Aux101 1 Input 5 Fault
2887*	Warning	Aux101 1 Input 6 Fault
2888*	Warning	Aux101 1 Input 7 Fault
2889*	Warning	Aux101 1 Input 8 Fault
2891*	Warning	Aux102 1 Expansion Input 9 Fault
2892*	Warning	Aux102 1 Expansion Input 10 Fault
2893*	Warning	Aux102 1 Expansion Input 11 Fault
2894*	Warning	Aux102 1 Expansion Input 12 Fault
2895*	Warning	PCCNet Device Failed
2896*	Shutdown	Critical PCCNet Dev Fail
2897*	Warning	Factory Memory Block Corrupt
2898*	Warning	Periodic or Fault Memory Block Corrupt
2899*	Warning	User Memory Block Corrupt
2911*	Warning	Trim Memory Block Corrupt
2914*	Shutdown	Genset AC Meter Failed
2915*	Warning	Gen Bus AC Meter Failed
2916*	Warning	Utility AC Meter Failed
2917*	Warning	Gen Bus Voltage OOR Hi
2918*	Warning	Utility Voltage OOR Hi
2919*	Warning	Utility Current OOR Hi
2921*	Warning	Gen Bus Current OOR Hi
2922*	Warning	High Genset Neutral Curr
2923*	Warning	Gen Bus kW OOR Hi
2924*	Warning	Gen Bus kVAR OOR Hi
2925*	Warning	Gen Bus kVA OOR Hi
2926*	Warning	Utility kW OOR Hi
2927*	Warning	Utility kVAR OOR Hi
2928*	Warning	Utility kVA OOR Hi

Code	Event/Lamp	Displayed Message
2931*	Shutdown	Aux101 Device ID Fault
2934*	Warning	High Ambient Temp
2935*	Warning	Low Ambient Temp
2936*	Warning	Fuel Level High
2937*	Warning	Fuel Level Low
2938*	Warning	Earth/Ground Fault
2939*	Warning	Modbus Failure
2941*	Event	Remote Shutdown Fault Reset Occurrence
2942*	Warning	Shutdown Override Fail
2943*	Warning	Manual Sw Config Fail
2944*	Warning	Auto Switch Config Fail
2945*	Warning	Rupture Basin Switch
2946*	Warning	Exhaust St 2 Temp Low
2947*	Warning	Exhaust St 1 Temp Low
2948*	Warning	Exhaust St 2 Temp High
2949*	Warning	Exhaust St 1 Temp High
2951*	Warning	Alternator 1 Temp High
2952*	Warning	Alternator 1 Temp Low
2953*	Warning	Alternator 1 Temp High
2954*	Warning	Alternator 2 Temp High
2955*	Warning	Alternator 2 Temp Low
2956*	Warning	Alternator 2 Temp High
2957*	Warning	Alternator 3 Temp High
2958*	Warning	Alternator 3 Temp Low
2959*	Warning	Alternator 3 Temp High
2962	Warning	EGR RPM Derate Error
2965*	Event	Genset Available
2967*		Governor Fault
2968*		AVR Fault Failure and Diagnosis
2969*		LON Fault Failure and Diagnosis
2971*	Warning	Test/Exercise Fault
2972*	Shutdown	Field Overload
2973	Warning	Charge Press IR Error
2977*	Warning	Low Coolant Level 2 Sw

Code	Event/Lamp	Displayed Message
2978*	Warning	Low Intake Manf 1 Temp
2979*	Warning	High Alternator Temp Sw
2981*	Warning	High Drive Bearing Temp
2982*	Warning	Low Drive Bearing Temp
2983*	Warning	High Drive Bearing Temp
2984*	Warning	High Free Bearing Temp
2985*	Warning	Low Free Bearing Temp
2986*	Warning	High Free Bearing Temp
2992*	Warning	High Intake Manf 1 Temp
2993*	Warning	Battery Charger Sw Fail
3131*	Shutdown	Secondary Engine Overspeed
3226*	Event	Genset is paralleled to utility in base load operation
3397*	Shutdown	Low Gearbox Oil Pressure – Condition Exists
3398*	Shutdown	High Gearbox Oil Pressure – Condition Exists
3399*	Shutdown	Differential Fault – Condition Exists
3411*	Warning	DC Power Supply Fault – Condition Exists
3412*	Warning	GIB Isolator Open Fault – Condition Exists
3413*	Warning	Radiator Fan Trip Fault – Condition Exists
3414*	Warning	Ventilator Fan Trip Fault – Condition Exists
3415*	Warning	Louvres Closed Fault – Condition Exists
3416*	Warning	Start System Fault – Condition Exists
3417*	Warning	Alternator Heater Trip Fault – Condition Exists
3457*	Warning	Loss of Bus Voltage Sensing
3479*	Warning	Start-Inhibit Warning Fault Event
3481*	Warning	Start-Inhibit Warning Fault Event
3482*	Shutdown	Start-Inhibit Shutdown Fault
3483*	Shutdown	High Alternator Temperature 1 Shutdown Fault
3484*	Shutdown	High Alternator Temperature 2 Shutdown Fault
3485*	Shutdown	High Alternator Temperature 3 Shutdown Fault
3486*	Shutdown	High Drive End Bearing Temperature Shutdown Fault
3487*	Shutdown	High Non-Drive End Bearing Temp Shutdown Fault
3513*	Warning	Negative Sequence Overcurrent
3599*	Warning	Ground Current OOR Warning
3611*	Warning	Custom Overcurrent Fault

Code	Event/Lamp	Displayed Message
3629*	Warning	Device Calibration Update Recommended
3631*	Shutdown	Device Calibration Update Required
3641*	Shutdown	Start Enable1 Shutdown Fault
3642*	Shutdown	Start Enable2 Shutdown Fault
3643*	Warning	Start Enable3 Shutdown Fault
4358*	Warning	SetUp Mode Run Fault
4761*	Warning	Genset Voltage Sensing MCB Protection
4766*	Warning	Customer Gas Valve Close
4767*	Warning	Customer Gas Valve Close
4872*	Warning	System Network Failure
4873*	Warning	Genset Failed to Come Online
4874*	Warning	Load Demand SW Version Incompatibility
4875*	Warning	Genset Ineligible for Load Demand
4876*	Warning	Genset Lost on System Network
4877*	Warning	System Settings not Synchronized
4878*	Warning	Check System Network Installation
4879*	Warning	Load Demand Setup Error
4881*	Warning	System Genset ID Conflict
4882*	Warning	Genset Bus Overload
5135*	Warning	Overload Shutdown Fault
5145*	Warning	Load Demand Genset Bus Failure
9945	Warning	Injector 6 Circuit 2 Error
9946	Warning	Injector 5 Circuit 2 Error
9947	Warning	Injector 4 Circuit 2 Error
9948	Warning	Injector 3 Circuit 2 Error
9949	Warning	Injector 2 Circuit 2 Error
9951	Warning	Injector 1 Circuit 2 Error
9954*	Warning	Differential Fault
9955*	Warning	DC Power Supply Fault
9956*	Warning	GIB Isolator Fault
9957*	Warning	Radiator Dan Trip Fault
9958*	Warning	Vent Fan Trip Fault
9959*	Warning	Louvres Closed Fault
9960*	Warning	Start System Fault

Code	Event/Lamp	Displayed Message
9961*	Warning	Alt Heater Trip Fault
9971*	Warning	ECM Derate Fault
9973*	Warning	Watchdog Reset Fault

5.4 Alternator Performance Troubleshooting

5.4.1 No Voltage (No Load)

5.4.1.1 No Voltage (No Load) - Diagnosis and Repair

1. Faulty permanent magnet generator, stator or rotor
    - Disconnect the permanent magnet generator leads from automatic voltage regulator terminals P18-1, P18-2, and P18-3.
        - Check voltage across leads with a multimeter, with the set running at correct speed.
        - For 50 Hz, voltage should be approximately 160 to 180 VAC.
        - For 60 Hz, voltage should be approximately 190 to 210 VAC.
2. Use a multimeter to test the phase-to-phase resistance of the PMG stator windings . Resistance to be within 10% of expected value balanced across phases.
3. Insulation failure to earth (ground) on permanent magnet stator
    - Disconnect leads P18-1, P18-2, and P18-3 and, use insulation test meter to measure the resistance value of the insulation to earth (ground).
4. Voltmeter faulty
    - Check and verify voltage at generator output terminals with a multimeter.
5. Loose, broken, or corroded connections
    - Check all connections, repair and replace where necessary.
6. Automatic voltage regulator high excitation protection circuit activated, collapsing output voltage
    - Automatic voltage regulator protection circuit is factory set to trip at +70 VDC across automatic voltage regulator output, X+ (F1) and XX- (F2), after pre-set time delay.
        - Shut down the alternator, start and run alternator up again. If the voltage builds up normally but collapses again, the protection circuit has operated.
        - Run alternator again and check the excitation voltage across automatic voltage regulator output. If greater than 70 VDC, the protection circuit is operating correctly.
7. Varistor short circuit
    - Use a multimeter to test varistors on the main rotating rectifier assembly.
8. Main rectifier diodes short circuit
    - Check diodes.
        - Test diodes on the main rotating rectifier assembly with a multimeter.
9. Open circuit in exciter stator windings
    - Remove external leads from generator. Check the resistance value of the exciter stator across these two leads (approximately 18 to 30 ohms) with a multimeter. Refer to the procedure(s) in the troubleshooting and repair manual for the specific alternator for correct values.

10. Faulty automatic voltage regulator
    - Replace control board and re-test.
11. Winding fault, open circuit, or short circuit
    - Remove external leads from the alternator.
        - Use appropriate metering equipment (Wheatstone bridge or Kelvin bridge). Measure the low resistance winding of the main rotor and stator.

5.4.2 Low Voltage (No Load)

5.4.2.1 Low Voltage (No Load) - Diagnosis and Repair

1. Low engine speed, under frequency roll-off
    - Under frequency roll-off protection is activated, indicating low engine speed.
        - Troubleshoot and repair the engine performance issue.
2. Faulty voltage sensing
    - Use a multimeter to check and verify voltage at the generator set's output terminals.
    - Check voltage at the control board.
3. Automatic voltage regulator voltage adjustment trim configured incorrectly
    - Use the InPower service tool to adjust the nominal voltage parameter to the appropriate value for the application level.
4. Faulty automatic voltage regulator
    - Replace the control board and re-test.

5.4.3 High Voltage (No Load)

5.4.3.1 High Voltage (No Load) - Diagnosis and Repair

1. Automatic voltage regulator voltage adjustment trim is configured incorrectly
    - With the InPower service tool adjust nominal voltage parameter to the appropriate value for the application level.
2. Low sensing supply from main stator
    - Check sensing supply at all of leads of the alternator.
        - Open circuit or low sensing signal will cause the automatic voltage regulator to produce high excitation, this will produce a high output voltage.
3. Faulty automatic voltage regulator
    - Replace control board and re-test.

5.4.4 Unstable Voltage (No Load)

5.4.4.1 Unstable Voltage (No Load) - Diagnosis and Repair

1. Engine speed hunting (unstable)
    - Check with a frequency meter or InPower for speed variations due to hunting, or cyclic irregularities in the engine.
        - This may improve as load is applied.

2. Automatic voltage regulator parameters configured incorrectly
    - Adjust automatic voltage regulator gain and/or damping trims to the appropriate value(s).
        - Check again when loaded.
3. Loose or corroded connections
    - Repair or replace as necessary.
4. Intermittent earth (ground) on machine
    - Use insulation test meter to test all the windings including the exciter stator.
        - Low insulation resistance can affect the automatic voltage regulator.

5.4.5 Unbalanced Voltage (No Load)

5.4.5.1 Unbalanced Voltage (No Load) - Diagnosis and Repair

1. Fault in the main stator winding
    - Disconnect all external leads to the alternator and re-test.
        - Separately excite alternator by connecting DC battery supply to the exciter stator leads X+ (F1) and XX- (F2).
        - A winding short will get hot, and engine will sound slightly loaded.
        - Shut down the set and check by hand for hot spots.

5.4.6 Unbalanced Voltage (with Load)

5.4.6.1 Unbalanced Voltage (No Load) - Diagnosis and Repair

1. Fault in the main stator winding
    - Disconnect all external leads to the alternator and re-test.
        - Separately excite alternator by connecting DC battery supply to the exciter stator leads X+ (F1) and XX- (F2).
        - A winding short will get hot, and engine will sound slightly loaded.
        - Shut down the set and check by hand for hot spots.

5.4.7 Unstable Voltage (with Load)

5.4.7.1 Unstable Voltage (with Load) - Diagnosis and Repair

1. Engine governing hunting (unstable)
    - Use InPower to check for engine hunting, or cyclic irregularities in the engine.
2. Leading power factor load created by power factor correction capacitors
    - Isolate the power factor correction capacitors until sufficient motor load has been applied to counteract the leading power factor.
3. Non-linear loads causing interaction between dynamic closed loop control systems
    - The interaction of the alternator and the engine closed loop systems controls the load.
        - Instability is caused by oversensitive control settings.
        - Reduce automatic voltage regulator gain (stability).

4. Fluctuations in load current (motor starting or reciprocating loads)
    - Check the load current on a stable supply (i.e., mains) or separately excite the machine.
        - A variable DC supply is required for on load separate excitation tests.
5. Automatic voltage regulator parameters configured incorrectly
    - With the InPower service tool, adjust AVR control parameters until the voltage is stable.

5.4.8 Poor Voltage Regulation (with Load)

5.4.8.1 Poor Voltage Regulation (with Load) - Diagnosis and Repair

1. Unbalanced load
    - Check voltage and load current on all phases.
        - If unbalanced, redistribute the load more evenly across the phases.
2. Automatic voltage regulator parameters configured incorrectly
    - With the InPower service tool, adjust automatic voltage regulator control parameters until voltage is stable.
3. Voltage drop between alternator and load, caused by losses in supply cable (power losses)
    - Check the voltage at both ends of the cable run at full load.
        - Large differences in voltages indicate a large volts drop along the cable.
        - A larger diameter cable is required in severe cases.
4. Fault on main rectifier or excitation winding
    - Check the no load excitation voltage across automatic voltage regulator X+ (F1) and XX- (F2).
        - Voltage should be no higher than 12 VDC.
5. Under frequency roll-off protection activated
    - Under frequency roll-off protection is activated, indicating low engine speed.
        - Adjust or correct engine speed to an acceptable nominal.

5.4.9 Poor Response to Load Surges or Motor Starting (with Load)

5.4.9.1 Poor Response to Load Surges or Motor Starting (with Load) - Diagnosis and Repair

1. Engine performance
    - Check performance of the engine during application of load.
2. Load current surges significantly exceed the full load of the generator set
    - Use a clip-on ammeter to check surges.
        - Check with the factory for advice on voltage dips for motor starting.
3. Under frequency roll-off protection on automatic voltage regulator operational
    - Use InPower to monitor the load.
        - Low engine speed will activate the under frequency roll-off protection circuit.

4. Voltage drop between alternator and load caused by power losses in supply cable. This will be worse during current surges (motor starting, etc.).
    - Check the voltage at both ends of the cable run at full load.
        - Differences in voltages indicate a voltage drop along the cable.
        - A larger diameter cable may be required in severe cases.
5. Automatic voltage regulator gains set incorrectly
    - Automatic voltage regulator gain and/or damping trims to the appropriate value(s).
        - Check again when loaded.
6. Fault on windings or rotating rectifier
    - Check the no load excitation voltage across the automatic voltage regulator X+ (F1) and XX- (F2).
        - The voltage should be no higher than 12 VDC.
7. Fault in automatic voltage regulator
    - Replace the control board and re-test when loaded.

5.4.10 Voltage Collapses (with Load)

5.4.10.1 Voltage Collapses (with Load) - Diagnosis and Repair

1. Severe overload or short circuit on across phases
    - Use InPower or a clip-on ammeter to check load current.
2. AVR fault
    - Replace the control board and re-test it with load.

5.4.11 High Voltage (with Load)

5.4.11.1 High Voltage (with Load) - Diagnosis and Repair

1. Unbalanced load
    - Check voltage on all three phases. If it is unbalanced, re-distribute loading over the three phases.
2. Leading power factor
    - Check for capacitive (leading) PF load (i.e., kVA correction fluorescent lights).
        - Apply motor (lagging) PF load, or switch off capacitors.
        - A leading power factor load will give abnormally low DC excitation volts across X+ (F1) and XX-(F2).
3. Faulty automatic voltage regulator
    - Replace the automatic voltage regulator and re-test.

5.4.12 Low Voltage (with Load)

5.4.12.1 Low Voltage (With Load) - Diagnosis and Repair

1. Under frequency roll-off protection circuit operational
   - Under frequency roll-off protection is activated, indicating low engine speed.
     - Correct engine performance problems.
2. Faulty permanent magnet generator stator or rotor
   - Disconnect the permanent magnet generator leads from automatic voltage regulator terminals P18-1, P18-2, and P18-3.
     - Check voltage across leads with a multimeter, with the set running at correct speed.
     - For 50 Hz, voltage should be approximately 160 to 180 VAC.
     - For 60 Hz, voltage should be approximately 190 to 210 VAC.
3. Automatic voltage regulator faulty
   - Replace automatic voltage regulator and re-test.
4. Fault on winding or rotating diodes
   - Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2).
     - Remove external leads from the alternator.
     - Use appropriate metering equipment (Wheatstone bridge or Kelvin bridge). Measure the low resistance winding of the main rotor and stator.
     - Check diodes.
     - Test diodes on the main rotating rectifier assembly with a multimeter.
5. Voltage drop between alternator and load, due to power losses in the cable
   - Check the voltage at both ends of the cable run at full load.
     - Differences in voltage levels indicate a voltage drop along the cable.
     - In severe cases, a larger diameter cable is required.
     - This will be worse during current surges (motor starting and etc).

5.4.13 Alternator Troubleshooting - HC

5.4.13.1 Fault Finding

Before starting any fault finding procedure, examine all wiring for broken or loose connections. If in doubt, refer to the wiring diagram supplied with the alternator.

The following list is to aid in troubleshooting and is not exhaustive. If after completing the appropriate action the problem still persists refer to the Fault Finding manual or consult Cummins Generator Technologies Customer Service Department. For details of your nearest outlet or to refer to the Fault Finding Manual visit www.stamford-avk.com.

5.4.13.1.1 Without AVR in Alternator

NOTICE
Do the tests in order, unless stated otherwise. Do the method steps in order. Achieve results before doing the next step, unless the action (in bold) states otherwise.

TABLE 16. FAULTFINDING: WITHOUT AVR

TEST	METHOD		RESULT and ACTION
1 External Excitation	1	Disconnect the exciter stator positive X+ (F1) lead from the control board.	-
	2	Disconnect the exciter stator negative XX- (F2) lead from the control board.	-
	3	Test the resistance across the exciter stator winding between the positive and negative leads with a multimeter.	Resistance of the exciter stator winding is greater than minimum values (see **Section 6.3.1.12.8.3.1 on page 231**).
	4	Connect an external 24 V variable DC source to the exciter stator leads, positive to positive, negative to negative. Test the voltage.	The measured excitation is 12 VDC ±10% error.
	5	Test the phase-to-phase and phase-to-neutral voltage at output terminals. Adjust variable DC source.	The measured output is equal to the rated voltage (with same error as excitation), balanced across phases within 1%. Main & exciter stators, main & exciter rotors, and rectifier diodes are functioning correctly. **Go to Test 7 AVR Sensing and Power Supply.** If unbalanced by more than 1%, **go to Test 2 Main Stator.** If balanced within 1%, but output voltage is more than 10% below rated voltage, and **Test 3 *not*** yet done, **go to Test 3 Rectifier.** If balanced within 1%, but output voltage is more than 10% below rated voltage, and **Test 3** already done, **go to Test 4 Exciter Rotor.**
2 Main Stator	A fault in the main stator will produce short circuit currents between turns in the windings. Test for symptoms to confirm diagnosis.		
	1	Disconnect main stator leads to exclude external components from the test.	-
	2	Test phase to neutral resistances of the main stator windings with a micro ohmmeter.	Resistances of main stator windings are dissimilar, and/or less than the minimum values (see **Section 6.3.1.12.8.3.1 on page 231**)
	3	Run up the alternator within 4% of nominal speed, no load or excitation. Connect the battery to the exciter stator (see **Test 1**).	When a battery is connected to excite the alternator, a short circuit fault creates heat and a burning smell. Engine sound changes with extra slight loading.
	4	-	Repair or replace the faulty main stator winding.
	5	Re-connect the main stator leads.	**Go to Test 1 External Excitation.**

TEST		METHOD	RESULT and ACTION
3 Rectifier	1	Test the rectifier varistors (see **Section 6.3.1.12.6 on page 225**).	Both varistors are functioning correctly.
	2	Test the rectifier diodes (see **Section 6.3.1.12.6 on page 225**).	All diodes are functioning correctly. **Go to Test 1 External Excitation.**
4 Exciter Rotor	1	Inspect windings and insulation.	Windings are not burnt or damaged.
	2	Disconnect the 6 exciter rotor leads from the AC connection studs on the rectifier.	-
	3	Taking 3 leads that were connected to the same rectifier plate, test the phase-to-phase resistance, with a milliohm meter or micro ohmmeter.	Resistance of each phase pair is greater than minimum values (see **Section 6.3.1.12.8.3.1 on page 231**).
	4	Re-connect the exciter rotor leads.	**Go to Test 5 Main Rotor.**
5 Main Rotor	1	Disconnect a main rotor lead from the connection stud on one of the rectifier plates.	**-**
	2	Test the resistance across the main rotor winding between positive and negative leads, with a multimeter or milliohm meter.	Resistance of the main rotor is greater than the minimum value (see **Section 6.3.1.12.8.3.1 on page 231**).
	3	Re-connect the main rotor lead.	**Go to Test 6 Exciter Stator Insulation.**
6 Exciter Stator Insulation	Poor insulation of the exciter stator winding can affect AVR performance.		
	1	Test the electrical insulation of the exciter stator winding (see **Section 6.3.1.12.8 on page 230**)	Resistance of exciter stator winding to earth is greater than minimum value. **Go to Test 7 AVR Sensing and Power Supply.**
7 AVR Sensing and Power Supply	Output voltage is sensed at the AVR for closed loop control of the excitation voltage. The alternator wiring diagram shows how sensing leads at the output terminals are connected to the AVR, via transformers (as required). AVR power is also taken from the sensing leads or from a permanent magnet generator (PMG).		
	1	Disconnect the sensing and power supply(ies) from the AVR	-
	2	Follow the method of **Test 1** to run the alternator with excitation from a battery.	The alternator runs within 4% of rated speed, 10% of rated output voltage, balanced within 1% across phases.
	3	Test the sensing voltage feedback at the AVR terminals. Check the circuit between the output terminals and the AVR.	The measured voltage is within range (see **Section 6.3.1.12.8.3.1 on page 231**), balanced across phases. There are no wiring or transformer faults.
	4	Disconnect the battery, re-connect the AVR and run the alternator.	**See Faultfinding: Self-Excited AVR or Faultfinding: Separately-Excited AVR.**

5.4.13.1.2 Self-Excited AVR - OFF LOAD

TABLE 17. FAULT SYMPTOM: NO VOLTAGE (NO LOAD)

CAUSE	ACTION
Connections loose, broken or corroded.	1. Inspect all control board terminals. 2. Repair or renew where necessary.
No residual magnetism of the laminated steel core of the exciter stator. As the alternator starts, residual magnetism gives excitation to provide sufficient sensing voltage (at least 3.5 V) to power a self-excited AVR. Residual magnetism can be lost after the following: • Extended storage • Reversed magnetic field by "flashing" with wrong battery polarity • Exciter stator rewind • Mechanical shock	Restore magnetism: 1. Run the alternator at rated speed, no load. 2. Attach leads to a 12 VDC battery with a diode in one lead. 3. Briefly (maximum one second) connect positive lead to AVR terminal X+ (F1) and negative lead to AVR terminal XX- (F2). • NOTICE: The AVR will be destroyed if it is connected with the wrong polarity and no diode.
Poor electrical insulation of exciter stator	Test the insulation resistance of the exciter stator windings. See the Windings section.
Poor electrical insulation of main stator	Test the insulation resistance of the main stator windings. See the Windings section.
Short circuit of varistor on rotating rectifier	Test the varistors. See the Rectifier System section.
Short circuit of diode(s) on rotating rectifier	Test the diodes. See the Rectifier System section.
Winding fault. Open circuit or short circuit on any winding in the machine	Perform fault-finding without the AVR. See the Alternator Fault-Finding section (Without AVR).
AVR fault	Replace the AVR and re-test.
Load applied to machine during run up of engine	The voltage may not build up until the load is disconnected from the machine. Open the circuit breaker and re-test.
No power to AVR from main stator	Test the AVR sensing supply feedback. See the Alternator Fault-Finding section (Without AVR).

TABLE 18. FAULT SYMPTOM: LOW VOLTAGE (NO LOAD)

CAUSE	ACTION
Engine speed low	Troubleshoot and repair the engine performance issue.
Under frequency protection (UFRO) circuit activated	Use InPower to adjust the UFRO.
AVR fault	Replace the control board and re-test.
Loose broken or corroded connections	Inspect the wiring for poor connections. Repair or replace them where necessary.
Faulty power to AVR from main stator	Test the AVR sensing supply feedback. See the Alternator Fault-Finding section (Without AVR).

TABLE 19. FAULT SYMPTOM: HIGH VOLTAGE (NO LOAD)

CAUSE	ACTION
Voltage sensing input to AVR is open circuit or too low	Test the AVR sensing supply feedback. See the Alternator Fault-Finding section (Without AVR).
AVR fault	Replace control board and re-test.
Connections loose, broken or corroded	1. Inspect all auxiliary board terminals. 2. Inspect control board connections. 3. Repair or renew where necessary.

TABLE 20. FAULT SYMPTOM: UNSTABLE VOLTAGE (NO LOAD)

CAUSE	ACTION
Engine governor unstable (hunting)	Use InPower to check engine speed stability. Sometimes this problem will clear when load is applied.
AVR gains incorrectly set	Use InPower to adjust gains.
Connections loose or corroded	1. Inspect all auxiliary board terminals. 2. Inspect the control board connections. 3. Repair or renew where necessary.
Intermittent earth ground (low resistance of windings insulation)	Test the insulation resistance of all windings. See the Alternator Fault-Finding section (Without AVR).
AVR components broken or corroded	Replace control board and re-test

TABLE 21. FAULT SYMPTOM: UNBALANCED VOLTAGE (NO LOAD)

CAUSE	ACTION
Fault on main stator windings	Test the main stator windings. See the Alternator Fault-Finding section (Without AVR).

5.4.13.1.3 Self-Excited AVR - ON LOAD

TABLE 22. FAULTFINDING: SELF-EXCITED AVR - ON LOAD

SYMPTOM	CAUSE	ACTION
LOW VOLTAGE (ON LOAD)	Engine speed low	Troubleshoot and repair engine performance issues.
	Under frequency protection (UFRO) circuit activated	Use InPower to check UFRO.
	Fault in AVR power supply from main stator	Separately excite machine as described in Faultfinding without AVR. Test the voltage across AVR terminals P18-1, P18-2, and P18-3. The voltage should be between 190 to 240 V AC.
	AVR fault	Replace control board and re-test.
	Fault on winding or rotating diodes	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). If it is higher than the voltage table, see the Faultfinding without AVR section.
	Voltage drop between alternator and load due to I^2R losses in the cable; this will be worse during current surges (e.g., motor starting)	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
HIGH VOLTAGE (ON LOAD)	Unbalanced load	Test voltages on all phases. If unbalanced, re-distribute the loading between phases.
	Leading power factor load (capacitor banks)	Test excitation volts across X+, (F1) and XX- (F2). A leading power factor will give an abnormally low DC excitation. Remove the power factor correction capacitors from the system at low load.
UNSTABLE VOLTAGE (ON LOAD)	Engine governor unstable (hunting)	Use InPower to test engine speed stability.
	Leading power factor load created by power factor correction capacitors	Isolate the power factor correction capacitors until sufficient inductive load has been applied.
	Fluctuations in load current (motor starting or reciprocating loads)	Test the load current on a stable supply (i.e., mains) using a variable DC supply. See the Faultfinding without AVR section.
	Non-linear load creating waveform distortion. (Contact factory for further information on non-linear loads)	Use a Permanent Magnet Generator (PMG) powered AVR control system.
	AVR stability control incorrectly adjusted	Use InPower to adjust AVR gain until voltage is stable.

SYMPTOM	CAUSE	ACTION
UNBALANCED VOLTAGE (ON LOAD)	Single-phase loads (phase - neutral) unevenly distributed over the three phases	Test the current in each phase with a clamp ammeter. The full load rated current must not be exceeded on any individual phase. Redistribute the load if necessary.
POOR VOLTAGE REGULATION (ON LOAD)	Unbalanced load	Test the voltage and load current on all phases. If it is unbalanced, redistribute the load more evenly across the phases.
	Voltage drop between alternator and load due to I^2R losses in the cable; this will be worse during current surges (e.g., motor starting)	Test the voltage at both ends of the cable when running at full load. In severe cases, a larger diameter cable is required.
	Fault on rectifier or excitation winding	Test the no load excitation VDC across AVR X+ (F1) and XX- (F2). If it is higher than 12 VDC, see the Faultfinding without AVR section.
	AVR Under frequency protection circuit (UFRO) activated	Use InPower to check UFRO. Test speed with tachometer and adjust to the correct nominal speed or frequency.
POOR VOLTAGE RESPONSE TO LOAD SURGES OR MOTOR STARTING	Engine performance issues	Repair engine performance problems.
	AVR frequency protection (UFRO) activated	Use InPower to check UFRO.
	Load surges cause current to exceed 2.5 times the full load current	Test the current with a clamp ammeter. The voltage dip may be excessive if the current exceeds 2.5 times full load. Contact the factory for motor starting calculations.
	Voltage drop between alternator and load due to I^2R losses in the cable; this will be worse during current surges (e.g., motor starting)	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
	Motor contactors dropping out during starting (large current surges, voltage dips greater than 30%)	All causes and actions in this section may apply to this problem. Refer to factory for typical voltage dips.
	AVR gain incorrectly adjusted	Use InPower to adjust gain.
	Fault on windings or rotating rectifier	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). See the Faultfinding without AVR section.
	AVR fault	Replace the control board.

5.4.13.1.4 Separately-Excited AVR - OFF Load

TABLE 23. FAULTFINDING: SEPARATELY-EXCITED AVR - OFF LOAD

SYMPTOM	CAUSE	ACTION
NO VOLTAGE (NO LOAD)	Faulty permanent magnet generator (PMG), stator or rotor	Disconnect the PMG leads from AVR terminals P18-1, P18-2, and P18-3. Run the alternator at rated speed. Test the phase-to-phase voltage at P18-1, P18-2, and P18-3 leads of the PMG with an RMS measuring instrument. Measure voltage 170 to 195 VAC (at 50 Hz), 204 to 234 VAC (at 60 Hz), balanced within 5% across phases. Refer to the factory for the latest voltage ranges in design data specification DD-15590. Test the phase-to-phase resistance of the PMG stator windings with a multimeter. Resistance should be within 10% of the expected value balanced across phases. Replace or re-test according to the PMG Fault Diagnosis table below.
	Insulation failure to earth (ground) on PMG stator	Test the insulation resistance of PMG stator windings. See the Windings section.
	Panel voltmeter faulty	Test the voltage at alternator terminals with a multimeter.
	Connections loose, broken or corroded	Inspect the control board connections. Repair or replace where necessary.
	Short circuit of varistor on rotating rectifier	Test the varistors. See the Rectifier System section.
	Short circuit of diode(s) on rotating rectifier	Test the diodes. See the Rectifier System section.
	Open circuit in exciter stator windings	See the Faultfinding without AVR section.
	AVR fault	Replace the control board and re-test.
	Winding fault (open circuit or short circuit on any winding in the machine)	See the Faultfinding without AVR section.
LOW VOLTAGE (NO LOAD)	Engine speed low	Troubleshoot and repair engine performance issues.
	Under frequency protection (UFRO) circuit activated	Use InPower to check UFRO.
	AVR fault	Replace the control board and re-test.
HIGH VOLTAGE (NO LOAD)	Voltage sensing input to AVR is open circuit or too low	Test the AVR sensing supply feedback. See the Faultfinding without AVR section.
	Faulty AVR	Replace the control board and retest.
UNSTABLE VOLTAGE (NO LOAD)	Engine speed hunting (unstable)	Test engine speed stability with InPower. Sometimes this problem will clear when load is applied.
	AVR gain incorrectly adjusted	Use InPower to adjust gain.
	Connections loose or corroded	Inspect all control board connections.

SYMPTOM	CAUSE	ACTION
UNBALANCED VOLTAGE (NO LOAD)	Intermittent earth (ground) (low resistance of windings insulation)	Repair or renew where necessary.
		Test the insulation resistance of all windings. See the Faultfinding without AVR section.
	Fault in main stator winding	Test the main stator windings. See the Faultfinding without AVR section.

TABLE 24. PMG FAULT DIAGNOSIS

PMG Stator Voltage		PMG Stator Phase-to-Phase Resistance	
		In Range & Balanced	**Out of Range or Unbalanced**
In range	Balanced	No fault	Re-test resistance
	Unbalanced	Check connector	Replace PMG stator
Out of range	Balanced	Replace PMG rotor	Replace PMG stator
	Unbalanced	Check connector	Replace PMG stator

5.4.13.1.5 Separately-Excited AVR - ON Load

TABLE 25. FAULTFINDING: SEPARATELY-EXCITED AVR - ON LOAD

SYMPTOM	CAUSE	ACTION
LOW VOLTAGE (ON LOAD)	Engine speed low.	Troubleshoot and repair engine performance issues.
	Under frequency protection (UFRO) circuit activated	Use InPower to check UFRO.
	Faulty permanent magnet generator (PMG) stator or rotor	Disconnect the PMG leads from AVR terminals P2, P3, P4. Check voltage across leads with a Multimeter, with the set running at correct speed. For 50 Hz, the voltage across P2, P3 and P4 should be approximately 160 VAC – 180 VAC. For 60 Hz, the voltage is approximately 190 VAC – 210 VAC.
	AVR fault	Replace control board and re-test.
	Fault on winding or rotating diodes	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). See the Faultfinding without AVR section.
	Voltage drop between alternator and load, due to I^2R losses in the cable; this will worsen during current surges (e.g., motor starting)	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
HIGH VOLTAGE (ON LOAD)	Unbalanced load	Test the voltages on all phases. If unbalanced, re-distribute loading between phases.
	Leading Power Factor Load	Test the excitation volts across X+, (F1) and XX- (F2). A leading power factor will give an abnormally **low** DC excitation. Remove power factor correction capacitors from system at low load.
UNSTABLE VOLTAGE (ON LOAD)	Engine governing unstable (i.e., hunting)	Test and repair the engine performance issue.
	Leading power factor load created by power factor correction capacitors	Isolate the power factor correction capacitors until sufficient motor load has been applied.
	Non-linear loads causing interaction between dynamic closed loop control systems	Interaction of closed loop systems controlling the load, the alternator and the engine. Instability is caused by oversensitive control settings. Try different settings of AVR stability, including AVR gain.
	Fluctuations in load current (i.e., motor starting, or reciprocating loads)	Test the load current on a stable supply (i.e., mains) or using a variable DC supply. See the Faultfinding without AVR section.
	AVR gain incorrectly adjusted	Adjust AVR gain until the voltage is stable.

SYMPTOM	CAUSE	ACTION
UNBALANCED VOLTAGE (ON LOAD)	Single-phase loads (phase - neutral) unevenly distributed over the three phases	Test current in each phase with clamp ammeter. The full load rated current must **not** be exceeded on any individual phase. Redistribute the load if necessary.
POOR VOLTAGE REGULATION (ON LOAD)	Unbalanced load	Check voltage and load current on all phases. If unbalanced, redistribute the load more evenly across the phases.
	Voltage drop between alternator and load, caused by losses in supply cable (I^2R losses)	Test the voltage at both ends of the cable run at full load. In severe cases, a larger diameter cable is required.
	AVR gain incorrectly adjusted	Adjust the AVR gain until the voltage is stable.
	Fault on rectifier or excitation winding	Test the no load excitation volts across AVR X+ (F1) and XX- (F2). If higher than 12 VDC, see the Faultfinding without AVR section.
	Under frequency protection (UFRO) activated	Use InPower to check UFRO.
POOR VOLTAGE RESPONSE TO LOAD SURGES OR MOTOR STARTING	Engine governor sticking or slow to respond	Check the performance of the engine during application of load. Check if the AVR LED is lit during motor starting. Check if AVR "DIP" or "DWELL" circuits are activated. Adjust as necessary. See the AVR instruction sheet.
	AVR Under frequency protection (UFRO) protection activated	Use InPower to check UFRO or reduce load.
	Load surges cause current to exceed 2.5 times the full load current	Test the current with a clamp ammeter. The voltage dip may be excessive if the current exceeds 2.5 times full load. Contact the factory for motor starting calculations.
	Voltage drop between alternator and load, caused by I^2R losses in supply cable; this will worsen during current surges (e.g., motor starting)	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
	Motor contactors dropping out during starting (large current surges, voltage dips greater than 30%)	All causes and actions in this section may apply to this problem. Contact the factory for typical voltage dips.
	AVR stability control incorrectly adjusted	Set AVR stability control for optimum performance. Adjust anticlockwise until voltage is unstable, then slightly clockwise until stable.
	Fault on windings or rotating rectifier	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). If higher than 12 VDC, see the Faultfinding without AVR section.
	AVR fault	Replace the control board and re-test on load.

SYMPTOM	CAUSE	ACTION
VOLTAGE COLLAPSES (ON LOAD)	AVR fault	Replace the control board and re-test on load.
	Severe overload or short circuit across phases	Check the load current with a clamp ammeter.

5.4.13.1.6 Parallel Operation

TABLE 26. FAULTFINDING: PARALLEL OPERATION

SYMPTOM	CAUSE	ACTION
CIRCUIT BREAKER WILL NOT CLOSE WHEN ATTEMPTING PARALLEL OPERATION	Circuit breaker fitted with 'Check Synchronizing' protection, which prevents out of phase synchronizing.	Ensure that the synchroscope is indicating that machines are IN PHASE, or close to the eleven o'clock position, (when rotating in a clockwise direction). Ensure that the speed difference between the incoming set and the busbar is small enough to prevent rapid rotation of the synchroscope, (or rapid fluctuations of the lights), before closing circuit breaker.
	Phase rotation of alternators differs.	DO NOT ATTEMPT TO PARALLEL until the phase rotation of all alternators are identical. Check the phase rotation of each alternator. Exchange the connections of two of the phases to reverse the phase rotation of an alternator.
	Voltage difference too high between the incoming alternator and the busbar.	The voltage on the incoming set can be up to 4% higher than the bus bar voltage. THIS IS NORMAL. Do not adjust original no-load Voltage settings. If difference is greater than 4%, check for excessive droop on the loaded alternator(s).
UNSTABLE IN-PHASE CONDITION, BEFORE SYNCHRONIZING	Governor drift on one or more of the engines.	Let engines warm up and stabilize before paralleling. If speed is still drifting check governors and engine condition.
	Load variation on the busbar causing speed/ frequency changes on the loaded alternator when synchronizing.	Disconnect any rapidly varying load. Check that there is no likelihood of a motor or automatic load starting when attempting to synchronize. DO NOT attempt to parallel if the load current is unstable.

SYMPTOM	CAUSE	ACTION
UNSTABLE FREQUENCY IN PARALLEL WHEN ON LOAD	Engine speed droop too ‘tight’ or cyclic irregularities (instability) between the engines. (Check kW meters for rapid shifting of kW power between sets).	Increase the engine governor speed droop to 4% (no load to full load). Check for "sticky" governors on a new engine. Check engines for cyclic problems, (firing, out of balance, etc),
STABLE VOLTAGE BEFORE AND AFTER BUT UNSTABLE WHILE SYNCHRONIZING	Usually results from ‘pick- up’ through the synchronizing panel and/or earth leakage protection circuits that can form a temporary ‘closed loop’ link between the alternators during synchronisation.	The fluctuation will decay when the alternators approach synchronizm, (almost identical speeds), and will disappear completely when the circuit breaker is closed. The synchronizing equipment, earth leakage protection, and/or wiring circuits in the switchboard can produce temporary pickup problems.
CURRENT UNCONTROLLED, RISES FAST WHEN CIRCUIT BREAKER CLOSED	Parallel droop equipment reversed on one of the alternators.	Check the droop CTs for reversal. Reverse lead S1-S2 on the droop CT. Test excitation volts - the alternator with reversed droop will have highest excitation volts.
STABLE CIRCULATING CURRENT ON ALL ALTERNATORS, NOT REDUCED BY VOLTAGE ADJUSTMENT	Parallel droop reversed on ALL alternators.	Check droops for reversal. Reverse leads S1–S2 to correct. This repeated wiring error will result in a stable circulating current which cannot be adjusted out by normal means.
STABLE CIRCULATING CURRENT ON BOTH ALTERNATORS AT NO LOAD	Voltage difference (excitation level) between the alternators.	Check Voltages at no load, (identical frequencies), and ensure all alternators have identical voltages. Do not adjust when load sharing.
	Parallel droop equipment reversed on BOTH alternators. (Unlike ONE droop reversal, which is a highly UNSTABLE condition).	Check ALL droop CTs for reversal.
	Incorrect setting of parallel droop equipment.	Check settings of droop trimmers. Check droop CTs are in correct phase. Check CT output to AVR S1-S2 is correct.
UNBALANCED POWER ON KILOWATT METERS	Engines not sharing the power (kW) equally.	Adjust the governor droop of the engines to equalize the kilowatt sharing.
UNBALANCED CURRENT ON AMMETERS AFTER EQUILIZING KILOWATTS	Voltage difference (excitation levels) between the machines.	Test the machines individually for exact voltage at no load.
	Parallel droop equipment incorrectly adjusted.	Adjust as stated in previous text.

SYMPTOM	CAUSE	ACTION
UNBALANCED POWER AS LOAD INCREASED OR DECREASED	Engine governors are incompatible, or new governors 'sticking', causing unequal kW sharing over load range variations.	The engine governors must be adjusted to give similar no load to full load characteristics. Check for 'sticky' governors on new or repainted engines. Electronic governors should be set with a minimum 2% speed droop to ensure satisfactory kilowatt load sharing. If tighter speed regulation is required, an Isochronous Load Sharing system should be installed.
INCREASING UNBALANCED CURRENT AS LOAD INCREASED	Difference in parallel droop level settings. Difference in no load to full load voltage regulation of AVRs. These settings are the major contributing factors to the load/voltage characteristics of the machine, and therefore must be set to give equal characteristics to the machines with which it is paralleled.	Run each alternator individually, and apply load at approximately 25%, 50% & 100% of full load. Test voltage at each load and compare values with the other alternators. Adjust control systems to remove regulation differences. Repeat method with as much inductive load as possible i.e. motors, transformers etc. Adjust the parallel droop trimmers, to achieve equal inductive load sharing.
POOR VOLTAGE REGULATION WHEN MACHINE RUNNING ALONE	Excess amount of parallel droop in circuit.	For normal voltage regulation as a single running machine, a shorting switch should be fitted across the parallel droop transformer. (S1-S2). This should be clearly marked 'Single' and 'Parallel' operation on the panel.
UNBALANCED POWER, ENGINES 'ROCK' ON MOUNTS	Electronic engine governor speed 'droop' characteristics are set too tight.	At least 2% engine droop is essential for kW (Active current) sharing. If 1% or less speed regulation is required, an electronic governing and Isochronous Load Sharing system should be installed.

5.5 Annunciator Fault Codes

5.5.1 Fault Code 1853 - Annunciator Input 1 Fault

Customer fault 1 (input 1, LED 1) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #1 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #1" has been configured for; ex. if "Annunciator Input #1" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured or Wiring Issue

1. Customer input 1 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 1 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 1 Activation	Negative Input (ground input)	Positive Input (B+ input)
Inverting Active Hardware Signals	Don't Invert	Invert

Negative or positive Input 1 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

Inverting active hardware signals: Input 1 has the capability to be inverted. If annunciator input 1 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

When set to default, event/fault code 1853 (customer input 1) becomes active when there is a ground input at TB1-1 on the back of the Universal Annunciator.

Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-1 and ensure that customer input 1 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-1 connection.
3. Check the sender, relay, or device that is activating Input 1 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.2 Fault Code 1854 - Annunciator Input 2 Fault

Customer fault 2 (input 2, LED 2) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #2 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #2" has been configured for; ex. if "Annunciator Input #2" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured or Wiring Issue

1. Customer input 2 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 2 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 2 Activation	Negative Input (ground input)	Positive Input (B+ input)
Inverting Active Hardware Signals	Don't Invert	Invert

Negative or positive Input 2 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

Inverting active hardware signals: Input 2 has the capability to be inverted. If annunciator input 2 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

When set to default, event/fault code 1854 (customer input 2) becomes active when there is a ground input at TB1-2 on the back of the Universal Annunciator.

Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-2 and ensure that customer input 2 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-2 connection.
3. Check the sender, relay, or device that is activating Input 2 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.3 Fault Code 1855 - Annunciator Input 3 Fault

Customer fault 3 (input 3, LED 3) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #3 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #3" has been configured for; ex. if "Annunciator Input #3" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured Or Wiring Issue

1. Customer input 3 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 3 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 3 Activation	Negative Input (ground input)	Positive Input (B+ input)
Inverting Active Hardware Signals	Don't Invert	Invert

Negative or positive Input 3 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

Inverting active hardware signals: Input 3 has the capability to be inverted. If annunciator input 3 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

When set to default, event/fault code 1855 (customer input 3) becomes active when there is a ground input at TB1-3 on the back of the Universal Annunciator.

Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-3 and ensure that customer input 3 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-3 connection.
3. Check the sender, relay, or device that is activating Input 3 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.4 Fault Code 1994 - Annunciator Output Configuration Error (Warning)

Annunciator output relay(s) are being activated by more than one source.

A. Annunciator output relay(s) activated by more than one source at the same time

1. Ensure that the annunciator(s) are only connected to one generator set control.

B. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.6 Auxiliary Codes-101

5.6.1 Fault Code 1667 - AUX 101 Exhaust Temperature OOR (Warning)

Exhaust gas temperature sensor signal is out of range – shorted high.

A. Faulty Exhaust Gas Temperature Sensor Connections

1. Inspect the exhaust gas temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the exhaust gas temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Exhaust Gas Temperature Sensor

1. Active Sensor.
   a. Check the exhaust gas temperature sensor supply voltage.
      i. Disconnect the engine harness connector from the exhaust gas temperature sensor.
      ii. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
      iii. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
   b. Check exhaust gas temperature sensor signal (sense) voltage.
      i. Disconnect the engine harness connector from the exhaust gas temperature sensor.
      ii. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
      iii. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the exhaust gas temperature sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the fuel pressure sensor.
   d. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the exhaust gas temperature sensor pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the exhaust gas temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the exhaust gas temperature sensor.
   c. Measure the resistance from the exhaust gas temperature return pin on the engine harness inline connector to the exhaust gas temperature return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness

1. Inspect the extension harness and the control connector pins.
    a. Disconnect the extension harness connector from the control.
    b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to the exhaust gas temperature return pin on the extension harness inline connection.
    d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
    d. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to all other pins in the extension harness connector.
    e. Measure the resistance from the exhaust gas temperature signal pin on the extension harness connector to all other pins in the extension harness connector.
    f. If all measurements are greater than 100k ohms, then the resistance is correct.

E. Verify the calibrations in the ECM and the PCC control

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
    a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the ECM.
    a. If the calibration in the ECM matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the ECM to the latest calibration

5.6.2 Code 2224 - Aux 101 Fuel Level OOR (Warning)

Fuel level sensor voltage is out of range.

A. Faulty Fuel Level Sensor Connections

1. Inspect the fuel level sensor and the engine harness connector pins.
    a. Disconnect the engine harness connector from the fuel level sensor.
    b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

c. Inspect for evidence of moisture in or on the connector.

d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Fuel Level Sensor

1. Check the resistance of the sensor

   a. Disconnect the engine harness connector from the fuel level sensor.

   b. Measure the resistance between the fuel level sensor signal pin and the fuel level sensor return pin.

C. Improper Wiring

1. Check wiring. Ensure wiring from the coolant temperature sensor is connected to the correct Aux 101 input.

2. Check wires for breaks or abrasions.

3. Check wires for moisture and debris at connection points.

D. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.

   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

2. Using the InSite Service tool, verify the calibration in the ECM.

   a. If the calibration in the ECM matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the ECM to the latest calibration.

5.6.3 Fault Code 2112 - AUX 101 Coolant Inlet Temperature OOR (Warning)

Coolant temperature sensor voltage is out of range.

A. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the engine harness connector pins.

   a. Disconnect the engine harness connector from the coolant temperature sensor.

   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

   c. Inspect for evidence of moisture in or on the connector.

   d. Inspect for missing or damaged connector seals.

   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Coolant Temperature Sensor

1. Check the resistance of the sensor

2. Disconnect the engine harness connector from the coolant temperature sensor.

3. Measure the resistance between the coolant temperature sensor signal pin and the coolant temperature sensor return pin.

C. Improper Wiring

1. Check wiring. Ensure wiring from the coolant temperature sensor is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

D. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the ECM.
   a. If the calibration in the ECM matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the ECM to the latest calibration.

5.6.4 Fault Code 2398 - AUX 101 Ambient Temperature OOR (Warning)

Ambient temperature sensor voltage is out of range.

A. Faulty Ambient Temperature Sensor Connections

1. Inspect the ambient temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the ambient temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Ambient Temperature Sensor

1. Check the resistance of the sensor.
   a. Disconnect the engine harness connector from the ambient temperature sensor.
   b. Measure the resistance between the ambient temperature sensor signal pin and the ambient temperature sensor return pin.

C. Improper Wiring

1. Check wiring. Ensure wiring from the coolant temperature sensor is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

D. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

2. Using the InSite Service tool, verify the calibration in the ECM.
   a. If the calibration in the ECM matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the ECM to the latest calibration.

5.6.5 Fault Code 2542 - AUX 101 Voltage Bias OOR (Warning)

Fuel level sensor voltage is out of range.

A. Faulty Fuel Level Sensor Connections

1. Inspect the fuel level sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the fuel level sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Fuel Level Sensor

1. Check the resistance of the sensor
   a. Disconnect the engine harness connector from the fuel level sensor.
   b. Measure the resistance between the fuel level sensor signal pin and the fuel level sensor return pin.

C. Improper Wiring

1. Check wiring. Ensure wiring from the coolant temperature sensor is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

D. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the ECM.
   a. If the calibration in the ECM matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the ECM to the latest calibration.

5.6.6 Fault Code 2619 - AUX 101 Input #1 Fault

Analog input #1 fault is active.

A. Condition For Which Analog Input #1 Is Configured Is Active

1. Check the condition for which "Analog Input #1" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #1 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #1. Ensure that the switch input setting is correctly set. If “Analog Input #1 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-1 (reference input 1) and J11-2 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.7 Fault Code 2621 - AUX 101 Input #2 Fault

Analog input #2 fault is active.

A. Condition For Which Analog Input #2 Is Configured Is Active

1. Check the condition for which "Analog Input #2" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #2 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #2. Ensure that the switch input setting is correctly set. If “Analog Input #2 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-3 (reference input 1) and J11-4 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.8 Fault Code 2622 - AUX 101 Input #3 Fault

Analog input #3 fault is active.

A. Condition For Which Analog Input #3 is Configured is Active

1. Condition for which "Analog Input #3" is configured is active
   a. Check the condition for which "Analog Input #3" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #3 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #3. Ensure that the switch input setting is correctly set. If “Analog Input #3 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-5 (reference input 1) and J11-6 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.9 Fault Code 2623 - AUX 101 Input #4 Fault

Analog input #4 fault is active.

A. Condition For Which Analog Input #4 Is Configured Is Active

1. Check the condition for which "Analog Input #4" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #4 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #4. Ensure that the switch input setting is correctly set. If “Analog Input #4 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-7 (reference input 1) and J11-8 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.10 Fault Code 2624 - AUX 101 Input #5 Fault

Analog input #5 fault is active.

A. Condition For Which Analog Input #5 Is Configured Is Active

1. Check the condition for which "Analog Input #5" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #5 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #5. Ensure that the switch input setting is correctly set. If “Analog Input #5 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-9 (reference input 1) and J11-10 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.11 Fault Code 2625 - AUX 101 Input #6 Fault

Analog input #6 fault is active.

A. Condition For Which Analog Input #6 Is Configured Is Active

1. Check the condition for which "Analog Input #6" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #6 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #6. Ensure that the switch input setting is correctly set. If “Analog Input #6 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-11 (reference input 1) and J11-12 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.12 Fault Code 2626 - AUX 101 Input #7 Fault

Analog input #7 fault is active.

A. Condition For Which Analog Input #7 Is Configured Is Active

1. Check the condition for which "Analog Input #7" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #7 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #7. Ensure that the switch input setting is correctly set. If “Analog Input #7 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-13 (reference input 1) and J11-14 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.13 Fault Code 2627 - AUX 101 Input #8 Fault

Analog input #8 fault is active.

A. Condition For Which Analog Input #8 Is Configured Is Active

1. Check the condition for which "Analog Input #8" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #8 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #8. Ensure that the switch input setting is correctly set. If "Analog Input #8 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-15 (reference input 1) and J11-16 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.14 Fault Code 2882 - AUX 101 (1) Input #1 Fault

AUX 101 1 Analog/Switch input #1 fault is active.

A. Condition For Which Analog/Switch Input #1 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #1 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
    a. If the fault does not clear go to the Aux 101 1 Analog Input #1 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #1 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #1. Go to: **Setup > Aux 101 Setup.**
    a. Verify that the switch input setting is set correctly.
    b. If Aux 101 1 Analog/Switch Input #1 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit’s connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, or Short Circuit to the AUX 101 Board

1. Check the wiring at J11-1 (reference input) and J11-2 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-2 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-2 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch’s output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch’s output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.15 Fault Code 2883 - AUX 101 (1) Input #2 Fault

AUX 101 1 Analog/Switch input #2 fault is active.

A. Condition For Which Analog Input #2 Is Configured Is Active

1. Check the condition for which "Analog Input #2" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Aux 101 1 Analog Input #2 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #2. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #2 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-1 (reference input) and J11-2 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11- 2 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11- 2 input pin to the engine block ground; value should be more than 100k ohms.

5.6.16 Fault Code 2884 - AUX 101 (1) Input #3 Fault

AUX 101 1 Analog/Switch input #3 fault is active.

Possible Causes:

1. Condition for which Analog/Switch Input #3 is configured for is active
2. Aux 101 1 Analog Input #3 active state selection parameter is configured incorrectly
3. Faulty switch unit
4. Faulty switch connector(s)
5. Wiring harness incorrectly wired, open circuit, or short circuit to the AUX 101 board

A. Condition for which Analog/Switch Input #3 is configured for is active

1. Verify the condition for which Analog/Switch Input #3 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the next step; **Aux 101 1 Analog Input #3 Active State Selection Parameter is Configured Incorrectly**.

B. Aux 101 1 Analog Input #3 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #3. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #3 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-5 (reference input) and J11-6 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-6 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-6 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.17 Fault Code 2885 - AUX 101 (1) Input #4 Fault

AUX 101 1 Analog/Switch input #4 fault is active.

A. Condition For Which Analog/Switch Input #4 Is Configured For Is Active

1. Condition for which Analog/Switch Input #4 is configured for is active
   a. Verify the condition for which Analog/Switch Input #4 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
      i. If the fault does not clear go to the Aux 101 1 Analog Input #4 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #4 Active State Selection Parameter is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #4. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #4 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-7 (reference input) and J11-8 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-8 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-8 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.18 Fault Code 2886 - AUX 101 (1) Input #5 Fault

AUX 101 1 Analog/Switch input #5 fault is active.

A. Condition For Which Analog/Switch Input #5 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #5 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 101 1 Analog Input #5 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #5 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #5. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #5 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-9 (reference input) and J11-10 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-10 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-10 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.19 Fault Code 2887 - AUX 101 (1) Input #6 Fault

AUX 101 1 Analog/Switch input #6 fault is active.

A. Condition For Which Analog/Switch Input #6 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #6 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
    a. If the fault does not clear go to the Aux 101 1 Analog Input #6 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #6 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #6. Go to: **Setup > Aux 101 Setup.**
    a. Verify that the switch input setting is set correctly.
    b. If Aux 101 1 Analog/Switch Input #6 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
    a. Bent or broken pins, pushed back, or expanded pins.
    b. Evidence of moisture or corrosion in or on the connector.
    c. Missing or damaged connector seals.
    d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Wiring harness incorrectly wired, open circuit, or short circuit to the AUX 101 board
    a. Check the wiring at J11-11 (reference input) and J11-12 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
    b. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-12 (switch input) side for an active closed parameter fault setting activation.
        i. With the switch disconnected measure the resistance from the J11-12 input pin to the engine block ground; value should be more than 100k ohms.

c. Disconnect the wiring harness.

i. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.

ii. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.20 Fault Code 2888 - AUX 101 (1) Input #7 Fault

AUX 101 1 Analog/Switch input #7 fault is active.

A. Condition For Which Analog/Switch Input #7 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #7 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 101 1 Analog Input #7 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #7 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #7. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #7 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-13 (reference input) and J11-14 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.

2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-14 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-14 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.7 Auxiliary Codes-102

5.7.1 Fault Code 2628 – AUX 102 Input #9 Fault

Discrete input #9 fault is active.

A. Condition For Which Discrete Input #9 Is Configured Is Active

1. Check the condition for which "Discrete Input #9" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Discrete Input #9 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Discrete Input #9. Ensure that the switch input setting is correctly set. If “Discrete Input #9 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J4-1 (switch input 1) and J4-2 (reference input) for an open circuit, short circuit, or a miswired condition.

5.7.2 Fault Code 2629 – AUX 102 Input #10 Fault

Discrete input #10 fault is active.

A. Condition For Which Discrete Input #10 Is Configured Is Active

1. Check the condition for which "Discrete Input #10" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Discrete Input #10 Active State Selection parameter is configured incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Discrete Input #10. Ensure that the switch input setting is correctly set. If “Discrete Input #10 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J4-3 (switch input 1) and J4-4 (reference input) for an open circuit, short circuit, or a miswired condition.

5.7.3 Fault Code 2632 – AUX 102 Input #12 Fault

Discrete input #12 fault is active.

A. Condition for which Discrete Input #12 is Configured is Active

1. Check the condition for which "Discrete Input #12" has been configured for. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Discrete Input #12 Active State Selection Parameter Is Configured Incorrectly

1. Check the wiring at J4-7 (switch input 1) and J4-8 (reference input) for an open circuit, short circuit, or a miswired condition.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J4-7 (switch input 1) and J4-8 (reference input) for an open circuit, short circuit, or a miswired condition

5.7.4 Fault Code 2891 - AUX 102 (1) Input #1 Fault

NOTICE
AUX 102 Input #1 may be referred to as Input #9 in some cases.

AUX 102 1 Discrete input #1 fault is active.

A. Condition For Which Discrete Input #1 Is Configured For Is Active

1. Verify the condition for which Discrete Input #1 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
    a. If the fault does not clear go to the Aux 102 1 Discrete Input #1 active state selection parameter is configured incorrectly step below.

B. Aux 102 1 Discrete Input #1 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Discrete Input #1. Go to: **Setup > Aux 101 Setup.**
    a. Verify that the switch input setting is set correctly.
    b. If Aux 102 1 Discrete Input #1 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
    a. Bent or broken pins, pushed back, or expanded pins.
    b. Evidence of moisture or corrosion in or on the connector.
    c. Missing or damaged connector seals.
    d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J4-2 (reference input) and J4-1 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 102 input side.
2. Verify the wiring harness running from the switch plug to the AUX 102 board for shorted low condition at the J4-1 (switch input) side for an active closed parameter fault setting activation.
    a. With the switch disconnected measure the resistance from the J4-1 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
    a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
    b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.7.5 Fault Code 2892 - AUX 102 (1) Input #2 Fault

AUX 102 1 Discrete input #2 fault is active.

NOTICE
AUX 102 Input #2 may be referred to as Input #10 in some cases.

A. Condition For Which Discrete Input #2 Is Configured For Is Active

1. Verify the condition for which Discrete Input #2 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 102 1 Discrete Input #2 active state selection parameter is configured incorrectly step below.

B. Aux 102 1 Discrete Input #2 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Discrete Input #2. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 102 1 Discrete Input #2 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J4-4 (reference input) and J4-3 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 102 input side.

2. Verify the wiring harness running from the switch plug to the AUX 102 board for shorted low condition at the J4-3 (switch input) side for an active closed parameter fault setting activation.
    a. With the switch disconnected measure the resistance from the J4-3 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
    a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
    b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.7.6 Fault Code 2893 - AUX 102 (1) Input #3 Fault

AUX 102 1 Discrete input #3 fault is active.

NOTICE
AUX 102 Input #3 may be referred to as Input #11 in some cases.

A. Condition For Which Discrete Input #3 Is Configured For Is Active

1. Verify the condition for which Discrete Input #3 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
    a. If the fault does not clear go to the Aux 102 1 Discrete Input #3 active state selection parameter is configured incorrectly step below.

B. Aux 102 1 Discrete Input #3 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Discrete Input #3. Go to: **Setup > Aux 101 Setup.**
    a. Verify that the switch input setting is set correctly.
    b. If Aux 102 1 Discrete Input #3 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
    a. Bent or broken pins, pushed back, or expanded pins.
    b. Evidence of moisture or corrosion in or on the connector.

c. Missing or damaged connector seals.

d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J4-6 (reference input) and J4-5 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 102 input side.
2. Verify the wiring harness running from the switch plug to the AUX 102 board for shorted low condition at the J4-5 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J4-5 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.7.7 Fault Code 2894 - AUX 102 (1) Input #4 Fault

AUX 102 1 Discrete input #4 fault is active.

NOTICE
AUX 102 Input #4 may be referred to as Input #12 in some cases.

A. Condition for which Discrete Input #4 is Configured for is Active

1. Verify the condition for which Discrete Input #4 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 102 1 Discrete Input #4 active state selection parameter is configured incorrectly step below.

B. Aux102_ 1 Discrete Input #4 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Discrete Input #4. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 102 1 Discrete Input #4 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired Open Circuit Or Short Circuit to the AUX 101 Board

1. Check the wiring at J4-8 (reference input) and J4-7 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 102 input side.
2. Verify the wiring harness running from the switch plug to the AUX 102 board for shorted low condition at the J4-7 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J4-7 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.8 Battle Short Procedures

5.8.1 Battle Short Mode Procedures

All of the following procedures are required to activate Battle Short mode.

These procedures require the equipment identified in the table below.

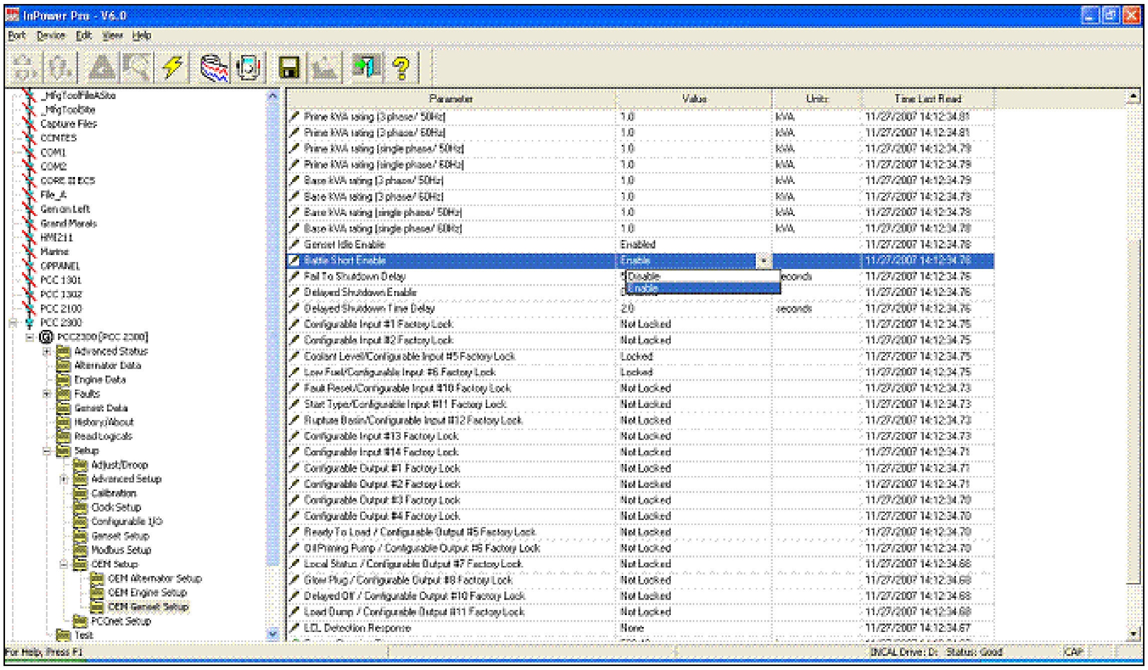
TABLE 27. REQUIRED EQUIPMENT FOR BATTLE SHORT MODE PROCEDURES

Part Description	Part Number
InPower Pro service tool	0998-0077-02 (existing user) 0988-0077-04 (new user)
INLINE 4 product kit	4918190
INLINE 5 product kit	4918416
PC-based service tool harness	0541-1199

5.8.2 Enable Battle Short Mode in the PCC

1. Put the PCC in Off mode.
2. Use the PC-based service tool harness to connect the computer to TB15 on the PCC base board.

3. Open InPower (make sure that the security dongle is attached to the computer), and select the control in the left side of the window (Example: PCC 2300 shown).
4. Click on the Setup >OEM Setup > OEM Genset Setup folders.
5. Set the Battle Short Enable parameter to Enable, as shown below.

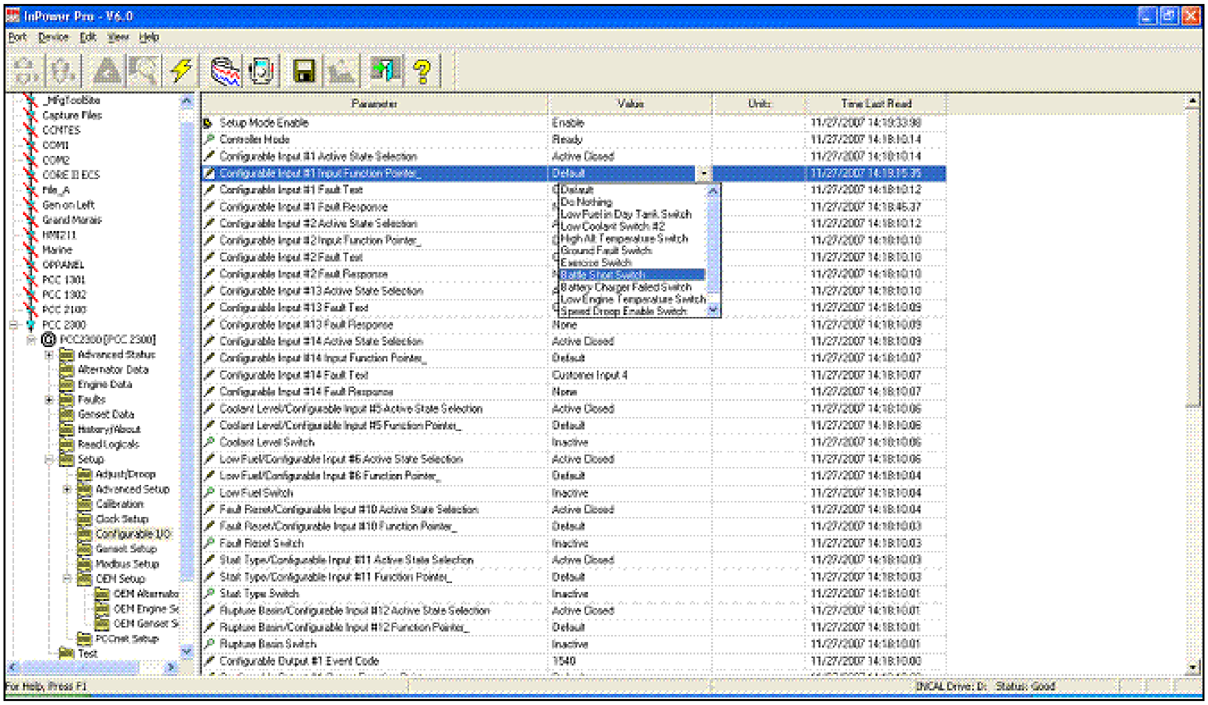


6. Click on Save in order to save the changes.

5.8.3 Activate Battle Short Mode

Each configurable input can be Active Open or Active Closed. Check the value of the configurable input that was configured to Battle Short Switch, and activate the configurable input accordingly.

For example, Configurable Input #1 Active State Selection is set to Active Closed below. In order to activate Battle Short mode, Configurable Input #1 (TB-12 and TB13) has to be closed (connected together).



If Configurable Input #1 Active State Selection were set to Active Open, Configurable Input #1 (TB-12 and TB13) has to be an open contact (disconnected) to activate Battle Short mode.

5.8.4 Battle Short Mode

⚠ WARNING

Automated Machinery

Battle Short mode overrides some parameters of generator set control. Unmonitored generator sets can cause a fire or electrical hazard, resulting in severe personal injury or death.

Make sure that the operation of the set is supervised during Battle Short operation.

Battle Short mode is used to satisfy local code requirements. While Battle Short mode is active, the PCC ignores non-critical shutdown faults and non-critical shutdown with cooldown faults. It does not initiate a stop sequence and continues to run the generator set until Battle Short Mode is inactive. Otherwise, generator set operation remains the same.

Battle Short mode must be set up at the factory or by an authorized service representative. Contact your local distributor for assistance.

Battle Short mode is active only when all of these conditions are met:

- *Battle Short Enable* is set to Enable.
- The ECM is set to enable Battle Short mode (Core 2 ECMs only).
- The Battle Short Switch or *Battle Short Switch (Modbus)* is active. (*Battle Short Switch (Modbus*) is not available in the Operator Panel.)

The PCC generates warning fault 2942 (Shutdown Override Fail) if the Battle Short Switch is active but any of the other conditions are not met.

Battle Short mode is not a distinct mode of operation . The PCC is still in Off mode, Manual mode, or Auto mode while Battle Short mode is active. The PCC still follows the appropriate sequence of operation to start the generator set and to stop the generator set.

The PCC generates warning fault 1131 (Battle Short Active) as long as Battle Short mode is active.

While Battle Short mode is active, the PCC ignores most shutdown faults and only initiates a Shutdown Without Cooldown sequence if a critical shutdown fault occurs.

When the PCC overrides a shutdown fault, it generates warning fault 1416 (Fail To Shutdown) after *Fail To Shutdown Delay* as long as Battle Short mode remains active. It also turns on the Shutdown LED.

NOTICE

The faults that are overridden in Battle Short mode can affect generator set performance and might cause permanent engine, alternator, or connected equipment damage. All shutdown faults, including those overridden in Battle Short mode, must be acted upon immediately to ensure the safety and well-being of the operator and the generator set.

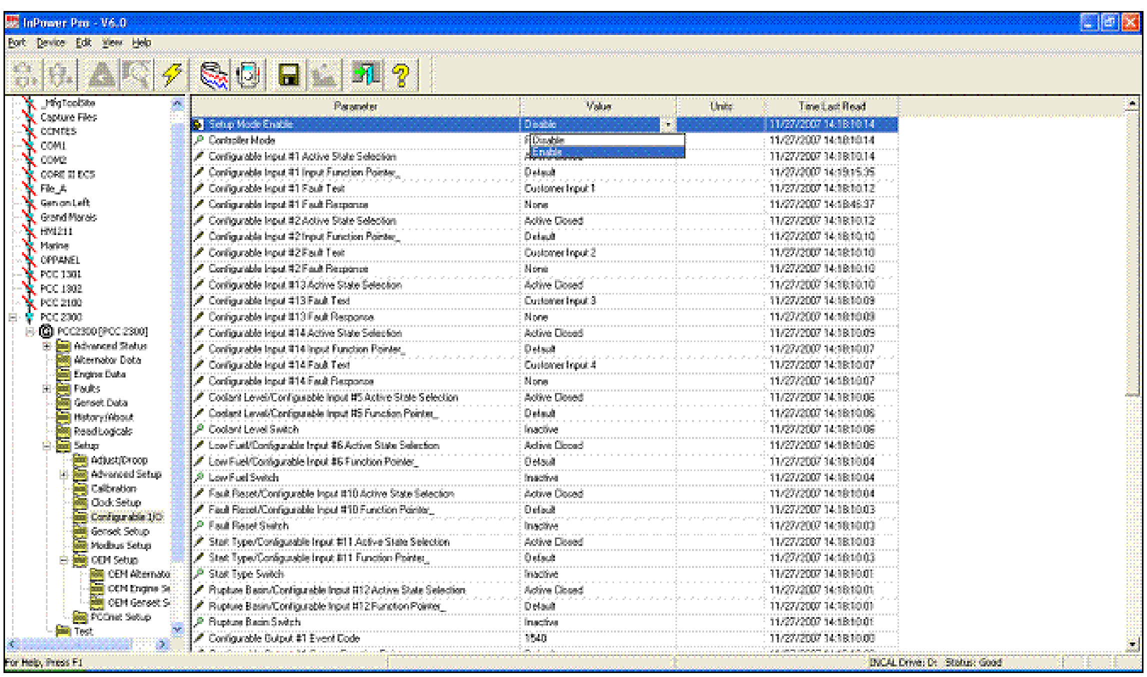
NOTICE

Any damage caused to the generator set as a direct result of running in Battle Short mode is not covered by the warranty.

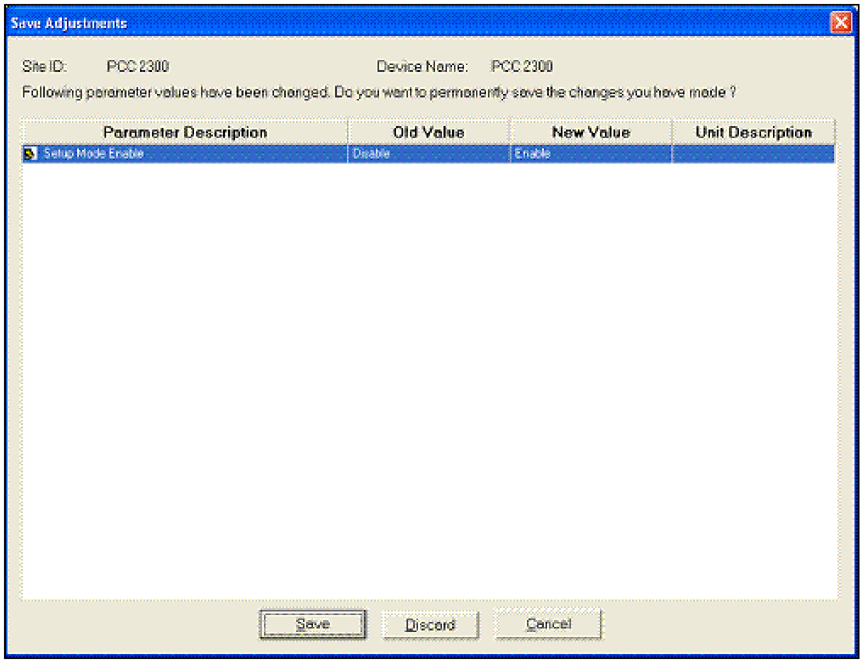
5.8.5 Map a Configurable Input to Battle Short Switch

After Battle Short mode is enabled in the ECM and the PCC, you have to map a configurable input to the Battle Short Switch.

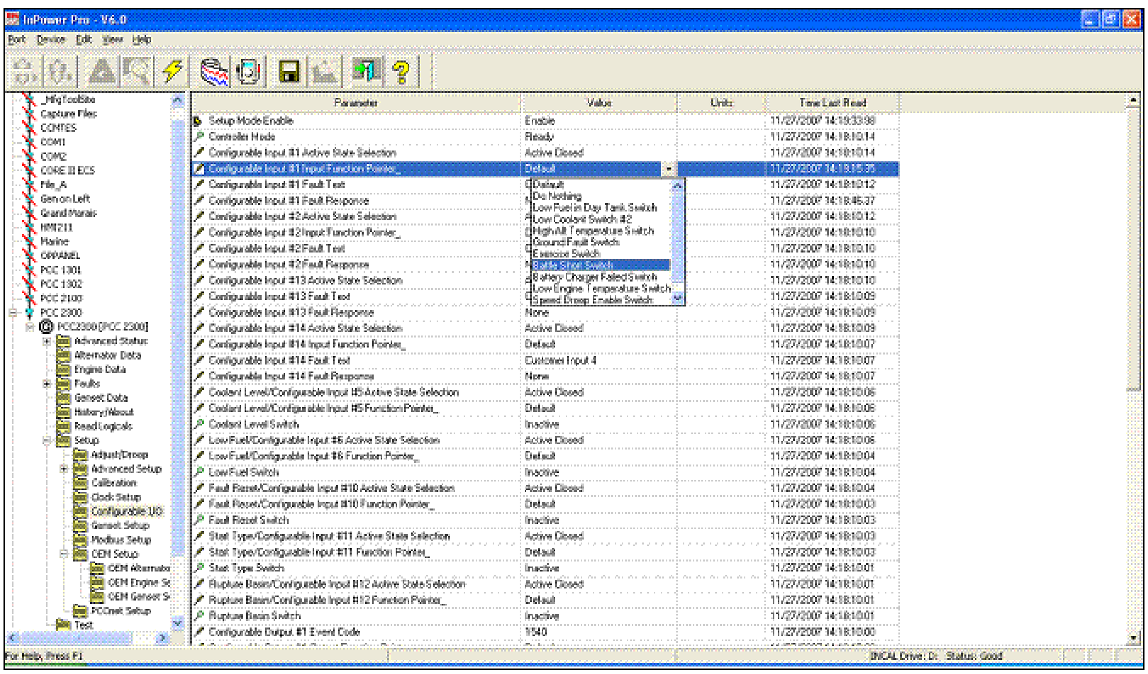
1. Put the PCC in Off mode.
2. Use the PC-based service tool harness to connect the computer to TB15 on the PCC base board.
3. Open InPower (make sure that the security dongle is attached to the computer) and click on the control (PCC 2300 in this example) in the left side of the window.
4. Click on the Setup >Configurable I/O folders.
5. Set the Setup Mode Enable parameter to Enable in order to enter Setup mode, as shown below.



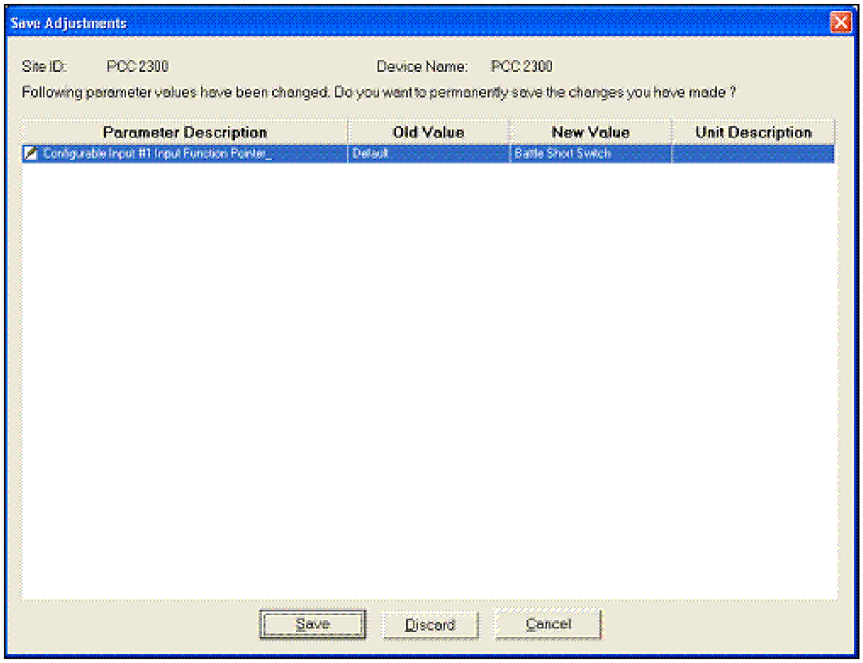
6. Click on Save, as shown below.



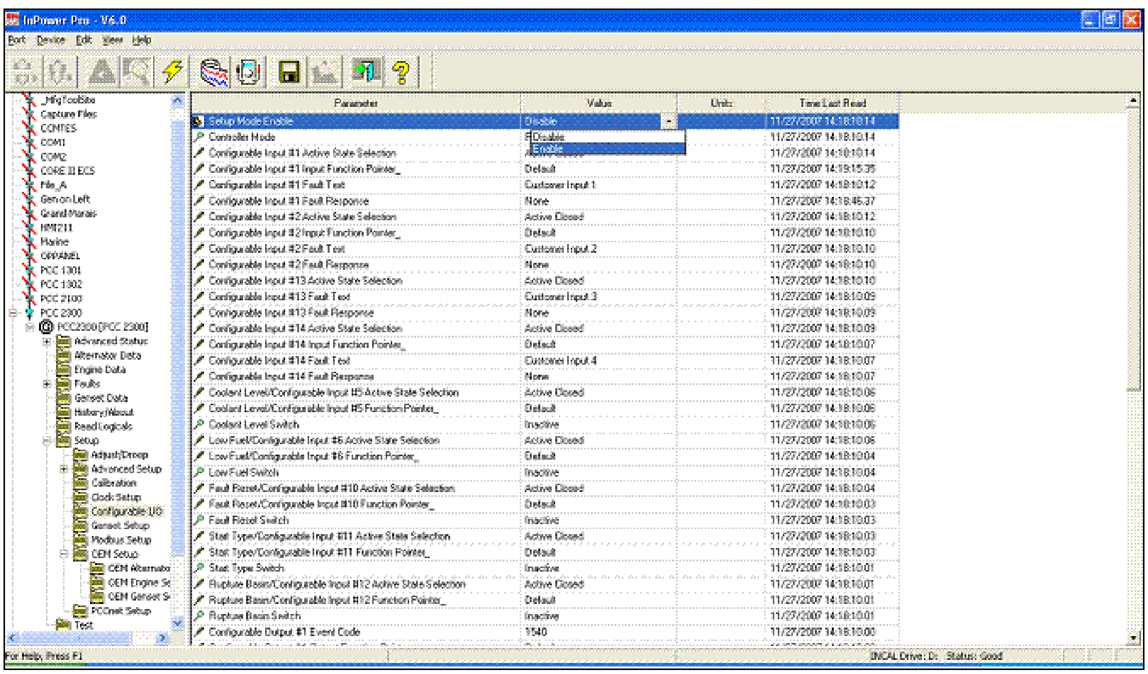
7. Any configurable input can be mapped to Battle Short Switch. Choose one of them. For example, set Configurable Input #1 Input Function Pointer parameter to Battle Short Switch, as shown below.



8. Click on Save, as shown below.



9. Set the Setup Mode Enable parameter to Disable, and click on Save in order to exit Setup mode.



5.9 Battery Troubleshooting

5.9.1 No DC Output (No Fault Message)

Charger cannot sense any DC output.

A. Tripped DC Circuit Breaker

1. Correct the possible overload and reset the circuit breaker.

B. Blown AC Fuse(s) (on 277, 380, 416 and 600 VAC Battery Chargers)

1. Correct the possible overload and replace the fuse(s).

C. Tripped AC circuit breaker(s) (on 120, 208 and 240 VAC battery chargers)

1. Correct the possible overload and reset the circuit breaker.

5.9.2 Low DC Output (No Fault Message)

Charger senses low DC output.

A. Battery Failure

1. Replace the battery and cycle through the Setup menus to clear the fault.

B. Charger Failure

1. Replace the battery charger.

5.9.3 High DC Output (No Fault Message)

Charger senses high DC Output.

A. Charger Failure

1. Replace the battery charger.

5.9.4 Fault Code 379 - Over Current

Charger output current is too high

A. Cycle Through The Setup Menus To Try And Clear The Fault

- If the fault returns, the charger control may have failed.

B. Clearing the Fault Code

NOTICE
Fault code can only be cleared by: • **Disconnect the charger harness plug,** • **Cycle completely through the setup menus,** **Or** • **Recycling the power.**

5.9.5 Fault Code 441 - Low Battery Voltage

Battery voltage is low.

A. No Battery Connected

1. Connect the battery.

B. Output Breaker Is In The Off (Down) Position.

1. Verify the output breaker is in "On" (up) position.

C. A 12V Battery Is Connected But The Charger Is Set For 24V Charging

1. Attach a 24V battery or set the charger for 12V charging

D. Battery Can No Longer Maintain Charge

1. Replace the battery.

E. The Wire Between The Charger And The Battery Is Loose Or Broken

1. Check the wire.

5.9.6 Fault Code 442 - High Battery Voltage

Battery voltage is high.

A. A 12V Battery Is Connected But The Charger Is Set For 24V Charging

1. Attach a 24V battery or set the charger for 12V charging

B. Large Load Dump May Have Caused Momentary Voltage Rise

Cycle through the Setup menus to clear the fault and restart charging.

C. Cycle Through The Setup Menus To Try And Clear The Fault

- If the fault returns, the charger control may have failed.

D. Clearing the Fault Code

NOTICE
Fault code can only be cleared by: • **Disconnect the charger harness plug,** • **Cycle completely through the setup menus,** **Or** • **Recycling the power.**

5.9.7 Fault Code 1442 - Weak Battery

This fault occurs when the engine is starting (cranking) and the voltage of the battery drops below the "Weak Battery Voltage threshold" for the time set in the "Weak Battery Voltage Set Time".

A. Weak Or Discharged Battery

1. Measure the voltage of the battery with a voltmeter. Battery voltage should be 12 VDC or greater in a 12 V system or 24 VDC or greater in a 24 VDC system. If the battery voltage is low, check the electrolyte level in the battery. Replenish the electrolyte level if low and recharge the battery; the specific gravity for a fully charged lead acid battery is approximately 1.260 at 80 °F (27 °C).
2. If the battery cannot hold adequate voltage, replace the battery.

B. Battery Connections Are Loose Or Dirty

1. Clean and tighten battery terminals and battery cable connectors. If the battery cable connectors are cracked or worn out, then replace.

C. Weak battery voltage threshold parameter is set too high

1. Ensure that the Weak Battery Voltage parameter is set to an appropriate voltage value that takes into account voltage drop during cranking (refer to the parameter list to see the default value). To access the battery voltage setup menu from the operator panel, go to **Setup > OEM Setup > OEM Engine Setup > Weak Battery** and change the weak battery voltage parameter of the control accordingly.

D. Insufficient Battery Charging Voltage

1. Ensure that the battery charger is charging the battery at an acceptable rate. Adjust the charge rate if the rate is below the recommendation of the manufacturer.
2. If the battery located far from the battery charger, ensure that a proper wire size is used to compensate for voltage drop.

E. Faulty Engine DC Alternator

1. Check the engine DC alternator. If normal charging voltage is not 12 to 14 VDC in a 12 V system or 24 to 26 VDC in a 24 V system then replace the DC alternator.

F. Faulty Harness

1. Measure the battery voltage at the battery terminals, then measure the battery voltage at the base board input. Measure the voltage at B+ (J20–9, J20–10, J20-20, J20–21) and B- (negative) input (J20–2, J20–4, J20–7, J20–12).
   - If the voltage at the battery terminals and the control is not the same then check the harness and replace if necessary.

5.9.8 Fault Code 1443 - Dead Battery

During cranking, the battery voltage drops below the operating voltage of the control, which resets the control. After the control has reset three consecutive times, event/fault code 1443 will become active.

A. Weak Or Discharged Battery

1. Measure the voltage of the battery with a voltmeter. Battery voltage should be 12 VDC or greater in a 12 V system or 24 VDC or greater in a 24 VDC system. If the battery voltage is low, check the electrolyte level in the battery. Replenish the electrolyte level if low and recharge the battery; the specific gravity for a fully charged lead acid battery is approximately 1.260 at 80 °F (27 °C).
2. If the battery cannot hold adequate voltage, replace the battery.

B. Battery Connections Are Loose Or Dirty

1. Clean and tighten battery terminals and battery cable connectors. If the battery cable connectors are cracked or worn out, then replace.

C. Insufficient Battery Charging Voltage

1. Ensure that the battery charger is charging the battery at an acceptable rate. Adjust the charge rate if the rate is below the recommendation of the manufacturer.
2. If the battery located far from the battery charger, ensure that a proper wire size is used to compensate for voltage drop.

D. Faulty Engine DC Alternator

1. Check the engine DC alternator. If normal charging voltage is not 12 to 14 VDC in a 12 V system or 24 to 26 VDC in a 24 V system then replace the DC alternator.

E. Faulty Harness

1. Measure the battery voltage at the battery terminals, then measure the battery voltage at the base board input. Measure the voltage at B+ (J20–9, J20–10, J20-20, J20–21) and B- (negative) input (J20–2, J20–4, J20–7, J20–12).
    - If the voltage at the battery terminals and the control is not the same then check the harness and replace if necessary.

5.9.9 Fault Code 2263 - High Battery Temperature

Battery temperature is above 55 °C (FOR INSTALLATIONS THAT INCLUDE THE OPTIONAL BATTERY TEMP SENSOR)

A. Battery's Ambient Temperature Is Too High

1. Move the battery into a cooler location.
    a. Charger will automatically begin charging again after the battery temp lowers.

B. Possible Shorted Cells Within The Battery Is Causing An Excessive Battery Temperature Increase

1. Replace the battery.

5.9.10 Fault Code 2331 - Low AC Voltage

AC input voltage is more than 10% below nominal rated voltage.

A. AC Input Voltage Is More Than 10% Below Nominal Rated Voltage

1. Check level of input voltage.
    - Charger will not operate with voltage 10% or more below nominal.

5.9.11 Fault Code 2358 - High AC Voltage

AC input voltage is more than 10% above nominal rated voltage.

A. AC Input Voltage Is More Than 10% Above Nominal Rated Voltage

1. Check level of input voltage.
   - Charger will not operate with voltage 10% or more above nominal.

5.9.12 Fault Code 2544 - Over Temperature

Charger is overheating

A. Charger's Ambient Temperature Is Too High

1. Move the charger to a cooler location.
   - The charger will automatically begin charging again after the internal temp lowers.

B. Charger's Internal Cooling Fan Is Blocked, Failed, Or Air Inlets Are Covered

1. Verify that the charger's air inlets on the side of the charger are not blocked and nothing is interfering with fan rotation.

5.9.13 Fault Code 2993 - Battery Charger Failed

A. Charger Failure

1. Replace the battery charger.

5.9.14 Fault Code 9115 - Battery Fail

Battery has failed.

A. Battery Failure

1. Replace the battery and cycle through the Setup menus to clear the fault.

5.10 CAN Datalink Troubleshooting

5.10.1 Fault Code 427 - CAN Datalink Lost Message

Important data was lost between the Base Board and the ECM or keyswitch to ECM was removed during genset operation.

A. Power Removed From ECM (Keyswitch) During Genset Operation

- O pressed on control during genset operation.

Reset control by pressing Fault Reset button with O/Manual/Auto switch in O (off) position.

B. Defective Datalink Harness Assembly

- Check for a defective datalink harness connection or open circuit.
  1. Inspect the datalink harness and connector pins from J11-20 to J1939 HIGH (J26-11).

2. Inspect the datalink harness and connector pins from J11-19 to J1939 LOW (J26-10) of the ECM.
3. Check the shield ground connection at J11-17.

- Check the terminating resistors.
  1. Disconnect connector J11 from the base board.
  2. Disconnect the engine datalink connection from the ECM.
  3. Measure resistance between pins J11-19 and J11-20 (60 ohms is satisfactory).
  4. If the resistance is not 60 ohms, check the terminating resistors. Each of the two terminating resistors should be 120 ohms; replace if not 120 ohms.

5.10.2 Fault Code 781 - CAN Datalink Lost Messages

Important data was lost between the Base board and the ECM or keyswitch to ECM was removed during genset operation.

A. Refer To Fault Code 427

5.10.3 Fault Code 1245 - CAN Engine Shutdown

The PCC received a shutdown message from the ECM.

A. ECM/Engine Fault

Troubleshoot Engine Fault Codes.

5.10.4 Fault Code 1246 - CAN Unknown Engine Fault

The PCC received an unknown message from the ECM.

A. ECM/Engine Fault

Troubleshoot Engine Fault Codes.

5.10.5 Fault Code 1247 - CAN Engine Unannounced Fault

The PCC received an unknown message from the ECM.

A. ECM/Engine Fault

Troubleshoot Engine Fault Codes.

5.10.6 Fault Code 1248 - CAN Engine Warning Fault

The PCC received an unknown message from the ECM.

A. ECM/Engine Fault

Troubleshoot Engine Fault Codes.

5.11 Engine Performance Troubleshooting

5.11.1 Engine Does Not Crank in Manual Mode (No Fault Message)

Control has not received or recognized a manual start signal.

5.11.1.1 Engine Does Not Crank in Manual Mode - Diagnosis and Repair

1. No power is supplied to the control. (The Control Alive indicator on the base board is not flashing).
    - Poor battery cable connections. Clean the battery cable terminals and tighten all connections using an insulated wrench.
    - Remove F4 and check continuity. If open, replace the fuse with one of the same type and amp rating (15 Amps).
        - If F4 is OK, remove connector P20 and check for B+ at P20-9, P20-10, P20-20, and P20-21 and GND at P20-2, P20-4, P20-7, and P20-12.
        - If B+ or ground missing, isolate to the harness and the TB BAT terminal mounted on the engine block.
        - If B+ and ground check OK, the base board may be defective. Cycle power to the base board by reconnecting P20.
2. The base board is not properly calibrated or the calibration is corrupt. (The Control Alive indicator flashes every ½ second.)
    - Confirm that the installed calibration part number matches the serial plate information. Re-enter a calibration file if necessary. (When properly installed, the Control Alive indicator flashes once every second.)
3. The Emergency Stop switch or wiring is defective.
    - With the Emergency Stop push button not activated, remove connector P25 and check for continuity between P25-2 (ESTOP-B-1) and P25-6 (ESTOP-B-2). (If the circuit is open, the control will detect a local E-Stop condition but will not display the E-Stop condition.) If the circuit is open, isolate to the Emergency Stop switch and wiring.
    - If there is continuity, go to the next step.
4. Oil pressure switch or wiring is defective.
    - Remove J11 connection and check wiring between J11-2 and J11-3 to the switch.
    - Verify control is configured for the type of sensor installed.
    - Verify proper operation of the switch.
5. Oil pressure sender, setup on wiring is defective.
    - Remove J11 connection and check wiring between J11-2 and J11-3 to the sender. Verify control is configured for the type of sender. Verify operation of the sender

5.11.2 Engine Does Not Crank in Remote Mode (No Fault Message)

Control has not received or recognized a remote start signal.

5.11.2.1 Engine Does Not Crank in Remote Mode - Diagnosis and Repair

1. The remote start switch or customer wiring is faulty.
    - Reset the control. Attempt to start and check for ground at P1-11.
        - If ground is not present, isolate to the remote switch or customer wiring. Repair as necessary.

5.11.3 Engine Lacks Power or Is Unstable (No Fault Message)

Control has not received or recognized a generator set fault.

5.11.3.1 Engine Lacks Power or Is Unstable - Diagnosis and Repair

1. Determine proper derates for ambient conditions. Refer to the Specification Sheet for site derating factors.
2. Replace the air filter element.
3. See the Installation Manual.
4. Check for low coolant and fill if necessary.
5. Check for air in the cooling system and, if necessary, bleed the cooling system.
6. Governor Gain is misadjusted. Refer to *Governor/Regulator Setup Menu* in the controller Service Manual.
7. Service the engine according to the engine service manual.

5.11.4 Engine is Difficult to Start or Does Not Start (Exhaust Smoke)

5.11.4.1 Engine is Difficult to Start or Does Not Start (Exhaust Smoke) - Diagnosis and Repair

1. Battery voltage
    - Battery voltage is low, interrupted, or open.
        - Check the batteries connections, unswitched battery supply circuit, and fuses.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Starting procedure/aid
    - Starting procedure is not correct.
        - Verify the correct starting procedure.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Starting aid is necessary for cold weather or starting aid is malfunctioning.
        - Check for the correct operation of the starting aid.
        - Refer to the manufacturer's instructions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
    - Inspect fuel lines, fuel connections and fuel filters for leaks.
        - Repair if leaks found.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
    - Add fuel to the fuel tank if the fuel level is found to be low.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Manual fuel shutoff valve is closed.
    - Check the OEM fuel shutoff valves.
    - Verify that the fuel tanks are open.
  - Fuel shutoff valve solenoid or circuit is malfunctioning.
    - Check the fuel shutoff valve solenoid and circuit.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for air in the fuel system.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for the fuel inlet restriction.
    - Check the fuel inlet lines for restriction.
    - Check for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for fuel drain line restriction.
    - Check the fuel drain lines for restriction.
    - Clear or replace the fuel lines, check valves, or tank vents as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Air intake or exhaust issue(s)
  - Air intake system restriction is above specification.
    - Check the air intake system for restriction.
    - Clean or replace the air filter and inlet piping as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Exhaust system restriction is above specification.
    - Check the exhaust system for restrictions.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5. Sensor issue(s)
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air pressure sensor is malfunctioning.
        - Check the ambient air pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
6. Other issue(s)
    - Engine parasitics are excessive.
        - Check engine-driven units for correct operation.
        - Check the cooling fan for correct operation and cycle time.
        - Refer to the OEM specifications.
    - Overhead adjustments are not correct.
        - Adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Base engine problem.
        - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Injector O-rings are damaged or missing.
        - Remove and check the injectors.
        - Replace the injector O-rings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.5 Engine is Difficult to Start or Does Not Start (No Exhaust Smoke)

5.11.5.1 Engine is Difficult to Start or Does Not Start (No Exhaust Smoke) - Diagnosis and Repair

1. Emergency stop/remote emergency stop
    - Emergency Stop/Remote Emergency Stop circuit energized.
        - Verify that either the Emergency Stop or the Remote Emergency Stop circuit is not energized.

2. Battery voltage
    - Battery voltage is low, interrupted, or open.
        - Check the battery connections, un-switched battery supply circuit, and fuses.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Run/Stop circuit issue
    - Run/Stop circuit is malfunctioning.
        - Check the generator Run/Stop circuit.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Fuel system issue(s)
    - Inspect fuel lines, fuel connections, and fuel filters for leaks.
        - Repair if leaks found.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
        - Add fuel to the fuel tank if the fuel level is found to be low.
    - Manual fuel shutoff valve is closed.
        - Check the OEM fuel shutoff valves.
        - Verify that the fuel tanks are open.
    - Fuel shutoff valve solenoid or circuit is malfunctioning.
        - Check the fuel shutoff valve solenoid and circuit.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - In-line check valve(s) are installed backwards or have incorrect part number.
        - Inspect the check valve(s) for correct installation and part number.
    - Check for air in the fuel system.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Gear pump is malfunctioning.
  - Check the gear pump output pressure.
  - Replace the gear pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5. Air intake or exhaust issues
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
6. Sensor issue(s)
   - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold pressure sensor is malfunctioning.
     - Check the intake manifold pressure sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air pressure sensor is malfunctioning.
     - Check the ambient air pressure sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
7. Other issue(s)
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Internal engine damage.
     - Analyze the oil and inspect the filters, pistons, camshaft, and other parts to locate an area of probable damage.

5.11.6 Engine Experiences Low Power, Poor Acceleration, or Poor Response

5.11.6.1 Engine Experiences Low Power, Poor Acceleration, or Poor Response - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Revisit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.

2. Fuel system issue(s)
   - Inspect fuel lines, fuel connections, and fuel filters for leaks.
     - Repair if leaks found.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to procedure in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Gear pump is malfunctioning.
     - Check the gear pump output pressure.
     - Replace the gear pump if necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel pump overflow valve is malfunctioning.
     - Check the overflow valve.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel lift pump is malfunctioning.
     - Check the fuel lift pump for correct operation.
     - Check the pump output pressure.
     - Replace the fuel lift pump if necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel injection pump is malfunctioning.
    - Remove and test the fuel injection pump.
    - Replace the pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Turbocharger is malfunctioning.
        - Monitor the turbocharger boost pressure with an INSITE electronic service tool.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
    - Coolant temperature sensor is malfunctioning.
        - Use InPower or INSITE service tool(s) to check the coolant temperature sensor.
        - Refer to the procedure in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air pressure sensor is malfunctioning.
        - Check the ambient air pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Engine is operating above recommended altitude.
        - Engine power decreases above recommended altitude.
        - Refer to the Engine Data Sheet for the specific engine for specifications.
    - Engine parasitics are excessive.
        - Check engine-driven units for correct operation.

- Check the cooling fan for correct operation and cycle time.
- Refer to the OEM specifications.

- Overhead adjustments are not correct.
  - Adjust the overhead settings.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.7 Engine Runs Rough or Misfires

5.11.7.1 Engine Runs Rough or Misfires - Diagnosis and Repair

1. Air intake or exhaust issue(s)
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Fuel system issue(s)
   - Inspect fuel lines, fuel connections, and fuel filters for leaks.
     - Repair if leaks found.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
    - Check the overflow valve.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
    - Check the fuel lift pump for correct operation.
    - Check the pump output pressure.
    - Replace the fuel lift pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel injection pump is malfunctioning.
    - Remove and test the fuel injection pump.
    - Replace the pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Sensor issue(s)
    - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Coolant temperature sensor is malfunctioning.
        - Use InPower service tool to check the coolant temperature sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Ambient air temperature sensor is malfunctioning.
  - Check the ambient air temperature sensor.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Engine mounts are worn, damaged, loose, or not correct.
     - Verify the condition of the mounts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.8 Engine Shuts Off Unexpectedly or Dies During Deceleration

5.11.8.1 Engine Shuts Off Unexpectedly or Dies During Deceleration - Diagnosis and Repair

1. Emergency Stop/Remote Emergency Stop
   - Emergency Stop/Remote Emergency Stop circuit energized.
     - Verify that either the Emergency Stop or the Remote Emergency Stop circuit is not energized.
2. Fuel system issue(s)
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Manual fuel shutoff valve is closed.
     - Check the OEM fuel shutoff valves.
     - Verify that the fuel tank isolation valves are open.
   - Fuel shutoff valve solenoid or circuit is malfunctioning.
     - Check the fuel shutoff valve solenoid and circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Check for fuel inlet restriction.
  - Check the fuel inlet lines for restriction.
  - Check for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel drain line restriction.
  - Check the fuel drain lines for restriction.
  - Clear or replace the fuel lines, check valves, or tank vents as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
  - Check all fuel system lines for restrictions or debris.
  - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
  - Check the gear pump output pressure.
  - Replace the gear pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Electronic control module related issue(s)
   - Battery voltage supply to the electronic control module has been lost.
     - Check the battery connections.
     - Check the un-switched battery supply circuit.
     - Refer to the operation and maintenance manual, for the specific engine.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Electronic control module is not grounded correctly.
     - Check the electronic control module for correct placement of star washers.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Electronic control module is malfunctioning.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Other issue(s)
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.9 Engine Speed Surges at High or Low Idle

5.11.9.1 Engine Speed Surges at High or Low Idle - Diagnosis and Repair

1. Fuel system issue(s)
    - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
        - Add fuel to the fuel tank if the fuel level is found to be low.
    - Check for air in the fuel system.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel lift pump is malfunctioning.
        - Check the fuel lift pump for correct operation.
        - Check the pump output pressure.
        - Replace the fuel lift pump if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Gear pump is malfunctioning.
        - Check the gear pump output pressure.
        - Replace the gear pump if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for injector malfunction.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel pump overflow valve is malfunctioning.
        - Check the overflow valve.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel injection pump is malfunctioning.
  - Remove and test the fuel injection pump.
  - Replace the pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

2. Sensor issue(s)
   - Crankshaft or camshaft speed or position sensor(s) reading incorrectly.
     - Refer to the troubleshooting procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Alternator is malfunctioning.
     - Temporarily disconnect the alternator and test-run the engine.
     - Replace the alternator if necessary.
     - Refer to the OEM service manuals.

5.11.10 Engine Speed Surges Under Load or in Operating Range

5.11.10.1 Engine Speed Surges Under Load or in Operating Range - Diagnosis and Repair

1. Parameter(s) configured incorrectly
   - With the InPower service tool verify that all of the configurable parameters that can affect the engine operation are set correctly.
     - Adjust parameter(s) accordingly only when found to be configured incorrectly.
2. Alternator paralleling control
   - Alternator paralleling controls are sending inconsistent or incorrect commands to the engine electronic control system.
     - Verify that the alternator paralleling controls are functioning correctly.
     - Refer to the paralleling controls user manual for specifications.

3. Fuel system issue(s)
    - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
        - Operate the engine from a tank of high-quality fuel.
        - Refer to Fuel for Cummins Engines, Bulletin 3379001.
    - Check for air in the fuel system.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Gear pump is malfunctioning.
        - Check the gear pump output pressure.
        - Replace the gear pump if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for injector malfunction.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
    - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
        - Refer to the troubleshooting procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Moisture in the wiring harness connectors.
        - Dry the connectors with Cummins electronic cleaner, Part Number 3824510.

- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Alternator is malfunctioning.
  - Temporarily disconnect the alternator and test-run the engine.
  - Replace the alternator if necessary.
  - Refer to the OEM service manuals.

5.11.11 Engine Starts But Will Not Keep Running

5.11.11.1 Engine Starts But Will Not Keep Running - Diagnosis and Repair

1. Parameter(s) configured incorrectly
   - With the InPower or INSITE service tool(s) verify that engine idle speed is not set too low.
     - Verify the correct idle speed setting.
     - Increase the idle speed if necessary.
2. Battery voltage
   - Battery voltage is low, interrupted, or open.
     - Check the battery connections, un-switched battery supply circuit, and fuses.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Run/Stop circuit issue(s)
   - Run/Stop circuit is malfunctioning.
     - Check the alternator Run/Stop circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Fuel system issue(s)
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.

    - Refer to the OEM specifications.
- Base engine problem.
    - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine..

5.11.12 Poor Engine Transient Response

5.11.12.1 Poor Engine Transient Response - Diagnosis and Repair

1. Excessive load(s)
    - Ensure that the load on the generator set does not exceed the generator set KW rating.
        - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
        - Refer to the T−030 manual for proper generator set sizing and application.
2. Fuel system issue(s)
    - Inspect fuel lines, fuel connections, and fuel filters for leaks.
        - Repair if leaks found.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
        - Operate the engine from a tank of high-quality fuel.
        - Refer to Fuel for Cummins Engines, Bulletin 3379001.
    - Low or no fuel pressure at the fuel filters (primary pressure).
        - Use an electronic service tool to measure the fuel pressure at the fuel filter.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for air in the fuel system.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Air intake or exhaust issues
   - Air intake or exhaust leaks.
     - Inspect the air intake and exhaust systems for air leaks.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Turbocharger is malfunctioning.
     - Monitor the turbocharger boost pressure.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
   - Intake manifold air temperature is below specification.
     - Refer to the coolant temperature below normal symptom tree in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Coolant temperature sensor is malfunctioning.
     - Use InPower service tool(s) to check the coolant temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold pressure sensor is malfunctioning.
     - Check the intake manifold pressure sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air temperature sensor is malfunctioning.
     - Check the ambient air temperature sensor.

  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5. Other issue(s)
   - Engine is operating above recommended altitude.
     - Engine power decreases above recommended altitude.
     - Refer to the specific Engine Data Sheet for specifications.
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.13 Engine Will Not Reach Rated Speed (RPM)

5.11.13.1 Engine Will Not Reach Rated Speed (RPM) - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.
2. Air intake or exhaust issue(s)
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Sensor issue(s)
    - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air temperature sensor is malfunctioning.
        - Check the ambient air temperature sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Engine parasitics are excessive.
        - Check engine-driven units for correct operation.
        - Check the cooling fan for correct operation and cycle time.
        - Refer to the OEM specifications.
    - Engine is operating above recommended altitude.
        - Engine power decreases above recommended altitude.
        - Refer to the specific Engine Data Sheet for specifications.
    - Overhead adjustments are not correct.
        - Adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Injector O-rings are damaged or missing.
        - Remove and check the injectors.
        - Replace the injector O-rings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.14 Engine Will Not Shut Off

5.11.14.1 Engine Will Not Shut Off - Diagnosis and Repair

1. Run/Stop circuit issue
   - Run/Stop circuit is malfunctioning.
     - Check the alternator Run/Stop circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Fumes in the intake air
   - Engine is running on fumes drawn into the air intake.
     - Check the air intake ducts.
     - Locate and isolate the source of the fumes.
     - Repair as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel shutoff valve solenoid or circuit is malfunctioning.
     - Check the fuel shutoff valve solenoid and circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for injector malfunction.
     - Perform the cylinder performance test.
     - Replace injectors as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Turbocharger seal leak
   - Turbocharger oil seal is leaking.
     - Check the turbocharger for oil seals and for leaks.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.15 Fuel Consumption is Excessive

5.11.15.1 Fuel Consumption is Excessive - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.
2. Maintenance, repair, or environment effect(s)
   - Fuel consumption has increased after an engine repair.
     - Evaluate the engine repair to determine its effect on fuel consumption.
     - Check part numbers to make sure the correct parts were used.
   - Lubricating oil level is above specification.
     - Check the oil level.
     - Verify the dipstick calibration and oil pan capacity.
     - Fill the system to the specified level.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Environmental factors are affecting fuel consumption.
     - Consider altitude and ambient air temperature when evaluating fuel consumption.
     - Refer to the specific Engine Data Sheets for altitude derate information.
3. Air intake or exhaust issue(s)
   - Air intake or exhaust leaks.
     - Inspect the air intake and exhaust systems for air leaks.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Turbocharger is not correct.
     - Check the turbocharger part number and compare it to the control parts list.
     - Replace the turbocharger if necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Fuel system issue(s)
   - Inspect fuel lines, fuel connections and fuel filters for leaks.
     - Repair if leaks found.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
    - Operate the engine from a tank of high-quality fuel.
    - Refer to Fuel for Cummins Engines, Bulletin 3379001.
  - Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel pump overflow valve is malfunctioning.
    - Check the overflow valve.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel lift pump is malfunctioning.
    - Check the fuel lift pump for correct operation.
    - Check the pump output pressure.
    - Replace the fuel lift pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel injection pump is malfunctioning.
    - Remove and test the fuel injection pump.
    - Replace the pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5. Sensor issue(s)
  - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
    - Refer to the troubleshooting procedure in the troubleshooting and repair manual for specific engine.
  - Fuel system pressure sensors (fueling/timing) are malfunctioning.
    - Check the fuel system pressure sensors (fueling/timing).
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
6. Other issue(s)
  - Engine parasitics are excessive.
    - Check engine-driven units for correct operation.
    - Check the cooling fan for correct operation and cycle time.
    - Refer to the OEM specifications.
  - Overhead adjustments are not correct.
    - Adjust the overhead settings.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Base engine problem.
    - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.16 Fuel in the Coolant

5.11.16.1 Fuel in the Coolant - Diagnosis and Repair

1. Coolant is contaminated
   - Bulk coolant supply is contaminated.
     - Check the bulk coolant supply.
     - Drain the coolant and replace with non-contaminated coolant.
     - Replace the coolant filters.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Cracked cylinder head
   - Cylinder head is cracked or porous.
     - Remove intake and exhaust manifolds.
     - Check for evidence of coolant leak.
     - If necessary, operate engine at low idle.
     - Pressure-test the cylinder head.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.17 Fuel in the Lubricating Oil

5.11.17.1 Fuel in the Lubricating Oil - Diagnosis and Repair

1. Oil is contaminated
   - Bulk oil supply is contaminated.
     - Check the bulk oil supply.
     - Drain the oil and replace with non-contaminated oil.
     - Replace the oil filters.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Excessive idle time
   - Engine idle time is excessive.
     - Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes).
     - Shut off the engine rather than idle for long periods.
     - If idle time is necessary, raise the idle speed.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Fuel system leaks
    - Fuel pump or injector is leaking fuel.
        - Perform the fluorescent dye tracer test.
        - Check the fuel pump.
        - Check the overhead for an injector leak.
        - Replace the fuel pump or injector(s) if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for injector malfunction.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Cracked cylinder head
    - Cylinder head is cracked or porous.
        - Remove intake and exhaust manifolds.
        - Check for evidence of oil leak.
        - If necessary, operate engine at low idle.
        - Pressure-test the cylinder head.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Engine problem
    - Base engine problem.
        - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.18 Excessive Smoke - Black

5.11.18.1 Excessive Smoke - Black - Diagnosis and Repair

1. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Turbocharger is malfunctioning.
  - Monitor the turbocharger boost pressure with an INSITE electronic service tool.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

2. Sensor issue(s)
   - Intake manifold pressure sensor is malfunctioning.
     - Check the intake manifold pressure sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold temperature sensor is malfunctioning.
     - Check the intake manifold temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air temperature sensor is malfunctioning.
     - Check the ambient air temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine..
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for injector malfunction.
     - Perform the cylinder performance test.
     - Replace injectors as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Other issue(s)
   - Turbocharger oil seal is leaking.
     - Check the turbocharger oil seals for leaks.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.19 Excessive Smoke - White

5.11.19.1 Excessive Smoke - White - Diagnosis and Repair

1. Cold ambient conditions
   - Engine is cold.
     - Starting aid is necessary for cold weather or starting aid is malfunctioning.
     - Check for the correct operation of the starting aid.
     - Refer to the OEM manufacturer's instructions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Sensor issue(s)
   - Coolant temperature sensor is malfunctioning.
     - Use InPower service tool(s) to check the coolant temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold temperature sensor is malfunctioning.
     - Check the intake manifold temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air temperature sensor is malfunctioning.
     - Check the ambient air temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.

- Check for air in the fuel system.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel inlet restriction.
  - Check the fuel inlet lines for restriction.
  - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel drain line restriction.
  - Check the fuel drain lines for restriction.
  - Clear or replace the fuel lines, check valves, or tank vents as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
  - Check all fuel system lines for restrictions or debris.
  - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
  - Perform the cylinder performance test.
  - Replace injectors as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
  - Check the overflow valve.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Injector protrusion is not correct.
  - Check the injector protrusion.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Other issue(s)
   - Coolant level is below specification.
     - Check the coolant level and for air in the coolant system.
     - Completely bleed air from the coolant system.
     - Refer to the operation and maintenance manual for the specific engine.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Raw fuel in the intake manifold.
    - Check the intake manifold for fuel.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Intake manifold is contaminated with lubricating oil.
    - Check the intake manifold for oil.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Base engine problem.
    - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.20 Engine Noise Is Excessive

5.11.20.1 Engine Noise is Excessive - Diagnosis and Repair

1. Lubricating issue(s)
    - Lubricating oil level is below specification.
        - Check the oil level.
        - Verify the dipstick calibration and the oil pan capacity.
        - Fill the system to the specified level.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Lubricating oil pressure is below specification.
        - Check the oil pressure.
        - If the pressure is low, refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Lubricating oil is thin or diluted.
        - Analyze the oil.
        - Refer to Cummins Engine Oil Recommendations, Bulletin 3810340.
2. Cooling issue(s)
    - Coolant temperature is above specification.
        - Check the coolant level.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fan drive belt is loose, tight, or not in alignment.
        - Check the fan drive belt.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Air intake or exhaust leaks
    - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Worn mounts
    - Engine mounts are worn, damaged, or incorrect.
        - Check the engine mounts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Turbocharger noise
    - Inspect the turbocharger(s) for excessive mechanical noise.
        - Replace if necessary.
        - Refer to the Engine Noise Excessive - Turbocharger symptom tree.
6. Mechanical or internal component wear or damage
    - Overhead adjustments are not correct.
        - Measure and adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Overhead components are damaged.
        - Inspect the rocker levers, rocker shafts, cam followers or tappets, push rods, and valves for damage or excessive wear.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust valve to piston contact.
        - Inspect the rocker levers, rocker shafts, crossheads, valves, and pistons for damage.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Injector is malfunctioning.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Vibration damper is damaged.
        - Inspect the vibration damper.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Gear train backlash is excessive or the gear teeth are damaged.
        - Check the gear backlash and the gear teeth.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Main bearing or connecting rod bearing noise.
        - Refer to the Engine Noise Excessive - Main Bearing symptom tree (engine specific manual).
    - Flywheel or flexplate cap screws are loose or broken.
        - Check the flywheel or flexplate and the mounting cap screws.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Piston, piston rings, or cylinder liner is worn or damaged.
        - Refer to the Engine Noise Excessive – Piston symptom tree (engine specific manual).

- Internal engine damage.
    - Analyze the oil and inspect the filters to locate an area of probable damage.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.11.21 Engine Does Not Crank in Manual Mode

Logic:

This indicates that the control has not received or recognized a manual start signal.

Possible Causes:

- No power supplied to the control.
- Control not properly calibrated or corrupt calibration.
- The Emergency Stop switch or wiring is defective.
- Oil pressure switch or wiring is defective.
- Oil pressure sender, setup on wiring is defective.

Diagnosis and Repair:

1. No power supplied to the control.
    a. Check if the control is in Manual mode and when the Start button is pressed, and that there are no shutdown faults present.
    b. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
    c. Check for blown fuses.
    d. Remove connector P16 and check for B+ at P16-2 and GND at P16-5. If B+ or ground missing, check the harness. If B+ and ground check OK, cycle power to control by reconnecting P16. Press Reset button to wake the control up. And retry operation.
2. Control not properly calibrated or corrupt calibration.
    a. Confirm that the installed calibration part number matches the serial plate information. Re-enter calibration file if necessary.
3. The Emergency Stop switch or wiring is defective.
    a. With Emergency Stop push button not activated (switch closed), remove leads from TB2-5 and B- and check for continuity between these two leads. If circuit is open, isolate to Emergency Stop switch and wiring. If there is continuity, go to next step.
4. Oil pressure switch or wiring is defective.
    a. Remove P16 connection and check wiring between P16-9 and P16-11 to the switch.
    b. Verify control is configured for the type of sensor installed.
    c. Verify proper operation of the switch.
5. Oil pressure sender, setup on wiring is defective.
    a. Remove P16 connection and check wiring between P16-9, P16-11 to the sender. Verify control is configured for the type of sender. Verify operation of the sender.

5.11.22 Engine Does Not Crank in Remote Mode

Logic:

This indicates that the PS0500 control has not received or recognized a remote start signal.

Possible Causes:

1. The remote start switch or wiring is faulty.

Diagnosis and Repair:

1. The remote start switch or wiring is faulty.
   a. Check if the control is in Auto mode and there are no shutdown faults present. Attempt to start, and check for ground at TB2-1.
      - If ground level is not present, isolate to the remote switch or wiring. Repair as necessary.
      - If ground level is present then the control is bad. Replace the control.

5.12 Troubleshooting - PowerCommand 2.3

5.12.1 No Code - The Operator Panel Is Unavailable After Changing the PCCNet Network

The Operator Panel was working until a PCCNet device was added or removed from the PCCNet network.

A. Bad Installation of PCCNet Device

1. Check the installation of the PCCNet device, in particular the connection at TB1. J25 and TB1 share the same electrical connection. If the PCCNet device is installed incorrectly, the Operator Panel on J25 stops working. Make sure the PCCNet device is connected correctly and is functioning properly.

5.12.2 Fault Code 121 - Loss of Speed Sense (Shutdown)

No engine speed signal detected from one of two signals: engine crankshaft speed or engine camshaft position.

A. Faulty Crankshaft Speed Sensor Connections

1. Inspect the crankshaft speed sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the crankshaft speed sensor.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Crankshaft Speed Sensor

1. Check the crankshaft speed sensor supply voltage.
   a. Disconnect the engine harness connector from the crankshaft speed sensor.
   b. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.

2. Check the crankshaft speed sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Camshaft Position Sensor Connections

1. Inspect the camshaft position sensor and the engine harness connector pins
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

D. Faulty Camshaft Position Sensor

1. Check the camshaft position sensor supply voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the camshaft position sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

E. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seal.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the crankshaft speed sensor.

c. Disconnect the engine harness from all sensors that have a shared supply or return with the crankshaft speed sensor.

d. Measure the resistance from the crankshaft speed 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

f. Measure the resistance from the crank shaft speed signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.

   a. Disconnect the extension harness from the control.

   b. Disconnect the extension harness from the engine harness.

   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.

   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.

   e. If the measurement is more than 100k ohms, then the resistance is correct.

4. Check for an open circuit on the crankshaft speed sensor conductors.

   a. Disconnect the engine harness connector from the extension harness.

   b. Disconnect the engine harness from the crankshaft speed sensor.

   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.

   d. If the measurement is less than 10 ohms, then the resistance is correct.

5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.

   a. Disconnect the engine harness from the extension harness.

   b. Disconnect the engine harness connector from the camshaft position sensor.

   c. Disconnect the engine harness from all sensors that have a shared supply or return with the camshaft position sensor.

   d. Measure the resistance from the camshaft position 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   e. Measure the resistance from the camshaft position return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   f. Measure the resistance from the camshaft position signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   g. If all measurements are greater than 100k ohms, then the resistance is correct.

6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.

   a. Disconnect the extension harness from the control.

   b. Disconnect the extension harness from the engine harness.

   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.

   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.

e. If the measurement is more than 100k ohms, then the resistance is correct.

7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the camshaft position sensor.
   c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

F. Faulty Extension Harness

1. Inspect the extension harness and control pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the crankshaft speed return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the camshaft position sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
    d. Measure the resistance from the camshaft position return pin on the extension harness connector to all other pins in the extension harness connector.
    e. Measure the resistance from the camshaft position signal pin on the extension harness connector to all other pins in the extension harness connector.
    f. If all measurements are greater than 100k ohms, then the resistance is correct.
6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
    a. Disconnect the extension harness from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
    d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
    e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
    a. Disconnect the extension harness from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
    d. If the measurement is less than 10 ohms, then the resistance is correct.

G. Damaged Crankshaft Target Wheel

1. Visually inspect the crankshaft target wheel.
    a. Inspect for damaged, malformed, missing or broken target wheel teeth.
    b. Inspect for evidence of corrosion or other materials on or around the target wheel teeth.
    c. Inspect for dirt or debris on the target wheel teeth.

H. Verify the calibrations in the PowerCommand controls

1. Using the display or the InPower Service tool, verify the calibration in the PCC.
    a. If the calibration in the PCC matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the base board.
    a. If the calibration in the base board matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the base board to the latest calibration.

5.12.3 Fault Code 151 - Engine Coolant Temperature High (Shutdown)

Engine coolant temperature has exceeded the alarm (shutdown) threshold for high coolant temperature.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.
2. Clean if necessary.

E. Coolant Level Is Below Specification

1. Inspect the engine, cooling system, and surrounding area for external coolant leaks.
2. Repair as required.
3. Verify that the coolant level is correct via the sight glass.
4. Add coolant as necessary.

F. Antifreeze And Water Mixture Is Not Correct

1. Verify the concentration of antifreeze in the coolant. Add coolant as necessary.

G. Fan Shroud Is Damaged Or Air Recirculation Baffles Are Damaged

1. Inspect shroud and baffles for damage and clearance.
2. Repair or replace if damaged.

H. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.
2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

I. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

J. Radiator Cap Is Faulty

1. Inspect radiator cap and gasket for damage and proper pressure operation.
2. Replace if damaged or worn.

K. Thermostat Is Faulty

1. Remove thermostat and inspect/test for proper operation.
2. Replace if damaged or malfunctioning.

L. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

M. Intake Manifold Air Temperature Is Above Specification

1. Use a thermocouple to verify manifold air temperature.
2. Repair or replace faulty after cooler components.

N. Cooling System Is Contaminated With Dirt, Scale, Or Sludge

1. Inspect cooling system components for external contaminates and clean as required.
2. Open the radiator cap and inspect for contaminated coolant and scale.
3. Flush the cooling system per the engine service manual.

O. Water Pump Is Malfunctioning

1. Inspect water pump for proper operation.
2. Replace if damaged or worn.

P. Air Or Combustion Gases Are Entering The Cooling System

1. Inspect engine for head gasket leak.
2. Repair or replace faulty components.

Q. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

R. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.

3. If the fault simulation is disabled, there is no problem.

S. Incorrect Threshold Setting

1. Use the service tool to connect to the base board (PCC) and verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.
3. Recalibrate the base board (PCC) to reset the threshold settings.

5.12.4 Fault Code 234 - Engine Speed High (Shutdown)

Engine speed signals indicate an engine speed greater than shutdown threshold.

A. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

B. Incorrect Threshold Setting

1. Use the service tool to connect to the base board (PCC) and verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.
3. Recalibrate the base board (PCC) to reset the threshold settings.

C. Incorrect Fuel Type Setting

1. Connect InPower
2. Verify the fuel source set with InPower is the same fuel used by the generator.

D. Faulty Engine Speed Sensor Connections

1. Inspect the engine speed sensor and the harness connector pins.
2. Disconnect the engine harness connector from the engine speed sensor.
3. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
4. Inspect for evidence of moisture in or on the connector.
5. Inspect for missing or damaged connector seals.
6. Inspect for dirt or debris in or on the connector pins.

E. Faulty Engine Harness - General

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.

f. Disconnect harness from base board and sensor.

g. Measure the resistance in each pin from base board to sensor. Resistance should be 5 ohms or less.

h. Repair or replace harness as necessary.

F. Faulty Extension Harness

1. Inspect the extension harness and the control connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to the exhaust gas temperature return pin on the extension harness inline connection.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the exhaust gas temperature signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.

G. Faulty Engine Speed Position Sensor

1. Inspect the engine speed sensor.
2. Disconnect the engine speed/position sensor from the engine and engine harness.
3. Inspect sensor for bent, corroded or loose pins.
4. Inspect the sensor for structural deficiencies.
5. Check the crankshaft speed sensor supply voltage.
6. Disconnect the engine harness connector from the crankshaft speed sensor.
7. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
8. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
9. Check the crankshaft speed sensor signal (sense) voltage.

10. Disconnect the engine harness connector from the camshaft position sensor.
11. Install the speed/position sensor breakout cable between the sensor and the sensor harness connector.
12. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

5.12.5 Fault Code 359 - Fail To Start

Engine has failed to start after the last crank cycle.

A. Faulty Ignition Relay

1. Remove the keyswitch relay. Measure resistance across terminals A1 and A2. If the resistance is infinite or zero, the coil is broken or shorted. Replace relay.
2. Check keyswitch relay signals at J26-13 and J26-15. When normal operation, J26-13 should have B+ and J26-15 should be ground.

B. Incorrect Flywheel Teeth Setting

1. Connect to the control via InPower. Make sure *Teeth Pulses Per Revolution* matches the actual number of flywheel teeth.

C. Incorrect Starter Disconnect Speed

1. Connect to the control via InPower. Make sure Starter Disconnect Speed is set to a reasonable value. Check the engine manual.

D. Faulty Engine Harness Oil Pressure Sensor

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the oil pressure sensor.
   d. Measure the resistance from the oil pressure 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the oil pressure return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the oil pressure signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Measure the resistance from the oil pressure return pin on the engine harness inline connector to the oil pressure return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

E. Faulty Extension Harness Oil Pressure Sensor

1. Inspect the extension harness and the AUX 105 connector pins.
   a. Disconnect the extension harness connector from the AUX 105.
   b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the AUX 105.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the oil pressure return pin on the extension harness connector to the oil pressure return pin on the extension harness inline connection.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the AUX 105.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the oil pressure 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the oil pressure return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the oil pressure signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.

5.12.6 Fault Code 427 - CAN Data Link Degraded

Communication between the engine control (ECM) and the generator set control is severed.

A. The Engine ECM Has Lost Power Or Failed

1. Emergency (E-Stop) button is a closed relay when it is pulled out (not active), and open relay when depressed (active). The E-Stop button on the Operator Panel disables power to the engine ECM when it is depressed (active); CAN-LINK communication will cease when power to the ECM is lost. Ensure that the E-Stop is not active on the control. Follow the procedure below:
    a. Reset the Local/Remote Emergency Stop.
        i. Pull-out (not active) the Local/Remote Emergency Stop button.
        ii. Press the Off button on the Operator Panel.
        iii. Press the Reset button.
        iv. Select Manual or Auto as required.
2. Ensure that the emergency stop button is functioning correctly, measure the outputs of the E-Stop (Normally Open and Normally Closed contacts) and ensure that the outputs switch state correctly when engaged and disengaged, replace the switch if faulty.
3. Check the wiring from the base board.
4. Keyswitch control relay is a normally open relay. Ensure that B+ is available at the relay input, then measure the voltage output. If there is a B+ at both the input and output of the Keyswitch control relay, the relay is not faulty. If B+ is noted at the input but not at the output of the Keyswitch control relay, replace the relay.
5. Connect to the engine ECM with InPower and/or Insite, to verify that the ECM is functioning properly and is communicating with the CAN-LINK network. Refer to the engine service manual for ECM troubleshooting procedures, if the ECM is faulty, replace.

B. The CAN Datalink Has Failed

1. There is a defective datalink harness connection, or open circuit; inspect the Datalink harness and connector pins from J11-20 to J1939+ and from J11-19 to J1039-; also check the shield ground connection at J11-17.
2. Check the terminating resistors. With connector J11 disconnected from the base board and the engine datalink connection disconnected from the ECM control, measure resistance between pins J11-19 and J11-20 (60 ohms is satisfactory). If the resistance is not 60 ohms, check the terminating resistors. Each of the two terminating resistors should be 120 ohms, replace if not 120 ohms.

5.12.7 Fault Code 611 - Engine Hot Shut Down

Engine shutdown hot without a proper cooldown run period.

A. Critical Shutdown Fault

1. A critical shutdown fault (e.g., overspeed) has caused the engine to shut down immediately without allowing the engine to complete the proper cooldown process. Troubleshoot the other shutdown fault(s) that are causing the generator set to shut down.

B. Emergency Shutdown

1. An Emergency Stop command has immediately shutdown the engine, which has bypassed the proper cooldown process for the engine.

C. Incorrect Shutdown of Generator Set

1. The generator set has been shut down without allowing the proper cooldown process for the engine (control switched to OFF manually by user/operator).

5.12.8 Fault Code 781 - ECM CAN Datalink Has Failed

Communication between the engine control module (ECM) and the generator set control is severed.

A. The CAN Datalink Has Failed

1. There is a defective datalink harness connection, or open circuit; inspect the Datalink harness and connector pins from J11-20 to J1939+ and from J11-19 to J1039-; also check the shield ground connection at J11-17.
2. Check the terminating resistors. With connector J11 disconnected from the base board and the engine datalink connection disconnected from the ECM control, measure resistance between pins J11-19 and J11-20 (60 ohms is satisfactory). If the resistance is not 60 ohms, check the terminating resistors. Each of the two terminating resistors should be 120 ohms, replace if not 120 ohms.

B. The Engine ECM Has Lost Power Or Failed

1. Emergency (E-Stop) button is a closed relay when it is pulled out (not active), and open relay when depressed (active). The E-Stop button on the Operator Panel disables power to the engine ECM when it is depressed (active); CAN-LINK communication will cease when power to the ECM is lost. Ensure that the E-Stop is not active on the control. Follow the procedure below:
    a. Reset the Local/Remote Emergency Stop.
        i. Pull-out (not active) the Local/Remote Emergency Stop button.
        ii. Press the Off button on the Operator Panel.
        iii. Press the Reset button.
        iv. Select Manual or Auto as required.
2. Ensure that the emergency stop button is functioning correctly, measure the outputs of the E-Stop (Normally Open and Normally Closed contacts) and ensure that the outputs switch state correctly when engaged and disengaged, replace the switch if faulty.
3. Check the wiring from the base board.
4. Keyswitch control relay is a normally open relay. Ensure that B+ is available at the relay input, then measure the voltage output. If there is a B+ at both the input and output of the Keyswitch control relay, the relay is not faulty. If B+ is noted at the input but not at the output of the Keyswitch control relay, replace the relay.
5. Connect to the engine ECM with InPower and/or Insite, to verify that the ECM is functioning properly and is communicating with the CAN-LINK network. Refer to the engine service manual for ECM troubleshooting procedures, if the ECM is faulty, replace.

5.12.9 Fault Code 1124 - Delayed Shutdown

Provides advance warning of an impending generator set shutdown to loads which cannot handle sudden losses of power.

A. A Shutdown Fault

1. Event/fault code 1124 is activated as a result of another non-critical shutdown fault. Troubleshoot the other non-critical shutdown fault(s) that is(are) causing the generator set to shutdown. This event/fault code was designed to send an external notification through a configurable customer output relay on the base board to loads which cannot handle a sudden loss of power. The generator set base board will send a signal to critical loads and will wait for the amount of time in the “Delayed Shutdown Time" parameter before shutting down the generator set. Go to **Setup > Genset Setup > Delayed shutdown delay** from the operator panel and set appropriately.

5.12.10 Fault Code 1131 - Battle Short Active

Battle Short has been enabled.

A. Battle Short Enabled

1. Disable Battle Short.
   a. The purpose of this fault is to provide a record in the fault history and fault occurrence list that the Battle Short feature is activate. The Battle Short fault becomes active when all of the following are true:
      - The Battle Short parameter is Enabled.
      - One of the configurable inputs on the base board is configured for Battle Short.
      - The configurable input configured for Battle Short becomes Active.

5.12.11 Fault Code 1132 - Controlled Shutdown

A fault set to Shutdown with Cooldown is active and has put the generator set in a controlled shutdown.

A. A Fault Set to Shutdown With Cooldown is Active

1. Event/fault code 1132 is activated by another active event/fault that is set to "Shutdown with Cooldown". Troubleshoot the other shutdown fault(s) that are causing the generator set to shutdown. A controlled shutdown of the system allows first for loads to be transferred or ramped off, and then for a proper cooldown of the generator set to take place before shutting down. Go to **Setup > Genset Setup > Ctrld Shutdown Advance** from the Operator Panel in order to appropriately set the Controlled Shutdown Advanced Notice Delay.

5.12.12 Fault Code 1243 - Engine Derated

Event/fault code 1243 will become active if the engine has gone into a derate mode to protect itself from a shutdown, and if there are no other active derate events on the PCC.

A. A Derate Condition Has Been Initiated by The Engine Base Board

1. Event/fault code 1243 is activated by another active engine fault. Determine the fault(s) that caused the engine to derate by checking the operator panel or using InPower or InSite to connect to the base board. Troubleshoot the event/fault(s) and resolve the issue(s) (Reference the Engine Service Manual). After the issue is resolved, press the Reset button on the genset control to allow the genset to return to a normal mode of operation. If the issue is not resolved when the Reset button is pressed, the engine will stay in derated mode.

5.12.13 Fault Code 1245 - Engine Shutdown Fault

Engine shutdown fault has occurred in the base board, and no other active shutdown faults exist on the PCC.

A. Engine Shutdown Fault

1. Event/fault code 1245 is activated by another active shutdown fault in the base board. Connect to the Ebase board with InPower to determine the actual shutdown fault that is generating event/ fault code 1245; then troubleshoot the shutdown fault(s) (Reference the Engine Service Manual).

5.12.14 Fault Code 1246 - Unknown Engine Fault

An unrecognized engine fault has been received over the datalink.

A. The genset control has received an unknown event/fault code from the Base Board

1. Connect directly to the base board with InPower or the ECM with InSite to determine the actual warning or shutdown fault that is generating event/fault code 1246. Troubleshoot the fault(s) that are causing the genset to display event/fault code 1246 (Reference the Engine Service Manual).

5.12.15 Fault Code 1248 - Engine Warning

An engine warning fault has occurred in the base board, and there are no active warning faults on the PCC.

A. An Engine Warning Fault Is Active

1. Event/fault code 1248 is activated by another active warning fault in the base board. Connect to the base board with InPower or the ECM with Insite to determine the actual warning fault that is generating event/fault code 1248; then troubleshoot the warning fault(s) (Reference the Engine Service Manual).

5.12.16 Fault Code 1311 - Ruptured Basin (Warning or Shutdown)

Logic:

This fault is used when an optional ruptured basin switch is installed. The nature of the fault is an optional customer selection.

The fault function can be programmed (using the InPower service tool), as follows:

- Enable/disable input (Default: enable)
- Status, Warning, or Shutdown (Default: #1-None, #2 and #3-Warning)
- Active closed or open (Default: closed [ground])
- Change the display name using up to 19 characters (Default: #1- Customer Fault 1, #2-Ground Fault, #3-Low Fuel)

A. Disconnect The Signal Lead From TB1 and Reset The Control

1. CONFIG INPUT 1 TB1-12
2. If the message goes away, the external wiring has a short circuit. Grounding of either input activates fault.

5.12.17 Fault Code 1416 - Fail To Shutdown

To provide a record in the fault history that generator set shutdown faults were bypassed while the control was in Battle Short mode.

A. A Shutdown Fault was Bypassed While the Battle Short Feature was Enabled on the Control

1. Event/fault code 1416 is activated because of an active “Shutdown fault" while the control is operating in battle-short mode. Troubleshoot the other shutdown fault(s) that are causing the generator set to display event/fault code 1416.

5.12.18 Fault Code 1417 - Power Down Failure

The PCC has failed to go to sleep.

A. Faulty Base Board

1. Remove power (B+) from the PCC for 5−10 seconds and reconnect B+ to the PCC. If the PCC fails to go to sleep after power is cycled from the PCC and the PCC shows event/fault code 1417 again, replace the base board.

5.12.19 Fault Code 1433 - Local E-Stop

The Local Emergency Stop has been activated.

A. The Local Emergency Stop Button Has Been Activated

1. Pull the Local Emergency stop button out.
2. Press the Off button.
3. Press the Reset button.
4. Select Manual or Auto as required.

B. Faulty Connection Or Faulty Emergency Stop Switch

1. Check the Emergency Stop button, and verify that it is working properly. The Emergency Stop button is a closed relay when it is pulled out (not active), and open relay when depressed (active).
2. Verify that the connection/wiring from the Local Emergency Stop switch to the control for an open circuit condition. A ground connection to the Local E−Stop control input (J25 – 2 Input; J25 – 6 Ground) disables the emergency stop alarm. An open circuit should activate the Emergency stop alarm.

   J25 – 2 Input

   J25 – 6 Ground

5.12.20 Fault Code 1434 - Remote E-Stop

The Remote Emergency Stop has been activated.

A. The Remote Emergency Stop Button Has Been Activated

1. Reset the Remote Emergency Stop:
   a. Pull the Remote Emergency stop button out.

b. Press the Off button.

c. Press the Reset button.

d. Select Manual or Auto as required.

2. If the Remote Emergency Stop is not used:

   a. Install a jumper between the following:

      TB1 – 16 Input

      TB1 – 15 Ground

   b. Reset the Remote Emergency Stop:

      i. Pull the Remote Emergency stop button out.

      ii. Press the Off button.

      iii. Press the Reset button.

      iv. Select Manual or Auto as required.

B. Faulty Connection Or Faulty Emergency Stop Switch

1. Check the Emergency Stop button, and verify that it is working properly. The Emergency Stop button is a closed relay when it is pulled out (not active), and open relay when depressed (active).

2. Verify that the connection/wiring from the Remote Emergency Stop switch to the PCC for an open circuit condition. A ground connection to the Remote E−Stop control input (TB1 – 16 Input; TB1 – 15 Ground) disables the emergency stop alarm. An open circuit should activate the Emergency stop alarm.

   TB1 – 16 Input

   TB1 – 15 Ground

5.12.21 Fault Code 1435 - Low Coolant Temperature

Engine coolant temperature is below the low coolant temperature warning threshold.

A. Threshold Is Set Too High

1. On the operator panel, access the LCT Warning Threshold parameter by navigating to **Setup > Genset Setup > LCT Warning Threshold.** Verify that the LCT Warning Threshold parameter is set to an appropriate threshold.

B. Faulty or Incorrectly Configured PCCNet Annunciator

1. If a PCCNet Annunciator is not used, go to step 3. If a PCCNet Annunciator is used, check the wiring from the back of the PCCNet Annunciator at TB2-8 to the Low Coolant Temp sender and ensure that an open circuit or short circuit does not exist in the wiring.

2. Refer to the PCCNet Annunciator Operator's Manual to ensure that the Annunciator is configured correctly; since inputs can be configured to Active Open or Active Closed. Then check the input on the back of the PCCNet Annunciator at TB2–8 and insure that the input signal into the PCCNet Annunciator is properly configured.

C. Coolant Heater(s) Are Not Operating Properly

1. Ensure that the coolant heater(s) are connected properly to a working power supply:

   - Check for open circuits in the wiring.

- Ensure that the power supply of the coolant heater is working properly.

2. Measure the temperature of the coolant heater(s) using a proper temperature measuring device. If the ambient temperature is above 4.5 °C (40 °F), the measured temperature of the coolant heater(s) should be above 32 °C (90 °F).
   - If the temperature of the coolant heater(s) is close to the ambient temperature, replace the coolant heater(s).
   - If the ambient temperature is very low, do not replace the coolant heaters, go to "Thermostat Not Operating Properly".

D. Low Ambient Temperature

1. If the coolant heaters are working properly and the radiator has enough coolant, but the ambient temperature around the generator set is less than 3.5 °C (40 °F), the coolant heaters might not have the capability to keep the coolant temperature above 21 °C (70 °F). This could be an application issue and will need to be further investigated.

E. Thermostat Not Operating Properly

1. Check the operation of the thermostat.

5.12.22 Fault Code 1438 - Fail to Crank (Shutdown)

The engine failed to crank after the generator control received a start signal.

A. Dead or Weak Battery

1. Verify battery voltage is at least 12 VDC (24 VDC where applicable).
2. Charge or replace the battery as necessary.

B. Blown 20Amp Supply Fuse

1. Verify the switched B+ supply fuse is in place and functional.
2. Replace fuse as necessary.

C. Failed Starter

1. Press the Reset/Fault Acknowledge button on the display.
2. Attempt to start the generator and test for B+ at the starter supply lug.
3. If B+ is present at the starter supply lug, the starter could be defective. Test the starter according to the appropriate engine service manual and replace if faulty.
4. If B+ is not present at the starter, check the emergency stop switch and switch connections.

D. Failed Starter Solenoid

1. Press the Reset/Fault Acknowledge button on the display.
2. Check wiring for continuity between terminal 87 on the starter relay and start solenoid SW terminal. Resistance should be less than 5 Ohms.
3. Attempt to start the generator and test for B+ at SW terminal of the starter solenoid.
4. Check wiring for continuity between the solenoid COM terminal and B+ lug of the battery. Resistance should be less than 5 Ohms.
5. Attempt to start the generator and test for B+ at the solenoid output lug.

6. If B+ is not present, the starter solenoid is defective.

E. Failed Starter Relay

1. Check wiring for continuity between terminal 86 on the starter relay and J20-13 control board terminal. Resistance should be less than 5 Ohms.
2. Check wiring for continuity between terminal 85 on the starter relay and J20-15 control board terminal. Resistance should be less than 5 Ohms.
3. Check for B+ at terminal 30 on the starter relay. If voltage is not present, verify 20 Amp fuse is in place and functional.
4. Attempt to start the generator and test for B+ at terminal 86 of the starter relay.
5. Check wiring for continuity between terminal 85 of the starter relay and ground. Resistance should be less than 5 Ohms.
6. Attempt to start the generator and test for B+ at terminal 87 of starter relay.
7. If B+ is not present, the starter relay is defective.

F. Engine Or Rotor Is Locked Or Binding

1. Verify that the generator can rotate freely by barring the engine over by hand. If generator cannot be turned over, identify the source of bind and repair as necessary.

G. Failed Emergency Stop Switch Or Wiring

1. Push emergency stop button in, remove the configurable leads from TB1–15 and TB1–16 and check for continuity between these two leads.
2. If the circuit is open, isolate to the emergency stop switch and wiring.
3. Push emergency stop button in and remove P25 from the base board. Check for continuity between J25–2 and J25–6.
4. Repair or replace the emergency stop switch or the wiring as necessary.

5.12.23 Fault Code 1439 - Low Day Tank Fuel

Indicates day tank fuel supply is running low.

A. Fuel Sender Incorrectly Wired

1. Check the wiring for improper wiring, a short or open circuit from the fuel sensor to the discrete configurable input on the base board that was configured for the “Low Day Tank Fuel Level". If a short or open circuit or improper wiring is found, correct the wiring.

B. Faulty Fuel Sender

1. Measure the resistance of the fuel sender at the day tank. If the sender is reading incorrectly (Shorted or Open Circuit), replace the fuel sender.

C. The Configurable Input Active State Selection Parameter is Configured Incorrectly

1. With InPower or through the operator panel, check the switch input setting (active closed or active open) for the configurable input that was configured to “Low Fuel in Day Tank Switch". Ensure that the switch input setting is correctly set. If the “Configurable Input Function Pointer" parameter is set to “Low Fuel in Day Tank Switch" and the “Configurable Input Active State Selection" parameter is set to “active closed", event/fault code 1439 will become active when the configurable input that was configured to “Low Fuel in Day Tank Switch" is connected to ground.

   If the “Configurable Input Function Pointer" parameter is set to “Low Fuel in Day Tank Switch" and the “Configurable Input Active State Selection" parameter is set to “active open", event/fault code 1439 will become active when the configurable input that was configured to “Low Fuel in Day Tank Switch" is an open circuit.

   To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the “Configurable Input Active State Selection" parameter appropriately for the configurable input that was configured to “Low Fuel in Day Tank Switch".

5.12.24 Fault Code 1441 - Low Fuel Level

The "Fuel level % (AUX 101)" input has gone below the "Low Fuel Level Threshold (AUX 101)" setting for the time in the "Low Fuel Level Time (AUX 101)" setting.

A. Fuel Sender Incorrectly Wired

1. Check the wiring of the fuel sensor.
   a. Ensure that the sender is correctly wired to the base board. Check the wiring for a short circuit from the fuel sensor to the input on the base board that is configured for the “Fuel Level". If a short circuit is found, correct the wiring.

B. Faulty Fuel Sender

1. Measure the resistance between the fuel level signal pin and the fuel level return pin. The resistance should be between 600 Ohms to 2500 Ohms when the tank is full. Replace the sender if the resistance value is below the recommended threshold when the fuel tank is full.

C. The Low Fuel Set/Clear Time Parameter is Configured Incorrectly

1. Check the low fuel level setup parameter. To access the input configuration on the operator panel go to **Setup > Genset Setup** and set the "Low Fuel Set/Clear Time" parameter appropriately for the application.

5.12.25 Fault Code 1444 - kW Overload

The "Overload Threshold" has been exceeded for the time that is registered in the "Overload Set Time" parameter.

A. The Overload Threshold Parameter is Set Too Low

1. To access the input configuration on the operator panel go to **Setup > Genset Setup** and set the "Overload Threshold" parameter appropriately for the application. Refer to the parameter section to see the default value for Overload (Setting the overload threshold too high can cause damage to the alternator).

B. Short In the Load or Load Cables

1. Check the load and load cables. Repair if necessary.

C. Incorrect CT Ratio, CTs, or CT Connections

1. Check the CT Ratio, CTs, and CT connections, reference event/fault code 2814.

D. Incorrect PT Ratio, PTs, or PT Connections

1. Check the PT Ratio, PTs, and PT connections, reference event/fault code 2816

5.12.26 Fault Code 1445 - Short Circuit

The generator output current has exceeded 175% of rated current.

NOTICE
This fault remains active and cannot be reset until the Alternator Overheat Integral time has expired (which takes up to five minutes). The Alternator Overheat Integral time allows the alternator to cool down before allowing a restart.

A. Short In the Load or Load Cables

1. Check the load and load cables. Repair if necessary.

B. Faulty CTs, Incorrect CT Ratio, CTs, CT Connections

1. Verify the CT connections are correct from the CTs to the input of the base board.
2. Ensure the control is set up for the correct CT ratio. Reference event/fault code 2814 for CT ratio troubleshooting information.
3. Check the current going into the CT input on the control board (use a current probe to check the secondary output of the CT). This should be the value that the control secondary is calibrated with. (e.g. If the control is calibrated with a CT Ratio of 1000:5, the current input into the base board should not be more than 5 A.)
4. If previous steps check out ok, replace the base board.

5.12.27 Fault Code 1446 - High AC Voltage

One or more of the phase voltages has exceeded the high AC voltage threshold.

A. Fault Simulation is Enabled

Connect with InPower and ensure that the fault simulation for High AC Voltage is not enabled. If InPower is not available, cycle power to the control:

1. Depress the Emergency Stop button and wait 30 seconds.
2. Disconnect/disable the battery charger.
3. Disconnect the battery (disconnect negative first).
4. Leave the controller without power for 1 minute.
5. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. The High AC Voltage Trip Parameter is Incorrectly Set For the Application

1. Ensure that the High AC voltage parameter is set correctly for the application.

   If the control is set up as “Inverse time", it will be more sensitive to voltage spikes and will trip more rapidly; “Inverse time" follows the “Instantaneous High AC Voltage Threshold".

   If the control is set to “Fixed Time", it will allows a greater time delay until shutdown when voltage overshoots; when trying to start a large motor, the “Fixed time" setting is recommended. This parameter works with the “High AC Voltage Delay" parameter.

   To access the configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > High AC Voltage Trip** and set the “High AC Voltage Trip" parameter appropriately for the application.

C. The High AC Voltage Threshold is Set Too Low for the Application

1. To access the High AC Voltage configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > High AC Voltage Threshold** and set the “High AC Voltage Threshold" parameter appropriately for the application. Refer to the parameter list to see the default value for High AC Voltage.

D. Faulty PTs, Incorrect PT Ratio, PTs, PT Connections

1. Check the connections from the alternator to the PT, and from the PT to the base board. (Three phase inputs on the base board: L1 = J22-1, L2 = J22-2, L3 = J22-3, LN = J22-4; for single phase use L1, L2 and LN). If the wires are incorrectly connected, or there is an open circuit, correct the wiring issue. (If the voltage input is less than 600 VAC, a PT is not required.)
2. Ensure that the control is set up with the correct PT ratio (primary vs. secondary). Reference event/fault code 2816 for troubleshooting information on the PT ratio. To access the PT Ratio configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the PT ratio appropriately for the application.
3. Measure the voltage going into the PT from the alternator.

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

   Then measure the voltage output of PT to the base board. (Three phase inputs on the base board: L1 = J22-1, L2 = J22-2, L3 = J22-3, LN = J22-4; for single phase use L1, L2 and LN). The control calibrated PT ratio (PT voltage input: PT voltage output) should match the voltage input into and output of the PT.
4. If the control calibrated PT ratio matches the voltage input into the PT, but does not match the voltage output (e.g., control calibrated PT ratio is 13,500:480, the voltage input into the PT is 13,500 VAC, but the output of the PT is 589 VAC instead of 480 VAC), replace the PT module.

E. Faulty AVR

1. For alternators that do not include an AVR, go to step 3.

2. Measure the output of the AVR at J17-1 and J17-2. The output should be at 9-12 VDC when the generator set is operating at “No Load". If the voltage output of J17-1 and J17-2 is constantly high, then the AVR portion of the base board is faulty. Replace the base board.
3. Using a True RMS meter, measure the PWM at J19-2 (AVR PWM +) and J19-9 (AVR PWM -) while turning the generator set “ON". This is a 2.5 VDC max output from the base board to the AUX 103 AVR; if the voltage at J19-2 and J19-9 is continuously 2.0-2.5 VDC, without any change, then replace the base board.
4. Measure the output of the AUX 103 AVR at J17-1 and J17-2, the output should be at 9-12 VDC when the generator set is operating at “No Load", if the voltage output of J17-1 & J17-2 is constantly high, then the AUX 103 AVR is faulty replace the AUX 103 AVR.

F. Faulty PMG

1. Start the generator set and run at rated speed. Measure the voltages at the AVR terminals P2 (J18-1), P3 (J18-2), and P4 (J18-3). These should be balanced and within the following ranges:

   50Hz generators - 170-180 Volts

   60Hz generators - 200-216 Volts
2. Should the voltages be unbalanced, stop the generator set, remove the PMG sheet metal cover from the non drive end bracket and disconnect the multi-pin plug in the PMG output leads. Check leads P2, P3, and P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within +/-10% of 2.3 Ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct the PMG rotor must be replaced.

G. Governor Preload Offset Percentage Too High

If this fault code occurs during startup,

1. Connect with InPower.
2. Check the governor preload offset percentage. The higher the percentage, the larger the overshoot. Lower the governor preload offset.

5.12.28 Fault Code 1447 - Low AC Voltage (Shutdown)

One or more of the phase voltages has dropped to 85% of nominal for more than 10 seconds.

A. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

B. Incorrect Threshold Setting Or AVR Settings

1. Check threshold settings.
2. Connect InPower.
3. Verify that fault threshold is within the normal operating range for low AC voltage.
4. Verify AVR settings. Compare gains, settings, and calibration factors against default calibrations.
5. Adjust or recalibrate as necessary

C. Overload

1. Check for overload.
2. Check that load is within proper operating range.
3. Check inrush current.
4. Check for current spikes.
5. Check for motor starts.
6. Check operation by disconnecting the load and restarting the unit.
7. Correct any overload.

D. Improper Connections At Generator Output Terminals

1. Check connections.
2. Compare connections in generator to wiring schematic.
3. Correct according to the appropriate schematic as needed.

E. The Voltage Sense Or Setup Wiring Connection Could Be Incorrect

1. Verify that the voltage sensing inputs J22-1, J22-2, J22-3, and J22-4 are connected to L1, L2, L3, and L4 respectively.
2. Verify that excitation inputs J18–1 and J18–2 are connected to the correct generator PMG terminals.

F. Damaged Voltage Regulator

1. Bring the generator to idle.
2. Connect InPower.
3. Using InPower, verify that the AC voltage output is greater than residual.
4. If the AC voltage output is residual, than the regulator is operating correctly.
5. Inspect the voltage regulator and the generator control harness connector pins.
6. Turn off the generator.
7. Disconnect the generator control harness from the voltage regulator.
8. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

G. The Rotating Rectifier Assembly (diodes CR1 through CR6) Is Faulty

1. Check each diode. See the alternator service manual.

5.12.29 Fault Code 1448 - Underfrequency

The frequency has dropped below the “Underfrequency Threshold" for the time set in the “Underfrequency Delay" parameter.

A. Fault Simulation is Enabled

1. Connect with InPower and ensure that the Fault simulation for Low Frequency is not enabled. If InPower is not available, cycle power to the control:
    a. Depress the Emergency Stop button and wait 30 seconds.
    b. Disconnect/disable the battery charger.
    c. Disconnect the battery (disconnect negative first).
    d. Leave the controller without power for 1 minute.
    e. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. Underfrequency Threshold is Set Too High

1. To access the Underfrequency configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Underfrequency Threshold** and set the “Underfrequency Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Underfrequency.

C. Overload

1. Ensure that the load on the generator set does not exceed the Genset KW Rating. If the generator set is producing correct frequency with no load, but shutting down on underfrequency when the generator set picks up certain loads, the underfrequency shutdowns are being cause by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set. Revisit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

5.12.30 Fault Code 1449 - Overfrequency

Frequency has gone above the "Overfrequency Threshold" for the time that is registered in the "Overfrequency Delay" parameter.

A. Fault Simulation is Enabled

1. Connect with InPower and ensure that the Fault simulation for Overfrequency Enable is not enabled. If InPower is not available, cycle power to the control:
    a. Depress the Emergency Stop button and wait 30 seconds.
    b. Disconnect/disable the battery charger.
    c. Disconnect the battery (disconnect negative first).
    d. Leave the controller without power for 1 minute.
    e. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. Overfrequency Threshold is Set Too Low

1. To access the Overfrequency configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Overfrequency Threshold** and set the "Overfrequency Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Overfrequency.

5.12.31 Fault Code 1459 - Reverse Power

The “Reverse KW threshold" has been exceeded for the time that is registered in the “Reverse KW time delay" setting.

A. CTs are Incorrectly Connected or Installed

1. If event/fault code 1459 becomes active as soon as the generator set picks up load, check the generator set operator panel under the **Alternator Data** menu and view the **L1 KW, L2 KW, and L3 KW** parameters when the generator set picks up load (right before the generator set shuts down). If L1 KW, L2 KW, or L3 KW is a negative value, it is likely that the CT connected to the negative KW value has an incorrect orientation or is connected backwards. Verify the CT orientation and CT wiring at L1: J12-1 and J12-4, L2: J12-2 and J12-5, L3: J12-3 and J12-6, correct if miswired.

B. Reverse KW Threshold Is Set Too Low

1. To access the Reverse KW threshold configuration menu on the operator panel go to **Setup > Genset Setup > Reverse KW Threshold** and set the “Reverse KW Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Reverse KW.

C. Loading Issue

1. Ensure that the load on the genset does not exceed the Genset KW Rating. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imaging Equipment, and Fire Pumps have a considerable and different influence on a generator. Revisit the genset sizing process to ensure that the genset is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

NOTICE
Increasing the KW threshold or time delay may have adverse effects on the alternator. Always check the capability of the alternator

5.12.32 Fault Code 1461 - Loss of Field

The “Reverse KVAR threshold" has been exceeded for the time that is registered in the “Reverse KVAR time delay" setting.

A. Improperly Set Leading Power Factor

1. If loss of excitation occurs when the generator set is lightly loaded, a leading power factor may be the cause. Leading Power factor can be caused by operation of filters and power factor correction capacitors when the KW load level on the generator set is low. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imaging Equipment, Fire Pumps and certain types of lighting have a considerable and different influence on a generator and can also cause a leading power factor. Leading power factor loads can cause the generator set to lose control of the output voltage of the generator set. To access the Power Factor menu on the operator panel, go to **Alternator Data** and view the value of L1 PF, L2 PF, L3 PF, and Total PF, right before the generator set shuts down on event/fault code 1461. Revisit the generator set sizing process if the power factor is leading to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

NOTICE

Increasing the KVAR threshold or time delay may have adverse effects on the alternator. Always check the capability of the alternator.

5.12.33 Fault Code 1464 - Load Dump

If the "Load Dump" parameter is enabled and the generator set KW output exceeds the "Overload Threshold" for the "Overload Set Time" or the output frequency of the generator set drops below the "Under-frequency Offset" for the "Under-frequency Set Time"; the generator set will dump its electrical load.

A. Active Fault Code Is Set To Derate

1. Event/fault code 1464 can be activated as a result of another active fault that is set to "Derate". Troubleshoot the other active fault(s) that are set to Derate.

B. The Under-frequency Offset Is Set To Low

1. To access the Under-frequency Offset configuration menu on the operator panel go to **Setup > Genset Setup** and set the "Under-frequency Offset" parameter appropriately for the application. Refer to the parameter list to see the default value for "Under-frequency Offset".

C. The Overload Set Time or Under-frequency Set Time Is Set Too Low

1. To access the "Overload Set Time" and "Under-frequency Set Time" configuration menu on the operator panel go to **Setup > Genset Setup** and set the "Overload Set Time" and "Under-frequency Set Time" Parameters appropriately for the application. Refer to the parameter list to see the default values for "Overload Set Time" and "Under-frequency Set Time".

D. Incorrect CTs or CT Connections

1. Check the CTs, CT Connections, and CT ratio. For installation instructions, refer to the section on Current Transformer Installation or reference event/fault code 2814 and event/fault code 2815.

5.12.34 Fault Code 1469 - Speed/Hz Mismatch

Engine speed and genset output frequency do not match.

A. Fly Wheel Teeth Number Is Incorrectly Set

1. Access the Flywheel Teeth setup screen through the Operator Panel and ensure that the PCC is set up with the correct number of engine flywheel teeth.

B. Faulty Magnetic Pick-up

1. Inspect the MPU wires/connector pins for shorts and open circuits. Remove the MPU connectors and check for 3.5 to 15 VAC at the MPU while cranking. If the MPU tests satisfactorily, then check the voltage output of the board at J11-9 (MPU +) and J11-10 (MPU -).

C. Incorrect Engine Speed Data

1. Through the operator panel verify the engine speed by going to **Engine Data > Engine Speed.** Refer to the engine service manual to correct.

Correct Speeds

1800 RPM at 60 Hz

1500 RPM at 50 Hz

D. A New Alternator Was Installed With A Different Number Of Poles

1. If a new alternator with a different number of poles replaced an original alternator, then the speed and frequency ratio is inaccurate. Go to **Setup > OEM Setup >OEM Engine Setup > Freq/Speed** and adjust the “Frequency to Speed Gain Select" parameter accordingly to the alternator. To calculate the Frequency to Speed value use the following equation:

   Frequency to Speed = 120 / Number of poles of the Alternator

E. Load Induced

1. Non-linear loads like Uninterruptible Power Supply (UPS) and certain types of lighting have a considerable and different influence on a generator which can cause significant frequency fluctuations that do not match measured engine speed; ex: a UPS causes 62 Hz at 1800 RPM. This is an application issue; correct the application issue and refer to the T030 manual.

F. Speed/Frequency Mismatch Threshold Set Too Low

1. Connect with InPower
2. Make sure the speed/frequency mismatch threshold is set within 0.1-20 Hz.

G. Speed/Frequency Mismatch Fault Time

1. Connect with InPower.
2. Make sure the speed/frequency mismatch threshold time is set within 0.2-10 sec.

H. Frequency-to-speed Gain Select

1. Connect with InPower.
2. Make sure the frequency-to-speed gain select is set properly.

I. Gearbox Teeth Incorrect

In the case of gearbox setup, make sure the settings are correct.

1. Connect with InPower.
2. Make sure the flywheel teeth parameter is set to the number of teeth of the gearbox.

5.12.35 Fault Code 1471 - High AC Current (Warning)

The generator output current has exceeded at least 110% of rated current for greater than 60 seconds.

A. Short or overload

1. Inspect the load cables and the AC harness connections.
2. Disconnect the AC harness from the load cables.
3. Inspect the AC harness and board connector pins.
4. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

5. Check for a short circuit to engine block ground.

B. Incorrect CTs, CT Connections, Or CT Setup

1. Check CTs.
   a. Check that correct CT's have been installed.
   b. Check that CT connections are secure by zip ties to corresponding wires.
   c. Check that CTs are installed in the correct order.
   d. Connect InPower.
   e. Verify the correct CT ratio has been entered in the generator setup.
   f. Adjust the setting(s) as necessary.

C. CT Harness Connections

1. Measure the resistance of the CT harness on each pin.
2. Disconnect connector P12 from the control board and CTs.
3. Verify the resistance from board connector to CT connections. Resistance should be 5 ohms or less.
4. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
5. Verify the CT connections are correct from P12 to the CT terminals.

   P12–1 (CT1) to P12–4 (CT1–COM)

   P12–2 (CT2) to P12–5 (CT2–COM)

   P12–3 (CT3) to P12–6 (CT3–COM)
6. Re-terminate connections as necessary.

D. Incorrect Rating Setup

1. Connect InPower.
2. Verify the generator rating in the control is set correctly.
3. Verify CT ratings in the control are set correctly.
4. Adjust settings as necessary.

5.12.36 Fault Code 1472 - High AC Current (Shutdown)

The generator output current has exceeded at least 150% of rated current.

A. Short or overload

1. Inspect the load cables and the AC harness connections.
2. Disconnect the AC harness from the load cables.
3. Inspect the AC harness and board connector pins.
4. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
5. Check for a short circuit to engine block ground.

B. Incorrect CTs, CT Connections, Or CT Setup

1. Check CTs.
    a. Check that correct CT's have been installed.
    b. Check that CT connections are secure by zip ties to corresponding wires.
    c. Check that CTs are installed in the correct order.
    d. Connect InPower.
    e. Verify the correct CT ratio has been entered in the generator setup.
    f. Adjust the setting(s) as necessary.

C. CT Harness Connections

1. Measure the resistance of the CT harness on each pin.
2. Disconnect connector P12 from the control board and CTs.
3. Verify the resistance from board connector to CT connections. Resistance should be 5 ohms or less.
4. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
5. Verify the CT connections are correct from P12 to the CT terminals.

    P12–1 (CT1) to P12–4 (CT1–COM)

    P12–2 (CT2) to P12–5 (CT2–COM)

    P12–3 (CT3) to P12–6 (CT3–COM)
6. Re-terminate connections as necessary.

D. Incorrect Rating Setup

1. Connect InPower.
2. Verify the generator rating in the control is set correctly.
3. Verify CT ratings in the control are set correctly.
4. Adjust settings as necessary.

5.12.37 Fault Code 1689 - Reset Real Time Clock

Power to the Real Time Clock (RTC) chip on the base board has been lost and the clock is no longer accurate.

A. Battery Power Has Been Lost

1. The RTC chip requires little, but constant, power to keep the control's internal clock accurate. It has an internal capacitor that keeps the RTC operating for up to 1 hour when the battery is disconnected or dead. If battery power is lost for over 1 hour, the RTC will stop functioning. When battery power is supplied to the control again, the control will display event/fault code 1689, because the RTC is no longer accurate. If the fault clears after being acknowledged, then the control is OK. To set the real time clock, on the operator panel go to **Setup > Clock Setup** and set the RTC clock appropriately.

5.12.38 Fault Code 1847 - Engine Coolant Temperature High (Shutdown with Cooldown)

Exhaust gas temperature sensor signal is out of range – shorted high.

A. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

B. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

C. Threshold Setting Too Low

1. Use the service tool to connect to the base board and verify fault threshold settings for the sensor and compare to the specifications called out in the engine manual.
2. Verify base board and PCC calibration number and revision is correct.
3. Recalibrate the engine base board to reset the threshold settings.

5.12.39 Fault Code 1915 - Genset Phase Rotation

Generator set phase rotation is incorrect.

A. Genset Voltage Sensing Connections are Incorrectly Wired at the Base Board

1. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.
   - Measure the phase rotation and voltage input into the base board from the Generator set at: L1, J22-1; L2, J22-2; L3, J22-3. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring.
2. If the nominal voltage is over 600 VAC, measure the voltage sensing connections from the base board to the PT and the PT to the Generator set.

⚠ WARNING

Hazardous Voltage

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

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

- Measure the phase rotation and voltage input into the base board from the PT (Potential Transformer) at: L1, J22-1; L2, J22-2; L3, J22-3. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the base board to the PT and correct if necessary.
- Measure the phase rotation and voltage input into the PT (Potential Transformer) from the Generator set. The voltage into the PT should match the Generator set voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the PT to the Generator set and correct if necessary.

5.12.40 Fault Code 2335 - Excitation Fault

The control has detected the simultaneous loss of all phases of sensing.

A. Incorrectly Configured or Wiring Issue

1. Ensure that the configuration of the “Lost AC Voltage Threshold" parameter is set appropriately for the application. To access the Lost AC Voltage Threshold configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Lost AC Voltage Threshold** and set the “Lost AC Voltage Threshold" parameter appropriately for the application. Refer to the parameter list to see the default value for “Lost AC Voltage Threshold".
2. All the connections that are used to calculate voltage and current by the control have been lost (either by disconnection or no voltage, current, frequency input into the control, etc.) Check the voltage sensing (L1: J22 -1; L2: J22 -2, L3: J22-3, L4: J22-4) and current sensing (L1: J12-1, J12-4; L2: J12-2, J12-5; L3: J12-3, J12-6;) connections into the control and ensure that voltage and current are available at these connections when the genset is running. If using a PT also check the inputs and outputs of the PT.

5.12.41 Fault Code 2336 - Checksum Fault

Integrity check has found corrupted memory block(s) in the PCC.

A. PCC Has Corrupted Memory Block(s)

1. The PCC has corrupted memory block(s), this is indicated by all of the LEDs on the base board flashing. Perform an initial calibration on the base board with the newest Incal files. If the Incal update does not resolve the issue, then replace the base board.

5.12.42 Fault Code 2342 - Too Long In Idle

The engine has been running at Low Speed Idle for a time longer than the "Max Idle Time" parameter.

A. Idle Time Parameters are Configured Incorrectly

1. If the genset has been running in Idle and displays event/fault code 2342, ensure that the genset is not configured to run in idle for more than 10 min. Long periods of engine idling (more than 10 min) can eventually affect engine performance and may not be covered by the engine warranty. Set the **"Idle Warmup Time"** and **"Idle Cooldown Time"** to an appropriate value. To access these parameters, on the operator panel go to **Setup > Genset Setup > Idle Warmup Time** or **Idle Cooldown Time** and set these parameter appropriately for the application. Refer to the parameter list to see the default value for "Idle Warmup Time" and "Idle Cooldown Time".
2. The "Max Idle Time" parameter might be set too low. To access the Max Idle Time configuration menu on the operator panel go to **Setup > Genset Setup > Max Idle Time** and set the "Max Idle Time" parameter appropriately for the application. Refer to the parameter list to see the default value for "Max Idle Time" parameter.
3. If the "Idle Warmup Coolant Temp" is set too high, the genset will idle for a longer period of time until the temperature of the engine reaches this set point. To access the Idle Warmup Coolant Temp configuration menu on the operator panel go to **Setup > Genset Setup > Idle Warmup Coolant Temp** and set the "Idle Warmup Coolant Temp" parameter appropriately for the application. Refer to the parameter list to see the default value for "Idle Warmup Coolant Temp" parameter.

5.12.43 Fault Code 2545 - Keyswitch Reset Required (Warning)

CAN datalink communication has been lost between the generator set control and base board, therefore event/fault code 2545 becomes active if event/fault code 781 “CAN Data Link Failure" is also active at the base board.

A. CAN Datalink Failure

1. Reset the Keyswitch manually.
   a. Put the generator set control in the OFF position and press the Reset button on the operator panel. This action will clear any shutdown faults and resets the Keyswitch.
   b. Enable the Keyswitch through the operator panel. Go to **Test > Output > Engine > Keyswitch Driver Override Enable**, set to Enable.
2. Reset the base board and PCC controls
   a. Push the Emergency Stop button in.
   b. Wait 30 seconds.
   c. Disconnect the battery terminals from the battery.
   d. Wait 10-15 seconds.
   e. Reconnect the battery cables to the battery terminals correctly.
   f. Pull the Emergency Stop button out.
   g. Press the Fault Reset button.
3. Check the relay that is proving power to the Keyswitch. This relay is normally open, and if faulty, replace.
4. Check the terminating resistors. With connectors J11 and J26 removed, measure resistance between pins J11-19 and J11-20 (60 ohms, is satisfactory).
5. Reference the troubleshooting procedure for event/fault code 781 in the engine service manual.

B. Faulty Base Board

1. After ensuring that the base board has an adequate B+ supply, connect to the base board with InPower or Insite in order to determine if it is functioning correctly and can communicate with the PCC controller. Replace the controller if communication to it with InPower is not possible.

5.12.44 Fault Code 2661 - One or More Unacknowledged Engine Fault Codes

Logic:

Fault code 2661 (unacknowledged engine fault): One or more unacknowledged Engine Shutdown Faults are active.

Diagnoses and Repair: Troubleshoot Engine Fault Codes.

5.12.45 Fault Code 2662 - At Least One ACK:Mod Severe Fault

Logic:

Fault code 2662: One or more acknowledged Engine Shutdown Faults are active.

Diagnoses and Repair: Troubleshoot Engine Fault Codes.

NOTICE
For PCC software version 3.280 and later, FC 2662 is no longer active. FC 2662 has been replaced with FC 6598 which has similar logic. Please see the troubleshooting for FC 6598 for additional information.

5.12.46 Fault Code 2677 - Fail to Stop (Shutdown)

Generator set continues to run after receiving shutdown command from the controller.

A. Stuck Fuel Shut-off Actuator

1. Check the wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.
3. Check that the fuel shut-off valve is not mechanically stuck. Use a light tapping with a plastic or rubber mallet to dislodge a stuck actuator.
4. Refer to the engine service manual.

B. Generator Set is operating in a Fuel Rich Environment

1. Check ventilation. Ventilate area to disperse combustible gasses.

C. Keyswitch Short

1. Check wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.

D. Governor Failure

1. Check wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.

3. Refer to engine service manual.

5.12.47 Fault Code 2678 - Charging Alternator Fail

Battery charging alternator is not functioning correctly or is sensing too high of external battery voltage.

A. Faulty Engine DC Alternator Or Open Circuit

1. Check the wiring of the alternator for open circuits. If the wiring is satisfactory, measure the output voltage of the alternator to the battery while the engine is running. Normal charging voltage is 12-14 VDC in a 12 V system or 24-26 VDC in a 24 V system. If the appropriate output is not observed, replace the DC alternator.

5.12.48 Fault Code 2693 - Speed Bias OOR (Warning)

Indicates The Speed Bias Circuit Output Is Out Of Range (OOR), High Or Low.

A. Sensor/wiring is defective

1. Check wiring. Ensure speed bias OOR wiring is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

5.12.49 Fault Code 2814 - Genset CT Ratio Low

The genset CT ratio (primary vs. secondary) is too small for the control to function properly for the voltage and KW rating of this generator set.

A. Incorrect CT Ratio Setup Or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset CT Ratio** and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The CTs Are Incorrectly Sized

1. Change the CTs to the correct size.

C. Incorrect Voltage Or kW Rating Setup

1. The PCC uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. If the voltage or kW setup is incorrect, event/fault code 2814 can become active. Use the CT calculator in InPower to determine the correct voltage and kW rating for this generator set. To access the generator set voltage and kW rating setup on the Operator Panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset Nominal Voltage** and **Setup > OEM Setup > OEM Genset Setup** and set the parameters appropriately for the application.

5.12.50 Fault Code 2815 - Genset CT Ratio High

The ratio of the genset CT is too large for this generator set. The genset CT ratio (primary vs. secondary) is too large for the control to calculate current accurately at the voltage and KW ratings for this generator set.

A. The Control Is Set Up With The Incorrect CT Ratio or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The CTs Are Incorrectly Sized

1. Change the CTs to the correct size.

C. Incorrect Voltage Or kW Rating Setup

1. The PCC uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. If the voltage or kW setup is incorrect, event/fault code 2815 can become active. Use the CT calculator in InPower to determine the correct voltage and kW rating for this generator set. To access the generator set voltage and kW rating setup on the Operator Panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset Nominal Voltage** and Setup > OEM Setup > OEM Genset Setup and set the parameters appropriately for the application.

5.12.51 Fault Code 2816 - Genset PT Ratio Low

The genset PT ratio is too small for the generator set rating. The genset PT ratio (primary vs. secondary) is too small and will cause high voltage readings.

A. The Control Is Set Up With The Incorrect CT Ratio or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The PTs Are Incorrectly Sized Ratio Low

1. Use the following equation to determine if the correct PT for the application is installed: (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage > 600 VAC, your PT ratio is too small.
2. Check the voltage input into the control board. When the generator set is running, the voltage input between L1 and L2 (J22-1 and J22-2) or L2 and L3 (J22-2 and J22-3) should not be more than 600 VAC.

5.12.52 Fault Code 2817 - Genset PT Ratio High

The genset PT ratio is too large, which causes an inaccurate reading of nominal voltage during normal operation; when the genset PT is used (above 600 VAC).

A. The Control Is Set Up With The Incorrect PT Ratio

1. The control uses nominal voltage and the PT ratio in order to determine if the PT ratio is correct for the operation of the generator set. Voltage input into the control board should exceed 50% of the nominal voltage to allow the control to obtain an accurate voltage reading, whether an external PT is used or not. Use the following equation to determine if you have the correct PT ratio: If (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage < (Nominal voltage *.5), the PT ratio is too large.

   Then configure the control with the correct PT ratio. To access the genset PT ratio configuration menu on the operator panel, go to **Setup > OEM Setup > OEM Alt Setup >** and set the “Genset PT Ratio primary" and “Genset PT Ratio secondary" parameters appropriately for the application.

B. The PTs Are Incorrectly Sized Ratio High

1. Use the following equation to determine if you have the correct PT for the application: (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage < (Nominal voltage *.5), your PT ratio is too large.

   B. Check the voltage input into the control board. When the generator set is running, the voltage input between L1 and L2 (J22-1 and J22-2) or L2 and L3 (J22-2 and J22-3) should be greater than (Genset Bus Nominal Voltage *.5) VAC.

5.12.53 Fault Code 2895 - PCCnet Device Failed

A non-critical PCCNet device has failed.

A. PCCNet Communication Has Been Lost Or PCCNet Device Is Faulty

1. If a PCCNet device has lost network communication, the network status light for that device will turn RED. Locate the device with the red network status LED to identify the affected device.
2. Ensure that the network device has sufficient voltage (12-24 V), as measured at the input of the device, not at the source or battery. Also verify that the device is awake and has a heartbeat. A heartbeat is a LED on the PCCNet device that blinks every 1 second to inform the operator that the device is functioning.
3. Check the network cable connections of the device(s) and ensure that there are no open or short circuits. The PCCNet network devices are polarity sensitive. For example: Control (RS485+) to Annunciator (RS485+) and Control (RS485-) to Annunciator (RS485-). If the connections are incorrect, the devices will not properly communicate over the network. Ensure that the shield is grounded at one point ONLY. Refer to the respective PCCNet device manual for line limitations and cable requirements.
4. If previous steps are satisfactory, replace the network device.
5. If replaced device is still exhibiting network issues, this can be due to a grounding loop or ground referencing for remotely mounted and powered network, incorrect network wire, or a noise (EMI) issue. As a test, connect the PCCNet device close (2-5 FT) to the base board, using the power supply from the base board (TB1-5, B+ and TB1-3 ground) and use the required network wire. If the network device functions appropriately, correct the grounding issue, EMI issue, or replace the network wire with the required network wire.

5.12.54 Fault Code 2896 - Critical PCCnet Device Fail

A critical PCCNet device has failed and has caused the generator set to shut down.

A. PCCNet Communication Has Been Lost Or PCCNet Device Is Faulty

1. If a PCCNet device has lost network communication, the network status light for that device will turn RED. Locate the device with the red network status LED to identify the affected device.
2. Ensure that the network device has sufficient voltage (12-24 V), as measured at the input of the device, not at the source or battery. Also verify that the device is awake and has a heartbeat. A heartbeat is a LED on the PCCNet device that blinks every 1 second to inform the operator that the device is functioning.
3. Check the network cable connections of the device(s) and ensure that there are no open or short circuits. The PCCNet network devices are polarity sensitive. For example: Control (RS485+) to Annunciator (RS485+) and Control (RS485-) to Annunciator (RS485-). If the connections are incorrect, the devices will not properly communicate over the network. Ensure that the shield is grounded at one point ONLY. Refer to the respective PCCNet device manual for line limitations and cable requirements.
4. If previous steps are satisfactory, replace the network device.
5. If replaced device is still exhibiting network issues, this can be due to a grounding loop or ground referencing for remotely mounted and powered network, incorrect network wire, or a noise (EMI) issue. As a test, connect the PCCNet device close (2-5 FT) to the base board, using the power supply from the base board (TB1-5, B+ and TB1-3 ground) and use the required network wire. If the network device functions appropriately, correct the grounding issue, EMI issue, or replace the network wire with the required network wire.

5.12.55 Fault Code 2922 - Genset Neutral Curr OOR Hi

The Genset Neutral current is above the “Genset Neutral Current Calibration" parameter for the time in the “Genset Neutral Current OOR Delay" time parameter.

A. CT Ratio Is Too Small Or The CTs Are Not Sized Correctly For The Genset Voltage And kW Rating

1. Please see event/fault code 2814.

B. Genset Neutral Current Is Above The Genset Neutral Current Calibration Parameter

1. Measure the Genset Neutral current input into the control board with a current probe at J22-4. The maximum value of current going into the control CTs should not be more than the value of the “Genset CT Secondary Current" value that the control is calibrated for. For example, if secondary setting in the control is 1 Amp, current going into the control should not be more than 1 Amp. To access the Genset CT Secondary Current configuration menu on the operator panel go to **Setup > OEM Setup > OEM Alt Setup > CT Sec** and set the “Genset CT Secondary Current" parameter appropriately for the application.

C. Faulty CT

1. If the above is satisfactory, check the CT and replace if faulty.

5.12.56 Fault Code 2938 - Earth/Ground Fault

Short to ground in the external wiring.

A. Configurable Input Active State Selection Parameter Is Incorrectly Configured For Ground Fault

1. Through the operator panel, check the switch input setting (active closed or open) for the Configurable Input setup for Ground Fault. Ensure that the switch input setting is correctly set. If "Configurable Input Function Pointer" parameter is set to Ground Fault and if "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2938 will become active when the input is a ground input.
2. If "Configurable Input Function Pointer" parameter is set to Ground Fault and if "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2938 will become active when the input is an open circuit.
3. To access the input configuration on the operator panel go to **Setup > Configurable I/O > Config Input Menu > Active** and set the "Configurable Input Active State Selection" parameter appropriately for the application.

B. Incorrectly Wired Open Or Short Circuit In The Wiring

1. Depending on the "Configurable Input Active State Selection" parameter setting, check the wiring for an open/short circuit, or mis-wired condition from the generator set (L1, J22-1; L2, J22-2; L3, J2-3; LN, J22-4) to the Ground Fault Alarm Relay (Input 6 and 8), correct if faulty.

C. Faulty Ground Fault Alarm Relay

1. Ensure that the input voltage to the Ground Fault Alarm Relay is 24 VDC, at input 1 and 2.
2. Verify that the Trip Current and Time Delay settings on the Ground Fault Alarm Relay are set appropriately for the application.
3. If the previous steps are satisfactory, replace the Ground Fault Alarm Relay.

(refer to instruction sheet C648a).

5.12.57 Fault Code 2942 - Shutdown Override Fail

The genset has failed to transition to Battle Short mode or Delayed Shutdown mode.

A. Battle Short Or Delayed Shutdown Is Not Enabled In The Genset Control

1. Through the operator panel, verify that the “Battle Short" parameter is set to enable. To access the “Battle Short" configuration menu on the operator panel go to **Setup > OEM Setup > OEM Genset Setup > Battle Short** and set the parameter to enable, if the battle short mode is required by the customer.
2. Ensure that one of the configurable inputs is set up to activate Battle Short mode (e.g., Configurable Input #1 = Battle Short). Battle Short may now be enabled by activating the configurable input that was set up for Battle Short (e.g., Enable Configurable Input #1 with a ground input).
3. Through the operator panel, verify that the “Delayed Shutdown" parameter is set to enable. To access the “Delayed Shutdown" configuration menu on the operator panel go to **Setup > OEM Setup > OEM Genset Setup > Delayed Shutdown** and set the parameter to enable, if the Delayed Shutdown mode is required by the customer.

B. Battle Short Is Not Enabled In The Baseboard

1. Connect to the baseboard with InPower and enable the Battle Short parameter in the baseboard. Under “Engine Protection", set “Shutdown Manual Override" to “Enable".

5.12.58 Fault Code 2943 - Manual Sw Config Fail

Event/fault code 2943 is activated when the control receives an active Manual input from both the operator panel and the PCCNet network at the same time for two seconds or more.

A. Two Manual Command Inputs That Are Active At The Same Time_Manual

1. Ensure there is only one Manual switch input to the control that is active, either through the operator panel or PCCNet Network (PCCNet DIM) but not both at the same time.

5.12.59 Fault Code 2944 - Auto Switch Config Fail

Event/fault code 2944 is activated when the control receives an active Auto input from both the operator panel and the PCCNet network at the same time for two seconds or more.

A. Two Auto Command Inputs That Are Active At The Same Time

1. Ensure there is only one Auto switch input to the control that is active, either through the operator panel or through PCCNet Network (PCCNet DIM) but not both at the same time

5.12.60 Fault Code 2945 - Rupture Basin

Main fuel tank is leaking into the rupture basin.

A. Rupture Basin/Configurable Input #12 Active State Selection Parameter Is Incorrectly Configured

1. Through the operator panel check the switch input setting (active closed or open) for the Rupture Basin/Configurable Input #12 Active State Selection. Ensure that the switch input setting is correctly set. If "Rupture Basin/Configurable Input #12 Function Pointer" parameter is set to Default and if "Rupture Basin/Configurable Input #12 Active State Selection" parameter is set to "active closed", event/fault code 2945 will become active when the input is a ground input.
2. If ""Rupture Basin/Configurable Input #12 Function Pointer" parameter is set to Default and if "Rupture Basin/Configurable Input #12 Active State Selection" parameter is set to "active open", event/fault code 2945 will become active when the input is an open circuit.
3. To access the input configuration on the operator panel go to **Setup > Configurable I/O > Rupture Basin/Configurable Input #12 Active State Selection** and set the "Rupture Basin/Configurable Input #12 Active State Selection" parameter appropriately for the application.

B. Incorrectly Wired; Open Or Short Circuit In The Wiring

1. Depending on the "Rupture Basin/Configurable Input #12 Active State Selection" parameter setting, check the wiring at for an open/short circuit, or miswired condition, from the rupture basin sender to the base board at J20-19 and J20-8; correct if wiring is faulty.

C. Faulty Sender

1. Measure the rupture basin sender for an open or short circuit reading, replace if faulty.

5.12.61 Fault Code 2972 - Field Overload

If the time that the Field AVR Duty Cycle is operating at maximum output is longer than the time in the "Max Field Time" parameter, event/fault code 2972 will become active.

NOTICE
Excessive voltage is possible during testing. Make sure your meter can handle alternator full voltage.

A. Max Field Time Delay Is Set Too Low

1. Through the operator panel, check the "Max Field Time" parameter setting. Verify that the "Max Field Time" is not set to zero. The "Max Field Time" parameter may require adjustment to a value more appropriate for the application. To access the Max Field Time configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > Max Field Time and set the "Max Field Time" parameter appropriately for the application. Refer to the parameter list to see the default value for "Max Field Time".

B. Voltage Sensing Into The Base Board Is Too Low, Or There Is An Open/Short Circuit

1. Measure the voltage going into the base board at L1 = J22-1, L2 = J22-2, L3 = J22-3, and LN = J22-4 (for single phase applications use L1, L2 and LN). If the generator set control is not sensing voltage, it will try to overcompensate by maxing out the AVR output. If the voltage going into the control board is zero, or less than the voltage that the control was calibrated for (Nominal Voltage), then check the wiring from the alternator to the base board for an open circuit or short circuit.
2. If the generator set is over 600 VAC, check connections from the alternator to the PT, and from the PT to the base board. If there is voltage going into the PT, but not coming out of the PT, replace the PT.
3. Measure the output of the AVR at J17 -1 and J17-2 while turning the generator set on. The output should be at least 30 VDC when the generator set is starting, but the voltage should decrease significantly when the generator set builds up voltage. If the output of J17-1 and J17-2 is constantly high or is locked in, then the AVR portion of the PCC is faulty. Replace the base board if the AVR is faulty.

C. Application Issue

1. If the generator set runs adequately with no load or some load but as soon as additional load is applied, the generator set shuts down on "Field Overload"; then this might be an application issue (load issue, generator set undersized, etc.).

5.12.62 Fault Code 2977 - Low Coolant Level 2

Low Coolant Level switch #2 indicates that the coolant level is low in the second radiator.

Possible Causes:

1. Low Coolant.
2. Coolant sender incorrectly wired.
3. Faulty coolant level sender.
4. The "Configurable Input Active State Selection" parameter is configured incorrectly.

5. Faulty Extension Harness Coolant Level Sensor.

A. Low Coolant

1. Stop the engine and allow the engine to cool down.
2. Visually inspect that engine coolant is at the appropriate level through the sight glass or expansion tank.
3. Remove radiator cap and check that coolant is up to the required level.
4. If coolant is below 1 in. (2.54 cm) from the top of the radiator add manufacturer's prescribed coolant.

B. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

C. Coolant Sender Incorrectly Wired

1. Check for improper wiring, such as a short or open circuit from the coolant sensor to the discrete configurable input on the base board that was configured for the "Low Coolant Level 2 Switch". If a short/open circuit or improper wiring is found, correct the wiring.

D. Configurable Input Active State Selection parameter is configured incorrectly

1. Through the operator panel, check the switch input setting (active closed or active open) for the Configurable Input that was configured to "Low Coolant Level 2 Switch". Ensure the setting is correct. If the "Configurable Input Function Pointer" parameter is set to "Low Coolant Level 2 Switch" and the "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2977 will become active when the Configurable Input that was configured to "Low Coolant Level 2 Switch" is connected to ground.

   If the "Configurable Input Function Pointer" parameter is set to "Low Coolant Level 2 Switch" and the "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2977 will become active when the Configurable Input that was configured to "Low Coolant Level 2 Switch" is an open circuit.

   To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the "Configurable Input Active State Selection" parameter appropriately for the Configurable Input that was configured to "Low Coolant Level 2 Switch".

E. Faulty Coolant Level Sensor

Perform the checks in Generator Set Sensors.

F. Faulty Extension Harness-Coolant Level Sensor

1. Inspect the extension harness and the extension harness connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

2. Check for an open circuit.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin at the engine harness sensor connector.
    d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to coolant level sensor signal pin at then engine harness sensor connector.
    e. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Disconnect the engine harness from all sensors that have a shared return with the coolant level sensor. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
    d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
    e. If all measurements are greater than 100k Ohms, then the resistance is correct.

5.12.63 Fault Code 2979 - High Alternator Temp

Indicates that the alternator temperature is high.

A. Alternator Temperature Sender Incorrectly Wired

1. Check for improper wiring or a short/open circuit from the alternator temperature sender to the discrete configurable input on the base board that was configured for the "High Alternator Temp Switch". If a short/open circuit or improper wiring is found, correct the wiring.

B. Faulty Alternator Temperature Sender

1. Measure the resistance between the alternator temperature signal pin and return pin. The resistance should be between 530 Ohms to 2214 Ohms. Replace the sender if the resistance value is out of specification.

C. Configurable Input Active State Selection parameter is configured incorrectly

1. Through the operator panel, check the switch input setting (active closed or open) for the Configurable Input that was configured to "High Alternator Temp Switch". Ensure the setting is correct. If the "Configurable Input Function Pointer" parameter is set to "High Alternator Temp Switch" and the "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2979 will become active when the Configurable Input that was configured to "High Alternator Temp Switch" is connected to ground.

    If the "Configurable Input Function Pointer" parameter is set to "High Alternator Temp Switch" and the "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2979 will become active when the Configurable Input that was configured to "High Alternator Temp Switch" is an open circuit.

To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the "Configurable Input Active State Selection" parameter appropriately for the Configurable Input that was configured to "High Alternator Temp Switch".

5.12.64 Fault Code 6598 - At Least One ACK:Mod Severe Fault

Fault code 6598 (acknowledged engine fault): One or more acknowledged Engine Shutdown Faults are active.

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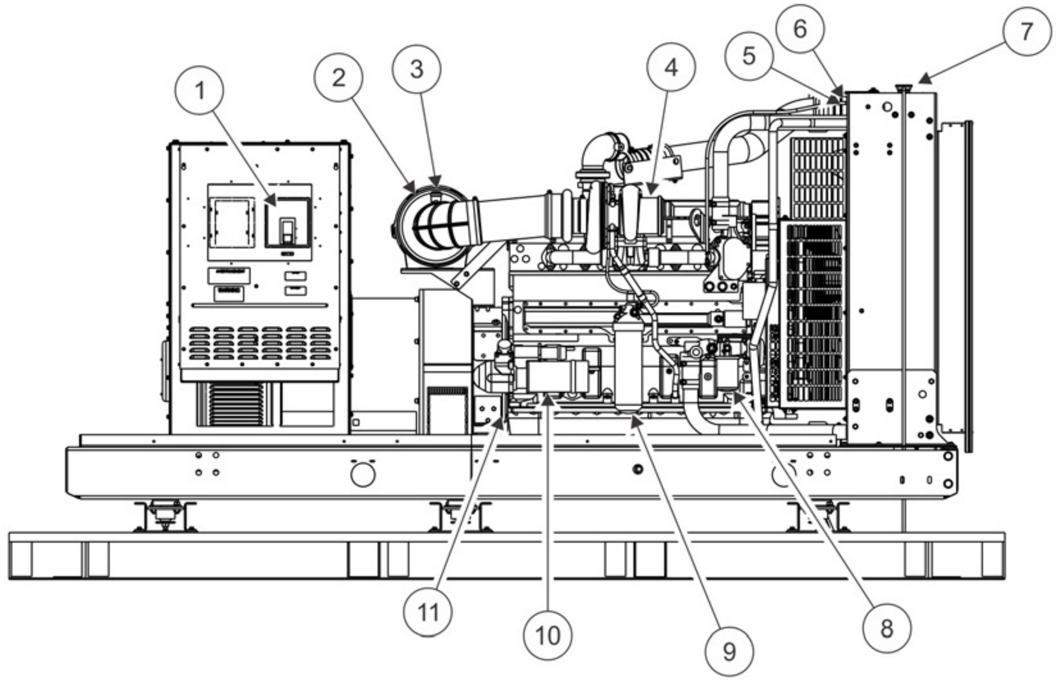
6 Generator Set Subsystems

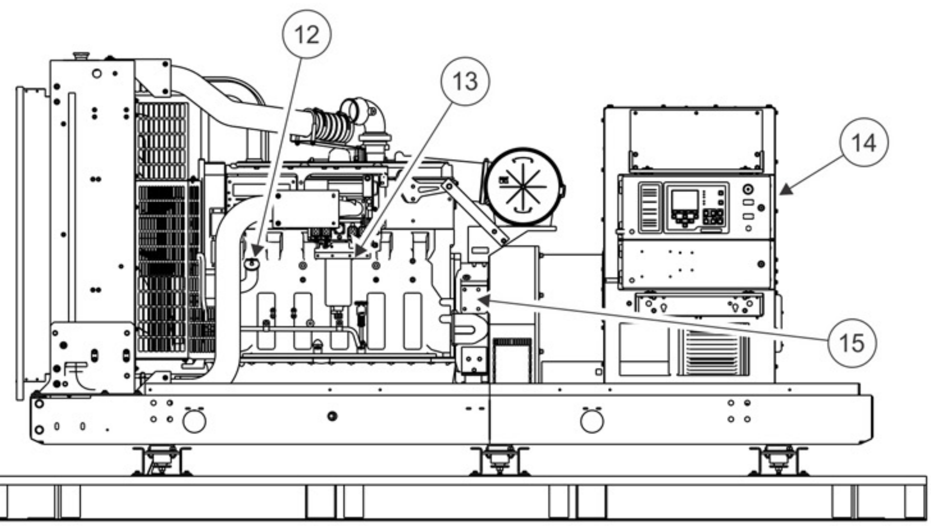
6.1 Generator Set

6.1.1 Generator Set Components

The main components of a typical QSX15-G9 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	Circuit Breaker Lever	9	Oil Filter
2	Air Cleaner	10	Starter
3	Service Indicator	11	Coolant Heater (not pictured)
4	Turbo Out Connection	12	Oil Fill
5	Coolant Level Sight Glass (not pictured)	13	Fuel Filter
6	Coolant Level Sensor (not pictured)	14	Control - Side Mount
7	Coolant Fill	15	Fuel Filter (not pictured)
8	Fuel/Water Separator		

FIGURE 7. TYPICAL GENERATOR SET COMPONENT LOCATIONS

6.1.2 Current Transformer

6.1.2.1 Current Transformer Installation Requirements

Current transformers (CTs) reduce high voltage currents (AC) to enable safe monitoring.

The CT has a dot on one side. This dot must be facing toward the alternator reconnection terminal block (conventional current flowing into the dot). A dot is also used to indicate pin 1 of the CT.

Route the load lead through the appropriate CT. See the Alternator Reconnection Drawing section.

The CTs have dual secondaries (3 pins):

- The CT secondary wire marked 1 is connected to pin 1 of the CT.
- The CT secondary wire marked 2/3 is connected to pin 3 for low voltage generator sets.

6.2 Sensors

6.2.1 Low Coolant Level Switch

Figure 8 shows the location of the coolant level switch. The low coolant level switch functions by closing the circuit to the engine chassis ground (battery negative [–]).

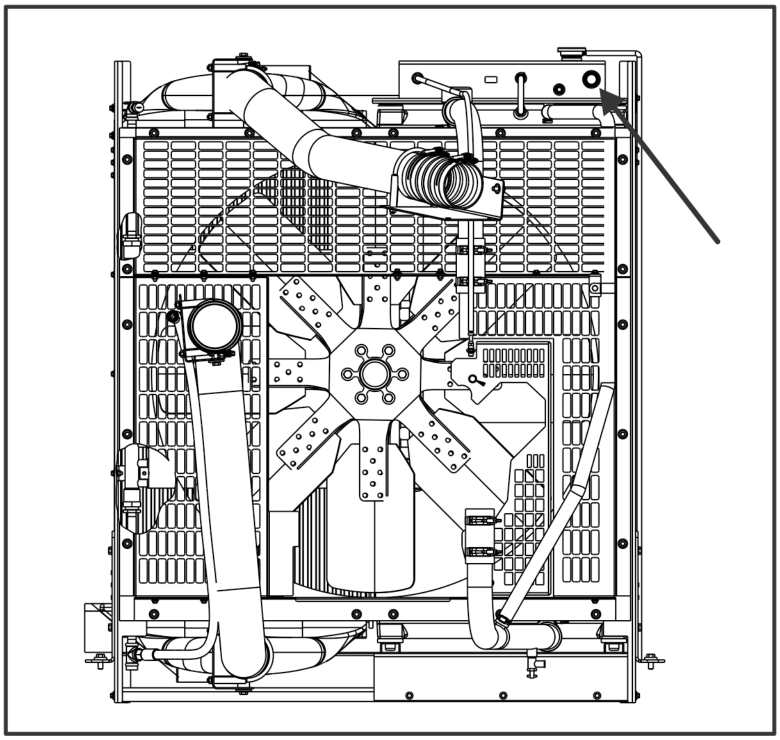


FIGURE 8. LOW COOLANT LEVEL SWITCH

6.2.2 Coolant Temperature Sender

Figure 9 shows the location of the coolant temperature sender port. The coolant temperature sender functions by varying the resistance with the coolant temperature. With 5 VDC supplied to the sensors, the output signal (which varies with temperature) is supplied to the base board. The coolant sender enables the base board to detect low, pre-high, and high coolant temperatures.

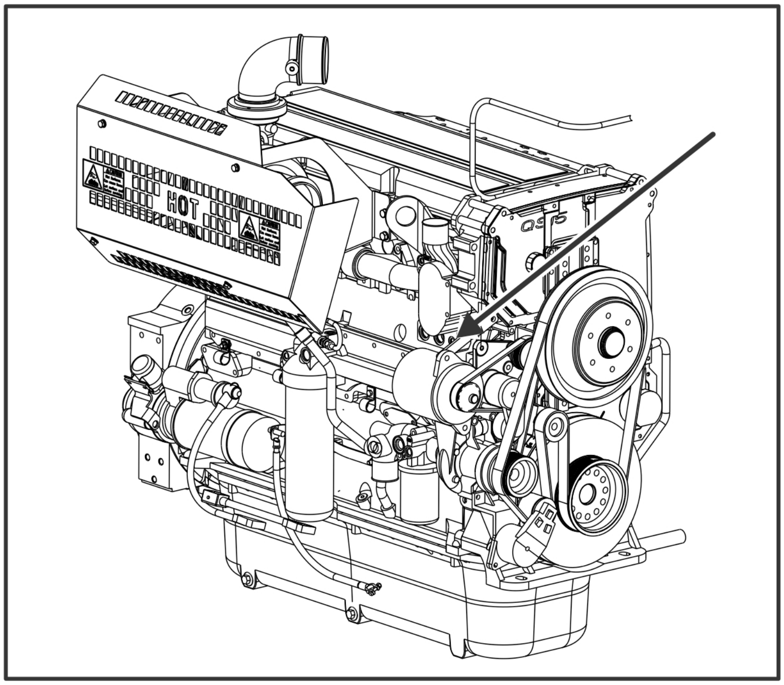


FIGURE 9. COOLANT TEMPERATURE SENDER PORT LOCATION

6.2.3 Oil Pressure Sensor

The oil pressure sensor is a normally open switch. When engine oil pressure falls below 6 psi, the switch closes. Once the ECM detects that the switch is grounded it sends a shutdown signal to the engine. The ECM allows the engine to be restarted but does not continue to send a shutdown signal if the pressure remains below 6 psi.

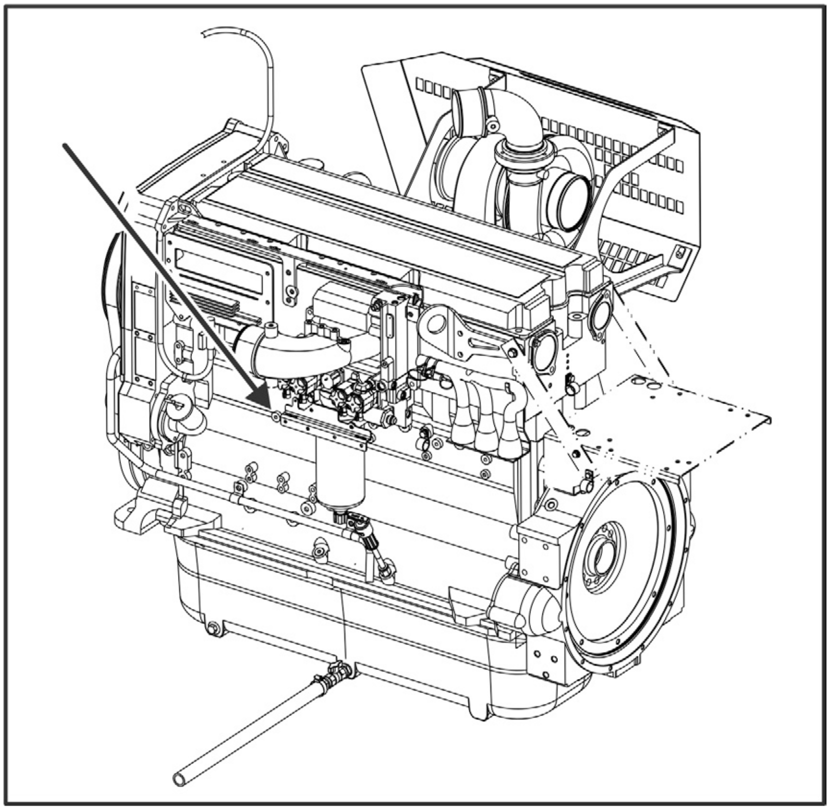


FIGURE 10. OIL PRESSURE SENSOR PORT LOCATION

6.2.4 Cylinder Head Temperature (CHT) Sensor

The cylinder head temperature (CHT) sensor is a thermistor device, which uses changes in resistance dependent on the temperature. The sensor is installed in the aluminum cylinder head and measures the temperature of the metal. The CHT can provide complete engine temperature and is used to infer coolant temperature.

6.2.5 Crankshaft Position (CKP) Sensor

The crankshaft position sensor (CKP) is used to determine engine RPM and crankshaft position. The CKP uses a Hall Effect type sensor which generates a square wave form. The CKP is located next to the trigger wheel mounted on the end of the crankshaft. The trigger wheel contains 60 teeth spaced 6 degrees apart with two teeth missing. By magnetically locating the empty space on each revolution, the ECM can determine the position of the crankshaft and engine speed.

6.2.6 Camshaft Position (CMP) Sensor

The camshaft position sensor (CMP) is a magnetic pickup (MPU) sensor. The CMP is used to determine when cylinder 1 reaches its compression stroke. The ECM uses this information to control fuel delivery to the proper cylinder.

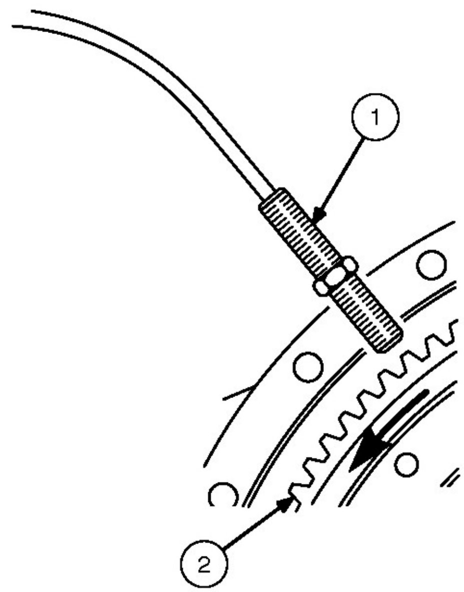
6.2.7 Magnetic Speed Pickup Unit (MPU) Installation

Measure the resistance of the magnetic speed pickup (MPU). Replace the MPU if the resistance is over 1,000 Ohms.

With the MPU removed from the generator set, bar the engine until a gear tooth on the flywheel lines up in the center of the mounting hole. Thread the sensor in gently by hand until it just touches the gear tooth. Back it out 1/4 turn and set the locknut.

NOTICE
Do not use the fan blade to bar over the engine. That can damage blades and cause property damage and personal injury.

After adjustment, make sure the output voltage of the MPU is correct. Replace the MPU if output voltage at cranking speed is less than 1.5 VAC.

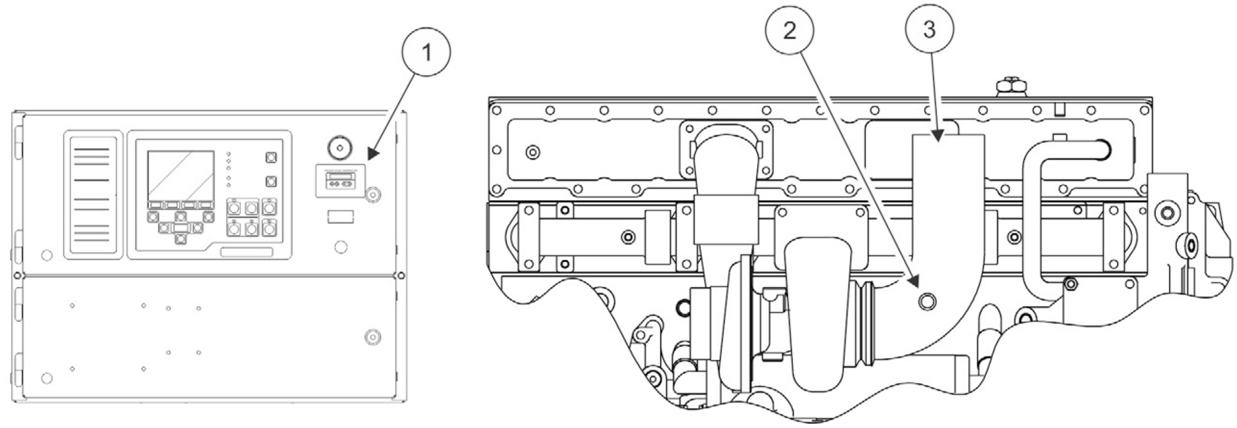


No.	Description	No.	Description
1	MPU Sensor	2	Engine Flywheel Ring Gear

FIGURE 11. MPU SENSOR

6.2.8 Pyrometer

A pyrometer measures engine exhaust gas temperature.



No.	Description	No	Description
1	Temperature Meter	2	Temperature Sender
3	Exhaust Outlet Elbow		

FIGURE 12. PYROMETER LOCATION

6.2.9 Additional Sensors

In addition to the sensors already mentioned, the ECM monitors a throttle position sensor (TIP) and temperature manifold absolute pressure (TMAP) sensor to maintain fuel control and emissions.

6.3 Alternator

6.3.1 HC Alternators

6.3.1.1 General Description

HC alternators are of brushless rotating field design, available up to 690 V, 50 Hz (1000 RPM, 6 pole and 1500 RPM, 4 pole) or 60 Hz (1200 RPM, 6 pole and 1800 RPM, 4 pole), and built to meet BS5000 Part 3 and international standards.

HC alternators are available self-excited, where excitation power is from the main output windings, or separately-excited, where a permanent magnet generator (PMG) supplies excitation power.

6.3.1.2 Environment

The alternators are protected to IP23 as standard. IP23 is not adequate protection for use outdoors without additional measures.

TABLE 28. ENVIRONMENTAL SPECIFICATION

Ambient Temperature	-15 °C to 40 °C (5 °F to 104 °F)
Relative Humidity	< 70%
Altitude	< 1000 m (3280 ft)

The alternator has been designed for the environment shown in the table. The alternator can operate outside these conditions if it is rated accordingly; the nameplate gives details. If the operating environment is changed after purchase, refer to the factory for a revised alternator rating.

6.3.1.3 Air Flow

TABLE 29. MINIMUM AIR FLOW AND MAXIMUM PRESSURE DIFFERENCE

Alternator Model and Frequency	Minimum Air flow, m^3/s (ft^3/min)		Maximum intake to outlet pressure difference in mm (in) water gauge
	50 Hz	60 Hz	
HC4	0.8 (1700)	0.99 (2100)	6 (0.25)
HC5	1.04 (2202)	1.31 (2780)	6 (0.25)
HCK5	1.23 (2615)	1.59 (3366)	6 (0.25)
HC6	1.62 (3420)	1.96 (4156)	6 (0.25)

Make sure that the air inlets and outlets are not blocked while the alternator is running.

6.3.1.4 Airborne Contaminants

Contaminants such as salt, oil, exhaust fumes, chemicals, dust, and sand will reduce the effectiveness of the insulation and the life of the windings. Consider using air filters and an enclosure to protect the alternator.

6.3.1.5 Air Filters

Air filters trap airborne particulates above 5 microns. The filters must be cleaned or replaced regularly, depending on site conditions. Check the filters frequently to establish an appropriate service interval.

Alternators with factory-fitted filters are rated to account for the reduced flow rate of cooling air. If filters are retrofitted, the alternator rating must be reduced by 5%.

Air filters do not remove water. Keep the filters dry with additional protection. Wet filters further restrict airflow, causing the alternator to overheat and leading to premature failure of the insulation.

6.3.1.6 Humid Conditions

The water carrying capacity of air depends on temperature. If the air temperature falls below its saturation point, dew may form on the windings, reducing the electrical resistance of the insulation. In humid conditions, additional protection may be required even if the alternator is fitted inside an enclosure. Anti-condensation heaters are supplied on request.

6.3.1.7 Anti-Condensation Heaters

⚠ DANGER
Live Electrical Conductors
Live electrical conductors can cause serious injury or death by electric shock and burns.
To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

Power to the anti-condensation heater is supplied from a separate source. Anti-condensation heaters raise the air temperature around the windings to deter condensation forming in humid conditions when the alternator is not operating. Best practice is to energize the heaters automatically when the alternator is off.

6.3.1.8 Enclosures

Fit an enclosure to protect the alternator from adverse environmental conditions. Make sure that air entering the alternator is of adequate flowrate, free from moisture and contaminants, and below the maximum ambient temperature on the rating plate.

Make sure there is sufficient access around the alternator for safe maintenance.

6.3.1.9 Vibration

The alternators are designed to withstand the vibration levels encountered on generator sets built to meet the requirements of ISO 8528-9 and BS 5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generator set).

NOTICE
Exceeding either of the above specifications will have a detrimental effect on the life of the bearings and other components, and may invalidate the alternator warranty.

NOTICE
The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Refer to the Installation Manual to connect the load cables to the terminal box. Refer to CGT before fixing any additional mass to the terminal box.

6.3.1.9.1 Definition of BS5000–3

Alternators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25 mm between 5 Hz and 8 Hz, and velocities of 9.0 mm/s RMS between 8 Hz and 200 Hz, when measured at any point directly on the carcass or main frame of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

6.3.1.9.2 Linear Vibration Limits

TABLE 30. HC ALTERNATOR LINEAR VIBRATION LEVEL MEASUREMENTS

Engine Speed RPM (min^{-1})	Power Output (kVA)	Vibration Displacement RMS (mm)	Vibration Velocity RMS (mm/s)	Vibration Acceleration RMS (mm/s^2)
1300 ≤ RPM ≤ 2000	250 < S	0.32	20	13
720 ≤ RPM < 1300	250 < S ≤ 1250	0.32	20	13
Note: The broadband is taken as 10 Hz - 1000 Hz.				

6.3.1.10 Bearings

6.3.1.10.1 Bearing Life

Factors that reduce bearing life or lead to bearing failure include:

- Adverse operating conditions and environment
- Stress caused by misalignment of the generator set
- Vibration from the engine that exceeds the limits in BS 5000-3 and ISO 8528-9

- Long periods (including transportation) when the alternator is stationary and subjected to vibration can cause false brinelling wear (flats on the balls and grooves on the races)
- Humid or wet conditions that cause corrosion and deterioration of the grease by emulsification.

6.3.1.10.2 Health Monitoring of the Bearings

We recommend that the user checks the bearing condition using vibration monitoring equipment. Best practice is to take initial readings as a reference and periodically monitor the bearings to detect a deteriorating trend. It will then be possible to plan a bearing change at an appropriate generator set or engine service interval.

6.3.1.10.3 Bearing 'Service Life' Expectancy

Bearing manufacturers recognize that the service life of bearings depends on factors that are outside their control. Rather than quote a service life, practicable replacement intervals are based on the L10 life of the bearing, the type of grease, and the recommendations of the bearing and grease manufacturers.

For general purpose applications: If the correct maintenance is carried out, vibration levels do not exceed the levels stated in ISO 8528-9 and BS5000-3, and the ambient temperature does not exceed 50 °C, plan to replace the bearings within 30,000 hours of operation.

If in doubt regarding any aspect of bearing life of a STAMFORD® alternator, contact the nearest authorized supplier of the alternator or contact CGT Customer Service.

6.3.1.11 Installation into the Generator Set

6.3.1.11.1 Lifting the Alternator

⚠ WARNING
Falling Mechanical Parts
Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping.
To prevent injury and before lifting the alternator:
• ***Do not lift the complete generator set by the alternator lifting fixtures.***
• ***Keep the alternator horizontal when lifting.***
• ***Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.***

Lift the alternator by hooks or shackles attached to the lifting points (lugs or eyes) provided. A label attached to a lifting point shows the correct lifting arrangement. Use chains of sufficient length, and a spreader bar if necessary, to make sure that the chains are vertical when lifting. Make sure that the capacity of the lifting equipment is sufficient for the alternator mass shown on the label.

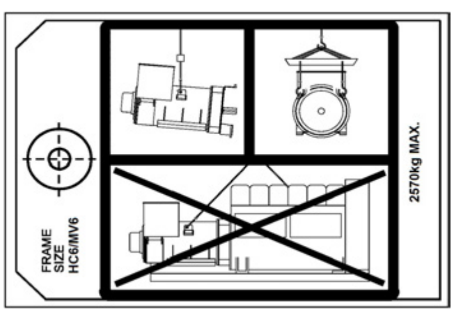


FIGURE 13. LIFTING LABEL

6.3.1.11.2 Storage

If the alternator will not be used immediately, it must be stored in a clean, dry, vibration-free environment. We recommend the use of anti-condensation heaters, when available.

If the alternator can be rotated, turn the rotor a minimum of 6 revolutions every month during storage.

6.3.1.11.2.1 After Storage

After a period of storage, carry out the pre-running checks to determine the condition of the windings. If the windings are damp or the insulation resistance is low, follow one of the drying out procedures (see Section 6.3.1.12 on page 211).

- For re-greasable bearings that have been rotated during storage and have been in storage for between 6 months and 2 years, regrease the bearings before first use of the alternator.
- For re-greasable bearings that have not been rotated during storage and have been in storage for more than 12 months, replace the bearings before first use of the alternator.
- For sealed bearings that have been in storage for more than 12 months, replace the bearings before first use of the alternator.

6.3.1.11.3 Generator Set Coupling

⚠ WARNING
Moving Mechanical Parts
Moving mechanical parts during generator set coupling can cause serious injury by crushing, severing or trapping.
To prevent injury, keep arms, hands and fingers away from mating surfaces when coupling the generator set.

Efficient operation and long component life depend on minimizing mechanical stresses on and damage to the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress. In addition, rotating the alternator rotor using a lever against the vanes of the cooling fan will damage the fan. The fan is not designed to withstand such forces.

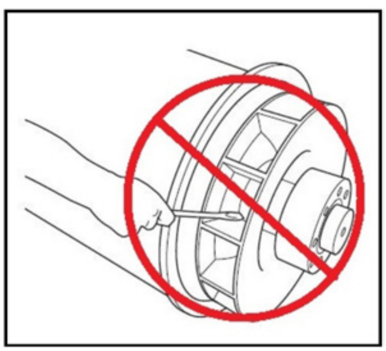


FIGURE 14. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER

Generator sets need a substantial flat continuous bedplate to suit the installation site floor loading with engine and alternator mounting pads to make a firm base for accurate alignment. The height of all mounting pads must be within 0.25 mm for skid mounting, 3 mm for non-adjustable anti-vibration mounts (AVM) or 10 mm for adjustable height AVMs. Use shims to achieve level. The rotational axes of alternator rotor and engine output shaft must be coaxial (radial alignment) and perpendicular to the same plane (angular alignment). The axial alignment of the alternator and engine coupling must be within 0.5 mm, to allow for thermal expansion without unwanted axial force on the bearings at operating temperature.

Vibration can occur by flexing of the coupling. The alternator is designed for a maximum bending moment not exceeding 140 kgm (1000 lbs ft) for frame sizes 4 and 5, and not exceeding 275 kgm (2000 lbs ft) for frame size 6. Check the maximum bending moment of the engine flange with the engine manufacturer.

Close-coupling of alternator and engine can increase the rigidity of the generator set. Both single and two bearing alternators can be close-coupled. The generator set builder must supply guarding for open-coupled applications.

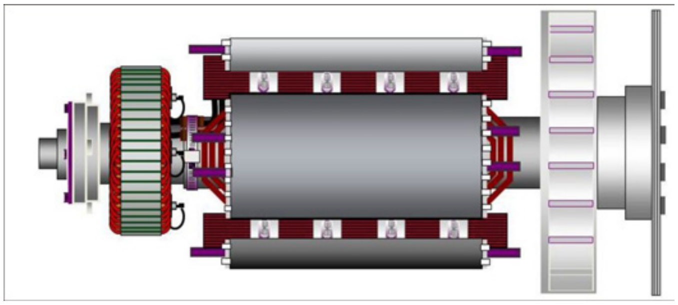


FIGURE 15. SINGLE BEARING ALTERNATOR ROTOR SHOWING COUPLING DISCS BOLTED TO DRIVE END COUPLING HUB AT RIGHT

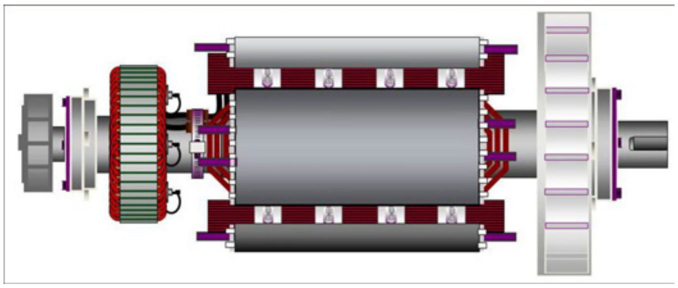


FIGURE 16. TWO BEARING ALTERNATOR ROTOR SHOWING SHAFT WITH KEYWAY FOR FLEXIBLE COUPLING AT RIGHT

To prevent rust during transit and storage, the alternator frame spigot, rotor coupling plates and shaft extension have been treated with a rust preventative coating. Remove this before coupling the generator set.

6.3.1.11.3.1 Single Bearing

⚠ WARNING

Falling Mechanical Parts

Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping.

To prevent injury and before lifting the alternator:

- ***Do not lift the complete generator set by the alternator lifting fixtures.***
- ***Keep the alternator horizontal when lifting.***
- ***Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.***

1. Remove the drive end transit bracket that keeps the rotor in place during transport.
2. Remove the air outlet covers from the drive end of the alternator to access the coupling and adaptor bolts.
3. Make sure the coupling discs are concentric with the adaptor.

4. Fit two alignment dowels into flywheel bolt holes 180 degrees apart to help align the disc and the flywheel.
5. Lift and offer the alternator to the engine, barring the engine over by hand to align discs and flywheel.
6. Engage the alignment dowels into coupling disc bolt holes and push the alternator towards the engine until the coupling discs are against the flywheel face.

NOTICE
Do not pull the alternator to the engine using bolts through the flexible discs.

7. Fit the adaptor bolts, using heavy gauge washers under the heads. Tighten the adapter bolts evenly around the adapter.
8. Check the torque of each bolt in a clockwise direction around the bolt circle to ensure all the bolts are tight. Refer to the engine manufacturer's manual for correct tightening torque.
9. Remove the alignment dowels. Fit the coupling bolts, using heavy gauge washers under the heads.
10. Tighten the bolts to fix the coupling disc to the flywheel in the sequence shown in **Figure 17 on page 205**.
11. Check the torque of each bolt in a clockwise direction around the bolt circle to ensure all the bolts are tight.
12. Remove the rotor support bracket, if supplied.
13. Replace all covers.

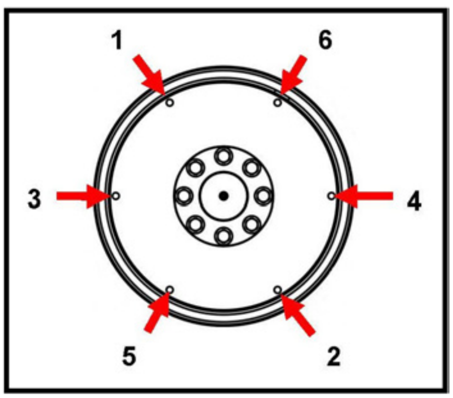


FIGURE 17. FIXING SEQUENCE

6.3.1.11.4 Pre-Running Checks

Before starting the generator set, test the insulation resistance of windings and check that all connections are tight and in the correct location. Make sure the alternator air path is clear of obstructions. Replace all covers.

6.3.1.11.5 Insulation Resistance Test

⚠ WARNING

Live Electrical Conductors

Live electrical conductors at the winding terminals after an insulation resistance test can cause serious injury or death by electric shock or burns.

To prevent injury, discharge the windings by shorting to earth through an earthing rod for at least 5 minutes.

NOTICE

Disconnect the AVR and voltage transformers (if fitted) before this test. Disconnect and earth all RTD and Thermistor temperature sensors (if fitted) before this test.

The resistance test must be carried out by a qualified person.

TABLE 31. INSULATION RESISTANCE TEST VALUES

Alternator Voltage (kV)	Test Voltage (V)	Minimum Insulation Resistance (MΩ)	
		In-Service Alternator	New Alternator
≤1	500	5*	10

You must dry out the alternator windings if the measured insulation resistance is less than the minimum value. See the Service & Maintenance section (**Section 6.3.1.12 on page 211**) of this manual.

*For heavily contaminated windings and component conditions the minimum insulation resistance should be >1MΩ.

6.3.1.11.5.1 Insulation Resistance with Temperature

Minimum insulation resistance values are given for windings at 20 °C ambient, but insulation resistance may be measured at a higher temperature, T. For comparison with minimum values, multiply the measured insulation resistances $(IR)_T$ by the appropriate factor from the table below to give the equivalent values at 20 °C, $(IR)_{20}$.

TABLE 32. WINDING TEMPERATURES AND INSULATION RESISTANCES

Winding Temperature, T (°C) for Measured $(IR)_T$	Equivalent Insulation Resistance at 20 °C, $(IR)_{20}$ (MΩ)
20	1 x $(IR)_T$
30	2 x $(IR)_T$
40	4 x $(IR)_T$
50	8 x $(IR)_T$
60	16 x $(IR)_T$
70	32 x $(IR)_T$
80	64 x $(IR)_T$

6.3.1.11.5.2 High Voltage Test

NOTICE

Windings have been tested at high voltage during manufacture. Repeated high voltage tests may degrade the insulation and reduce operating life. If a further test is required at installation for customer acceptance, it must be done at a reduced voltage, V = 0.8 x (2 x Rated Voltage + 1000). Once in service, any further tests for maintenance purposes must be done after passing visual checks and insulation resistance tests, and at a reduced voltage, V = (1.5 x Rated Voltage).

6.3.1.11.6 Voltage and Frequency

Check that the voltage and frequency shown on the alternator rating plate meet the requirements of the generator set application. Refer to detailed instructions in the AVR manual for adjustments.

6.3.1.11.7 Electrical Connections

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and system protection can cause serious injury or death by electric shock and burns.

To prevent injury, installers must be qualified and are responsible for meeting appropriate inspectorate and local electricity authority requirements and site safety rules.

NOTICE

The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Refer to CGT before fixing any additional mass to the terminal box. Panels must be removed to be drilled or cut, to prevent swarf entering the terminal box or alternator.

Fault current curves and alternator reactance values are available on request from the factory so that the system designer can calculate the necessary fault protection and/or discrimination.

The installer must check that the alternator frame is bonded to the generator set bedplate, and must bond to site earth. If anti-vibration mounts are fitted between the alternator frame and its bedplate, a suitably-rated earth conductor must bridge across the anti-vibration mount.

Refer to wiring diagrams for electrical connection of the load cables. Electrical connections are made in the terminal box, constructed with removable panels to suit site-specific cable entry and glanding. Route single core cables through the insulated or non-magnetic gland plates supplied. Panels must be removed to be drilled or cut to prevent swarf entering the terminal box or alternator. After wiring, inspect the terminal box, remove all debris using a vacuum cleaner if necessary and check that no internal components are damaged or disturbed.

As standard, the alternator neutral is not bonded to the alternator frame. If required, neutral may be connected to the earth terminal in the terminal box, by a conductor of at least one half of the sectional area of a phase lead.

Load cables must be supported appropriately to avoid a tight radius at the point of entry into the terminal box, clamped at the terminal box gland, and allow at least ±25 mm movement by the alternator set on its anti-vibration mountings, without causing excessive stress to the cables and alternator load terminals.

The palm (flattened part) of load cable lugs must be clamped in direct contact with the main stator output conductors so that the whole palm area conducts the output current, as shown in Figure 18 on page 208 and Figure 19 on page 208. The tightening torque of M12 fasteners is 70 Nm (51.6 ft-lb) (main nut) and 45 Nm (33.2 ft-lb) (lock nut) on insulated terminals, or 80 Nm (59 ft-lb) on busbars. As specified when ordering, cable lugs can be fixed to top or bottom of the busbar, and by one or two fasteners.

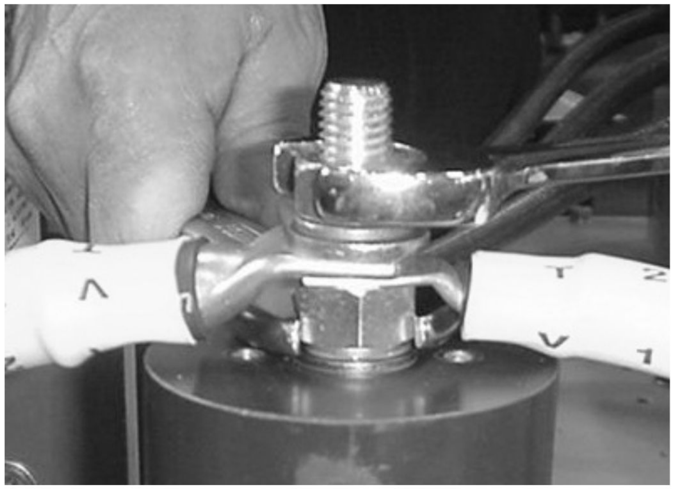


FIGURE 18. CORRECT CABLE CLAMPING (MULTIPLE CABLES)

FIGURE 19. CORRECT CABLE CLAMPING (SINGLE LOAD CABLE)

6.3.1.11.8 Grid Connection: Voltage Surges and Micro-Interruptions

Take precautions to prevent transient voltages generated by the connected load and/or the distribution system from causing damage to the alternator components.

To identify any possible risk, all aspects of the alternator’s proposed application should be considered, especially the following:

- Loads with characteristics that result in large load step changes.
- Load control by switchgear, and power control by any method likely to generate transient voltage spikes.
- Distribution systems susceptible to external influences, such as lightning strikes.
- Applications involving parallel operation to a mains supply, where the risk of a mains disturbance in the form of a micro-interruption could occur.

If the alternator is at risk from voltage surges or micro-interruptions, include adequate protection into the generation system, usually with surge arrestors and suppressors, to meet regulations and installation requirements.

Surge protection must reduce the peak voltage at the alternator of a transient pulse of 5 µs rise time to less than 1.25 x √2 x (2 x rated output voltage + 1000 V). Best practise is to fit protective devices close to the output terminals. Refer to guidance from professional bodies and specialist equipment suppliers for further advice.

6.3.1.11.9 Varying Load

Under certain conditions, load variations can reduce alternator life.

Identify any possible risk, especially the following:

- Large capacitive loads (for example Power Factor Correction equipment) can affect alternator stability and cause pole slip.
- Stepped grid voltage variation (for example Tap Changing).

If the alternator is at risk from varying load, include adequate protection into the generator set system by under-excitation protection.

6.3.1.11.10 Synchronization

⚠ WARNING

Ejected Debris

Debris ejected during catastrophic failure can cause serious injury or death by impact, severing or stabbing.

To prevent injury:

- ***Keep away from the air inlet and air outlet when the alternator is running.***
- ***Do not put operator controls near the air inlet and air outlet.***
- ***Do not cause overheating by running the alternator outside rating plate parameters.***
- ***Do not overload the alternator.***
- ***Do not run an alternator with excessive vibration.***
- ***Do not synchronize parallel alternators outside the specified parameters.***

6.3.1.11.10.1 Parallel or Synchronizing Alternators

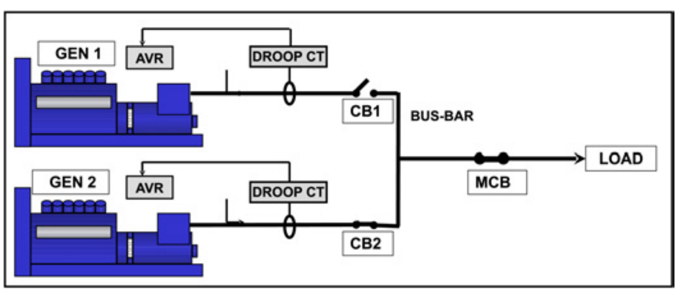


FIGURE 20. PARALLEL OR SYNCHRONIZING ALTERNATORS

The quadrature droop current transformer (Droop CT) gives a signal proportional to reactive current; the AVR adjusts excitation to reduce circulating current and allow each alternator to share reactive load. A factory-fitted droop CT is pre-set for 5% voltage drop at full-load zero power factor. Refer to the supplied AVR manual for droop adjustment.

- The synchronizing switch/breaker (CB1, CB2) must be of a type that will not cause “contact bounce” when it operates.

- The synchronizing switch/breaker must be adequately rated to withstand the continuous full load current of the alternator.
- The switch/breaker must be able to withstanding the rigorous closing cycles during synchronizing and the currents produced if the alternator is paralleled out of synchronizm.
- The closing time of the synchronizing switch/breaker must be under the control of the synchronizer settings.
- The switch/breaker must be capable of operation under fault conditions such as short circuits. Alternator data sheets are available.

NOTICE
The fault level may include a contribution from other alternators as well as from the grid/mains utility.

The method of synchronizing should be either automatic, or by check synchronizing. The use of manual synchronizing is not recommended. The settings on the synchronizing equipment should be such that the alternator will close smoothly. For the synchronizing equipment to achieve this, the phase sequence must match the parameters in the table below.

TABLE 33. SYNCHRONIZING EQUIPMENT PARAMETERS

Voltage Difference	**+/- 0.5%**
Frequency Difference	0.1 Hz/sec
Phase Angle	+/- 10°
C/B Closing Time	50 ms

The voltage difference when paralleling with the grid/mains utility is +/- 3% .

6.3.1.11.11 Re-Greasable Bearings

After long storage periods, grease in the exit port may become hard. To ensure correct function of the machine, remove any hard grease and refill the port with the correct fresh grease. Refer to the Re-Grease Bearings section (Section 6.3.1.12.2.3 on page 214) of the Service and Maintenance chapter in this manual.

6.3.1.11.12 Service and Maintenance

6.3.1.12 Service and Maintenance

TABLE 34. ALTERNATOR SERVICE SCHEDULE

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Replace	SERVICE LEVEL: Commission	SERVICE LEVEL: Post Commission / 250 hrs / 0.5 year	SERVICE LEVEL: Level 1 / 1000 hrs / 1 year	SERVICE LEVEL: Level 2 / 10,000 hrs / 2 years	SERVICE LEVEL: Level 3 / 30,000 hrs / 5 years
Alternator	Alternator rating		X				X				
Alternator	Bedplate arrangement		X				X				
Alternator	Coupling arrangement		X				X			*	X
Alternator	Environmental conditions and cleanliness		X				X	X	X	X	X
Alternator	Ambient temperature (inside & outside)			X			X	X	X	X	X
Alternator	Complete machine - damage, loose parts & earth bonds		X				X	X	X	X	X
Alternator	Guards, screens, warning and safety labels		X				X	X	X	X	X
Alternator	Maintenance access		X				X				
Alternator	Electrical nominal operating conditions & excitation	X		X			X	X	X	X	X
Alternator	Vibration*	X		X			X	X	X	X	X
Windings	Condition of windings		X				X	X	X	X	X
Windings	Insulation resistance of all windings (PI test for MV/HV)			X			X	*	*	X	X
Windings	Insulation resistance of rotor, exciter and PMG			X				X	X		
Windings	Temperature sensors	X		X			X	X	X	X	X
Windings	Customer settings for temperature sensors		X				X				

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Replace	SERVICE LEVEL: Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Bearings	Condition of bearings		X				X							X	
Bearings	Grease exhaust & trap				X			X		X		X		X	
Bearings	Grease in re-greasable bearing(s)	X				X		every 4000 to 4500 hours / 6 months							
Bearings	Sealed bearing(s)		X					every 4000 to 4500 hours							
Bearings	Re-greasable & sealed bearing(s)					X						*		X	
Bearings	Temperature sensors	X		X			X	X		X		X		X	
Bearings	Customer settings for temperature sensors		X				X								
Terminal Box	All alternator/customer connections and cabling		X				X	X		X		X		X	
Controls & Auxiliaries	Initial AVR & PFC set up	X		X			X								
Controls & Auxiliaries	AVR & PFC settings	X		X				X		X		X		X	
Controls & Auxiliaries	Customer connection of auxiliaries			X			X			X		X		X	
Controls & Auxiliaries	Function of auxiliaries			X			X	X		X		X		X	
Controls & Auxiliaries	Synchronization settings		X				X								
Controls & Auxiliaries	Synchronization	X		X			X	X		X		X		X	
Controls & Auxiliaries	Anti condensation heater					X						*		X	
Rectifier	Diodes and varistors		X				X	X		X		X			
Rectifier	Diodes and varistors					X								X	
Cooling	Air inlet temperature	X		X			X	X		X		X		X	
Cooling	Air flow (rate & direction)	X	X				X								
Cooling	Condition of fan		X				X	X		X		X		X	
Cooling	Condition of air filter (where fitted)			X			X	X		X		X		X	
Cooling	Air filters (where fitted)				X	X				*		*		*	

* For stand-alone alternator only.

6.3.1.12.2 Bearings

6.3.1.12.2.1 Introduction

NOTICE
Do not overfill a bearing with grease; the bearing may be damaged.
Do not mix lubricant types. Change gloves to handle different lubricant
Assemble bearings in static- and dust-free conditions while wearing lint free gloves.
Store removed parts and tools in static- and dust-free conditions, to prevent damage or contamination.
A bearing is damaged by the axial force needed to remove it from the rotor shaft. Do not reuse a bearing.
A bearing is damaged if the insertion force is applied through the bearing balls. Do not press fit the outer race by force on the inner race, or vice versa.
Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.

The alternator rotor is supported by a bearing at the non-drive end (NDE) and by either a bearing or a coupling to the prime mover at the drive end (DE).

- Lubricate each re-greasable bearing according to the recommended service schedule with the correct quantity and type of grease, also shown on a label fitted at the grease nipple.
- Inspect each sealed bearing according to the recommended service schedule. Seek advice from CGT Customer Service if grease has leaked out of the bearing, notifying the bearing type and quantity leaked.

6.3.1.12.2.2 Safety

⚠ DANGER
Rotating Mechanical Parts
Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping.
To prevent injury and before removing covers over rotating parts, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ WARNING
Hot Surfaces
Skin contact with hot surfaces can cause serious injury by burns.
To prevent injury, wear appropriate personal protection equipment (PPE).

⚠ CAUTION
Grease
Skin contact with grease can cause minor or moderate injury by contact dermatitis.
To prevent injury, wear appropriate personal protection equipment (PPE).

NOTICE
Do not overfill a bearing with grease; the bearing may be damaged.
Do not mix lubricant types. Change gloves to handle different lubricant
Assemble bearings in static- and dust-free conditions while wearing lint free gloves.
Store removed parts and tools in static- and dust-free conditions, to prevent damage or contamination.
A bearing is damaged by the axial force needed to remove it from the rotor shaft. Do not reuse a bearing.
A bearing is damaged if the insertion force is applied through the bearing balls. Do not press fit the outer race by force on the inner race, or vice versa.
Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.

6.3.1.12.2.3 Re-Grease Bearings

6.3.1.12.2.3.1 Requirements

TABLE 35. RE-GREASING: EQUIPMENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	Wear mandatory site PPE
Consumables	• Lint-free cleaning cloths • Thin disposable gloves
Parts	CGT recommended grease
Tools	Grease gun (calibrated for volume or mass)

6.3.1.12.2.3.2 Re-Grease Method

1. For each bearing, identify the grease nipple, re-greasing label and bearing type.
2. Make sure the new grease is not contaminated. It must be a uniform whitish-beige color and of stiff consistency throughout.
3. Clean the grease gun nozzle and grease nipple.
4. Clean the grease exhaust.
5. Fit the grease gun to the grease nipple and add the correct quantity of grease.
6. Run the alternator for at least 60 minutes, off- or on-load.
7. Clean the grease exhaust.
8. Inspect the color and consistency of the grease expelled from the exhaust and compare with the new grease, which should be whitish-beige and of stiff consistency.
9. Replace the bearing if the expelled grease is severely discolored or absent.

TABLE 36. RE-GREASING: GREASE QUANTITY

Bearing Type	Quantity of Recommended Grease	
	Volume (cm^3)	Mass (g)
Drive End (HC5)	46	41
Non-drive End (HC5)	33	29
Drive End (HC6)	75	66
Non-drive End (HC6)	60	53

6.3.1.12.2.4 Replace Bearings

Follow the steps below, in order:

1. Follow the **Remove Non-Drive End** section to access NDE bearing
2. If the DE bearing is to be replaced, follow the **Remove Drive End** section to access DE bearing.
3. Assemble and fit the new NDE bearing (and DE bearing, as required) onto the rotor shaft, following the **Assemble Bearing** section.
4. If the DE bearing has been replaced, follow the **Assemble Drive End** section to refit DE components.
5. Follow the **Assemble Non-Drive End** section to refit NDE components.

6.3.1.12.2.4.1 Requirements

TABLE 37. RE-GREASABLE BEARING REPLACEMENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	• Wear mandatory site PPE. • Wear heat-resistant gloves for handling heated parts.
Consumables	• Lint-free cleaning cloths • Thin disposable gloves • Washing fluid • Large plastic bags for storing parts • White anti-static assembly surface
Parts	• NDE bearing • DE bearing (if fitted) • CGT-recommended grease • CGT-recommended anti-fretting paste • O-rings (if fitted) • Wavy Washer • Grease Flinger
Tools	• Grease gun (calibrated for volume or mass) • Washing bowl and brush • Induction heater (with protective sleeve on bar) • Torque wrench • Bearing removal tooling (see Spares and After Sales Service chapter) • Rotor support packing (nylon strips 4 mm x 60 mm x core length) • Hydraulic cylinder jack and pump • M10 x 120 guide studs x 2

6.3.1.12.2.4.2 Remove Non-Drive End

NOTICE
Delicate exciter leads and temperature sensor leads may be fixed to the inside of the NDE bracket. Note the routing of leads and locations of all fasteners. Detach the leads carefully and keep all fasteners for re-use during assembly. Take care not to damage the leads when removing and storing the NDE bracket.

1. Turn off the anti-condensation heater (if fitted) and isolate from supply.
2. Remove the PMG cover (if fitted).
3. Remove the lower air inlet cover.

4. Remove the terminal box lid and side panel (left hand, viewed from NDE)
5. Unplug the PMG control cable (if fitted).
6. Disconnect the grease pipe (if fitted) from the bearing cartridge and the NDE bracket.
7. Disconnect the heater (if fitted).
8. Use a 10 mm open spanner to disconnect the RTD sensor for bearing temperature (if fitted) from the bearing.
9. Remove the PMG stator and PMG rotor together as an assembly.
10. Put the PMG assembly into a plastic bag. Seal the bag to protect the parts from debris.
11. Remove the PMG rotor location pin from the end of the rotor shaft, or use a bolt with a spacer inserted in the PMG rotor thread to prevent damage to the pin.
12. Remove the NDE bearing cap assembly.
13. Turn the main rotor so that the NDE keyway is at the top of the rotor shaft. In this position, the lowest rotor pole is vertical and will support the rotor weight when the bearing is removed. If the rotor cannot be turned and no rotor pole is vertical, fit two rotor support packing pieces (see below) to support the lower two poles.
14. Disconnect F1 (red) and F2 leads at the AVR, cut cable ties and withdraw the leads to the exciter stator.
15. Remove fasteners from the NDE bearing cartridge.
16. Fix two threaded guide studs at least 120 mm long into the NDE bearing cartridge.
17. Remove fasteners from NDE bracket.
18. Insert two M10 jacking bolts part way into threaded holes on the NDE bracket horizontal centreline to open a gap for a shackle between the NDE bracket and the frame – approximately 10mm movement.
19. Fix a shackle to the NDE bracket and support with a crane sling.
20. Insert the jacking bolts fully to release the NDE bracket from the frame.
21. For alternators with a DE bearing, insert a rotor support packing piece into the air gap between the lowest rotor pole and the stator, along the full length of the rotor pole. When the NDE bearing is removed, the packing will keep the rotor near-horizontal to reduce non-radial loading on the other bearing.
22. Gently lower the crane sling or jack to put the rotor weight onto the support packing and remove the sling.
23. Carefully slide the NDE bracket away from the alternator along the guide studs to avoid damaging the exciter stator windings on the exciter rotor.
24. Set aside the NDE bracket flat on the floor on wooden bearers, with the exciter stator face up.
25. Remove the guide studs.

6.3.1.12.2.4.3 Remove Drive End

1. Remove NDE components first, following **Remove Non-Drive End**.
2. Remove the DE air outlet screen and DE louvres (if fitted).
3. Disconnect the alternator from the prime mover.
4. Disconnect the grease tube (if fitted).
5. Disconnect the RTD sensor for bearing temperature (if fitted).
6. Remove the DE bearing cap.

7. Remove fasteners from the DE bearing cartridge.
8. Fix two threaded guide studs at least 120 mm long into the DE bearing cartridge.
9. Use a crane sling and lifting hooks fitted into the air outlet ducts to support the DE bracket.
10. Remove fasteners from the DE bracket.
11. Release the DE bracket from the frame by tapping with a mallet away from the frame
12. Gently lower the crane sling to put the rotor weight onto the support packing.
13. Carefully slide the DE bracket away from the alternator along the guide studs.
14. Remove the guide studs.

6.3.1.12.2.4.4 Assemble a Re-Greasable Bearing

1. Remove and discard the wavy washer (NDE only).
2. Use the tooling and jack to remove the grease flinger.
3. Remove the circlip (NDE only).
4. Use the tooling and jack to remove the bearing and cartridge assembly from the main rotor shaft.
5. Prepare for assembly, by cleaning:
   a. Wipe clean the anti-static assembly surface, using solvent on cloth.
   b. Wash the bearing cartridge, wavy washer and the bearing cap and inspect for contamination.
   c. Wipe off excess washing fluid with a lint-free cloth and place all components on the clean anti-static assembly surface.
   d. Thoroughly clean the external surface of the grease gun nozzle using a lint-free cloth.
6. Prepare the bearing:
   a. Remove the bearing from its packaging.
   b. Wipe off the preservative oil with a lint-free cloth from the surface of the inner and outer rings.
   c. Place the bearing on the clean anti-static assembly surface, with the bearing type identification markings face down.
7. Grease and assemble the bearing components:
   a. Fit a new O-ring in the groove in the bearing housing (NDE only).
   b. Apply the specified quantity of grease to the back face of the bearing cartridge. See **Table 38 on page 219** for quantities.
   c. Apply a small amount of grease to the grooved sealing surface in the cartridge.
   d. Without rubbing in, use a lint-free cloth to smear anti-fretting paste in a thin coherent layer to the bearing housing circumference.
   e. Apply half the specified quantity of grease to the upper face of the bearing (without the bearing designation markings).
   f. Press the grease into the bearing, ensuring good penetration into the raceways and between the balls.
   g. Assemble the bearing into the bearing cartridge, greased side first, by pressing **ONLY** on the bearing outer race. Ensure the bearing outer race contacts the location shoulder.
   h. Apply the remaining half of the specified quantity of grease to the exposed side of the bearing.
   i. Press the grease into the bearing, ensuring good penetration into the raceways and between the balls.

j. Apply the specified quantity of grease to the inside face of the bearing cap.

k. Fill the grease exhaust slot, with grease.

l. Apply a small amount of grease to the grooved sealing surface in the bearing cap.

m. Fill the grease pipe and grease nipple with grease.

8. Fit the bearing components:

   a. Expand the bearing and cartridge assembly by heating to 100 to 110 ºC in the induction heater.

   b. Slide the bearing and cartridge assembly over the rotor shaft, pushing it firmly against the seating shoulder.

   c. Oscillate the assembly (including inner race) 45 degrees in both directions, to ensure bearing is seated. Hold the bearing in place while it cools and contracts onto the rotor shaft.

   d. Refit the circlip (NDE only) into the main rotor shaft groove.

   e. Expand the grease flinger by heating to 110 °C in the induction heater.

   f. Slide the grease flinger over the rotor shaft and push it firmly against the bearing assembly. Hold the flinger in place while it cools and contracts onto the rotor shaft.

   g. Fit the wavy washer (NDE only).

   h. Wait for the bearing and cartridge assembly and flinger to cool to ambient temperature.

   i. Fit the bearing cap over the grease flinger and fix to the bearing cartridge.

9. Record the bearing change on the Service Report.

TABLE 38. INITIAL GREASING: QUANTITY OF RECOMMENDED GREASE

Bearing Type	Cartridge		Bearing		Bearing Cap		TOTAL	
	Volume (cm^3)	Mass (g)	Volume (cm^3)	Mass (g)	Volume (cm^3)	Mass (g)	Volume (cm^3)	Mass (g)
Drive End (HC5)	46	41	92	82	46	41	**184**	**164**
Non-Drive End (HC5)	33	29	65	58	33	29	**131**	**116**
Drive End (HC6)	78	69	156	139	78	69	**312**	**277**
Non-Drive End (HC6)	63	56	121	111	63	56	**247**	**223**

6.3.1.12.2.4.5 Assemble Drive End

1. Attach suitable lifting equipment and slide the DE bracket onto the rotor shaft and locate over the DE bearing assembly.

2. Use a crane sling to lift the rotor and DE bracket at the drive end a small amount, to support the weight.

3. Refit the DE bracket onto the frame.
4. Refix the DE bearing cartridge to the DE bracket.
5. Refit the DE bearing cap.
6. Reconnect the grease pipe (if fitted).
7. Reconnect the RTD sensor (if fitted).
8. Recouple the alternator to the prime mover.
9. Refit the DE air outlet screen and DE louvres.

6.3.1.12.2.4.6 Assemble Non-Drive End

NOTICE
Route the delicate exciter leads and temperature sensor leads carefully, and fix securely to the inside of the NDE bracket. Take care not to damage the leads when fitting the NDE bracket.

1. Fix the threaded guide studs into the NDE bearing cartridge.
2. Slide the NDE bracket onto the rotor shaft, guide onto the studs and locate over the NDE bearing assembly.
3. Use a crane sling to lift the rotor and NDE bracket a small amount, to support the weight.
4. Remove the rotor support packing piece(s).
5. Fix the NDE bracket to the frame.
6. Remove the guide studs.
7. Fix the NDE bearing cartridge to the NDE bracket.
8. Gently lower the crane sling to put the rotor weight onto the bearing and remove the sling.
9. Turn the rotor by hand to check bearing alignment and free rotation.
10. Refit the NDE bearing cap assembly.
11. Refit the PMG rotor and the PMG stator.
12. Reconnect the control cable plug.
13. Reconnect the grease pipe (if fitted).
14. Reconnect the RTD sensor (if fitted).
15. Secure the heater and exciter stator leads inside the alternator with heat stabilised cable ties.
16. Secure the leads with cable ties to the main stator leads and reconnect to the AVR.
17. Refit the PMG cover and lower air inlet cover.
18. Refit terminal box side panel and lid.
19. Reconnect the supply to the anti-condensation heater (if fitted).

6.3.1.12.3 Controls

6.3.1.12.3.1 Introduction

An operating alternator is a harsh environment for control components. Heat and vibration can cause electrical connections to loosen and cables to fail. Routine inspection and test can identify an issue before it becomes a failure that incurs unplanned downtime.

6.3.1.12.3.2 Safety

⚠ DANGER
Live Electrical Conductors ***Live electrical conductors can cause serious injury or death by electric shock and burns.*** ***To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.***

⚠ WARNING
Hot Surfaces ***Skin contact with hot surfaces can cause serious injury by burns.*** ***To prevent injury, wear appropriate personal protection equipment (PPE).***

6.3.1.12.3.3 Connection Test Requirements

TABLE 39. CONNECTION TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	Wear mandatory site PPE
Consumables	None
Parts	None
Tools	• Insulation test meter • Multimeter • Torque wrench

6.3.1.12.3.4 Inspect and Test

1. Remove the terminal box lid
2. Check the tightness of fasteners securing the load cables.
3. Check that cables are firmly clamped at the terminal box gland, and allow ±25 mm movement by an alternator on anti-vibration mounts.
4. Check that all cables are anchored and unstressed within the terminal box.
5. Check all cables for signs of damage.
6. Check that AVR accessories and current transformers are correctly fitted, and cables pass centrally through current transformers (if fitted).
7. If an anti-condensation heater is fitted:
   a. Isolate the supply and measure the electrical resistance of the heater element(s). Replace the heater element if open circuit.
   b. Connect together both ends of the heater leads.
   c. Apply the test voltage between the winding and earth.
   d. Measure the insulation resistance after 1 minute (IR 1min).
   e. Discharge the test voltage.

f. If the measured insulation resistance is less than the minimum acceptable level, replace the heater element. See Table 40 on page 222 for values.

8. Test the supply voltage to the anti-condensation heater at the heater connection box. 120 VAC or 240 VAC. (depending on cartridge option and shown on a label) should be present when the alternator is stopped.
9. Check that the AVR and AVR accessories fitted in the terminal box are clean, securely fitted on anti-vibration mounts, and the cable connectors are firmly attached to the terminals.
10. For parallel operation, check that the synchronization control cables are securely connected.
11. Refit and secure the terminal box lid.

TABLE 40. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ANTI-CONDENSATION HEATERS

Component	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service
Anti-condensation heater	500	10	1

6.3.1.12.4 Cooling System

6.3.1.12.4.1 Introduction

The alternators are designed to meet standards supporting EU Safety Directives, and are rated for the effect of operating temperature on winding insulation.

BS EN 60085 (≡ IEC 60085) Electrical insulation – Thermal Evaluation and Designation classifies insulation by the maximum operating temperature for a reasonable service life. Although chemical contamination and electrical and mechanical stresses also contribute, temperature is the dominant aging factor. Fan cooling maintains a stable operating temperature below the insulation class limit.

If the operating environment differs from the values shown on the rating plate, rated output must be reduced by

- 3% for class H utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 3.5% for class F utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 4.5% for class B utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 3% for every 500 m increase in altitude above 1000 m, up to 4000m, due to the reduced thermal capacity of lower density air, and
- 5% if air filters are fitted, due to restricted air flow.

Note: The values above are cumulative dependant on environmental conditions.

Efficient cooling depends on maintaining the condition of the cooling fan, air filters and gaskets.

6.3.1.12.4.2 Safety

⚠ DANGER
Rotating Mechanical Parts
Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping.
To prevent injury and before removing covers over rotating parts, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ WARNING
Hot Surfaces
Skin contact with hot surfaces can cause serious injury by burns.
To prevent injury, wear appropriate personal protection equipment (PPE).

⚠ CAUTION
Dust
Inhaling dust can cause minor or moderate injury by irritating the lungs. Dust can cause minor or moderate injury by irritating the eyes.
To prevent injury, wear appropriate personal protection equipment (PPE). Ventilate the area to disperse dust.

NOTICE
Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

NOTICE
Filters are designed to remove dust, not moisture. Wet filter elements can cause reduced air flow and overheating. Do not allow filter elements to get wet.

6.3.1.12.4.3 Cooling System Test Requirements

TABLE 41. COOLING SYSTEM TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	• Wear mandatory site PPE • Wear eye protection • Wear respiratory protection
Consumables	• Lint-free cleaning cloths • Thin disposable gloves
Parts	• Air filters (if fitted) • Air filter sealing gaskets (if fitted)
Tools	None

6.3.1.12.4.4 Inspect and Clean

1. Inspect the fan for damaged vanes and cracks.
2. Remove air filters (at the fan and terminal box, if fitted) from their frames.
3. Wash and dry the air filters and gaskets to remove contaminant particles.
4. Inspect the filters and gaskets for damage and replace, as necessary.
5. Install the filters and gaskets.
6. Reinstate the generator set for running.
7. Make sure the air inlets and outlets are not blocked.

6.3.1.12.5 Coupling

6.3.1.12.5.1 Introduction

Efficient operation and long component life rely on minimizing mechanical stresses on the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress.

The rotational axes of alternator rotor and engine output shaft must be coaxial (radial and angular alignment).

Torsional vibration can cause damage to internal combustion engine shaft-driven systems, if not controlled. The generator set manufacturer is responsible for assessing the effect of torsional vibration on the alternator: Rotor dimensions and inertia, and coupling details are available on request.

6.3.1.12.5.2 Safety

NOTICE
Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

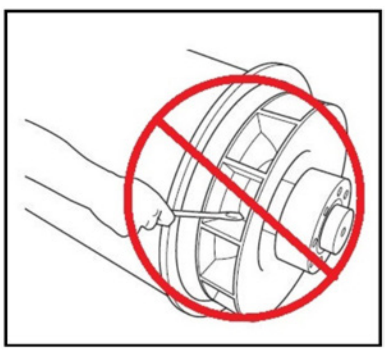


FIGURE 21. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER

6.3.1.12.5.3 Coupling Test Requirements

TABLE 42. COUPLING TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	Wear mandatory site PPE
Consumables	None
Parts	None
Tools	• Dial gauge • Torque wrench

6.3.1.12.5.4 Inspect Mounting Points

1. Check the generator set bedplate and mounting pads are in good condition, not cracked
2. Check that rubber in anti-vibration mounts has not perished
3. Check vibration monitoring historical records for a trend of increasing vibration

6.3.1.12.5.4.1 Single Bearing Coupling

1. Remove the DE adapter screen and cover to access the coupling.
2. Check that the coupling discs are not damaged, cracked or distorted, and the coupling disc holes are not elongated. If any are damaged, replace the complete set of discs.
3. Check tightness of bolts fixing the coupling discs to the engine flywheel. Tighten in the sequence shown for alternator coupling in the Installation chapter, to the torque recommended by the engine manufacturer.
4. Replace the DE adapter screen and drip proof cover.

6.3.1.12.6 Rectifier System

6.3.1.12.6.1 Introduction

The rectifier converts alternating current (AC) induced in the exciter rotor windings into direct current (DC) to magnetize the main rotor poles. The rectifier comprises two semicircular annular positive and negative plates, each with three diodes. In addition to connecting to the main rotor, the DC output of the rectifier also connects to a matched pair of varistors (one at each end of the plates). These additional components protect the rectifier from voltage spikes and surge voltages that may be present on the rotor under various loading conditions of the alternator.

Diodes provide a low resistance to current in one direction only: Positive current will flow from anode to cathode, or another way of viewing it is that negative current will flow from cathode to anode.

The exciter rotor windings are connected to 3 diode anodes to form the positive plate and to 3 diode cathodes to form the negative plate to give full wave rectification from AC to DC. The rectifier is mounted on, and rotates with, the exciter rotor at the non-drive end (NDE).

6.3.1.12.6.2 Safety

⚠ DANGER
Live Electrical Conductors
Live electrical conductors can cause serious injury or death by electric shock and burns.
To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ DANGER
Rotating Mechanical Parts
Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping.
To prevent injury and before removing covers over rotating parts, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

6.3.1.12.6.3 Requirements

TABLE 43. RECTIFIER SYSTEM: TEST AND REPLACE COMPONENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	Wear appropriate PPE.
Consumables	• Loctite 241 thread-locking adhesive • Dow Corning silicone heat sink compound type 340 or similar
Parts	• Full set of three anode lead diodes and three cathode lead diodes (all from the same manufacturer) • Two metal-oxide varistors (same type, same manufacturer, same voltage grading: A, B, C, D, E, F)
Tools	• Multimeter • Insulation tester • Torque wrench

6.3.1.12.6.4 Test and Replace Varistors

1. Inspect both varistors.
2. Record varistor as faulty if there are signs of overheating (discoloration, blisters, melting) or disintegration. Check for loose connectors vs. varistor body.
3. Disconnect one varistor lead. Store fastener and washers.
4. Measure the resistance across each varistor. Good varistors have a resistance greater than 100 MΩ.
5. Record varistor as faulty if the resistance is short circuit or open circuit in either direction.
6. If either varistor is faulty, replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) and replace all diodes.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

6.3.1.12.6.5 Test and Replace Diodes

NOTICE
Do not tighten a diode above the stated torque. The diode will be damaged.

1. Disconnect the lead of one diode where it joins the windings at the insulated terminal post. Store fastener and washers.
2. Measure the voltage drop across the diode in the forward direction, using the diode test function of a multimeter.
3. Measure the resistance across the diode in the reverse direction, using the 1000 VDC test voltage of an insulation tester.
4. Diode is faulty if the voltage drop in the forward direction is outside the range 0.3 to 0.9 VDC, or the resistance is below 20 MΩ in the reverse direction.
5. Repeat the tests for the five remaining diodes.
6. If any diode is faulty, replace the full set of six diodes (same type, same manufacturer):
   a. Remove diode(s).
   b. Apply a small amount of heat sink compound **only** to the base of the replacement diode(s), not the threads.
   c. Check polarity of diode(s).
   d. Screw each replacement diode into a threaded hole in the rectifier plate.
   e. Apply 2.6 to 3.1 Nm (23 to 27.4 in-lb) torque to give good mechanical, electrical and thermal contact.
   f. Replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F)
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

6.3.1.12.7 Temperature Sensors

6.3.1.12.7.1 Introduction

The alternators are designed to meet standards supporting EU Safety Directives, and recommended operating temperatures. Temperature sensors (where fitted) detect abnormal overheating of the main stator windings and bearing(s). Sensors are of two types: Resistance Temperature Detector (RTD) sensors, with three wires, and Positive Temperature Coefficient (PTC) thermistors, with two wires, which are connected to a terminal block in the auxiliary or main terminal box. The resistance of Platinum (PT100) RTD sensors increases linearly with temperature.

TABLE 44. RESISTANCE (Ω) OF PT100 SENSOR BETWEEN 40 TO 180 °C

Temperature (°C)		+1 °C	+2 °C	+3 °C	+4 °C	+5 °C	+6 °C	+7 °C	+8 °C	+9 °C
40.00	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01
50.00	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86
60.00	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69
70.00	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52
80.00	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33
90.00	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13
100.00	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91
110.00	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69
120.00	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46
130.00	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21
140.00	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95
150.00	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68
160.00	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03	164.40
170.00	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74	168.11
180.00	168.48									

PTC thermistors are characterised by a sudden increase in resistance at a reference “switching” temperature. Customer-supplied external equipment may be connected to monitor the sensors and generate signals to raise an alarm and to shutdown the generator set.

BS EN 60085 (≡ IEC 60085) Electrical insulation – Thermal Evaluation and Designation classifies insulation of windings by the maximum operating temperature for a reasonable service life. To avoid damage to windings, signals should be set, appropriate to the insulation class shown on the alternator rating plate.

TABLE 45. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR WINDINGS

Windings Insulation	Max. Continuous Temperature (°C)	Alarm Temperature (°C)	Shutdown Temperature (°C)
Class B	130	120	140
Class F	155	145	165
Class H	180	170	190

To detect overheating of bearings, control signals should be set according to the following table.

TABLE 46. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR BEARINGS

Bearings	Alarm Temperature (°C)	Shutdown Temperature (°C)
Drive End Bearing	45 + maximum ambient	50 + maximum ambient
Non-drive End Bearing	40 + maximum ambient	45 + maximum ambient

6.3.1.12.7.2 Safety

⚠ DANGER

The main terminal box cover must be removed to test temperature sensors. Risk of serious injury or death by electrocution from contact with live electrical conductors. To avoid injury; isolate the generator set from all energy sources and remove stored energy. Use lock and tag safety procedures before starting work.

⚠ WARNING

External surfaces may be very hot. Exposed skin can suffer serious and permanent burns, depending on the temperature and contact time. Avoid contact or wear protective gloves.

6.3.1.12.7.3 Test RTD Temperature Sensors

1. Remove the terminal box lid.
2. Identify the sensor leads at the terminal block and where each sensor is fitted
3. Measure the resistance between the white and each red wire of one sensor
4. Calculate the sensor temperature from the measured resistance
5. Compare calculated temperature with temperature indicated by external monitoring equipment (if available)
6. Compare alarm and shutdown signal settings (if available) with recommended settings
7. Repeat steps 3 to 7 for each sensor
8. Refit the terminal box lid.
9. Contact Cummins Customer Service Help Desk to replace faulty sensors.

6.3.1.12.7.4 Test PTC Temperature Sensors

1. Remove the auxiliary terminal box lid.
2. Identify the sensor leads at the terminal block and where each sensor is fitted.
3. Measure the resistance between the two wires.
4. Sensor is faulty if resistance shows open circuit (infinity Ω) or short circuit (zero Ω).
5. Repeat steps 3 to 5 for each sensor.
6. Stop the alternator and inspect the change in resistance as the stator winding cools.
7. Sensor is faulty if resistance does not change or change is not smooth.
8. Repeat steps 6 and 7 for each sensor.
9. Refit the auxiliary terminal box lid.
10. Contact Cummins Customer Service Help Desk to replace faulty sensors.

6.3.1.12.8 Windings

6.3.1.12.8.1 Safety

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns.

To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ WARNING

Live Electrical Conductors

Live electrical conductors at the winding terminals after an insulation resistance test can cause serious injury or death by electric shock or burns.

To prevent injury, discharge the windings by shorting to earth through an earthing rod for at least 5 minutes.

6.3.1.12.8.2 Requirements

TABLE 47. WINDING TEST REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	Wear mandatory site PPE.
Consumables	None
Parts	None
Tools	• Insulation test meter • Multimeter • Milliohm meter or microohm meter • Clamp ammeter • Infrared thermometer • Earth rod

6.3.1.12.8.3 Test the Electrical Resistance of Windings

1. Stop the alternator.
2. Verify the electrical resistance of the exciter field (stator) winding:
    a. Disconnect the exciter field leads F1 and F2 from the AVR.
    b. Measure and record the electrical resistance between F1 and F2 leads with a multimeter.
    c. Reconnect the exciter field leads F1 and F2.
    d. Make sure the fasteners are secure.
3. Verify the electrical resistance of the exciter armature (rotor) winding:
    a. Mark the leads attached to diodes on one of the two rectifier plates.
    b. Disconnect all exciter rotor leads from all diodes at the rectifier.

c. Measure and record the electrical resistance between pairs of marked leads (between phase windings). A specialist micro ohmmeter must be used.

d. Reconnect all exciter rotor leads to the diodes.

e. Make sure the fasteners are secure.

4. Verify the electrical resistance of the main field (rotor) winding:

   a. Disconnect the two main rotor DC leads from the rectifier plates.

   b. Measure and record the electrical resistance between the main rotor leads. A specialist micro ohmmeter must be used.

   c. Reconnect the two main rotor DC leads to the rectifier plates.

   d. Make sure the fasteners are secure.

5. Verify the electrical resistance of the main armature (stator) winding:

   a. Disconnect the leads of the main stator from the output terminals.

   b. Measure and record the electrical resistance between U1 and U2 leads and between U5 and U6 (if present). A specialist micro ohmmeter must be used.

   c. Measure and record the electrical resistance between V1 and V2 leads and between V5 and V6 (if present). A specialist micro ohmmeter must be used.

   d. Measure and record the electrical resistance between W1 and W2 leads and between W5 and W6 (if present). A specialist micro ohmmeter must be used.

   e. Reconnect the leads to the output terminals, as before.

   f. Make sure the fasteners are secure.

6. Verify the electrical resistance of the PMG armature (stator) winding, if fitted:

   a. Disconnect the three PMG output leads P2, P3 and P4 from the AVR.

   b. Measure and record the electrical resistance between pairs of the PMG output leads, with a multimeter.

   c. Reconnect the three PMG output leads P2, P3 and P4 to the AVR.

   d. Make sure the fasteners are secure.

7. Refer to the Technical Data (**Section 6.3.1.12.8.3.1 on page 231**) to verify the measured resistances of all windings agree with the reference values.

6.3.1.12.8.3.1 Technical Data

NOTICE
Compare measurements with the technical data sheet and the test certificate supplied with the alternator.

HC Winding Resistances

TABLE 48. HC WINDING RESISTANCES

Alternator	Resistance of Windings at 22 °C (Measured Values Should Be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)				
HC434C	0.0083	0.0115	0.0055	0.0020	0.0154	18	0.136	0.92	3.8
HC434D	0.0062	0.0100	0.0045	0.0160	0.0130	18	0.136	1.05	3.8
HC434E	0.0045	0.0075	n/a	0.0140	0.0100	18	0.136	1.19	3.8
HC434F	0.0037	0.0055	n/a	0.0105	0.0075	18	0.136	1.37	3.8
HC444C	0.0083	0.0115	0.0055	0.0020	0.0154	18	0.136	0.92	n/a
HC444D	0.0062	0.0100	0.0045	0.0160	0.0130	18	0.136	1.05	n/a
HC444E	0.0045	0.0075	n/a	0.0140	0.0100	18	0.136	1.19	n/a
HC444F	0.0037	0.0055	n/a	0.0105	0.0075	18	0.136	1.37	n/a
HC534C	0.0033	0.0053	0.0026	0.0100	0.0065	17	0.184	1.55	3.8
HC534D	0.0025	0.0040	0.0021	0.0075	0.0005	17	0.184	1.77	3.8
HC534E	0.0022	0.0034	0.0013	n/a	0.0044	17	0.184	1.96	3.8
HC534F	0.0019	0.0025	0.0013	0.0050	0.0041	17	0.184	2.46	3.8
HC544C	0.0033	0.0053	0.0026	0.0100	0.0065	17	0.184	1.55	n/a
HC544D	0.0025	0.0040	0.0021	0.0075	0.0005	17	0.184	1.77	n/a
HC544E	0.0022	0.0034	0.0013	n/a	0.0044	17	0.184	1.96	n/a
HC544F	0.0019	0.0025	0.0013	0.0050	0.0041	17	0.184	2.46	n/a
HC634G	0.0017	n/a	n/a	n/a	n/a	17	0.158	1.75	3.8
HC634H	0.0013	n/a	n/a	n/a	n/a	17	0.158	1.88	3.8
HC634J	0.0011	n/a	n/a	n/a	n/a	17	0.158	2.09	3.8
HC634K	0.0009	n/a	n/a	n/a	n/a	17	0.158	2.36	3.8

Alternator	Resistance of Windings at 22 °C (Measured Values Should Be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	312 (U1-U2) (V1-V2) (W1-W2)	07 (U1-U2) (V1-V2) (W1-W2)	13 (U1-U2) (V1-V2) (W1-W2)	26 (U1-U2) (V1-V2) (W1-W2)	28 (U1-U2) (V1-V2) (W1-W2)				
HC434F	n/a	n/a	0.0060	n/a	n/a	18	0.136	1.37	3.8
HC444F	n/a	n/a	0.0060	n/a	n/a	18	0.136	1.37	n/a
HC534E	n/a	n/a	n/a	0.0130	n/a	17	0.184	1.96	3.8
HC544E	n/a	n/a	n/a	0.0130	n/a	17	0.184	1.96	n/a
HC634G	0.0034	0.0055	0.0002	0.0090	0.0075	17	0.158	1.75	3.8
HC634H	0.0025	0.0036	0.0019	0.0080	n/a	17	0.158	1.88	3.8
HC634J	0.0022	0.0030	0.0015	0.0060	n/a	17	0.158	2.09	3.8
HC634K	0.0017	0.0026	0.0010	0.0045	0.0030	17	0.158	2.36	3.8
HC636G	0.0090	0.0102	n/a	n/a	n/a	17	0.200	1.12	8.22
HC636H	0.0063	0.0102	n/a	n/a	n/a	17	0.200	1.33	8.22
HC636J	0.0049	0.0070	n/a	n/a	n/a	17	0.200	1.50	8.22
HC636K	0.0039	0.0060	n/a	n/a	n/a	17	0.200	1.75	8.22

6.3.1.12.8.4 Test the Insulation Resistance of Windings

NOTICE
The alternator must not be put into service until the minimum insulation resistance is achieved.

TABLE 49. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

Part	Test Voltage (V)	Minimum Insulation Resistance at 1 Minute (MΩ)	
		New	In-Service
Main Stator	500	10	5
PMG Stator	500	5	3
Exciter Stator	500	10	5
Exciter Rotor, Rectifier & Main Rotor Combined	500	10	5

1. Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.

2. For main stators:
    a. Disconnect the neutral to earth conductor (if fitted).
    b. Connect together the three leads of all phase windings (if possible).
    c. Apply the test voltage from the table between any phase lead and earth.
    d. Measure the insulation resistance after 1 minute (IR_{1min}).
    e. Discharge the test voltage with an earth rod for five minutes.
    f. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
    g. Reconnect neutral to earth conductor (if fitted).
3. For PMG and exciter stators, and combined exciter and main rotors:
    a. Connect together both ends of the winding (if possible).
    b. Apply the test voltage from the table between the winding and earth.
    c. Measure the insulation resistance after 1 minute (IR_{1min}).
    d. Discharge the test voltage with an earth rod for five minutes.
    e. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
    f. Repeat the method for each winding.
    g. Remove the connections made for testing.

6.3.1.12.8.5 Dry the Insulation

Use the methods below to dry the insulation of the main stator windings. To prevent damage as water vapor is expelled from the insulation, make sure the winding temperature does not increase faster than 5 ºC per hour or exceed 90 ºC.

Plot the insulation resistance graph to show when drying is complete.

6.3.1.12.8.5.1 Dry with Ambient Air

In many cases, the alternator can be dried sufficiently using its own cooling system. Disconnect the cables from the X+ (F1) and XX- (F2) terminals of the AVR so there is no excitation voltage supply to the exciter stator. Run the generator set in this de-excited state. Air must flow freely through the alternator to remove the moisture. Operate the anti-condensation heater (if fitted) to assist the drying effect of the air flow.

After drying is complete, re-connect the cables between the exciter stator and AVR. If the generator set is not put into service immediately, turn on the anti-condensation heater (if fitted) and retest the insulation resistance before use.

6.3.1.12.8.5.2 Dry with Hot Air

Direct the hot air from one or two 1 to 3 kW electrical fan heaters into the alternator air inlet. Make sure each heat source at least 300 mm away from the windings to avoid scorching or over-heating damage to the insulation. Air must flow freely through the alternator to remove the moisture.

After drying, remove the fan heaters and re-commission as appropriate.

If the generator set is not put into service immediately, turn on the anti-condensation heaters (where fitted) and retest the insulation resistance before use.

6.3.1.12.8.5.3 Plot IR Graph

Whichever method is used to dry out the alternator, measure the insulation resistance and temperature (if sensors fitted) of the main stator windings every 15 to 30 minutes. Plot a graph of insulation resistance, IR (y axis) against time, t (x axis).

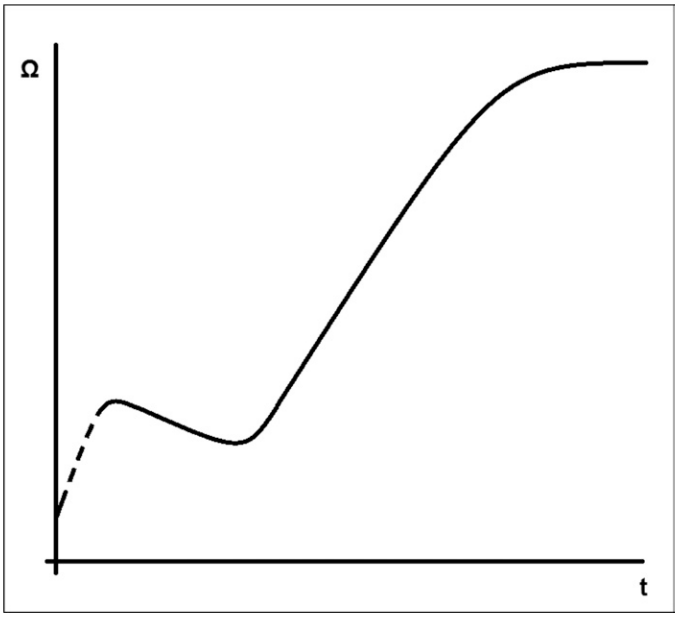


FIGURE 22. INSULATION RESISTANCE GRAPH

A typical curve shows an initial increase in resistance, a fall and then a gradual rise to a steady state; if the windings are only slightly damp the dotted portion of the curve may not appear. Continue drying for another hour after steady state is reached.

NOTICE
The alternator must not be put into service until the minimum insulation resistance is achieved.

6.3.1.12.8.6 Clean the Insulation

Remove the main rotor to gain access to the main stator windings to remove dirt contamination. Cleaning of the alternator should be conducted using PH neutral clean, uncontaminated water. In the event of heavy contamination, it is permitted to use only Karcher RM81 detergent in conjunction with hot water jet wash. Methods to remove and assemble the drive end (DE) and non-drive end (NDE) support are included in the Replace Bearing section of Service and Maintenance chapter.

6.3.1.12.8.6.1 Remove Main Rotor

NOTICE
The rotor is heavy, with a small clearance to the stator. Windings will be damaged if the rotor drops or swings in the crane sling and hits the stator or frame. To avoid damage, fit support packing and carefully guide the rotor ends throughout. Do not allow the sling to touch the fan.

NOTICE

To remove the main rotor safely and easily, use the following special tools: a rotor extension stub shaft, a rotor extension tube (of similar length to the rotor shaft) and a height-adjustable V roller extension tube support. Refer to the factory for the availability and specification of these tools.

1. Remove non-drive end bracket, see **Remove Non-Drive End** section.
2. For a two bearing alternator, remove drive end bracket, see **Remove Drive End** section.
3. For a one bearing alternator, remove drive end adapter as follows:
   a. Disconnect the alternator from the prime mover.
   b. Remove the DE adapter.
4. Fix the rotor shaft extension stub shaft to the main rotor at the non-drive end.
5. Fix the extension tube to the stub shaft.
6. Position the V roller support underneath the shaft extension tube, close to the alternator frame.
7. Raise the V roller support to lift the extension tube a small amount, to support the weight of the main rotor at the non-drive end.
8. Use a crane sling to lift the rotor at the drive end a small amount, to support its weight.
9. Carefully move the crane sling away so that the rotor withdraws from the alternator frame, as the extension tube rolls on the V rollers, until the rotor windings are fully visible.
10. Support the rotor on wooden blocks to prevent it rolling and damaging the windings.
11. Tightly bind the crane sling near the middle of the main rotor windings, near the rotor center of gravity.
12. Use a crane sling to lift the rotor a small amount, to test the rotor weight is balanced. Adjust the crane sling as necessary.
13. Carefully move the crane sling away so that the rotor withdraws completely from the alternator frame.
14. Lower the rotor onto wooden block supports and prevent it rolling and damaging the windings.
15. Remove the extension tube and stub shaft, as necessary.
16. Mark the position of the sling (to assist re-assembly) and remove the crane sling, as necessary.

6.3.1.12.8.6.2 Install Main Rotor

NOTICE

The rotor is heavy, with a small clearance to the stator. Windings will be damaged if the rotor drops or swings in the crane sling and hits the stator or frame. To avoid damage, fit support packing between the rotor and stator and carefully guide the rotor ends throughout. Do not allow the sling to touch the fan.

NOTICE

To install the main rotor safely and easily, use the following special tools: a rotor extension stub shaft, a rotor extension tube (of similar length to the rotor shaft) and a height-adjustable V roller extension tube support. Refer to the factory for the availability and specification of these tools.

1. Fix the rotor shaft extension stub shaft to the main rotor at the non-drive end (or to the NDE bearing cartridge on some alternator models).

2. Fix the extension tube to the stub shaft.
3. Tightly bind the crane sling near the middle of the main rotor windings near the rotor center of gravity.
4. Use a crane sling to lift the rotor a small amount, to test the rotor weight is balanced. Adjust the crane sling as necessary.
5. Position the V roller support at the non-drive end, close to the alternator frame.
6. Carefully use the crane sling to insert the rotor into the alternator frame, extension tube first.
7. Guide the extension tube onto the V roller support. Adjust the height of the V roller support as necessary.
8. Insert the rotor into the alternator frame, until the crane sling meets the frame.
9. Lower the rotor onto wooden blocks to prevent it rolling and damaging the windings.
10. Reposition the crane sling at the drive end of the rotor shaft.
11. Use the crane sling to lift the rotor at the drive end a small amount, to support its weight.
12. Carefully move the crane sling towards the alternator frame, as the extension tube rolls on the V rollers, until the rotor windings are fully inserted.
13. Gently lower the crane sling to put the rotor weight onto the support packing and remove the sling.
14. For a two bearing alternator, refit drive end bracket, see **Assemble Drive End** section.
15. For a one bearing alternator, assemble the drive end as follows:
    a. Refit the DE adapter
    b. Couple the alternator to the prime mover.
    c. Refit the upper and lower air outlet screen covers.
16. Refit the non-drive end bracket, see **Assemble Non-Drive End** section.
17. Remove the rotor shaft extension tube.
18. Remove the rotor shaft extension stub shaft.
19. Remove the V roller support.

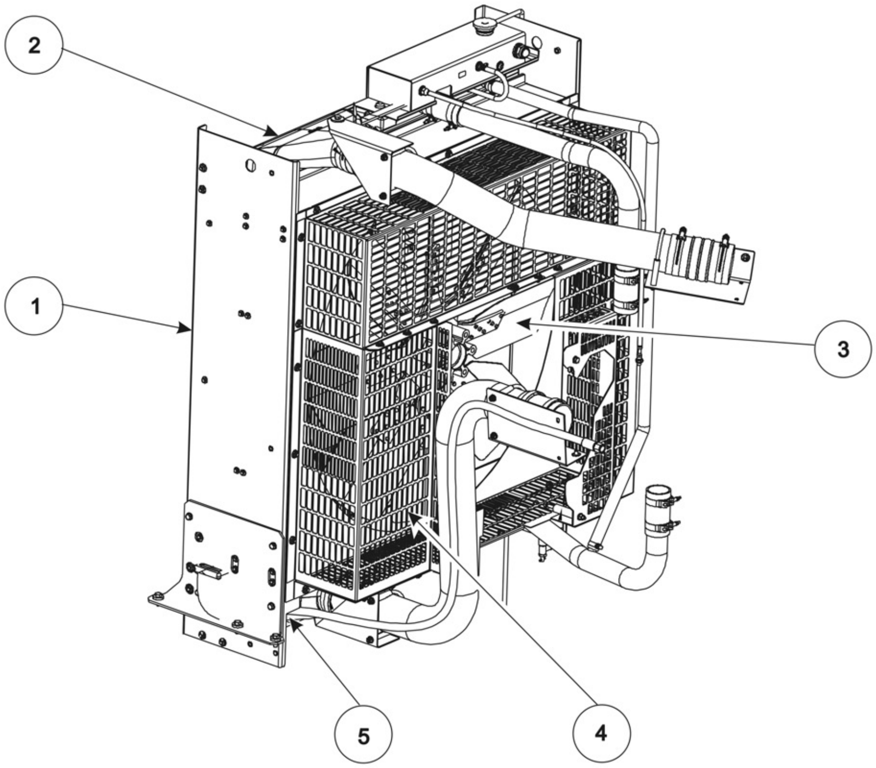
6.3.1.12.9 Parts Identification

6.3.1.12.9.1 Alternator Parts Identification

For specific parts identification, refer to the Parts Manual listed in **Chapter 2 on page 11**.

6.4 Cooling System

6.4.1 Cooling System Components



No.	Description	No.	Description
1	Radiator	4	Fan Guard
2	Radiator Guard (on back)	5	Coolant Drain
3	Fan		

FIGURE 23. COOLING SYSTEM FOR DFEG, DFEH, DFEJ, AND DFEK GENERATOR SET

6.4.2 Cooling System Maintenance

This section provides information on cleaning the radiator and updated information regarding bearings that has been provided by our supplier to enable efficient and prolonged life of the equipment.

NOTICE
The following information regarding the correct choice and fitting of hose clamps has also been provided by our supplier to assist and guide the user.

6.4.2.1 Hose Clamp Installation

This section provides general installation guidelines for the correct positioning, orientation and torque figures required when fitting hose clamps. Recommended hose and clamp combinations are also included.

6.4.2.1.1 Choosing the Right Hose Size

The recommended fit for hose to pipe is a 0.8 mm interference fit, i.e. the inner diameter of the hose should be 0.5 mm smaller than the overall diameter of the pipe.

6.4.2.1.2 Types of Hose Clamps

There are three main types of hose clamps:

- Constant Torque Clamps
- T-Clamps
- Worm Drive Clamps

6.4.2.1.2.1 Constant Torque Clamps

T Type	Worm Gear Type
	

FIGURE 24. CONSTANT TORQUE CLAMPS

TABLE 50. CONSTANT TORQUE CLAMP SPECIFICATIONS

DIA. RANGE (mm)	BOLT SIZE	PIPE DIA. (mm)	HOSE TYPE	INSTALLATION TORQUE
25.4 – 44.4	3/8”	25.4	EPDM RUBBER	8 Nm
31.7 – 54.1	3/8”	38.1	APT THICK WALL	14 Nm
31.7 – 54.1	3/8”	38.1	EPDM RUBBER	14 Nm
31.7 – 54.1	3/8”	38.1	SILICONE NOMEX	14 Nm
57.1 – 79.5	3/8”	57.1	EPDM RUBBER	14 Nm
57.1 – 79.5	3/8”	57.1	APT THICK WALL	14 Nm
69.8 – 92.2	3/8”	76.2	APT THICK WALL	14 Nm
69.8 – 92.2	3/8”	76.2	SILICONE NOMEX	14 Nm
69.8 – 92.2	3/8”	76.2	EPDM RUBBER	14 Nm

DIA. RANGE (mm)	BOLT SIZE	PIPE DIA. (mm)	HOSE TYPE	INSTALLATION TORQUE
82.5 – 104.9	3/8”	88.9	APT THICK WALL	14 Nm
95.2 – 117.65	3/8”	101.6	APT THICK WALL	14 Nm
95.2 – 117.65	3/8”	101.6	SILICONE NOMEX	14 Nm
95.2 – 117.65	3/8”	101.6	EPDM RUBBER	14 Nm
133.3 – 155.7	3/8”	127	APT THICK WALL	14 Nm

6.4.2.1.2.2 T-Clamps

FIGURE 25. T-CLAMP

DIA. RANGE (mm)	BOLT SIZE	PIPE DIA. (mm)	HOSE TYPE	INSTALLATION TORQUE
43 – 47	M6 X 50	38.1	SILICONE NOMEX	4 Nm
63 – 68	M7 X 60	57.1	EPDM RUBBER	4 Nm
68 – 73	M8 X 80	63.5	EPDM RUBBER	12 Nm
97 -104	M8 X 80	88.9	SILICONE NOMEX	12 Nm
121 – 130	M8 X 80	114.3	EPDM RUBBER	12 Nm
121 – 130	M8 X 80	114.3	SILICONE NOMEX	12 Nm
130 – 140	M8 X 80	127	EPDM RUBBER	12 Nm
130 – 140	M8 X 80	127	SILICONE NOMEX	12 Nm
162 - 174	M10 X 110	152.4	SILICONE NOMEX	30 Nm

6.4.2.1.2.3 Worm Drive Clamps

FIGURE 26. WORM DRIVE CLAMP

DIA. RANGE (mm)	INSTALLATION TORQUE	SOCKET REQUIRED	HOSE TYPE
8 - 16	3 Nm	7 mm	EPDM Rubber
12 - 20	3 Nm	7 mm	EPDM Rubber
16 - 25	4.5 Nm	7 mm	EPDM Rubber
25 - 40	4.5 Nm	7 mm	EPDM Rubber
20 - 32	4.5 Nm	7 mm	EPDM Rubber
32 - 50	4.5 Nm	7 mm	EPDM Rubber
40 - 60	4.5 Nm	7 mm	EPDM Rubber
50 - 70	4.5 Nm	7 mm	EPDM Rubber
60 - 80	4.5 Nm	7 mm	EPDM Rubber
70 - 90	4.5 Nm	7 mm	EPDM Rubber
80 - 100	4.5 Nm	7 mm	EPDM Rubber
90 - 110	4.5 Nm	7 mm	EPDM Rubber
100 - 120	4.5 Nm	7 mm	EPDM Rubber
120 - 140	4.5 Nm	7 mm	EPDM Rubber

6.4.2.2 Cleaning

6.4.2.2.1 General Cleaning

The Cleaning Of Radiator Cores Using Pressurized Water Equipment:

NOTICE

In specific dust laden environments, this procedure should not be used as the initial cleaning operation; it should follow Cleaning - Dust Laden Environments.

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator.

Inspect the exterior of the radiator 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 ensure the continued efficiency of the radiator, the core will require cleaning.

For thorough cleaning, pressure wash in the opposite direction to the airflow. A suitable proprietary degreasing additive (as recommended by the manufacturer of the pressure washer) should be applied via the pressure washer but this must not contain ammonia as it will corrode the core.

The recommended equipment for cleaning a radiator core is an industrial pressure washer, but it must be used in the correct manner as misuse can reduce the performance of the core. Protect the generator set from any over spray during this procedure.

To be effective, it is recommended that a hot water washer be used.

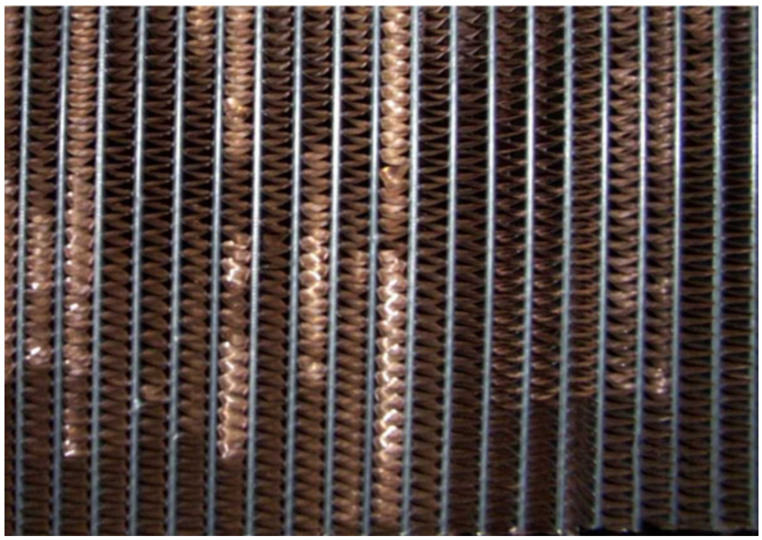


FIGURE 27. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE

NOTICE
With the pressures involved it is important that the distance between the core face and the nozzle is a minimum of 100 mm (3.93 inches); any closer and damage may occur.

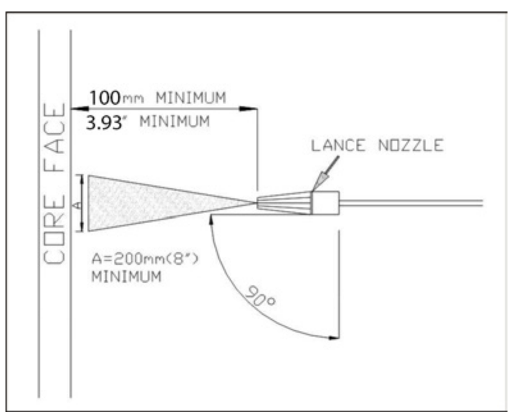


FIGURE 28. PRESSURE WASHER NOZZLE POSITIONING

NOTICE

Most Industrial pressure washers work at pressures of around 1500 psi to 2000 psi (103 bar to137.89 bar). It is very important that, when washing a core in this way, the lance must be kept at a right angle to the core

NOTICE

If your pressure washer works above 2000 psi, then the gap between the nozzle and the core face must be increased or fin damage will occur.

NOTICE

Always follow pressure washer Manufacturer's Health and Safety Guidelines.

Replace the end panel(s) where necessary.

6.4.2.2.2 Dust Laden Environments

Specific Instructions for the Cleaning of Radiator Cores Used in an Environment Subjected to Crushed Aggregate or Ceramic Dust Contamination

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator.

Inspect the exterior of the radiator for obstructions. During the service life of a radiator, a buildup of foreign matter can obstruct the flow of air through the radiator cores, reducing cooling capability. To maintain the efficiency of the radiator, the core will require cleaning.

Unless the radiator can be dismantled and the core treated in a professional caustic immersion cleaning system, the radiator should not be "wet" cleaned. This is because of the tendency of this type of contamination to coalesce and become extremely difficult to remove.

The correct procedure is to regularly blow through the entire core area with low pressure compressed air (against the direction of cooling airflow). It is very important to ensure that resultant debris blown from the core is subsequently removed and disposed of before engine start-up. An industrial vacuum cleaner will achieve this requirement. In most installations, it will be necessary to remove cowls and guarding.

To prevent damage to fins and resultant loss of cooling, it is important to ensure that the air gun used is maintained at right angles to the core face.

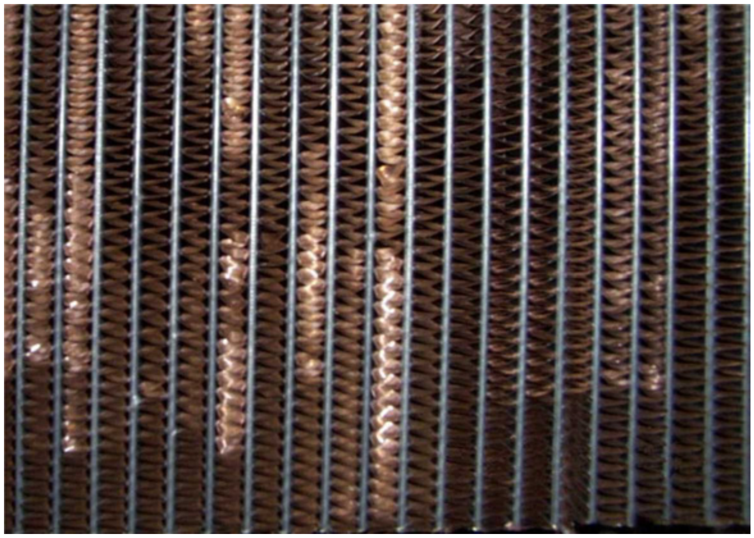


FIGURE 29. FINS DAMAGED BY COMPRESSED AIR AT ACUTE ANGLES TO CORE FACE

After this procedure has been effectively carried out with only the lightest of dust remaining, follow it immediately (if necessary) by cleaning the radiator cores using pressurized water equipment.

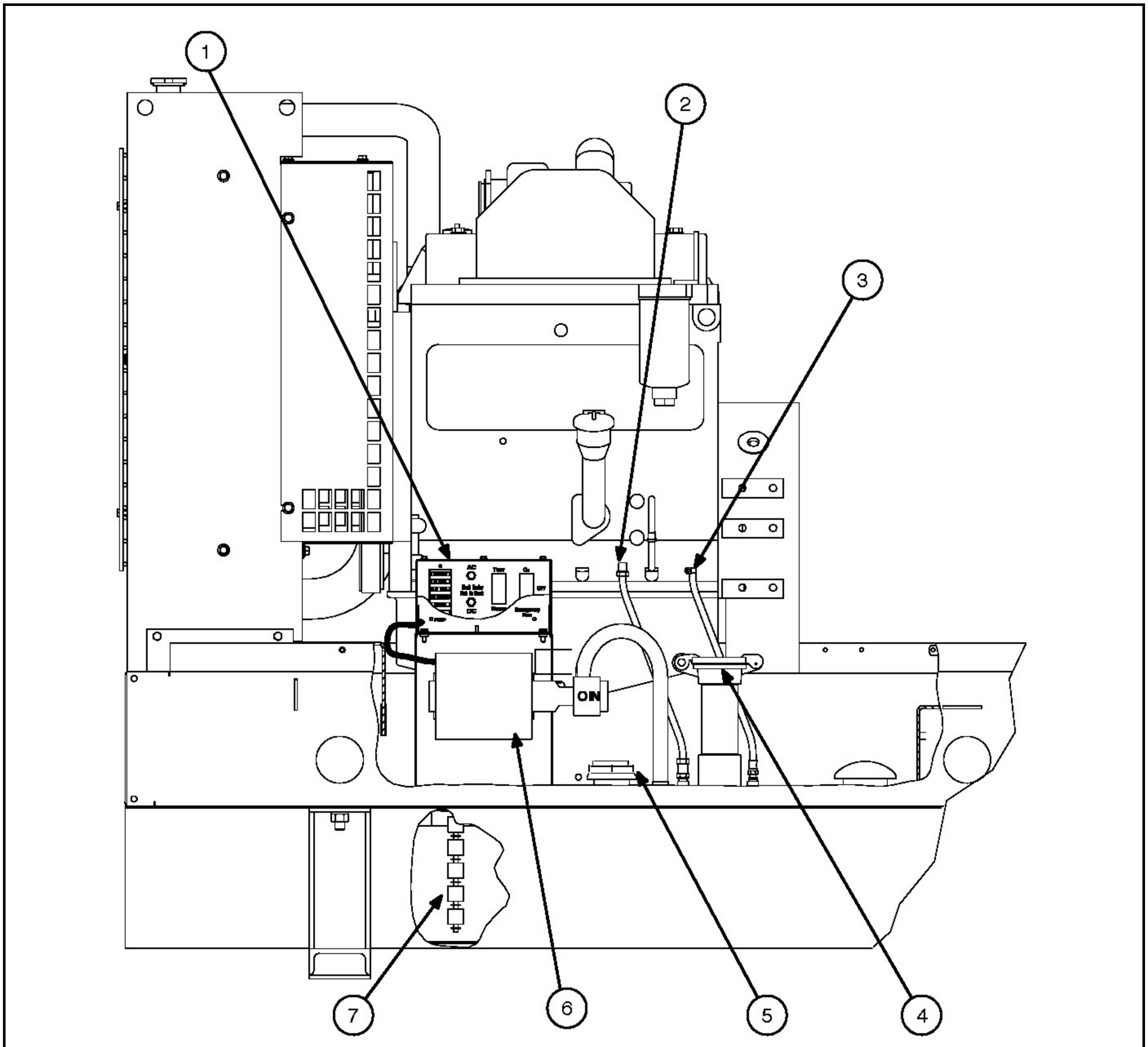
Replace the end panel(s) where necessary.

NOTICE
It is vitally important that the core is thoroughly dried before start-up.

6.5 Fuel Transfer Pump and Control

⚠ **WARNING**
Combustible Liquid
Fuel leaks are a fire and explosion hazard which can cause severe personal injury or death.
Make sure that only trained and experienced personnel install and service the generator set in accordance with applicable codes.

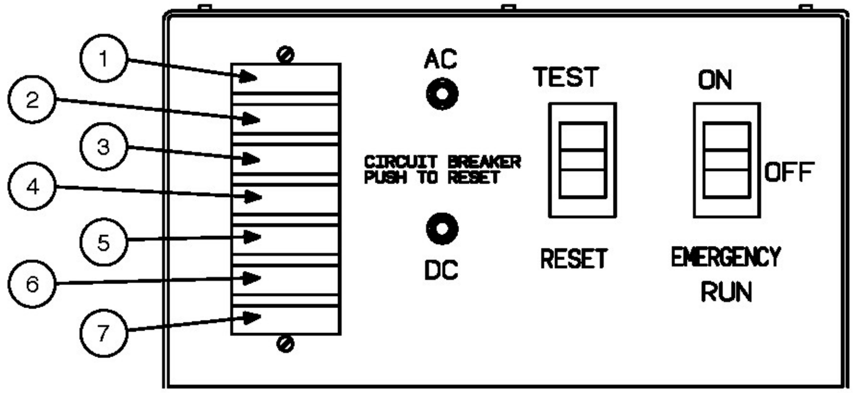
A fuel transfer pump and control are available when a sub-base or in-skid day tank are provided. The automatic control operates the fuel pump to maintain a reservoir of fuel in the sub-base or in-side day tank.



No.	Description	No.	Description
1	Control	5	Fuel Gauge
2	Flexible Fuel Return Line	6	Fuel Pump and Motor
3	Flexible Fuel Supply Line	7	Float Switch Assembly
4	Fuel Fill Cap		

FIGURE 30. TYPICAL SUB-BASE INSTALLATION

6.5.1 Fuel Pump Control Panel Operation



No.	Description	No.	Description
1	System Ready (Green)	5	Basin (Red)
2	Hi Fuel (Red)	6	Blank (Red)
3	Lo Fuel (Red)	7	Pump On (Green)
4	Lo Shutdown (Red)		

FIGURE 31. FUEL PUMP CONTROL PANEL

1. Push the control switch to the **ON** position for automatic operation . The green **SYSTEM READY** light will come on, and the pump will fill the tank if AC power is available for pumping and DC power is available for the internal logic circuits. The level of fuel in the tank will be automatically kept between a set of pump-on and pump-off float switches.

> ***NOTICE***
>
> **When filling an empty tank, the red LO SHUTDOWN and LO FUEL lights will come on when the control switch is pushed to the ON position. This is normal. Push the panel RESET switch to turn off the red lights after the tank has been filled.**
>
> **If the SYSTEM READY light does not come on, check for correct AC and DC power connections.**

2. The green **PUMP ON** light indicates when the pump is running. It will come on and go off as fuel is pumped to maintain the proper level in the tank.
3. Push the control switch to the **EMERGENCY RUN** position (momentary contact) to pump fuel into the tank if the control fails to operate the pump automatically. (The pump may continue to run after enabling the Emergency Run Switch to complete the filling cycle of the tank.)

> ***NOTICE***
>
> **The green PUMP ON light does not come on when the switch is in the EMERGENCY RUN position.**

4. The red lights indicate fault conditions and the need for service. The control panel includes the following lights:

   a. **HI FUEL**: The fuel in the tank has reached an abnormally high level, indicating possible failure of the pump-off float switch. The high-fuel float switch takes over as the automatic pump-off switch. The **HI FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level drops to normal but will come back on again during the next pumping cycle if the fault remains.

   > ⚠ **WARNING**
   >
   > ***Combustible Liquid***
   >
   > ***Fuel leaks are a fire and explosion hazard which can cause severe personal injury or death.***
   >
   > ***Make sure that only trained and experienced personnel install and service the generator set in accordance with applicable codes.***

   > ***NOTICE***
   >
   > **High-Fuel float switch failure can lead to spillage of large quantities of fuel if the high-fuel float switch fails. Do not continue operations with a HI FUEL fault present.**

   b. **LO FUEL**: The fuel in the tank has dropped to an abnormally low level, indicating possible failure of the pump-on float switch. The lo-fuel float switch takes over as the automatic pump-on switch. The **LO FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level rises to normal but will come back on again during the next pumping cycle if the fault remains.

   > ***NOTICE***
   >
   > **Continued operation with a LO FUEL fault present can lead to low-fuel shutdown if the low-fuel float switch fails.**

   c. **LO SHUTDOWN**: The fuel has dropped to a level near the bottom of the tank, indicating an empty main fuel tank, pump failure or possible failure of both the pump-on and low-fuel level float switches. Further operation will allow air to enter the engine fuel unit, causing shutdown and the necessity to bleed the fuel unit to start up the engine again. If the light comes on, check the fuel level in the main fuel tank and fill it if necessary. As the day tank is refilling, **RESET** the light with the panel switch.

   > ***NOTICE***
   >
   > **To restore engine operation following this fault, both the pump control and the engine control have to be RESET.**

   d. **BASIN**: Fuel has overflowed into the rupture basin (if provided), indicating possible failure of both the pump-off and hi-fuel level float switches, or a leak in the day tank. **RESET** the control after the fuel in the basin has been safely disposed of and the cause of the overflow corrected.

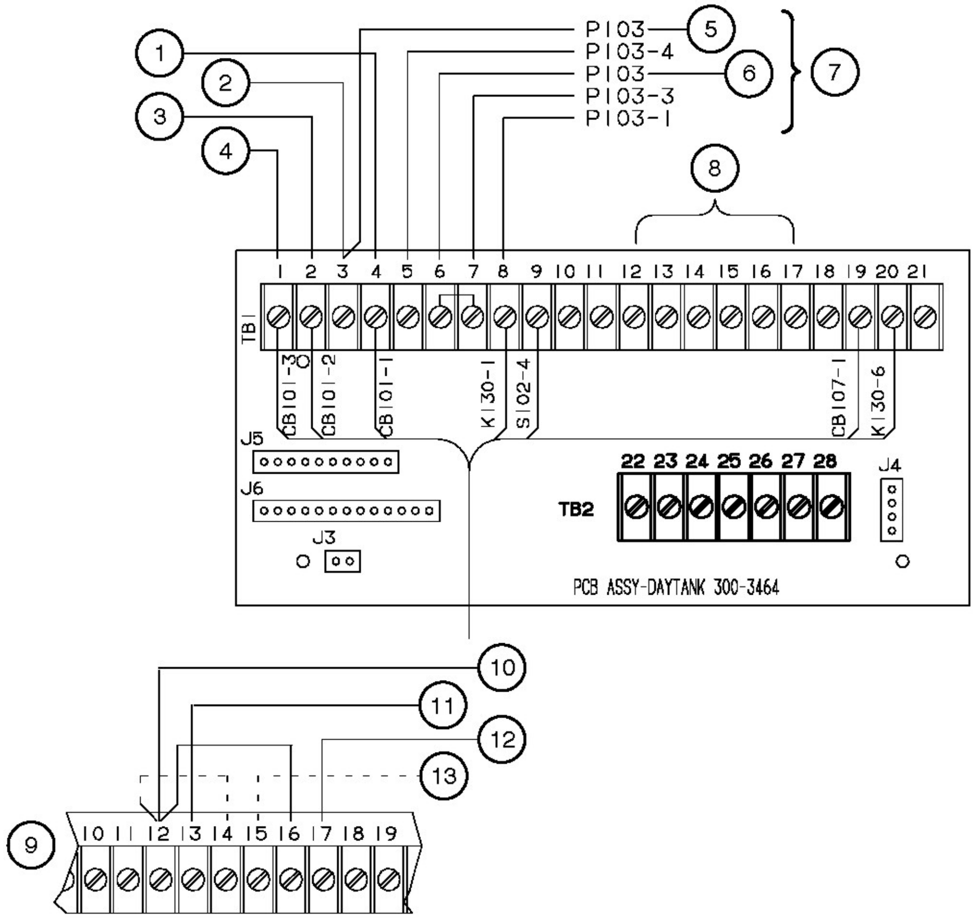
   e. **BLANK**: For customer use.

   > ***NOTICE***
   >
   > **The control fault circuits will trip and latch, requiring RESET, even if AC power is lost.**

5. Press the **TEST** switch to test the indicator lights and pump operating circuits. Replace any light that does not come on. The pump will stop automatically after it has filled the tank to the normal pump-off fuel level.
6. Press the reset button of the AC or DC circuit breaker if either has tripped.

6.5.2 Fuel Pump Control Terminal Board

See the wiring diagrams provided with your generator set when making connections at the control box terminal board.



No.	Description	No.	Description
1	AC (240V)	8	Use with PCC (See Detail A)
2	Earth Ground	9	Detail A
3	Neutral (120V)	10	GND CTB10-4, CTB11-4, or CTB12-4
4	AC (120/240V)	11	To engine harness lead S8 (Low Fuel Warning)
5	Ground	12	To engine harness lead S9 (Rupture Basin Warning).
6	White	13	For low fuel shutdown, connect to Customer Terminal Block CTB18-4 and CTB17-4 (Return).
7	Pump Designation (Ref)		

FIGURE 32. FUEL PUMP CONTROL TERMINAL BOARD

The following should be noted.

1. The control can be powered by 120 VAC or 240 VAC. The control is set up at the factory for connection to 240 VAC.

NOTICE

To convert the day tank controller from 240 VAC to 120 VAC, perform the following steps.

a. Remove the two jumpers between terminals TB1-6 and TB1-7 in the control box, and connect one jumper between terminals TB1-5 and TB1-6 and the other jumper between terminals TB1-7 and TB1-8.

b. Move selector switch S103 on the control PCB to the up position for 120 V.

c. On the control transformer, remove the two jumpers between terminals H2 and H3, and connect one jumper between H1 and H3 and the other jumper between H2 and H4.

NOTICE

To convert the day tank controller from 120 VAC to 240 VAC, perform the following steps.

a. Remove the jumpers between terminals TB1-5 and TB1-6 and TB1-7 and TB1-8 in the control box, and connect the two jumpers between terminals TB1-6 and TB1-7.

b. Move selector switch S103 on the control PCB to the down position for 240 VAC.

c. On the control transformer, remove the jumpers between terminals H1 and H3 and H2 and H4, and connect the two jumpers between H2 and H3.

2. Attach a tag to the control box indicating the supply voltage.
3. To immediately shut down the engine when the **LO SHUTDOWN** light comes on, jumper TB1-14 to GND at TB1-12, and connect TB1-15 to one of the programmable PCC customer fault inputs at the Customer Terminal Block CTB18-4 (Input) and CTB17-4 (Gnd). Program this fault for a shutdown.
4. Terminals TB1-10 through TB1-17 and TB2-23 through TB2-27 are available for connections to remote annunciators.
5. Terminals TB1-8 and TB1-5 are available for connection of a 120- or 240-VAC electric fuel shutoff valve rated not more than 0.5 amps. The voltage rating of the valve must correspond with the voltage utilized for the pump.

6.5.3 Fuel Transfer Pump Motor Connections

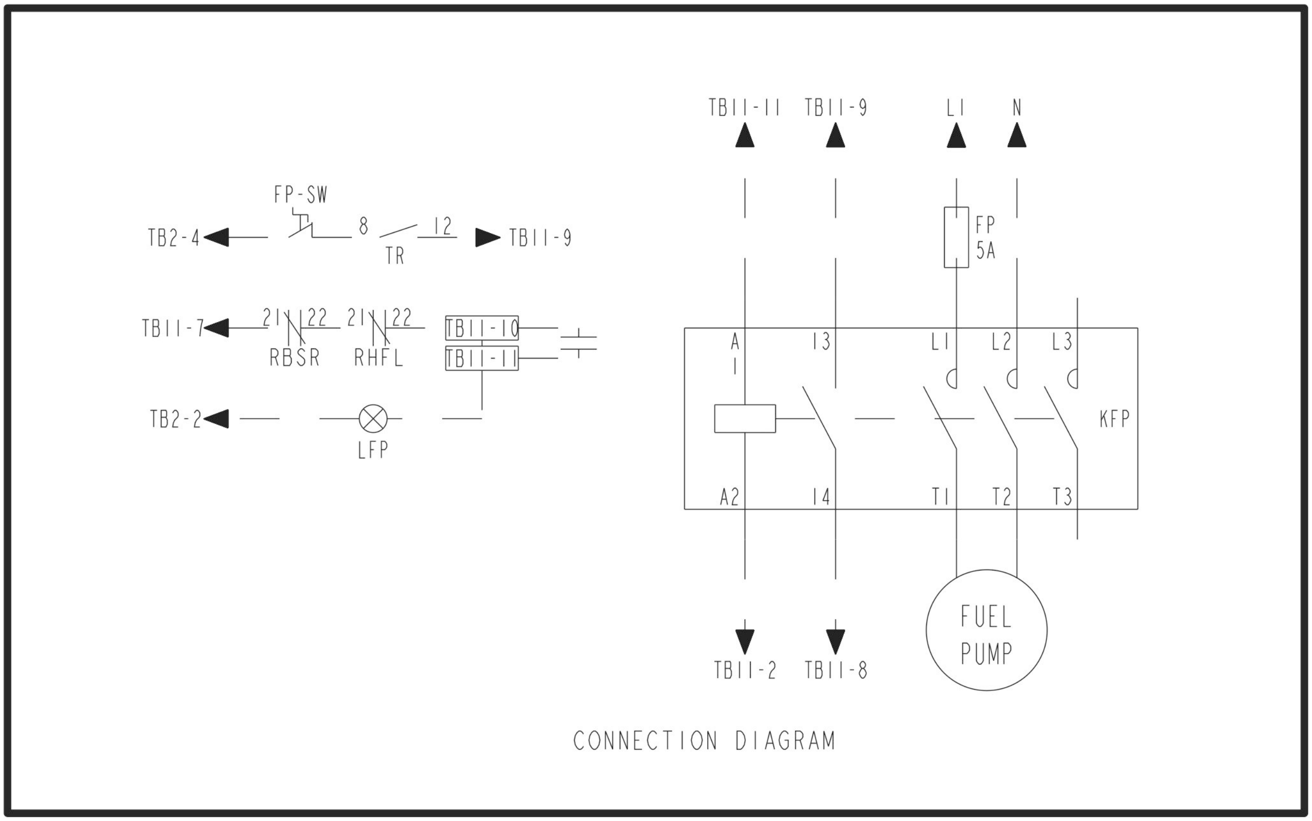
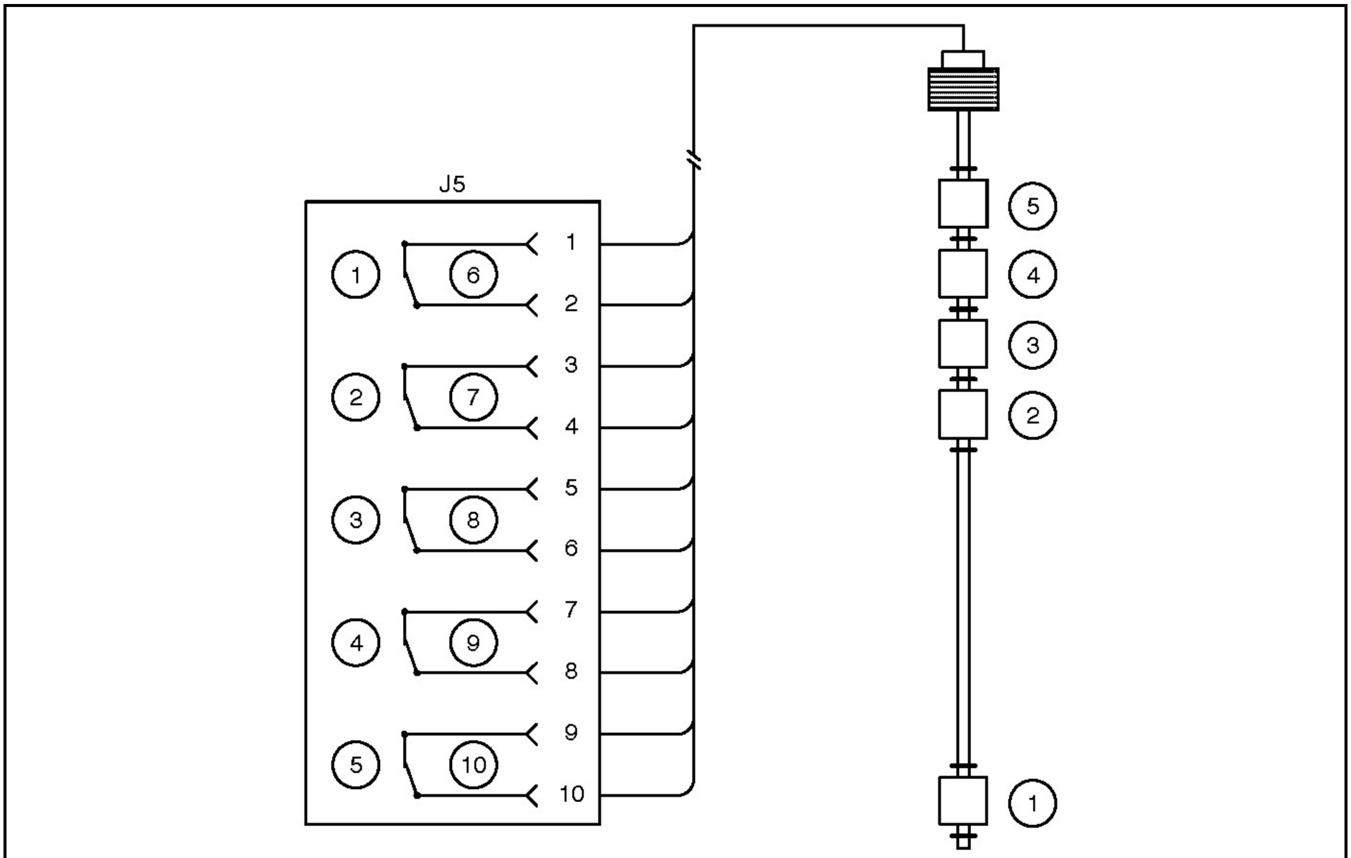


FIGURE 33. FUEL TRANSFER PUMP MOTOR CONNECTIONS

6.5.4 Testing the Float Switch Assembly

The float switch assembly consists of five switches. Each switch has a pair of color-coded leads connected to a common jack.



No.	Description	No.	Description
1	Switch 1 - Shutdown	6	Red
2	Switch 2 - Low Fuel	7	Yellow
3	Switch 3 - Pump On	8	Blue
4	Switch 4 - Pump Off	9	Brown
5	Switch 5 - Hi Fuel	10	Orange

FIGURE 34. FUEL SWITCH ASSEMBLY

To test the float switches, remove the fuel pump control cover, disconnect the wiring jack, and unscrew the assembly from the top of the day tank. Test as follows:

1. With an ohmmeter, test for electrical continuity (switch closed) between each pair of colored leads, while holding the assembly vertical. Replace the assembly if any switch is open. (All the readings should be zero.)
2. Lift each float, in turn, to 1/8 inch (3 mm) below the C-clip stop above it (use a feeler gauge), and test for electrical continuity. Replace the assembly if any switch does not open. (All the readings should be infinity.)
3. Use pipe thread sealant when replacing the assembly.

6.6 Air Intake System

The direct flow air cleaner consists of a primary filter and a secondary filter within the air cleaner housing. The air cleaner has been designed for a maximum restriction, at which point the filter elements should be changed. Refer to the Model Specifications section.

6.6.1 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.

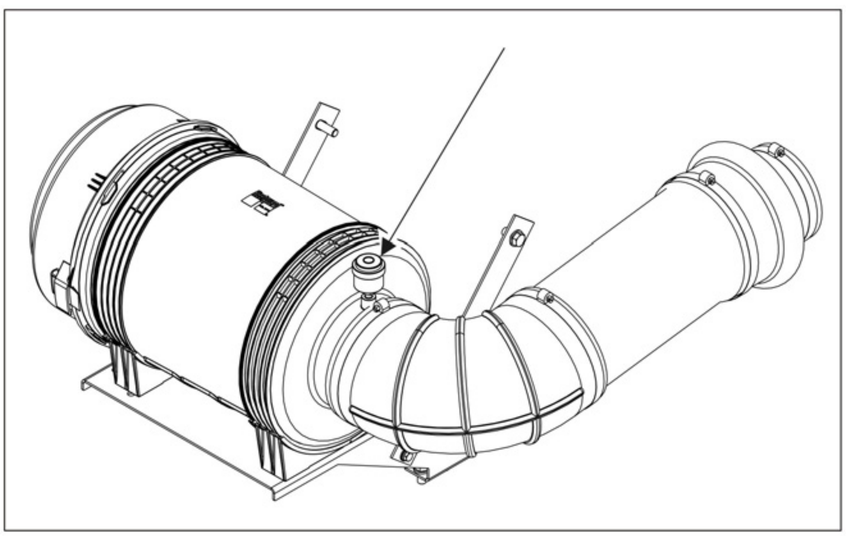


FIGURE 35. AIR CLEANER SERVICE INDICATOR

6.6.2 Normal Duty Air Cleaner

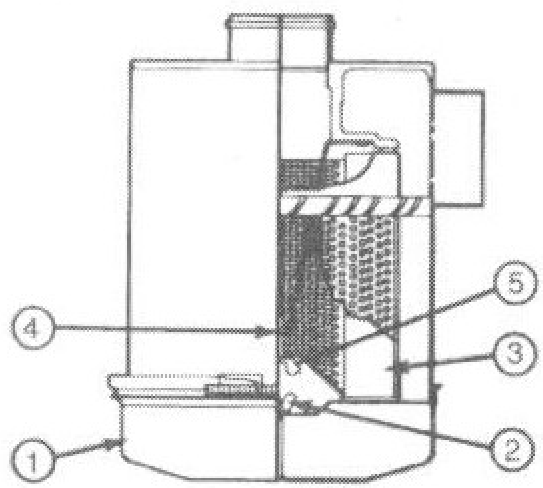
6.6.2.1 Air Cleaner Element Removal

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 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.



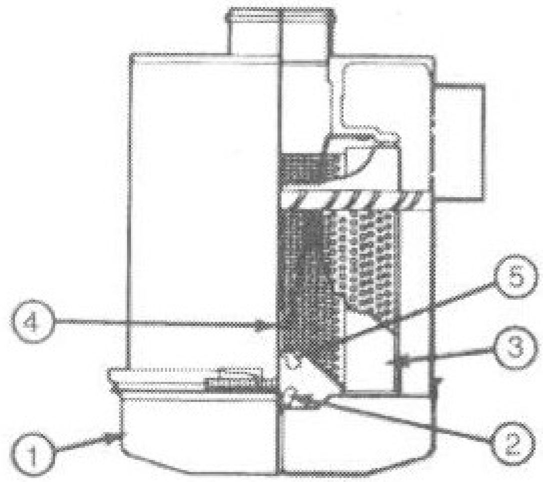
No.	Description	No.	Description
1	Dust Pan	4	Air Cleaner Element
2	Wing Bolt	5	Wing Nut
3	Dust Shield		

FIGURE 36. NORMAL DUTY AIR CLEANER

6.6.2.2 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 37. NORMAL DUTY AIR CLEANER

6.6.3 Heavy Duty Air Cleaner

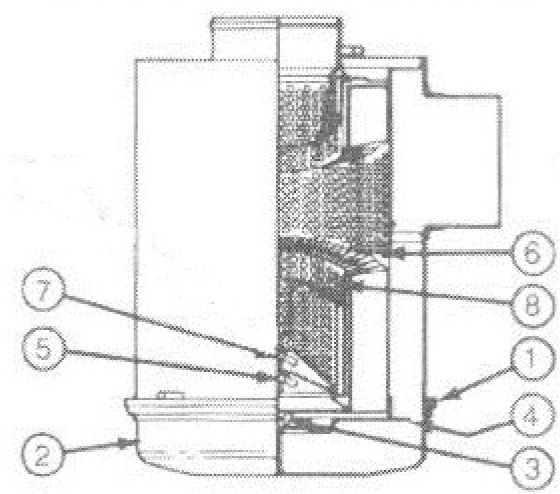
6.6.3.1 Heavy Duty Air Cleaner Element Removal

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

NOTICE
Cummins 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.

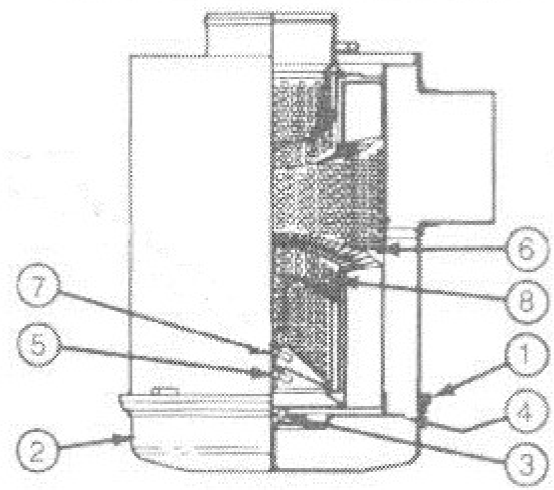


No.	Description	No.	Description
1	Wing Bolt	5	Wing Nut
2	Dust Pan	6	Air Cleaner Primary Element
3	Wing Nut	7	Wing Nut
4	Dust Shield	8	Air Cleaner Inner Safety Element

FIGURE 38. HEAVY DUTY AIR CLEANER

6.6.3.2 Heavy Duty 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 39. HEAVY DUTY AIR CLEANER

6.7 Exhaust System

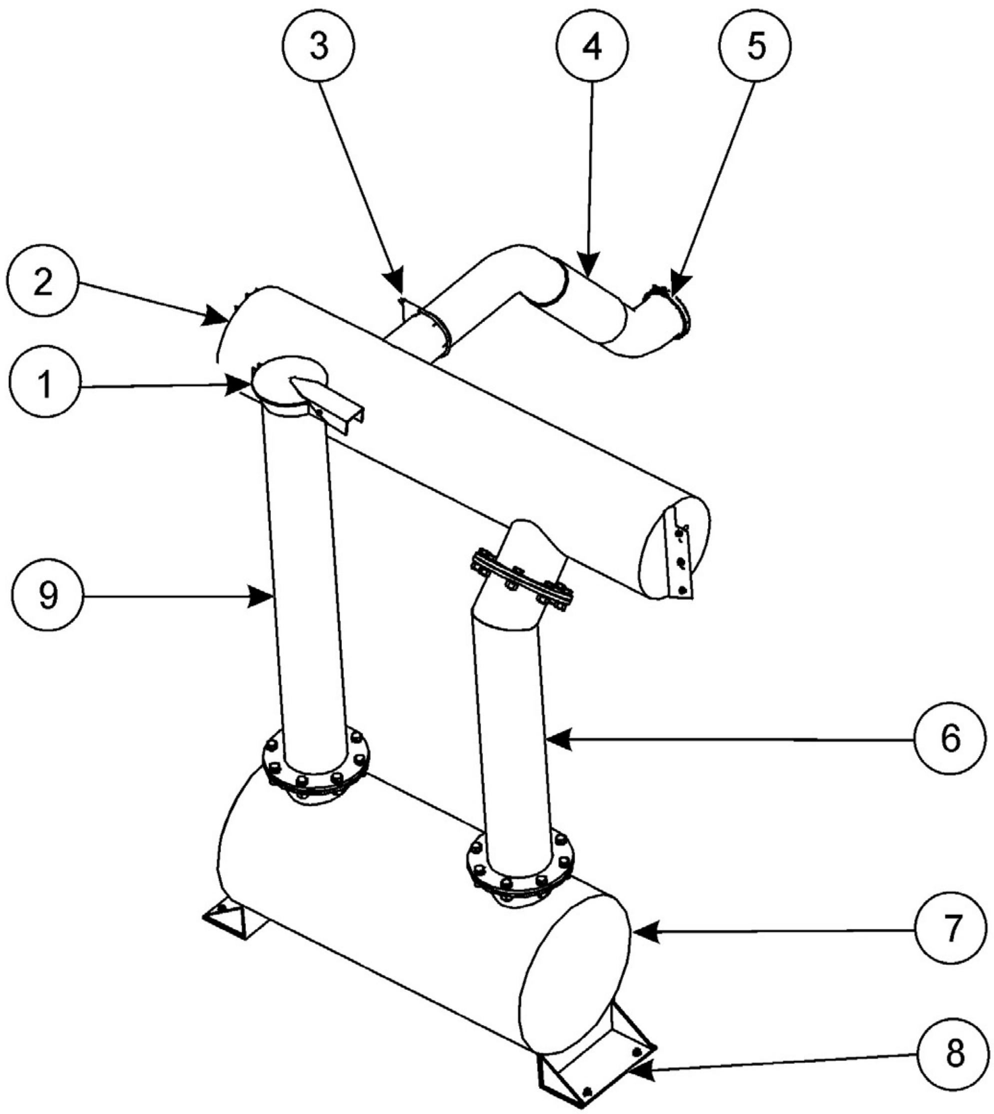
6.7.1 Overview

NOTICE

Read the warranty statement provided with the generator set for US Environmental Protection Agency (EPA) restrictions on servicing specific components.

The exhaust system is comprised of up to three active components - the turbocharger (if equipped), the oxygen sensor, and the muffler/catalytic converter (if equipped) - in addition to manifold(s) and piping connecting the components.

6.7.2 Exhaust System Graphic



No.	Description	No.	Description
1	Rain Cap	6	Exhaust Pipe
2	Muffler In	7	Muffler Out
3	Exhaust Clamp	8	Bracket
4	Exhaust Pipe	9	Tailpipe
5	Hose Clamp		

FIGURE 40. EXHAUST SYSTEM

6.8 Software

6.8.1 SAE J1939 CAN (Controlled Area Network)

The following section describes the function and operation of the J1939 Controlled Area Network (CAN) datalink, as it applies to this generator set. The engine control module (ECM) communicates to the generator set controller (PCC) over this network.

CAN communications follow the SAE J1939 communication protocol standard. The CAN datalink is based on a main trunk no more than 131 feet (40 meters) long and with 30 devices that is terminated by a 120 Ohm resistor at each end. Stubs no longer than 3.3 feet (1 meter) extend from the main trunk to each module in the bus.

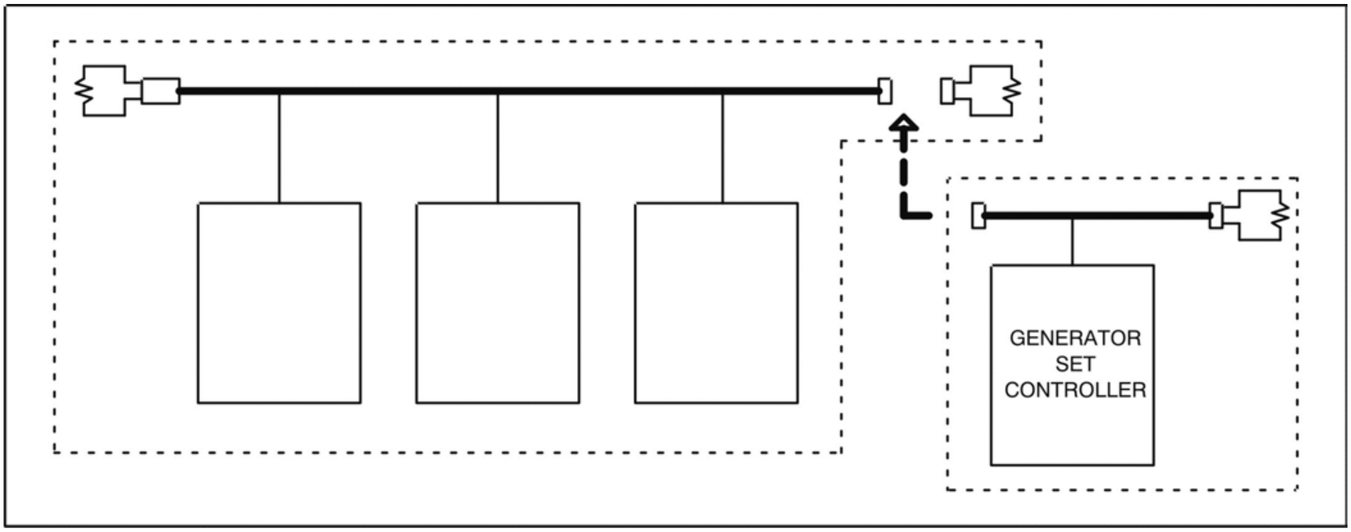


FIGURE 41. CAN DATALINK

6.8.1.1 CAN Datalink Signals

The CAN datalink carries the binary signal between the ECM (Engine Control Module) and the PCC controller. The binary signal is expressed by a change in voltage. The table below shows how the generator set controller distinguishes between the voltage signals.

TABLE 51. CAN DATALINK VOLTAGE DIFFERENTIALS

Signal	0	1
J1939 High (+)	2.5 V	3.5 V
J1939 Low (-)	2.5 V	1.5 V
Voltage Differential	0 V	2 V

The CAN datalink transmits the signal at 250 KBaud, or 250 kilobits per second. Hence, it is possible for the voltages on J1939 High (+) and J1939 Low (-) to change 250,000 times per second.

The figures below show examples of good and bad datalink signals, on a high-resolution oscilloscope. The bad signal is caused by termination problems (no termination, wrong termination, or bad termination).

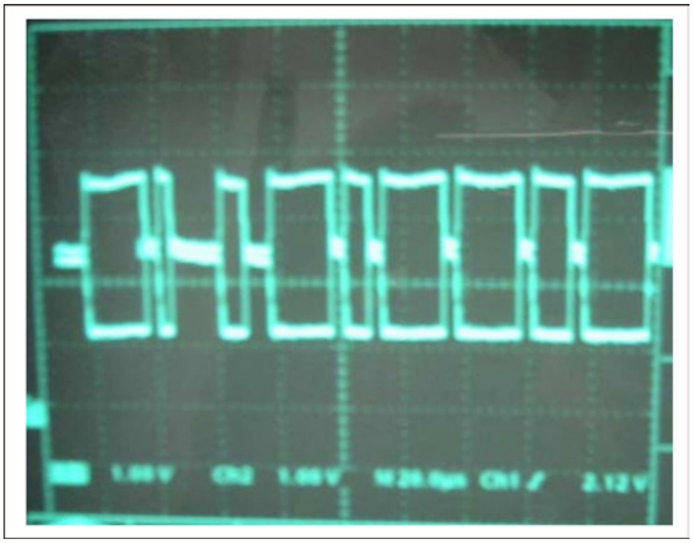


FIGURE 42. CAN DATALINK: GOOD SIGNAL

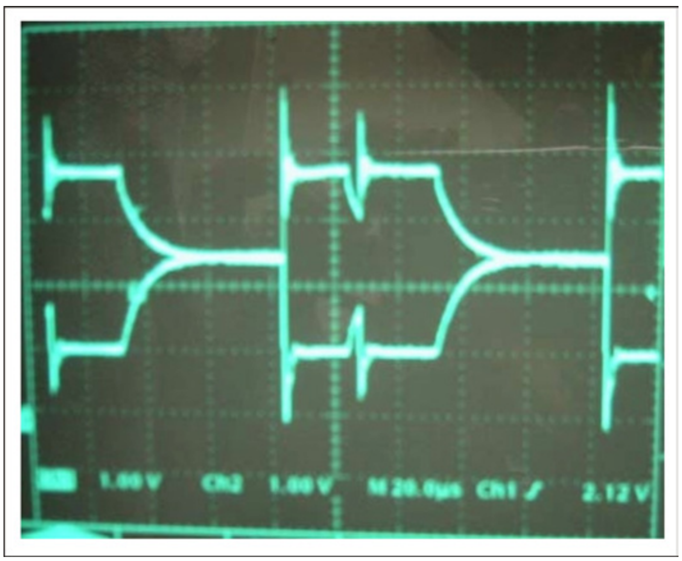


FIGURE 43. CAN DATALINK: BAD SIGNAL

6.8.1.2 J11 Connections

The CAN datalink connects to the PCC baseboard via connector J11. J11 pin connections for PC 2.3 and PC 3.3 are identified in the table below.

TABLE 52. CONNECTOR J11 - PC 2.3, PC 3.3

Description	Pin
CAN +	20
CAN -	19
CAN Shield	17
Keyswitch +	22 (not used)
Keyswitch -	21

The PCC uses this data to display engine status (sensor, warning and shutdown conditions). The datalink must remain active at all times. If not, the PCC will detect the inactive datalink and display a datalink error shutdown condition.

6.9 Circuit Breaker

6.9.2 Circuit Breaker Location

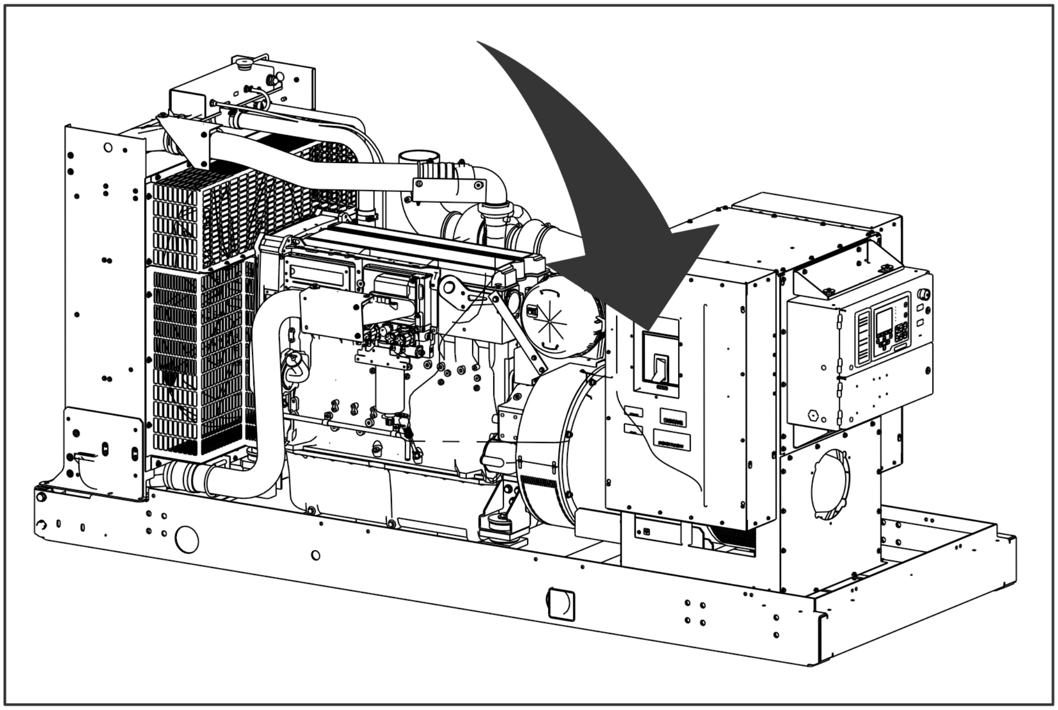


FIGURE 44. CIRCUIT BREAKER LOCATION, RIGHT OR LEFT SIDE, OR BOTH SIDES

6.9.3 Circuit Breaker Trip Adjustment

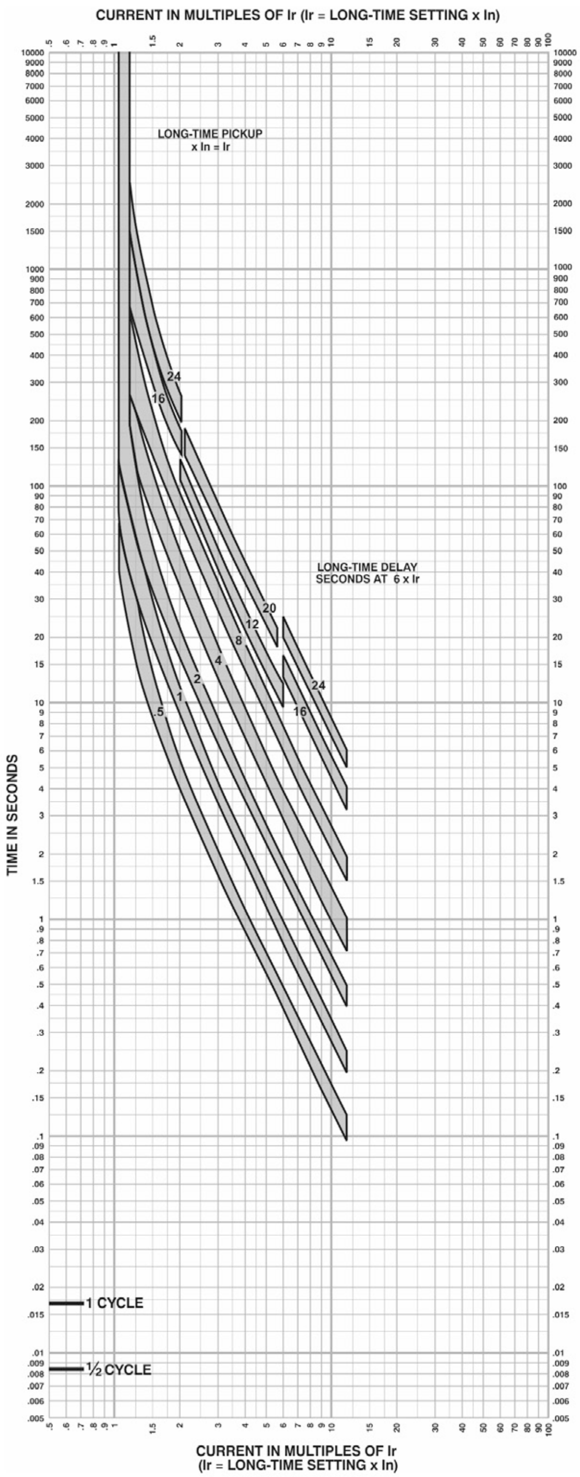
NOTICE
Overloading the circuit breaker may cause damage to the circuit breaker or circuits that it is protecting. Make sure the trip values are set correctly.

The trip unit is preset to zero at the factory during testing. It is the responsibility of the customer or commissioning engineer to set the values to meet their onsite requirements.

For Micrologic™ electronic trip units, refer to the trip unit user guide, which can be found on the Schneider Electric website (http://www.schneider-electric.com).

Adjustments to the circuit breaker can be made with the use of the Micrologic Full-Function Test kit (Schneider Electric P/N- S33595) by an approved service technician or by a technician provided by Schneider Electric. Do not attempt to adjust the default settings without consulting your local Cummins Power Generation distributor first. The material provided is for reference only.

Trip Unit Characteristic Trip Curve



Micrologic 3.0A Trip Unit

Long-Time Pickup and Delay

The time-current curve information is to be used for application and coordination purposes only.

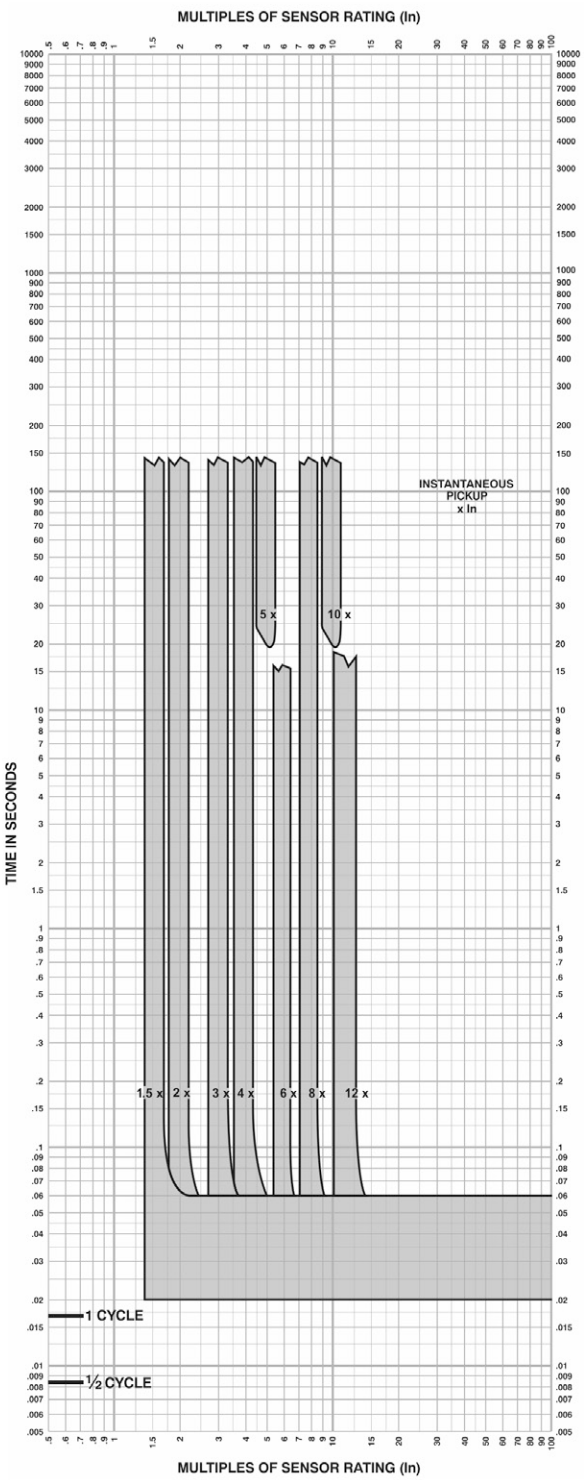
Curves apply from -30°C to +60°C (-22°F to +140°F) ambient temperature.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately twenty minutes is required between overloads to completely reset thermal-imaging.
2. The end of the curve is determined by the instantaneous setting of the circuit breaker.
3. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.

FIGURE 45. TRIP CURVE FOR LONG-TIME PICKUP AND DELAY

Trip Unit Characteristic Trip Curve



Micrologic 3.0A Trip Unit

Instantaneous Pickup, 1.5X to 12X

The time-current curve information is to be used for application and coordination purposes only.

Curves apply from -30°C to +60°C (-22°F to +140°F) ambient temperature.

Notes:

1. The end of the curve is determined by the interrupting rating of the circuit breaker.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
3. The instantaneous region of the trip curve shows maximum total clearing times. Actual clearing times in this region can vary depending on the circuit breaker mechanism design and other factors. The actual clearing time can be considerably faster than indicated. Contact your local sales office for additional information.

FIGURE 46. TRIP CURVE FOR INSTANTANEOUS PICKUP

6.9.4 Circuit Breaker (3-pole) Testing-Manual

⚠ WARNING

Electrical Generating Equipment

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

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

⚠ WARNING

Automated Machinery

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

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

NOTICE

Circuit breakers fitted with trip adjustment cannot be tested accurately using a multimeter.

The following test procedure is a basic test of the circuit breaker. For more detailed examination it is recommended that a switch analyzer be used or by component substitution.

1. Correct any active genset faults.
   - Check for active genset faults on the display (especially overload, short circuit, or ground faults); then correct these faults.
2. Ensure circuit breaker trip solenoid is configured correctly and is functioning properly.
   - Genset CB Trip settings are configured to trip at a low over-current threshold. Check other settings on the Genset CB that might cause it to trip since circuit breakers can have multiple trip settings. Configure the Genset CB Trip Solenoid to trip at adequate trip settings for the application.
   - Faulty Trip solenoid, replace.

   ⚠ WARNING

   Automated Machinery

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

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

3. Isolate the battery.
4. Inspect the circuit breaker (CB) connections for security and corrosion. Repair or replace as necessary.
5. With the CB in the "CLOSED" (ON) position, using a suitable multimeter check for resistance between the Line 1 input terminal and the Line 1 output terminal. If the reading is 0 ohms or low ohms then with the multimeter still connected, place the circuit breaker into the "OPEN" (OFF) position the reading should be Infinity (open circuit) the CB is serviceable.
6. Repeat step 5 for the other corresponding terminals.

6.9.5 Circuit Breaker Service

6.9.5.1 Circuit Breaker Troubleshooting

An electrically operated breaker is controlled at the control HMI. In manual mode, the CB open and CB close buttons can control the breaker when at rated speed. In Auto mode, the breakers open/close automatically. The generator set must not be in a stand-alone application for the control to operate the breaker.

Condition	Possible Cause	Solution
Circuit breaker fails to stay closed.	1. Trip adjustment set too low.	1. Adjust trip setting.
	2. Undervoltage trip not energized.	2. Energize undervoltage trip.
	3. Shunt trip energized.	3. De-energize shunt trip.
	4. Short circuit or overload on system.	4. Check system for short circuit or overload condition.
Circuit breaker trips, but no short circuit or overload condition is evident.	1. Trip adjustment set too low.	1. Adjust trip setting.
	2. Voltage is below undervoltage trip setting.	2. Check system for low voltage.
Push-to-trip button will not trip circuit breaker.	Circuit breaker already tripped or OFF (O).	Move circuit breaker handle to reset, then to ON (I).
Circuit breaker cannot be opened manually.	Damage to current path.	Contact local field office.
Engine running at rated rpm. The circuit breaker will not close. The generator set does not shut down.	Trying to close the circuit breaker at the circuit breaker.	Circuit breaker must be closed from the PowerCommand Control (PCC) when in Manual-Run Mode. In Auto mode, the breakers open/close automatically.
	Generator circuit breaker inhibit is active.	Remove the circuit breaker inhibit signal.

Engine running at rated rpm. The circuit breaker will not close. The generator set shuts down with the fail-to-close alarm.	1. Undervoltage release not working.	1. If 24 VDC is present on the undervoltage release terminals, then remove the undervoltage release from the circuit breaker to enable operation until a new one can be installed.
	2. DC Fuse is blown.	2. If no voltage, check fuses.
	3. Wiring problem to undervoltage release.	3. If no voltage, check wiring for loose or broken terminals or broken wires.
	4. Circuit breaker close-coil not working.	4A. Remove control wires from close-coil terminals.
		4B. Test coils for resistance.
		4C. If reading is infinite or zero ohms, the close-coil is faulty. Replace close-coil.
	5. Springs not charged.	5A. If springs are discharged, manually charge the springs and restart.
		5B. If the circuit breaker closes normally but the springs do not recharge, check the DC fuses.
		5C. If the DC fuses are good and there is 24 VDC across the charging motor, the motor is bad. Replace the motor.
Refer to the circuit breaker supplier for further troubleshooting and support.		

6.9.5.2 Circuit Breaker Installation

⚠ CAUTION
Failure to follow these instructions can result in serious injury or equipment damage.

1. Isolate all power sources to this equipment before working on or inside equipment.
2. Make sure circuit breaker is in tripped or OFF (O) position.
3. Check clearances between circuit breaker and closest grounded metal (ensure minimum enclosure distances are maintained as specified in **Table 53**).

NOTICE
Mount circuit breaker using only insulated mounting screws provided.

NOTICE
All four washers and mounting screws must be installed and torqued to designated value.

TABLE 53. CIRCUIT BREAKER ENCLOSURE DIMENSION

Circuit Breaker Rating		Circuit Breaker Enclosure Dimensions (H x W x D)		Ventilation Area
		in.	**mm**	**Bottom**
1200A	100% Rated	40.8 x 27.3 x 18.5	1036.3 x 693.4 x 469.9	35in.^{2}(22580.6mm^2)
800A				
600A				
400A				
250A				
1200A	80% Rated	42.2 x 27.3 x 9.2	1071.9 x 693.4 x 233.7	N/A
800A				
600A				
500A				
450A				
400A				
350A				
300A				
250A				

4. Mount circuit breaker using four washers (A, **Figure 47**) and four insulated 10-32 x 4.5 in. screws (B). Torque screws to 36 lb-in (4 Nm).

NOTICE
Electrically-operated circuit breakers must be grounded by installing insulated mounting screw in lower right mounting screw hole (C).

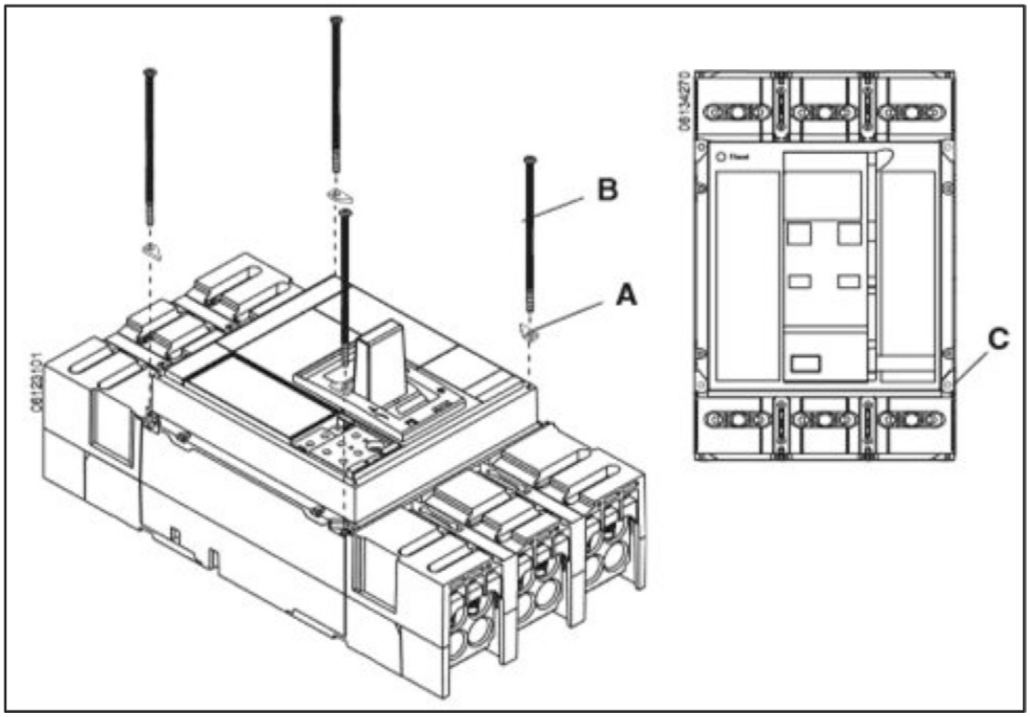


FIGURE 47. MOUNT CIRCUIT BREAKER

5. For bus connected circuit breakers, bolt bus to circuit breaker:

    a. Insert bolts (A) through holes in bus (B) into breaker nut plate (C). Using slotted screwdriver, torque bolts to 50 lb-in (5.65 Nm).

    b. Secure bus (B) with nuts (D). Torque nuts to 250 lb-in (28 Nm).

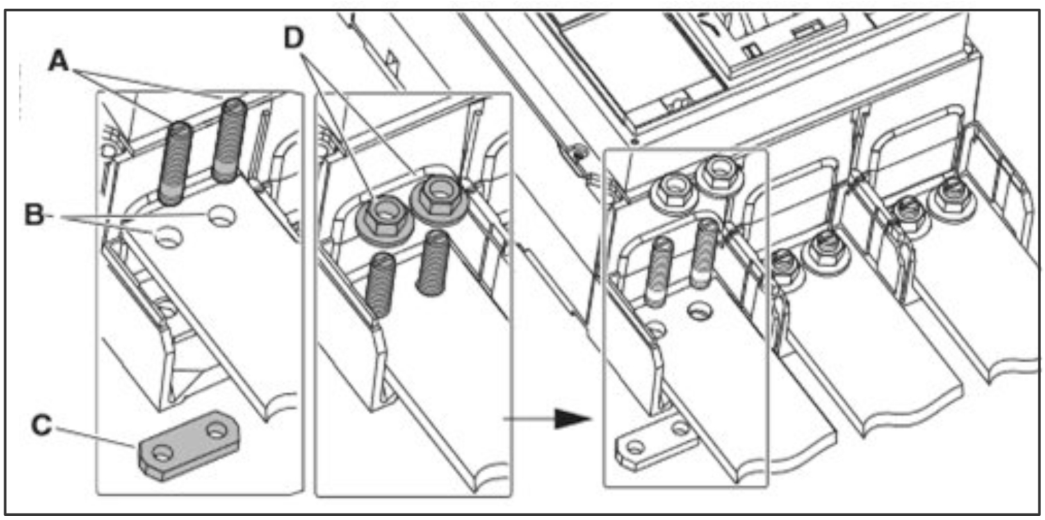


FIGURE 48. BUS CONNECTED CIRCUIT BREAKER

6.9.5.3 Circuit Breaker Removal

1. Isolate all power sources to this equipment before working on or inside equipment.
2. To remove the circuit breaker, follow the reverse of the Installation Instructions.

6.9.5.4 Install Accessories and Control Wiring

1. Make sure circuit breaker is in tripped, or off (**O**) position.
2. Loosen four accessory cover screws (A, **Figure 49**) and remove accessory cover (B).

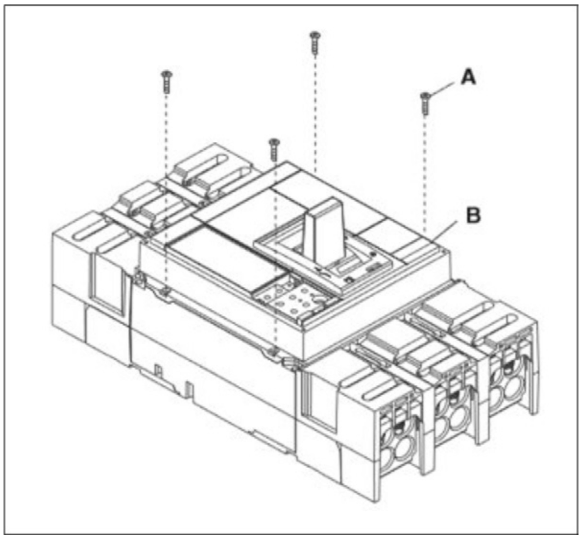


FIGURE 49. REMOVE CIRCUIT BREAKER COVER

3. Install control wiring (A) to accessories. Torque terminal screws to 10lb-in (1.2 Nm)

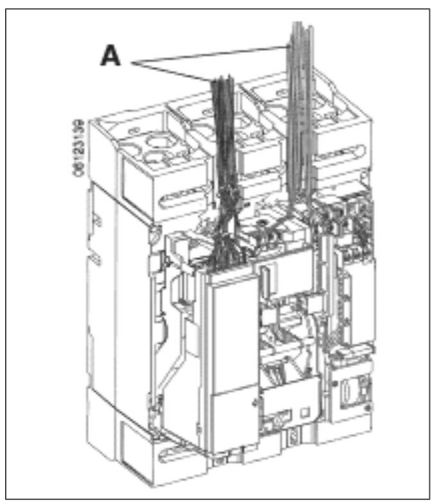


FIGURE 50. CONTROL WIRING (A) TO ACCESSORIES

4. Replace Accessory Cover: Replace all four accessory cover screws. Hand tighten screws to 11-13 lb-in (1.2-1.5 Nm). Do not exceed torque specifications of screws.

NOTICE
The accessory cover must be secured with all four screws tightened to stated torque. Do not over tighten, as equipment damage may result. Do not use power equipment to torque screws.

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7 Manufacturing Facilities

U.S. and CANADA	EMEA, CIS	EMEA, CIS
Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Inc. Columbus Avenue Manston Park Manston, Ramsgate Kent CT12 5BF United Kingdom	Cummins Inc. Royal Oak Way South Daventry Northamptonshire NN11 8NU United Kingdom
Toll Free 1-800-CUMMINS™ (1-800-286-6467) Phone +1 763-574-5000 Fax +1 763-574-5298	Phone +44 1843 255000 Fax +44 1843 255902	Phone +44 1327 88-6453 Fax +44 1327 88-6125
BRAZIL	**CHINA**	**INDIA**
Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 CNPJ: 43.2201.151/0001-10 Brazil	Cummins Inc. No.118 South Quanli Road , Wuhan Economic& Technological Development Zone , Hubei, P.R.China 430058	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka-Phaltan Dist- Satara, Maharashtra 415523 India
Phone 0800 286 6467	Phone + 86 (27) 8421 4008 Fax + 86 (27) 8421 4804	Phone +91 021 66305514
LATIN AMERICA	**MEXICO**	**ASIA PACIFIC**
3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	Cummins Sales and Service Singapore Pte Ltd 85 Tuas South Avenue 1 Singapore 637419
Phone +1 954 431 551 Fax +1 954 433 5797	Phone +52 444 870 6700 Fax +52 444 824 0082	Fax +65 6265 6909

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Appendix A. Alternator Reconnect Drawing

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

A.1 Reconnect Drawing for HC Alternator

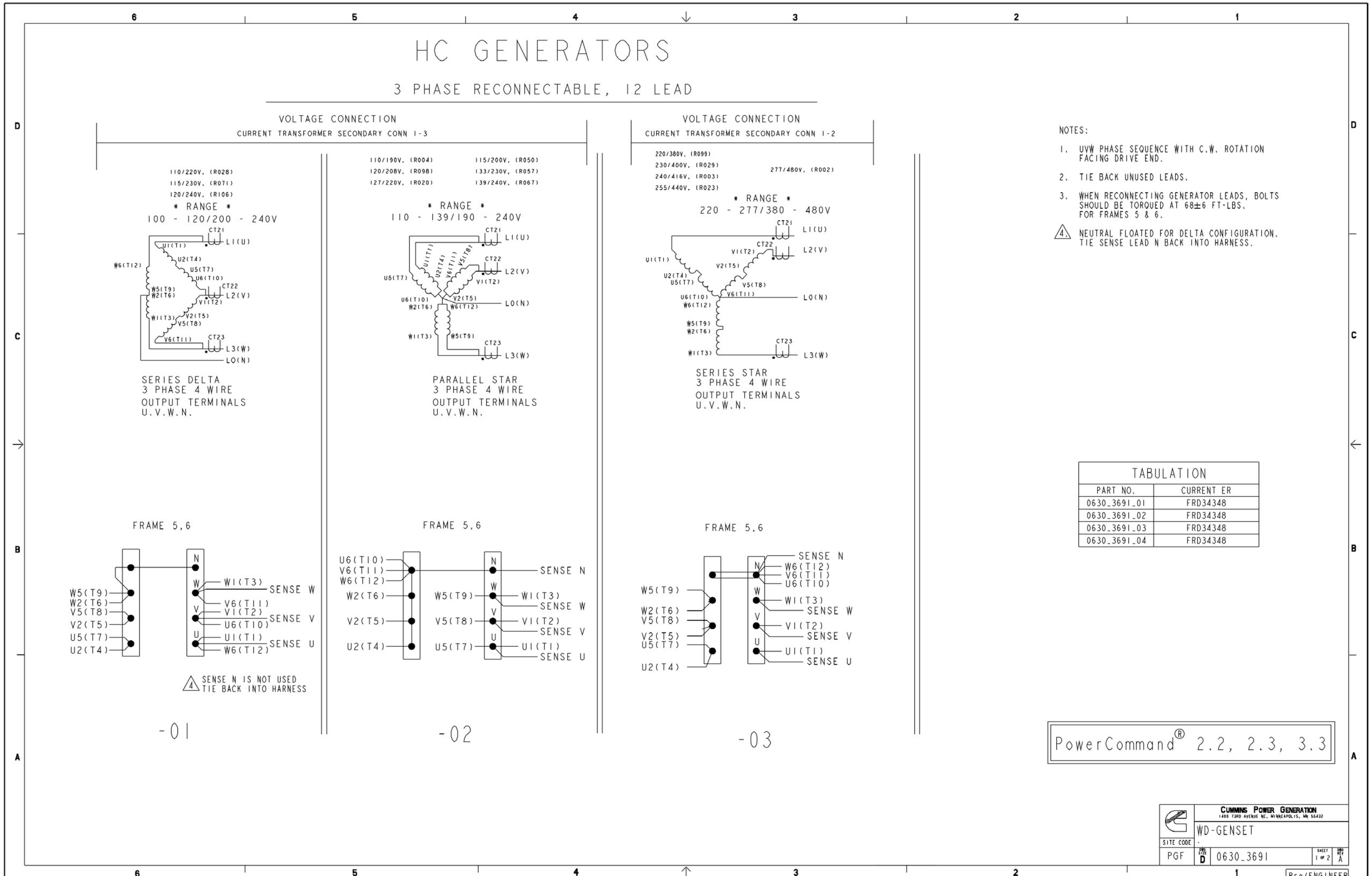


FIGURE 51. RECONNECT DRAWING HC ALTERNATOR (SHEET 1)

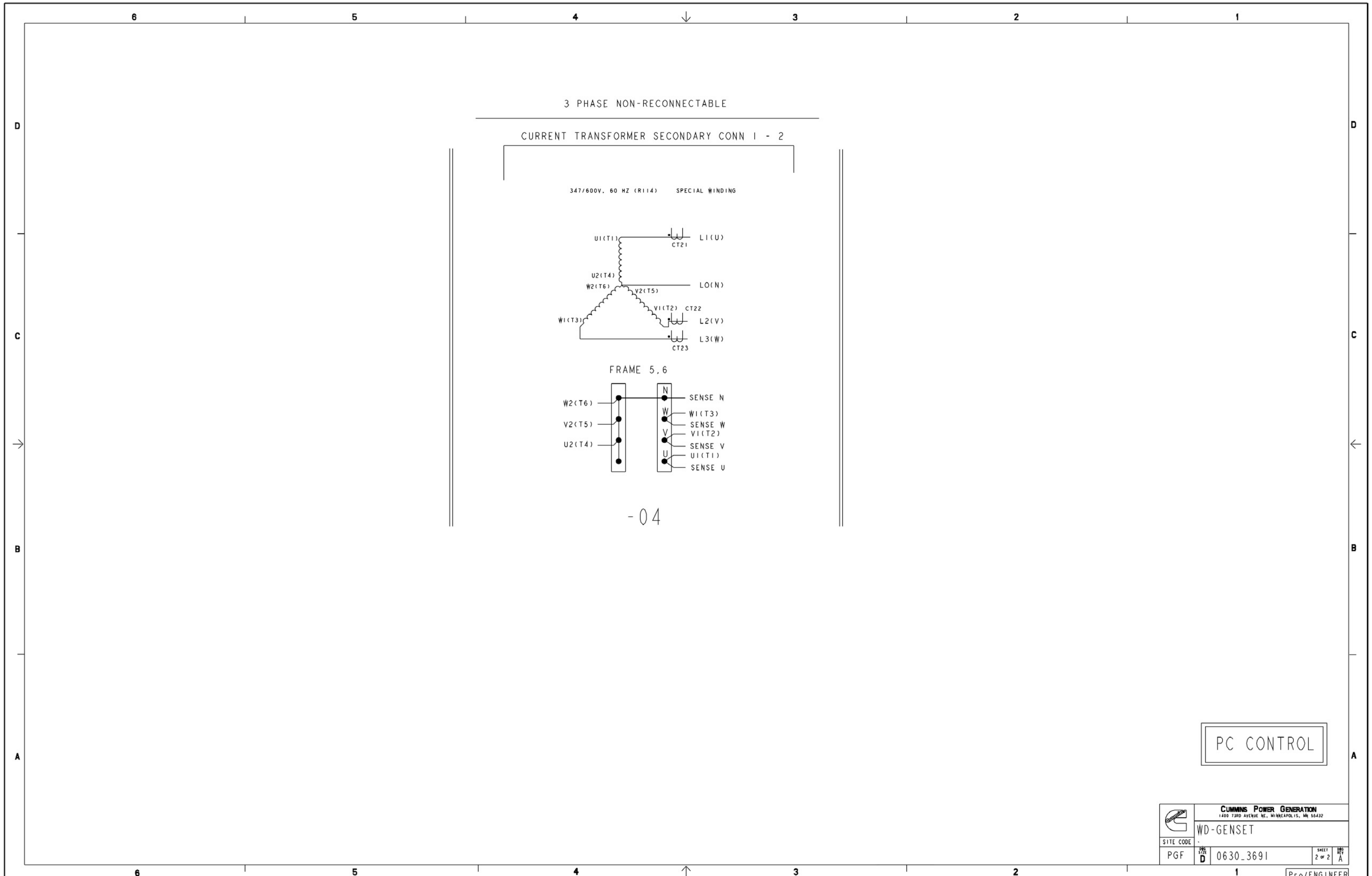


FIGURE 52. RECONNECT DRAWING HC ALTERNATOR (SHEET 2)

Appendix B. Outline Drawings

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

B.1 Outline Drawing Index

OUTLINE INDEX TAB A052W781

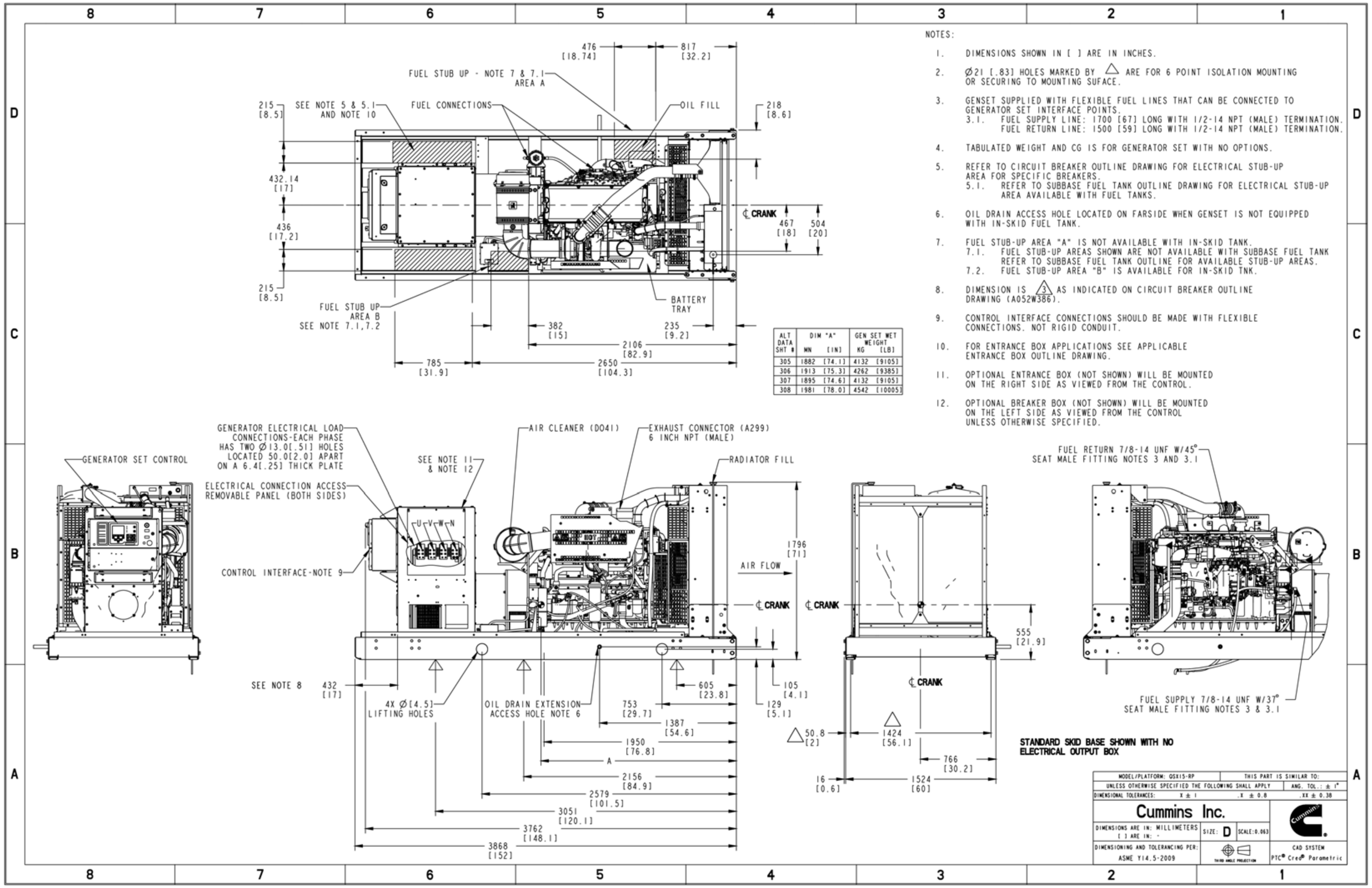
DESCRIPTIONS	FEATURE CODE	REMARKS	DFEJ	DFEK
KILOWATTS			450KW	500KW
GENERAL OUTLINES				
RADIATOR COOLED (NO ENCLOSURE)	STANDARD	40°,50° COOLING	SPEC A-N A052W393	
			SPEC P+ A063J084	
WEATHER PROTECTIVE	F183	ENCLOSURE MOUNTED ON GENSET	A034G461	
WEATHER PROTECTIVE	F200,F203	ENCLOSURE MOUNTED ON SUB-BASE TANK OR LIFT BASE C201-C207, F214	A034J587	
LEVEL 1 SOUND ENCLOSURE	F201,F204			
LEVEL 2 SOUND ENCLOSURE	F202,F205		A034J589	
WEATHER PROTECTIVE	F200,F203	ENCLOSURE MOUNTED ON SUB-BASE TANK C209	A034J591	
LEVEL 1 SOUND ENCLOSURE	F201,F204			
LEVEL 2 SOUND ENCLOSURE	F202,F205		A034J593	
AIR INLET RAIN HOOD	F209	OPTIONAL WITH F200 - F205	0500_3742	
HORIZONTAL AIR DISCHARGE	F208	OPTIONAL WITH F202, F205		
INSTALLATION MANUAL	STANDARD	PCC2300	A052B680	
		PCC3300	A052B686	
		PCC3300 W/MLD	A052F006	
MECHANICAL INTERFACES				
FOUNDATION LAYOUT				
FOUNDATION (FUEL, ELECTRICAL, ANCHORS)	STANDARD, F183	NO ENCLOSURE OR WITH F183 ENCLOSURE	SPEC A-N A052W393	
			SPEC P+ A063J084	
FOUNDATION (FUEL, ELECTRICAL, ANCHORS)	F200 - F205	ENCLOSURE MOUNTED ON TANK OR LIFTING BASE USE WITH OPTIONAL C201-C207, F214, C242	A035F947	
		USE WITH OPTIONAL C209	A035F951	
FUEL CONNECTION				
ENGINE CONNECTION	STANDARD	NOT WITH C212,C213,C214	SPEC A-N A052W393	
			SPEC P+ A063J084	
SUB-BASE TANKS WITH FUEL TRANSFER PUMP	C212,C213,C214	OPTIONAL WITH C201-C211	0500-3752	
FUEL SYSTEM OPTIONS				
EXTERNAL HIGH FUEL ALARM AND OVERFILL PROTECTION VALVE	C231	USE WITH C201 - C207	0500-3918	
EXTERNAL HIGH FUEL ALARM	C232			
EXTERNAL FILL SPILL BOX AND OVERFILL PROTECTION VALVE	C233		0500-3916	
EXTERNAL FILL SPILL BOX	C234			
FUEL TANK VENT EXTENSION	C235,C243		0500-3917	
COOLING CONNECTIONS				
RADIATOR DISCHARGE DUCT (50° C)	E074	NOT APPLICABLE WITH ANY ENCLOSURE	SPEC A-N A052W393	
			SPEC P+ A063J084	
EXHAUST CONNECTIONS				
PIPE	A299		SPEC A-N A052W393	
			SPEC P+ A063J084	
ASA FLANGE OR SLIP FIT	A335 OR A298		A052W391	
AC POWER ELECTRICAL CONNECTIONS				
ALTERNATOR RECONNECT	STANDARD		0630-3691-03	
AC DISTRIBUTION PANEL	H657		0500-3749 SHEET 2	
JACKET WATER COOLANT HEATER	H556,H557	PRE-WIRED WITH H657	0500-3820	
ENGINE OIL HEATER	H487		A052W391	
CONTROL CABINET HEATER	A460			
ALTERNATOR HEATER	A292,A293			
BATTERY CHARGER	B786		0500-3749 SHEET 3	
OPERATING LOUVERS	F210-F213		0500-3749 SHEET 1	
FUEL TRANSFER PUMP	C212,C213,C214		0500-3752	
ENTRANCE/TERMINAL/CIRCUIT BREAKER BOX OUTLINES				
OUTLINE TERMINAL BOX (T)	KU93-2, KU94-2	THOR	A052W775	
OUTLINE TERMINAL BOX (NT)	KU93-2, KU94-2	NON-THOR, BOTTOM ENTRY	A052W779	
OUTLINE TERMINAL BOX (NT)	KU93-2, KU94-2	NON-THOR, TOP ENTRY	A052W777	
OUTLINE ENTRANCE BOX	KU93-2, KU94-2	THOR	A052W946	
OUTLINE ENTRANCE BOX (NT)	KU93-2, KU94-2	NON-THOR, BOTTOM ENTRY	A052W948	
OUTLINE ENTRANCE BOX (NT)	KU93-2, KU94-2	NON-THOR, TOP ENTRY	A052W950	
OUTLINE CIRCUIT BRKR(NT)	KU93-2, KU94-2, KX23	NON-THOR	A052W386	
OUTLINE CIRCUIT BRKR	KU94-2, KU95-2	THOR	A052W389	
GENSET CONTROL CONNECTIONS				
WIRING DIAGRAM GENSET	H704-2, KX21-2	PCC3300, PCC3300 W/MLD	A052P338	
WIRING DIAGRAM GENSET	H703-2	PCC2300	A052P382	
CONTROL LOCATION	STANDARD		A052W391	
CONTROL LOCATION	H608/H609		A052W391	
CUSTOMER CONNECTION	STANDARD	PCC2300 REFERENCE INSTALLATION MANUAL "CUSTOMER CONNECTIONS"	A052B680	
CUSTOMER CONNECTION	STANDARD	PCC3300 REFERENCE INSTALLATION MANUAL "CUSTOMER CONNECTIONS"	A052B686	
CUSTOMER CONNECTION	STANDARD	PCC3300 W/MLD REFERENCE INSTALLATION MANUAL "CUSTOMER CONNECTIONS"	A052F006	
WIRING DIAGRAM		THOR OPTIONS	A052W745	

Cummins Inc.

Part Number: **A052W781** Part Revision: **B**
Part Name: **OUTLINE,GENSET**

FIGURE 53. OUTLINE DRAWING INDEX

B.2 Generator Set Outline Drawing



Part Number: **A063J084** Part Revision: **B**

Part Name: **OUTLINE,GENSET**

FIGURE 54. GENERATOR SET OUTLINE DRAWING (SHEET 1 OF 4)

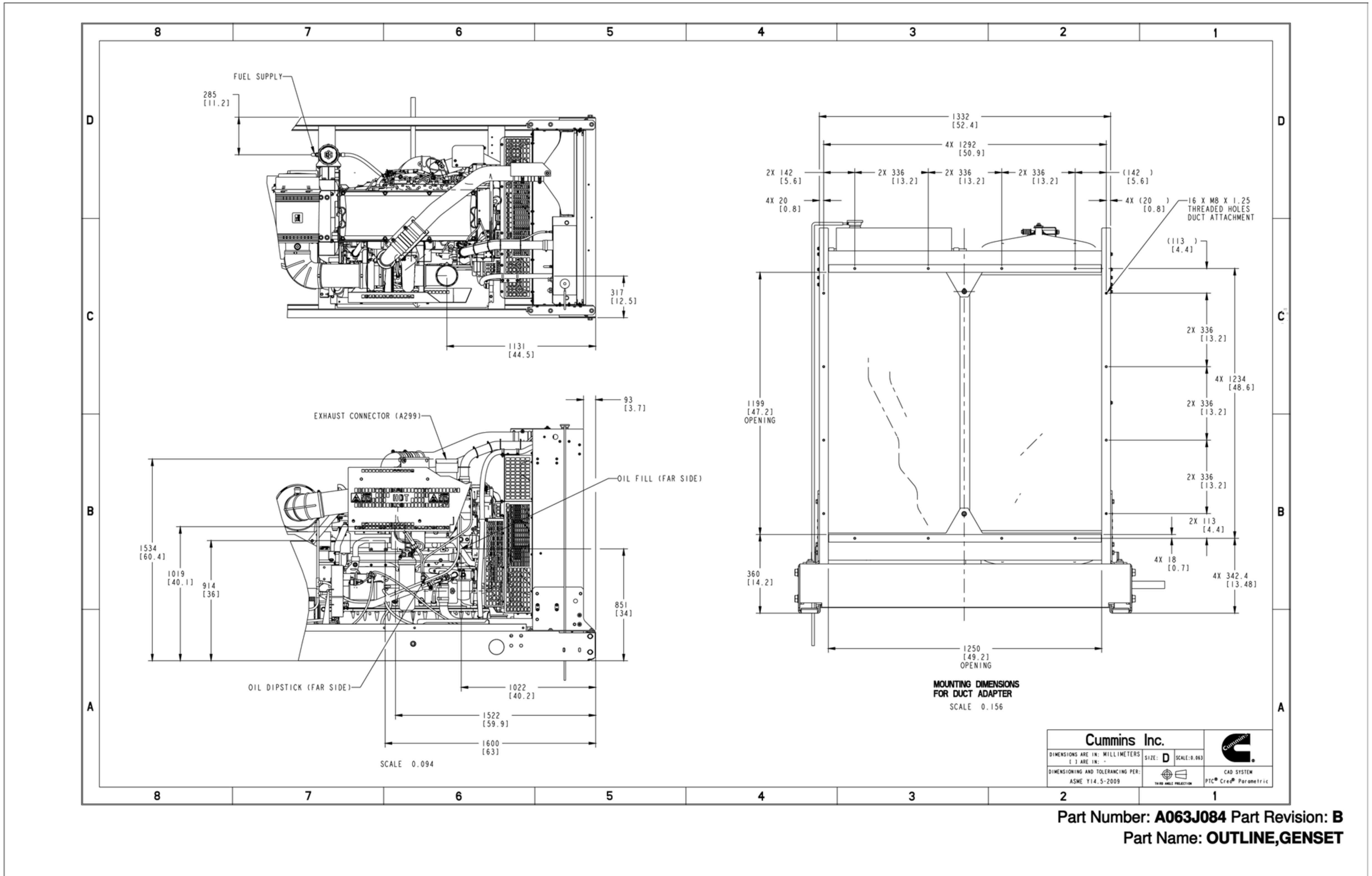


FIGURE 55. GENERATOR SET OUTLINE DRAWING (SHEET 2 OF 4)

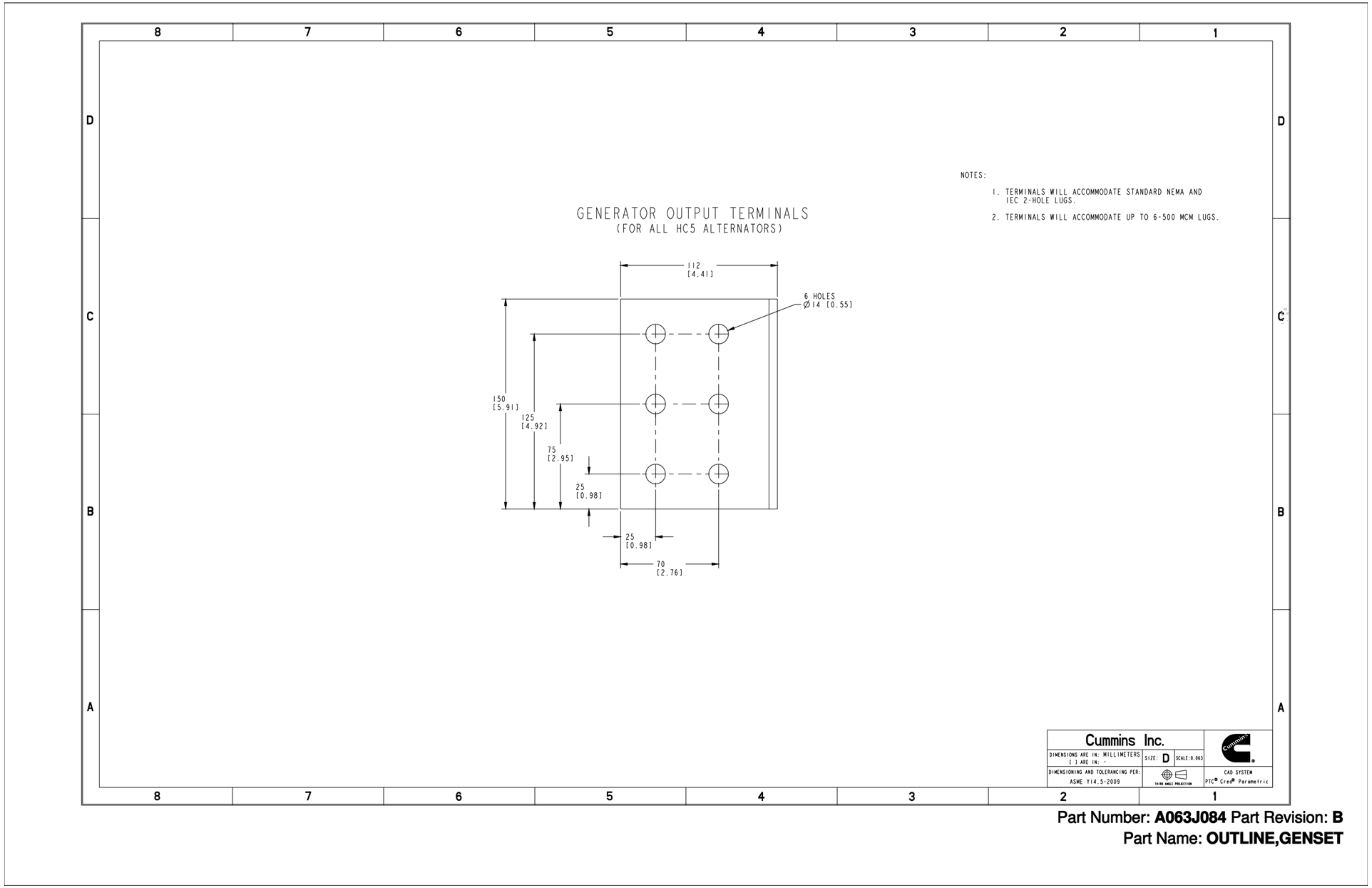


FIGURE 56. GENERATOR SET OUTLINE DRAWING (SHEET 3 OF 4)

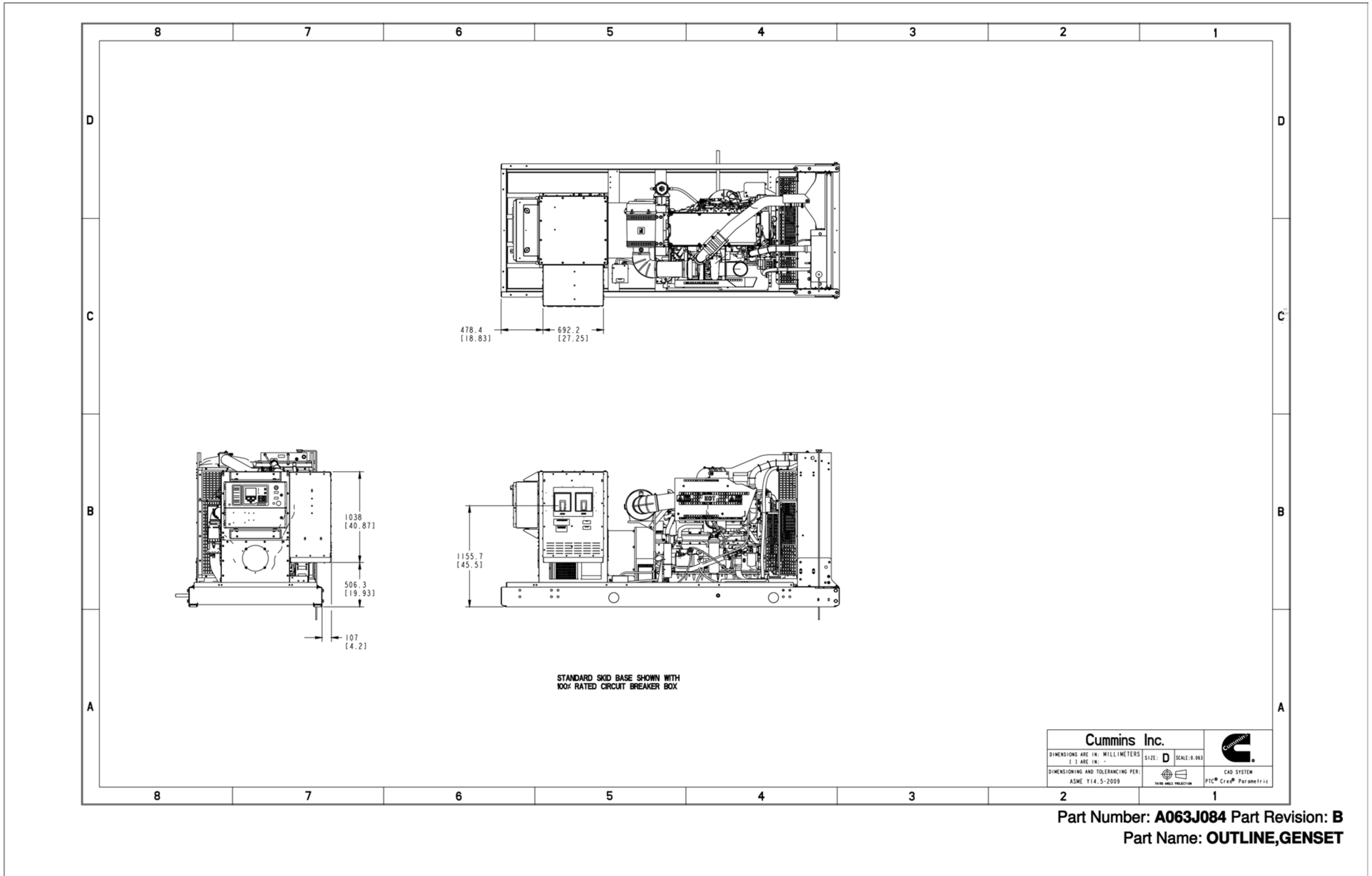


FIGURE 57. GENERATOR SET OUTLINE DRAWING (SHEET 4 OF 4)

B.3 Outline Drawing - Exhaust Connector, Air Cleaner

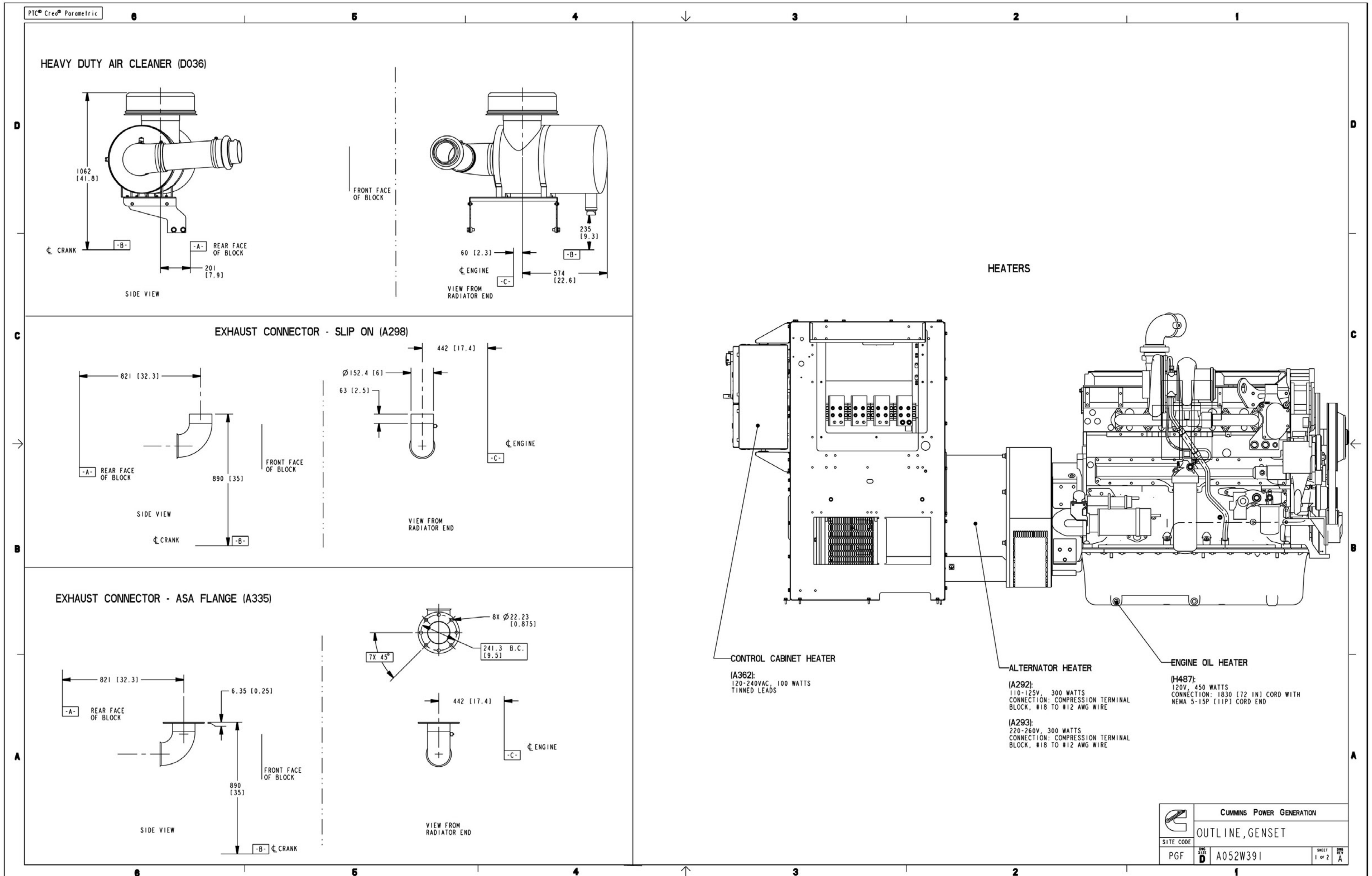


FIGURE 58. OUTLINE DRAWING - EXHAUST CONNECTOR, AIR CLEANER

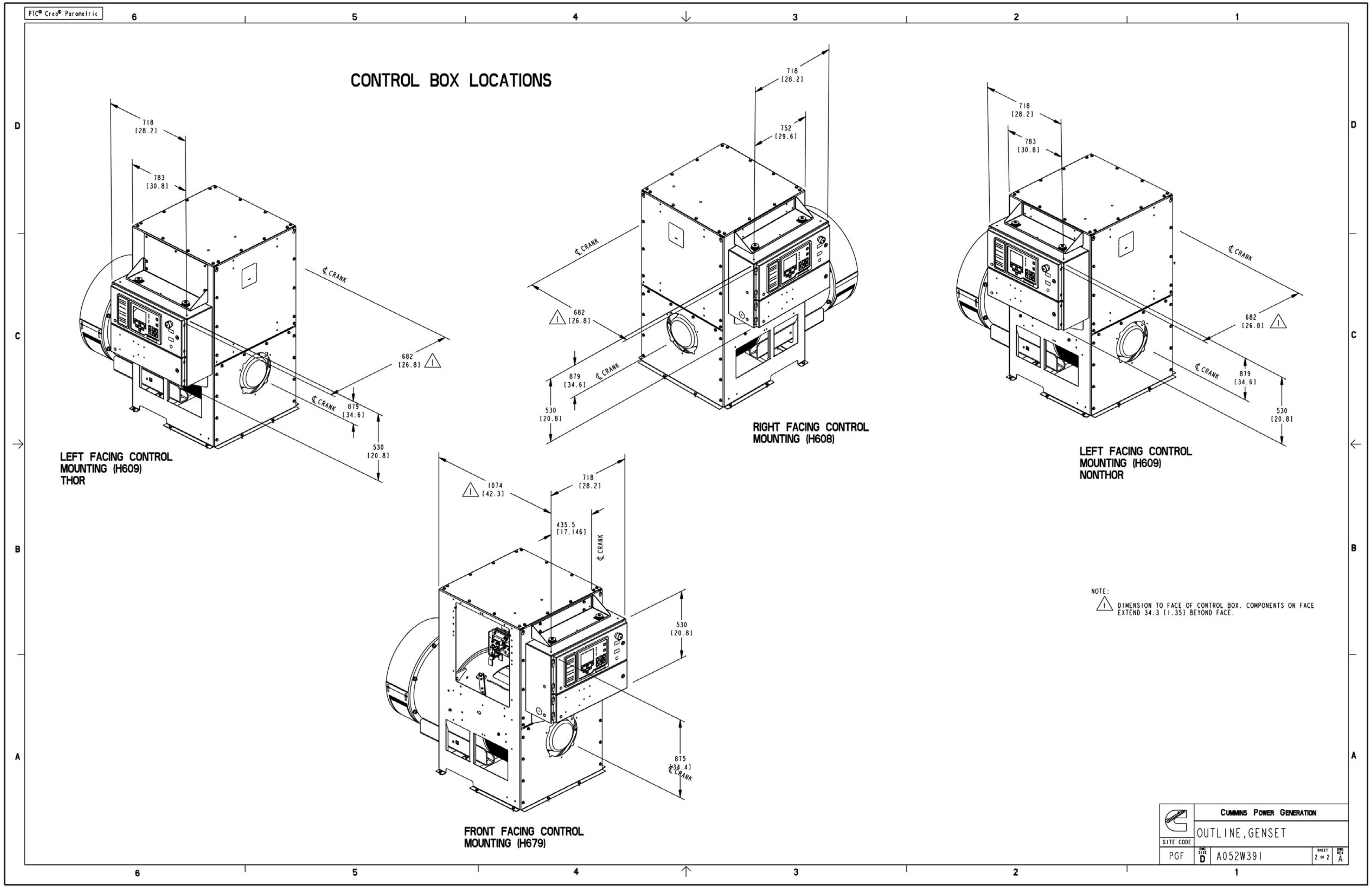


FIGURE 59. OUTLINE DRAWING - CONTROL BOX LOCATIONS

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Appendix C. Wiring Diagrams

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

C.1 Wiring Diagram with PowerCommand 2300 Control

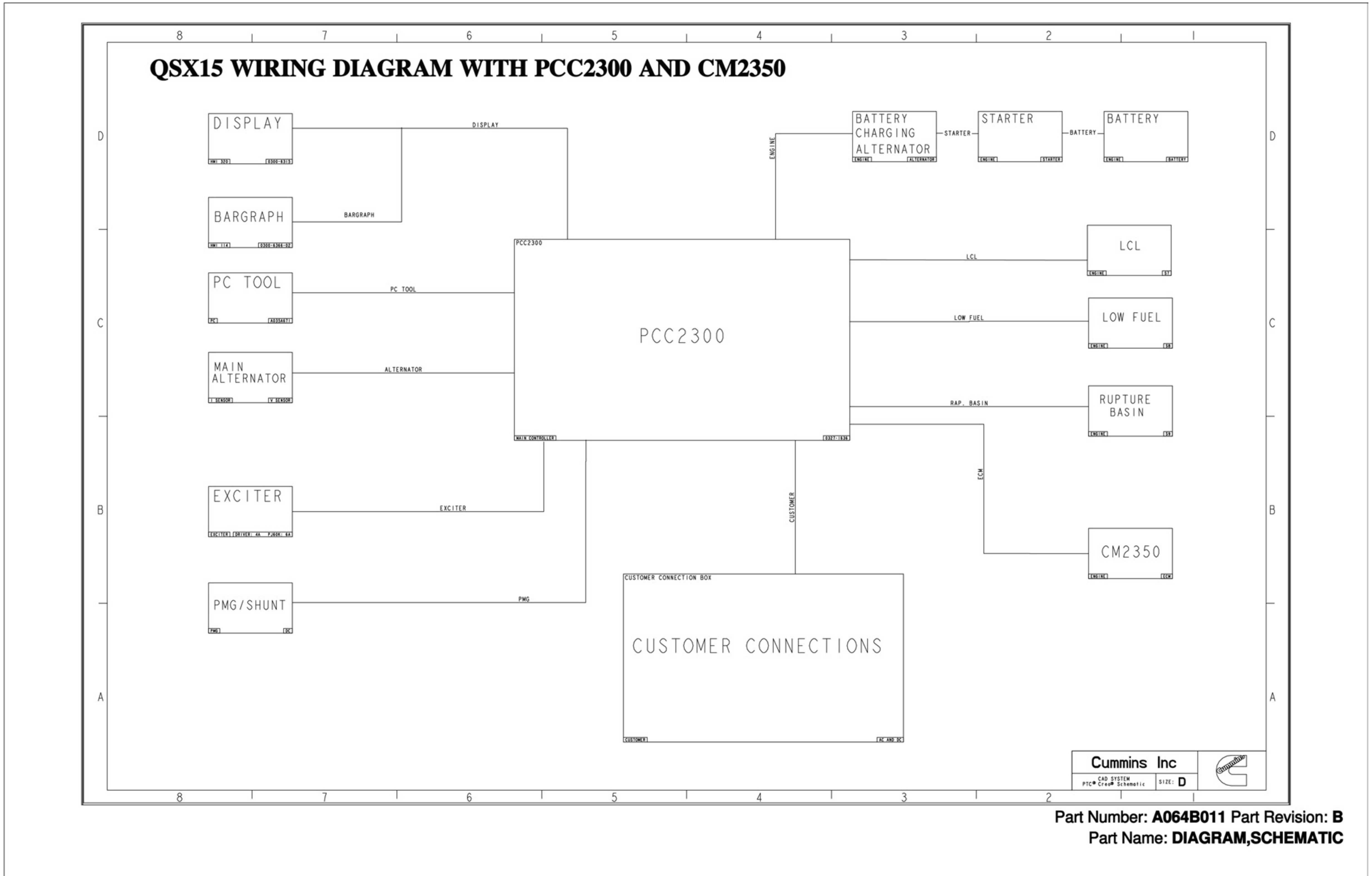


FIGURE 60. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 1 OF 7)

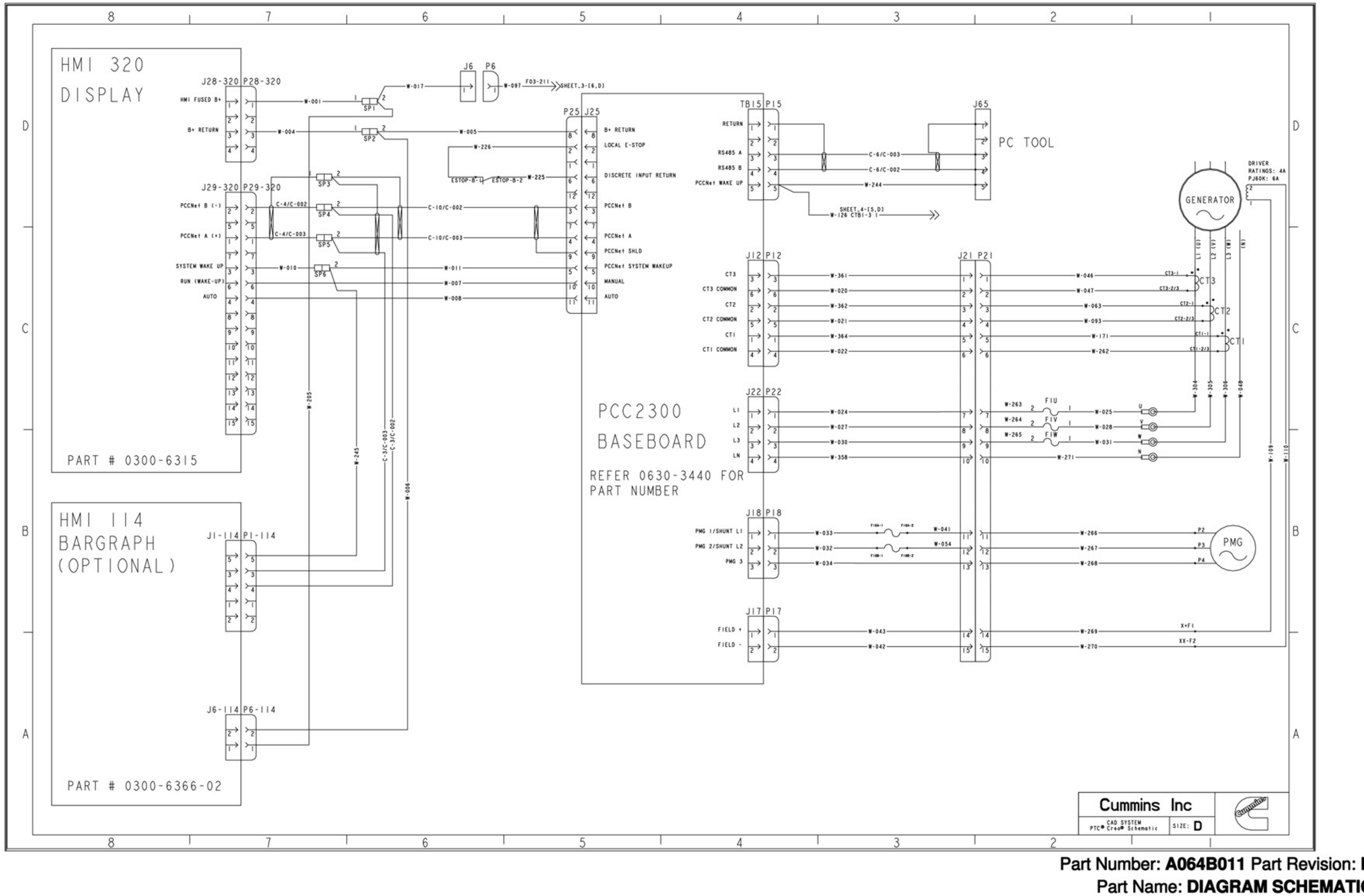


FIGURE 61. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 2 OF 7)

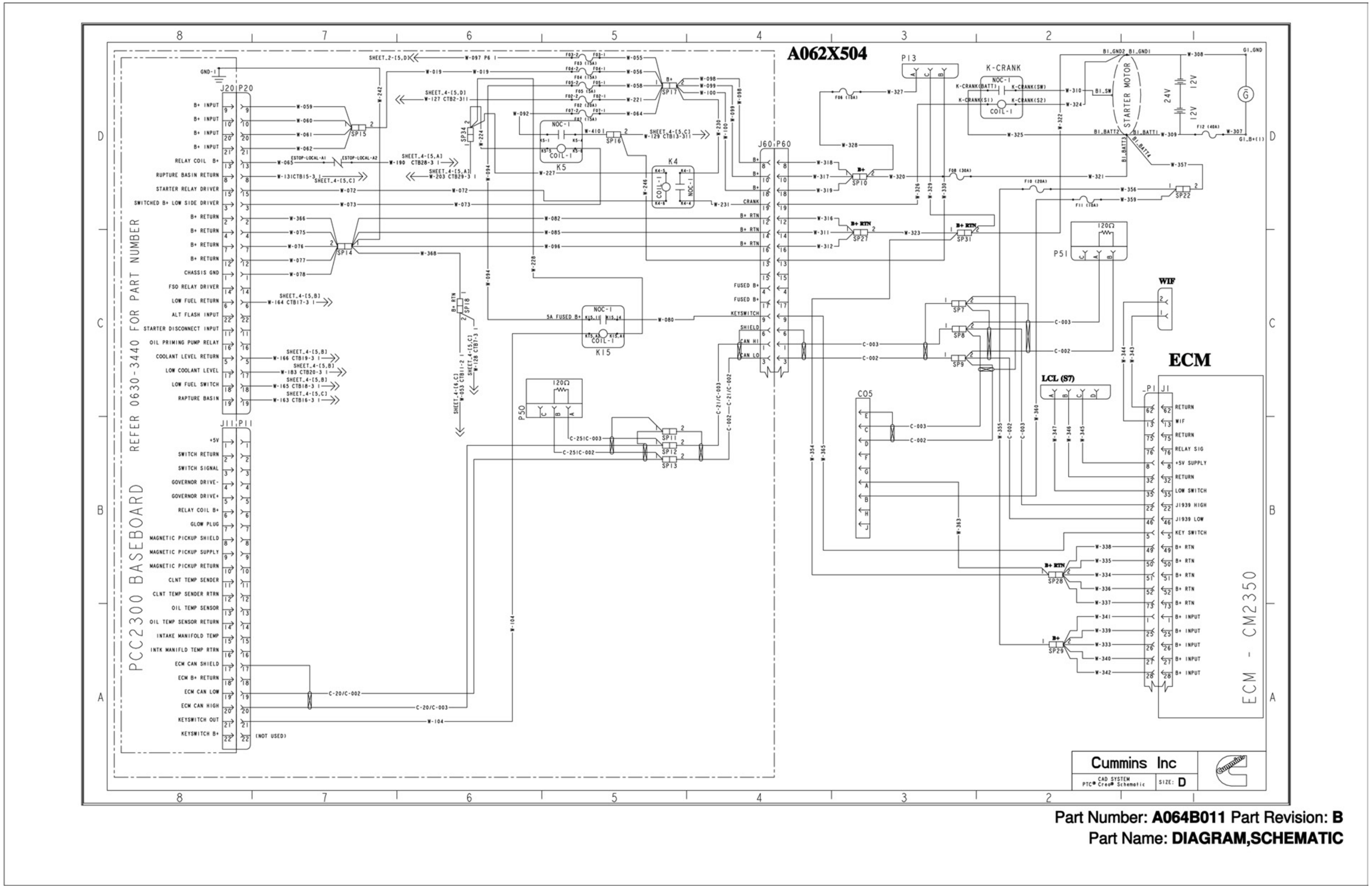
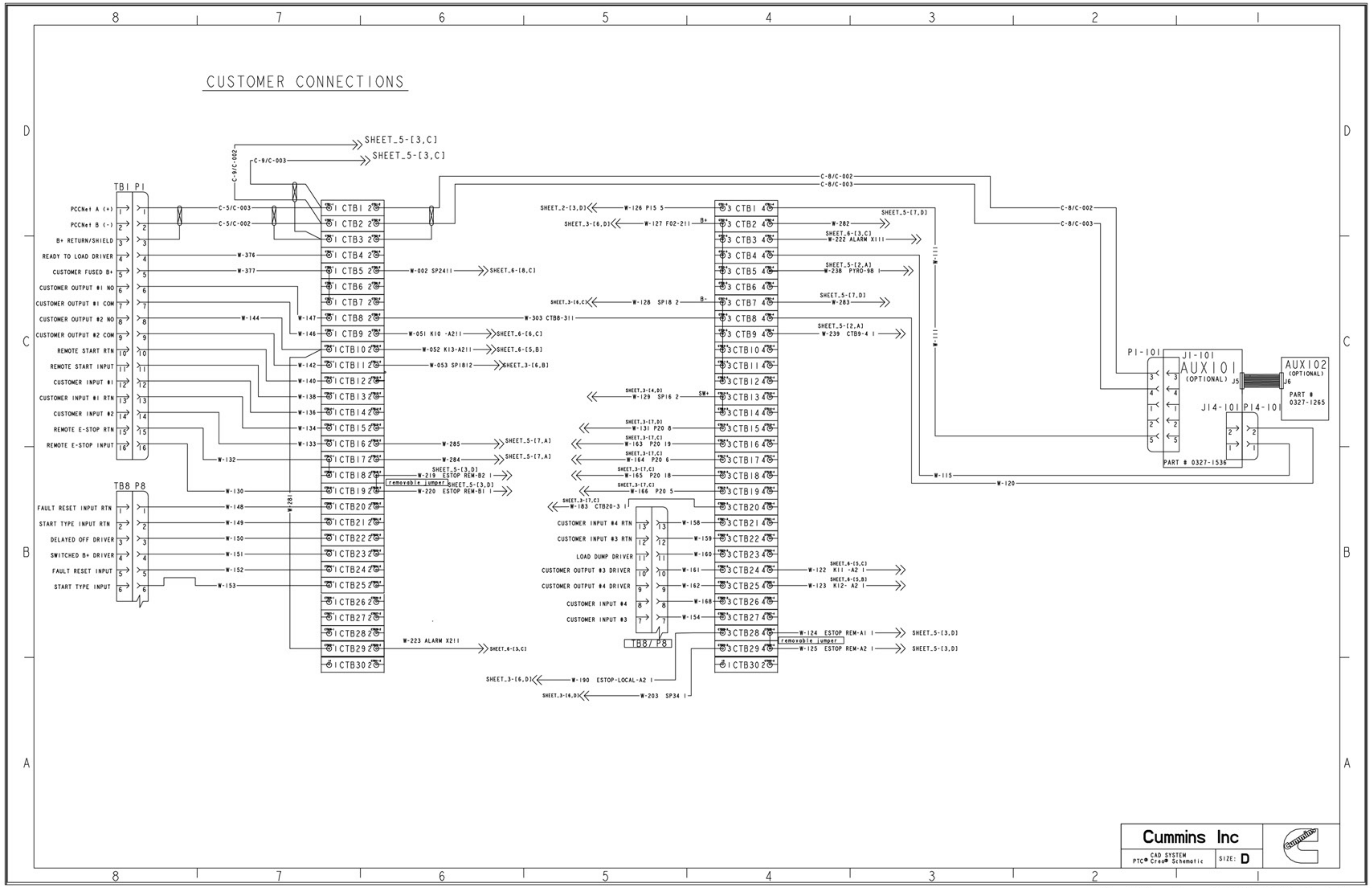
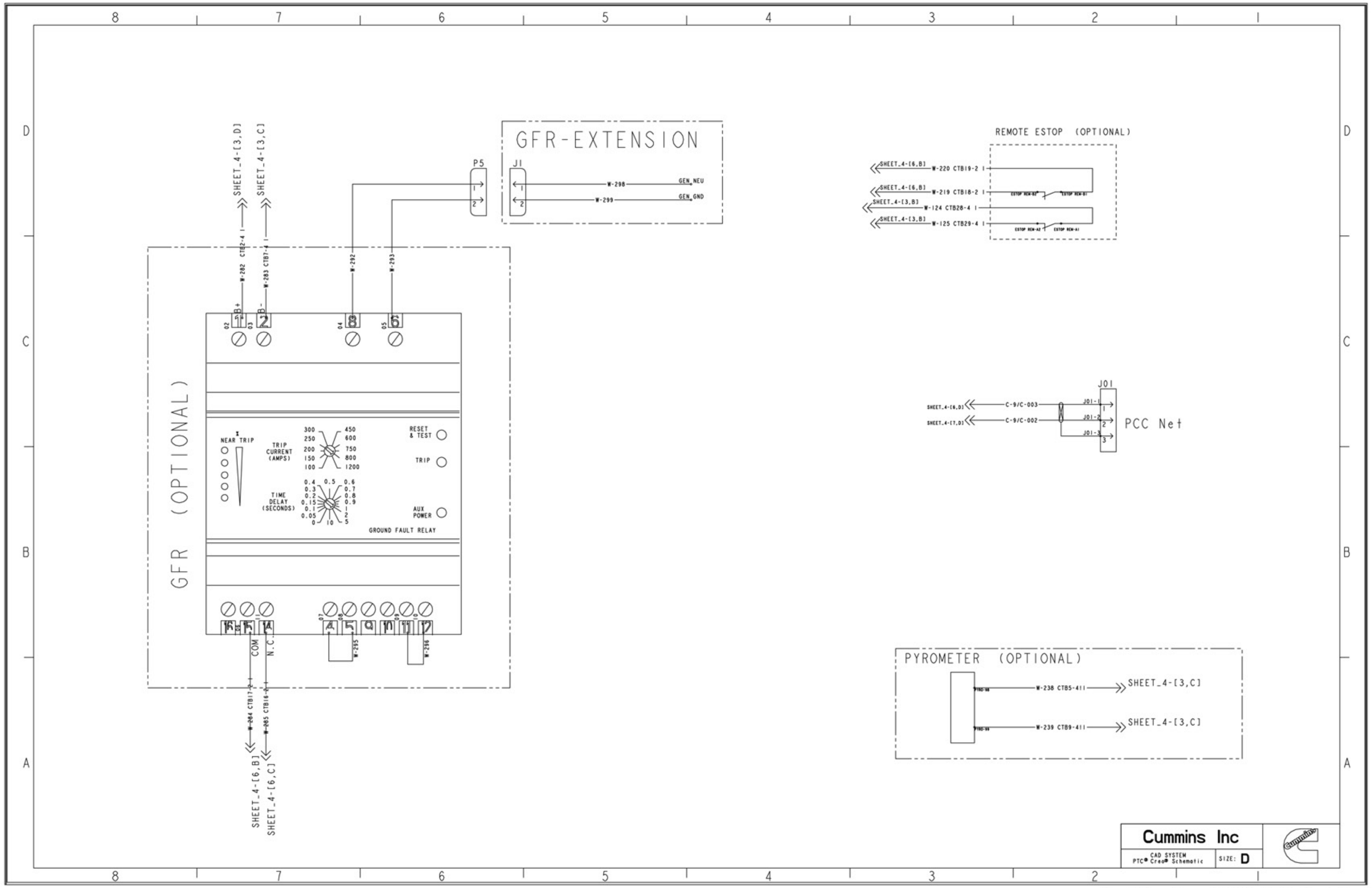


FIGURE 62. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 3 OF 7)



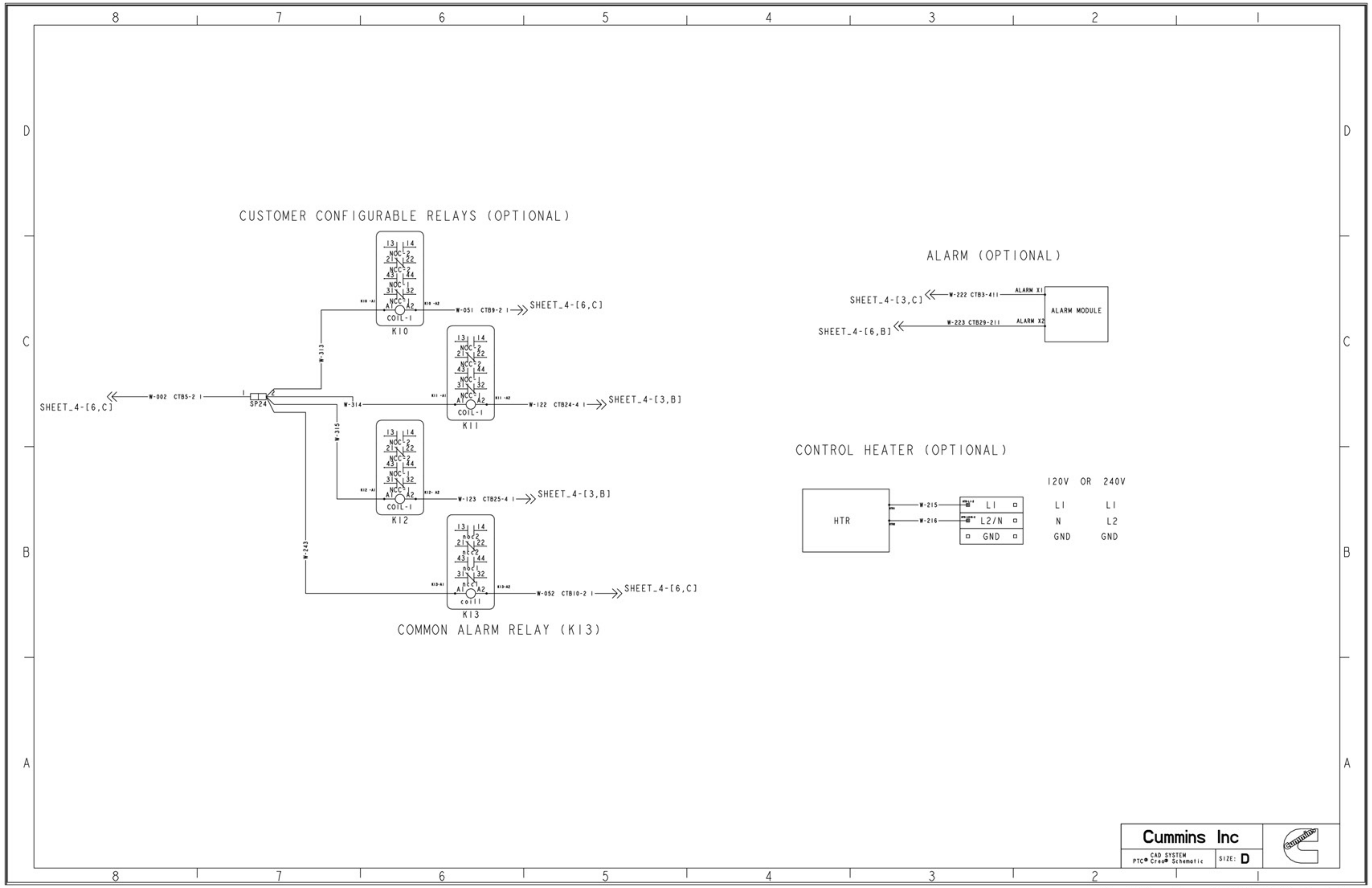
Part Number: **A064B011** Part Revision: **B**
Part Name: **DIAGRAM,SCHEMATIC**

FIGURE 63. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 4 OF 7)



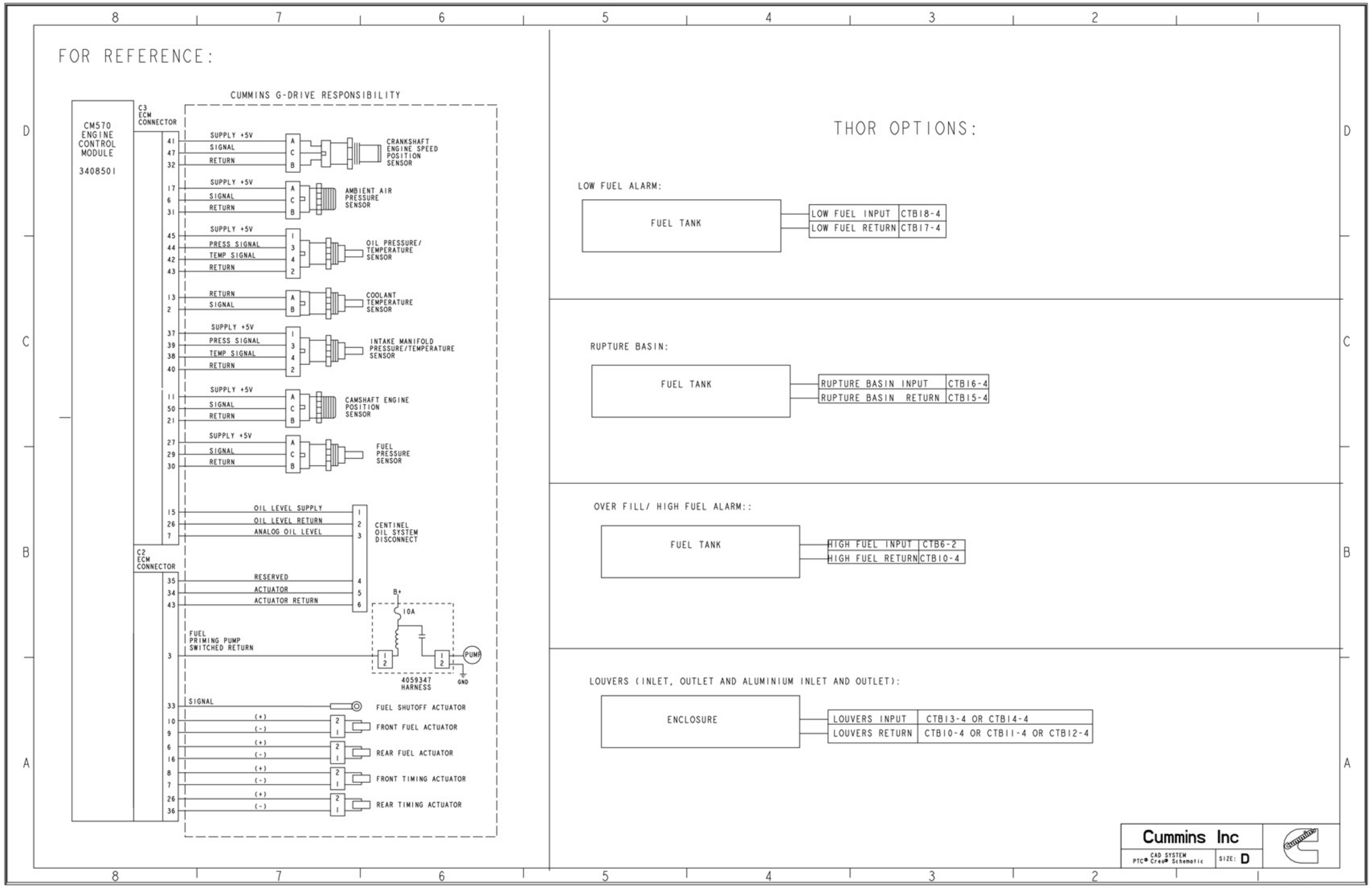
Part Number: **A064B011** Part Revision: **B**
Part Name: **DIAGRAM,SCHEMATIC**

FIGURE 64. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 5 OF 7)



Part Number: **A064B011** Part Revision: **B**
Part Name: **DIAGRAM,SCHEMATIC**

FIGURE 65. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 6 OF 7)



Part Number: **A064B011** Part Revision: **B**

Part Name: **DIAGRAM,SCHEMATIC**

FIGURE 66. WIRING DIAGRAM WITH POWERCOMMAND 2300 CONTROL (SHEET 7 OF 7)

C.2 Options Wiring Diagram

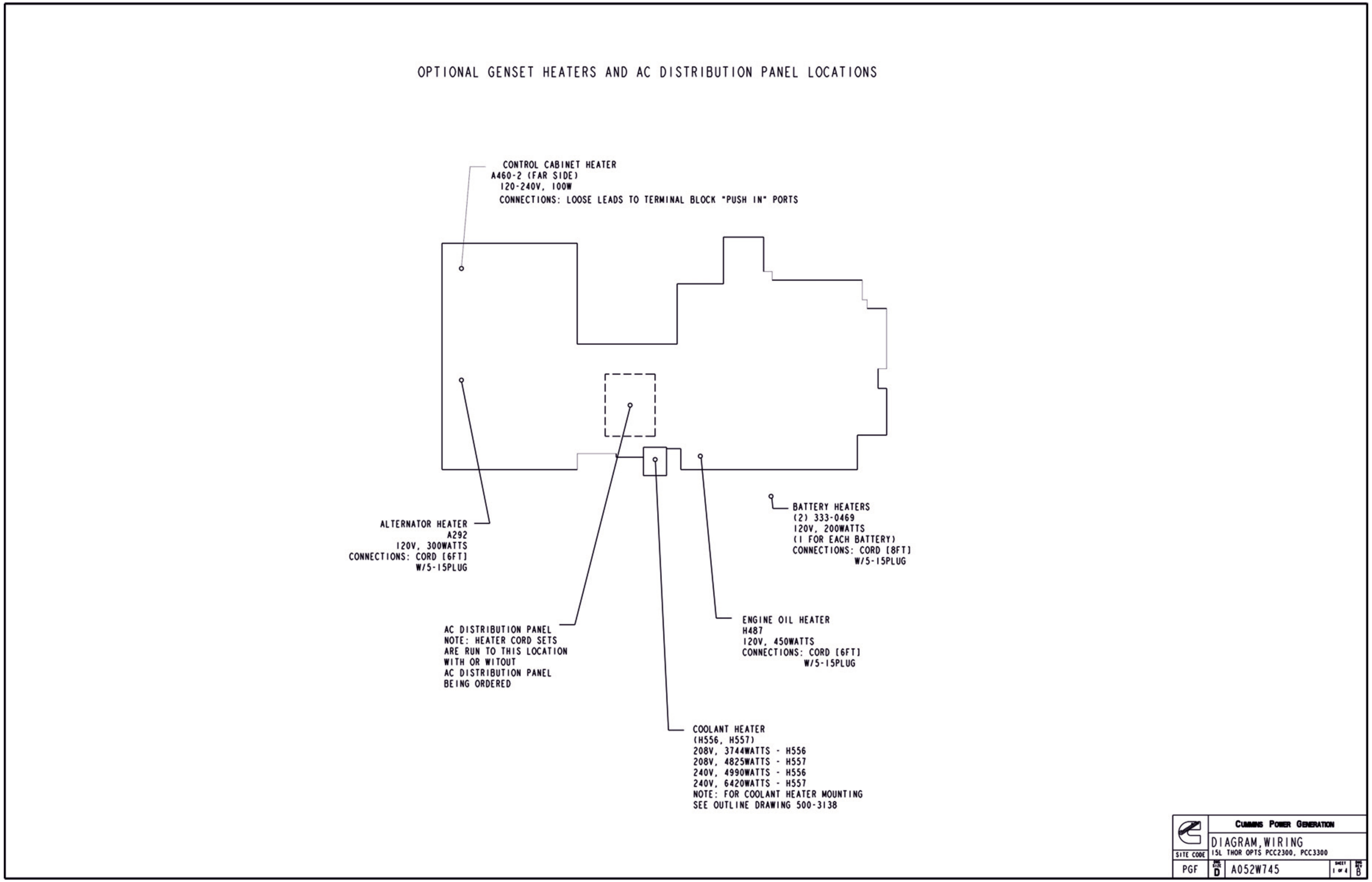


FIGURE 67. OPTIONAL GENERATOR SET HEATERS AND AC DISTRIBUTION PANEL LOCATIONS

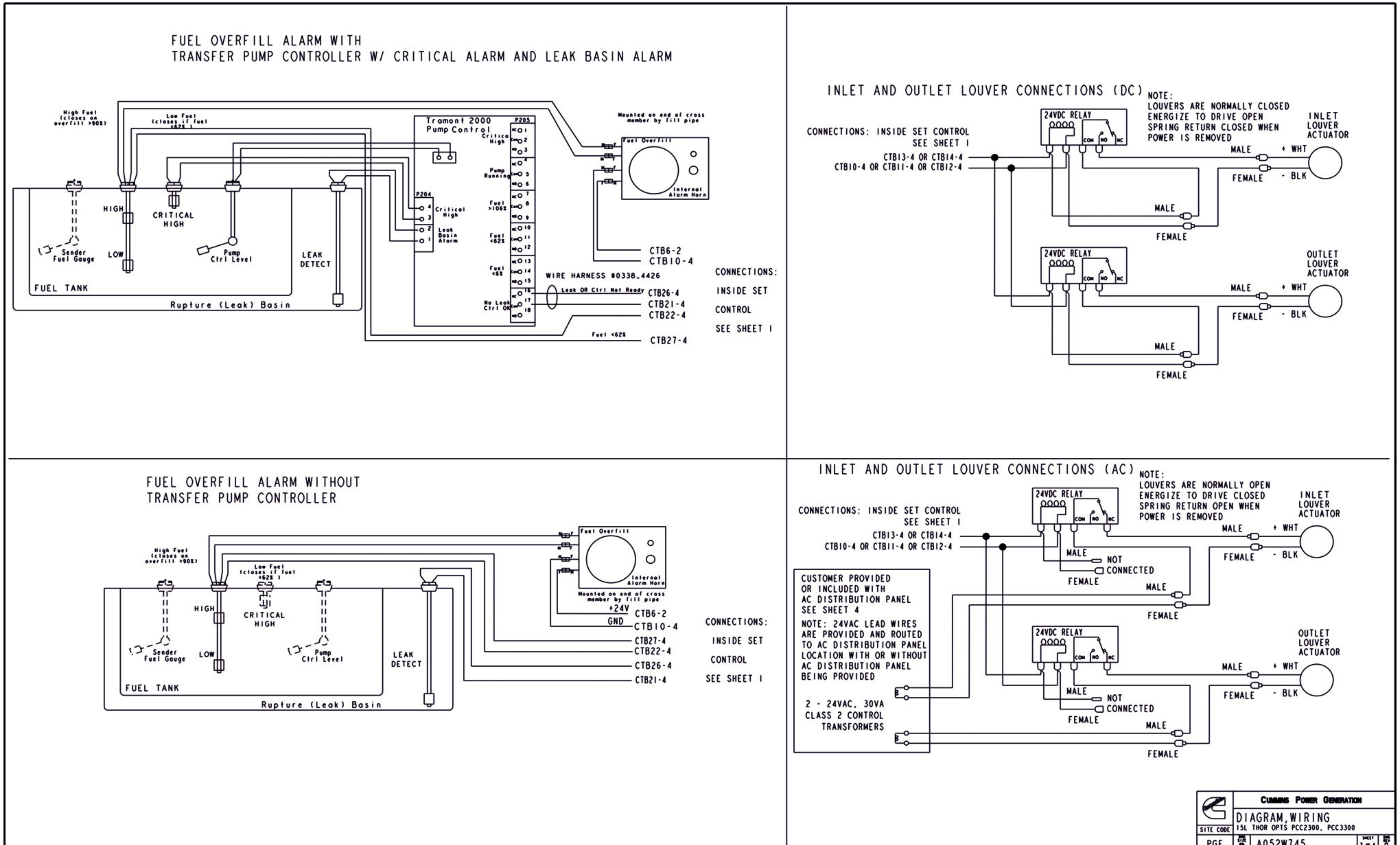


FIGURE 68. FUEL OVERFILL ALARM, LOUVER CONNECTIONS

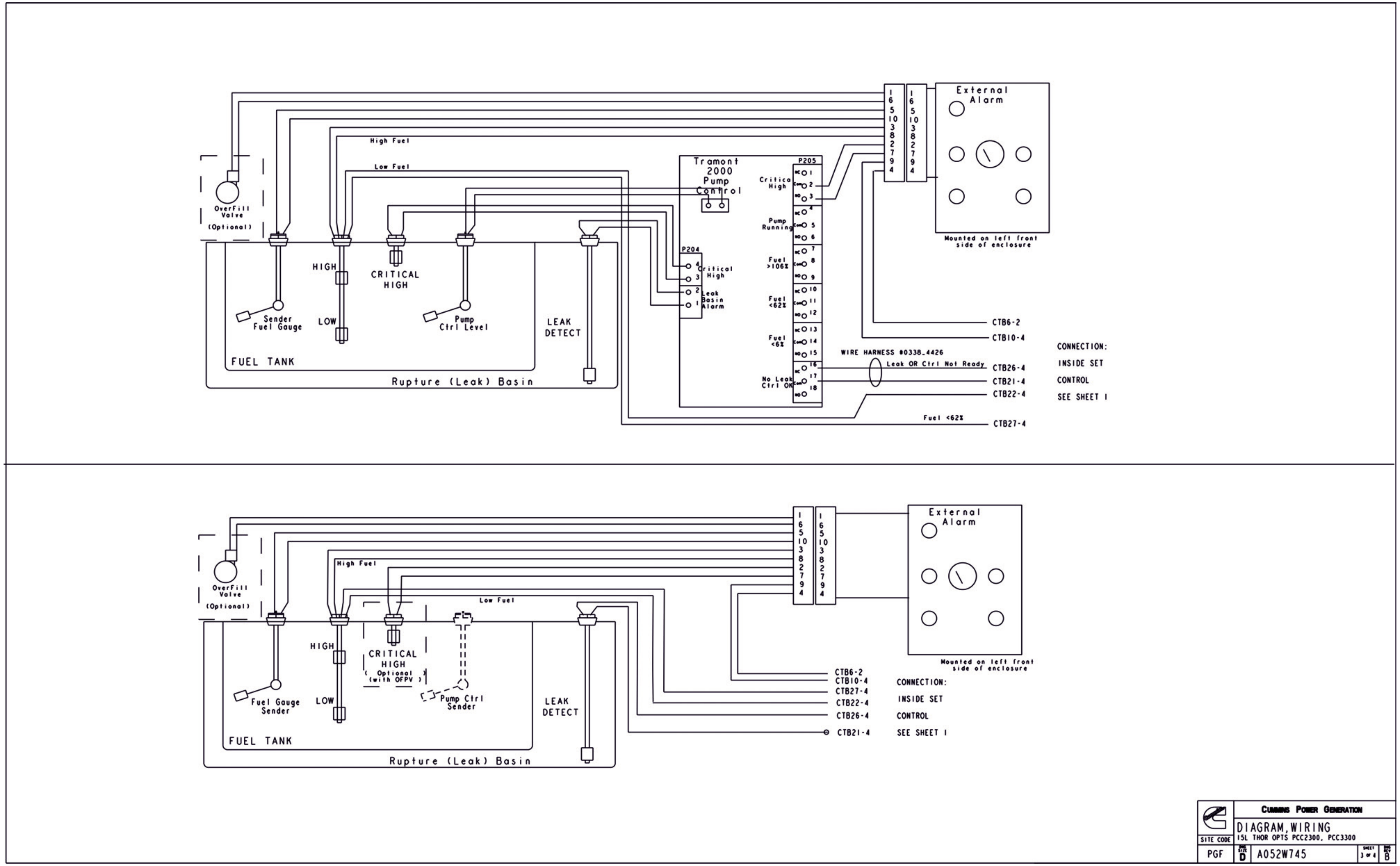
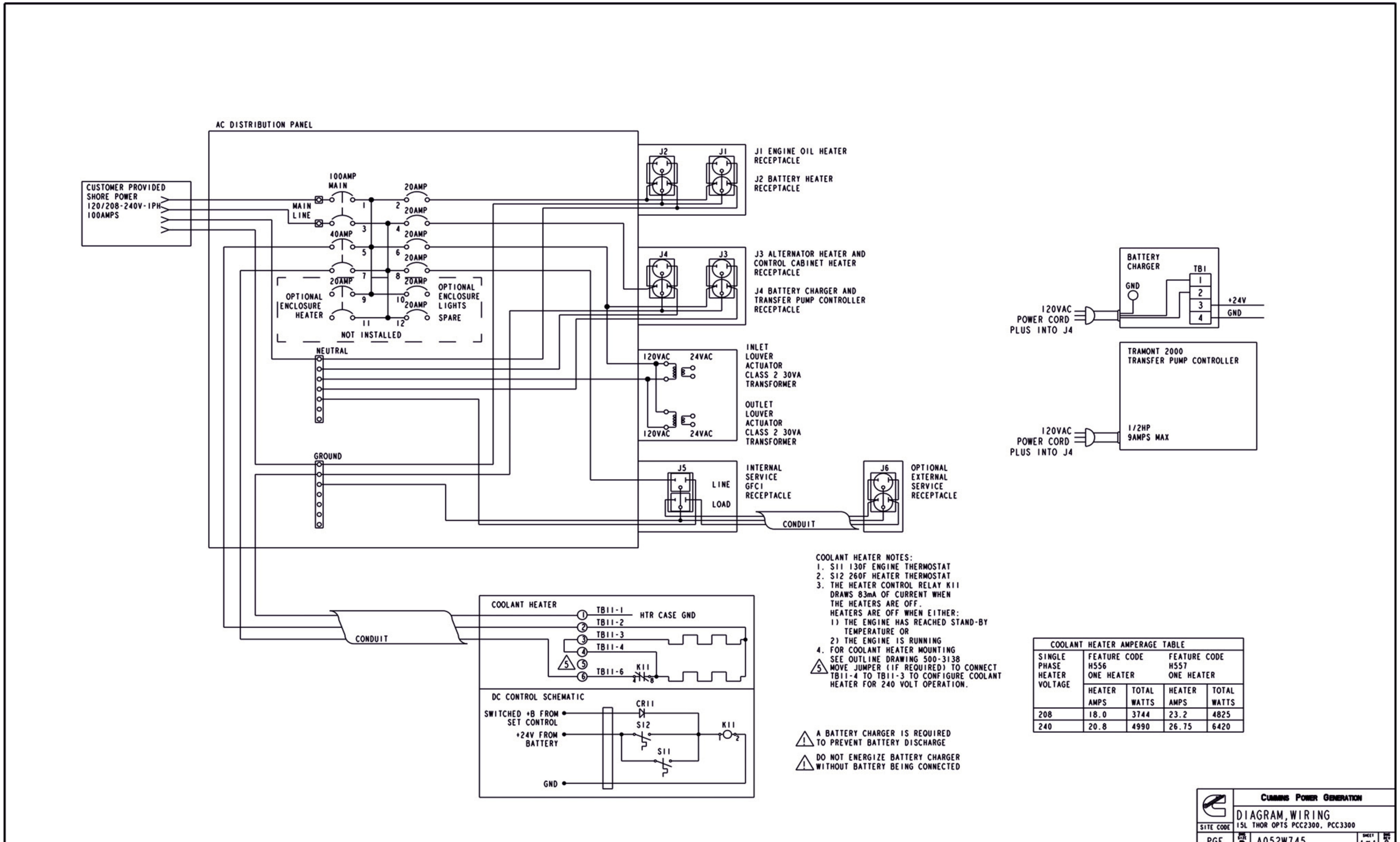


FIGURE 69. FUEL TANK EXTERNAL ALARM



COOLANT HEATER AMPERAGE TABLE

SINGLE PHASE HEATER VOLTAGE	FEATURE CODE H556 ONE HEATER		FEATURE CODE H557 ONE HEATER	
	HEATER AMPS	TOTAL WATTS	HEATER AMPS	TOTAL WATTS
208	18.0	3744	23.2	4825
240	20.8	4990	26.75	6420

FIGURE 70. AC DISTRIBUTION PANEL WITH OPTIONS

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Appendix D. Wiring Harnesses

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

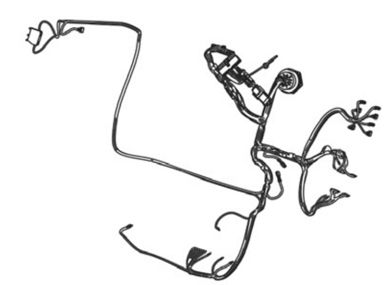
D.1 DFEJ DFEK Wiring Harness

TO/FROM TABLE

WIRE NAME	FROM	PIN	TO	PIN	WIRE	LENGTH (REFERENCE ONLY)	COLOR
C-20C-001	P11-17	0323-2466	SP11-1	SEE_REF_DES	A040H594	193	SHIELD
C-20C-002	P11-19	0323-2466	SP13-1	SEE_REF_DES	A040H594	193	BLACK
C-20C-003	P11-20	0323-2466	SP12-1	SEE_REF_DES	A040H594	193	WHITE
C-21C-001	SP11-2	SEE_REF_DES	J60-6	A034P515	A040H594	255	SHIELD
C-21C-002	SP13-2	SEE_REF_DES	J60-3	0323-1491	A040H594	255	BLACK
C-21C-003	SP12-2	SEE_REF_DES	J60-1	0323-1491	A040H594	255	WHITE
△16 C-25C-001	SP11-1	SEE_REF_DES	C-25	NONE	A040H594	126	SHIELD
C-25C-002	SP13-1	SEE_REF_DES	P50-B	0323-2513	A040H594	126	BLACK
C-25C-003	SP12-1	SEE_REF_DES	P50-A	0323-2513	A040H594	126	WHITE
W-019	SP15-2	SEE_REF_DES	F04-2	SEE_REF_DES	0334-0759	587	WHITE
W-053	SP18-2	SEE_REF_DES	CTB11-2	SEE_REF_DES	0334-0757	246	WHITE
W-055	F03-1	SEE_REF_DES	SP17-1	SEE_REF_DES	0334-0759	105	WHITE
W-056	F04-1	SEE_REF_DES	SP17-1	SEE_REF_DES	0334-0759	111	WHITE
W-058	F05-1	SEE_REF_DES	SP17-1	SEE_REF_DES	0334-0757	118	WHITE
W-059	P20-9	0323-2466	SP15-1	SEE_REF_DES	0334-0757	95	WHITE
W-060	P20-10	0323-2466	SP15-1	SEE_REF_DES	0334-0757	101	WHITE
W-061	P20-20	0323-2466	SP15-1	SEE_REF_DES	0334-0757	98	WHITE
W-062	SP15-1	SEE_REF_DES	P20-21	0323-2466	0334-0757	99	WHITE
W-064	F07-1	SEE_REF_DES	SP17-1	SEE_REF_DES	0334-0759	111	WHITE
W-065	P20-13	0323-2466	ESTOP-LOCAL-A1	SEE_REF_DES	0334-0757	1768	WHITE
W-072	K4-6	SEE_REF_DES	P20-15	0323-2466	0334-0757	784	WHITE
W-073	K5-6	SEE_REF_DES	P20-3	0323-2466	0334-0757	773	WHITE
W-075	P20-4	0323-2466	SP14-2	SEE_REF_DES	0334-0757	100	WHITE
W-076	P20-7	0323-2466	SP14-2	SEE_REF_DES	0334-0757	101	WHITE
W-077	P20-12	0323-2466	SP14-2	SEE_REF_DES	0334-0757	106	WHITE
W-078	P20-1	0323-2466	SP14-2	SEE_REF_DES	0334-0757	113	WHITE
W-080	K15,14	SEE_REF_DES	J60-9	0323-1491	0334-0757	490	WHITE
W-082	SP14-1	SEE_REF_DES	J60-12	0323-1838	0334-0760	327	WHITE
W-085	SP14-1	SEE_REF_DES	J60-14	0323-1838	0334-0760	326	WHITE
W-092	F07-2	SEE_REF_DES	K5-1	SEE_REF_DES	0334-0759	563	WHITE
W-094	K15,11	SEE_REF_DES	F05-2	SEE_REF_DES	0334-0757	409	WHITE
W-096	SP14-1	SEE_REF_DES	J60-16	0323-1838	0334-0760	322	WHITE
W-097	P6	SEE_REF_DES	F03-2	SEE_REF_DES	0334-0759	1704	WHITE
W-098	SP17-2	SEE_REF_DES	J60-8	0323-1838	0334-0760	423	WHITE
W-099	SP17-2	SEE_REF_DES	J60-10	0323-1838	0334-0760	432	WHITE
W-100	SP17-2	SEE_REF_DES	J60-18	0323-1838	0334-0760	429	WHITE
W-104	K15,A2	SEE_REF_DES	P11-21	0323-2466	0334-0757	698	WHITE
W-127	CTB2-3	SEE_REF_DES	F02-2	SEE_REF_DES	0334-0759	801	WHITE
W-128	SP18-2	SEE_REF_DES	CTB7-3	SEE_REF_DES	0334-0757	368	WHITE
W-129	SP16-2	SEE_REF_DES	CTB13-3	SEE_REF_DES	0334-0757	577	WHITE
W-131	P20-8	0323-2466	CTB15-3	SEE_REF_DES	0334-0757	860	WHITE
W-163	P20-19	0323-2466	CTB16-3	SEE_REF_DES	0334-0757	846	WHITE
W-164	P20-6	0323-2466	CTB17-3	SEE_REF_DES	0334-0757	858	WHITE
W-165	P20-18	0323-2466	CTB18-3	SEE_REF_DES	0334-0757	850	WHITE
W-166	P20-5	0323-2466	CTB19-3	SEE_REF_DES	0334-0757	842	WHITE
W-182	SP18-2	SEE_REF_DES	J16	SEE_REF_DES	0334-0759	141	WHITE
W-183	P20-17	0323-2466	CTB20-3	SEE_REF_DES	0334-0757	853	WHITE
W-190	CTB50-3	SEE_REF_DES	ESTOP-LOCAL-A2	SEE_REF_DES	0334-0757	1849	WHITE
W-203	CTB51-3	SEE_REF_DES	SP34-1	SEE_REF_DES	0334-0757	740	WHITE
W-221	SP17-1	SEE_REF_DES	F02-1	SEE_REF_DES	0334-0759	107	WHITE
W-224	SP34-2	SEE_REF_DES	K5-5	SEE_REF_DES	0334-0757	338	WHITE
W-227	SP34-2	SEE_REF_DES	K4-5	SEE_REF_DES	0334-0757	347	WHITE
W-228	SP34-2	SEE_REF_DES	K15,A1	SEE_REF_DES	0334-0757	245	WHITE
W-230	SP17-2	SEE_REF_DES	K4-1	SEE_REF_DES	0334-0758	404	WHITE
W-231	K4-4	SEE_REF_DES	J60-19	0323-1491	0334-0758	648	WHITE
W-242	GND-1	SEE_REF_DES	SP14-1	SEE_REF_DES	0334-0757	206	WHITE
W-246	SP16-2	SEE_REF_DES	J60-13	0323-1491	0334-0757	285	WHITE
W-334	SP16-2	SEE_REF_DES	J14-P	SEE_REF_DES	0334-0759	97	WHITE
W-366	P20-2	0323-2466	SP14-2	SEE_REF_DES	0334-0757	97	WHITE
W-368	SP14-1	SEE_REF_DES	SP18-1	SEE_REF_DES	0334-0759	293	WHITE
W-410	K5-4	SEE_REF_DES	SP16-1	SEE_REF_DES	0334-0759	375	WHITE

REFERENCE DESIGNATORS

REF_DES	PART NUMBER	DESCRIPTION
CTB11-2	A034V373	TERMINAL,PIN
CTB13-3	A034V373	TERMINAL,PIN
CTB15-3	A034V373	TERMINAL,PIN
CTB16-3	A034V373	TERMINAL,PIN
CTB17-3	A034V373	TERMINAL,PIN
CTB18-3	A034V373	TERMINAL,PIN
CTB19-3	A034V373	TERMINAL,PIN
CTB2-3	A034U836	TERMINAL,PIN
CTB20-3	A034V373	TERMINAL,PIN
CTB50-3	A034V373	TERMINAL,PIN
CTB51-3	A034V373	TERMINAL,PIN
CTB7-3	A034V373	TERMINAL,PIN
ESTOP-LOCAL-A1	A034V373	TERMINAL,PIN
ESTOP-LOCAL-A2	A034V373	TERMINAL,PIN
F02-1	A034U836	TERMINAL,PIN
F02-2	A034U836	TERMINAL,PIN
F03-1	A034U836	TERMINAL,PIN
F03-2	A034U836	TERMINAL,PIN
F04-1	A034U836	TERMINAL,PIN
F04-2	A034U836	TERMINAL,PIN
F05-1	A034V373	TERMINAL,PIN
F05-2	A034V373	TERMINAL,PIN
F07-1	A034U836	TERMINAL,PIN
F07-2	A034U836	TERMINAL,PIN
GND-1	0332_0804	TERMINAL,RING
J14-P	0332_1993	TERMINAL-RECEPTACLE
J16	0332_1993	TERMINAL-RECEPTACLE
J60	A040V771	CONNECTOR,RECEPTACLE
K15,11	A034V373	TERMINAL,PIN
K15,14	A034V373	TERMINAL,PIN
K15,A1	A034V373	TERMINAL,PIN
K15,A2	A034V373	TERMINAL,PIN
K4-1	0332_1993	TERMINAL-RECEPTACLE
K4-4	0332_1993	TERMINAL-RECEPTACLE
K4-5	0332_1992	TERMINAL-RECEPTACLE
K4-6	0332_1992	TERMINAL-RECEPTACLE
K5-1	0332_1993	TERMINAL-RECEPTACLE
K5-4	0332_1993	TERMINAL-RECEPTACLE
K5-5	0332_1992	TERMINAL-RECEPTACLE
K5-6	0332_1992	TERMINAL-RECEPTACLE
P11	0323_2161	PLUG,PIN
P20	0323_2446	CONNECTOR,PLUG
P50	0323_2514	CONNECTOR,PLUG
P6	0332_1993	TERMINAL-RECEPTACLE
SP11	0332_3058	SPLICE,BUTT
SP12	0332_4173	SPLICE-BUTT
SP13	0332_3058	SPLICE,BUTT
SP14	0332_0386	CONNECTOR, PARALLEL
SP15	0332_0417	CONNECTOR,PARALLEL
SP16	0332_0417	CONNECTOR,PARALLEL
SP17	0332_0386	CONNECTOR, PARALLEL
SP18	0332_0417	CONNECTOR,PARALLEL
SP34	0332_0417	CONNECTOR,PARALLEL
	0898_1337_06	HEATSHRINK



NOTES:

1. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER (CATEGORY ZPFW2). PACKAGING OR PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.
2. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.
3. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.
4. POINT TO POINT CONTINUITY TESTING SHALL BE PERFORMED ON THIS HARNESS ASSEMBLY.
5. HARNESS SHALL BE SHIPPED IN A PLASTIC BAG.

△6 ATTACH A MASTER HARNESS LABEL WITH THE FOLLOWING INFORMATION: CUMMINS PART NUMBER, CUMMINS PART REVISION LEVEL, MANUFACTURER'S NAME, MANUFACTURER'S LOCATION, AND MANUFACTURER'S DATE OF MANUFACTURE.

7. ALL WIRES TO BE HOT STAMPED WITH BOTH STATION NUMBERS LISTED IN THE TABULATION. MARKING SHALL APPEAR AT A MAXIMUM OF 75mm FROM EACH END AND EVERY 305mm.
8. APPLY TIE WRAP 0332-3388 ALONG ALL PORTIONS OF HARNESS AT A MAXIMUM OF 100mm INTERVALS.
9. APPLY TIE WRAP 0332-3388 SO AS TO MAINTAIN BREAKOUTS IN THEIR INTENDED LOCATIONS.
10. NOTE! UNLESS OTHERWISE INDICATED, ALL SPLICES HAVE CONNECTIONS AT BOTH ENDS.
11. COVER ALL SPLICES WITH THE THE APPROPRIATE SHRINK WRAP.
12. COVER ALL CABLE CONDUCTORS WITH THE APPROPRIATE SHRINK WRAP. UL APPROVED CLEAR TUBING MAY BE USED TO COVER DRAIN WIRES.
13. IF A VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANTITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.
14. (NOTE REMOVED)

△15 SPLICES SHALL BE STAGGERED TO AVOID EXCESSIVE BULGING.

△16 FOR WIRE C-25C-001, "TO" SHOULD BE P50 CUTOFF.

-THIS IS A CONTROLLED ITEM-
PER CPG PROCEDURE FRE-1002

RESPONSIBLE CIA ROLE STATIONARY GENSET CIA

TABULATION	
UNSPECIFIED TOLERANCES	
< 600	±6.25
600 - 1500	±9.5
> 1500	±12.5

CUMMINS POWER GENERATION
HARNESS,ENGINE
INTERNAL
SITE CODE PGF
SIZE E
A049F325
SHEET 1 OF 2
REV E

FIGURE 71. A049F325 ENGINE HARNESS (SHEET 1)

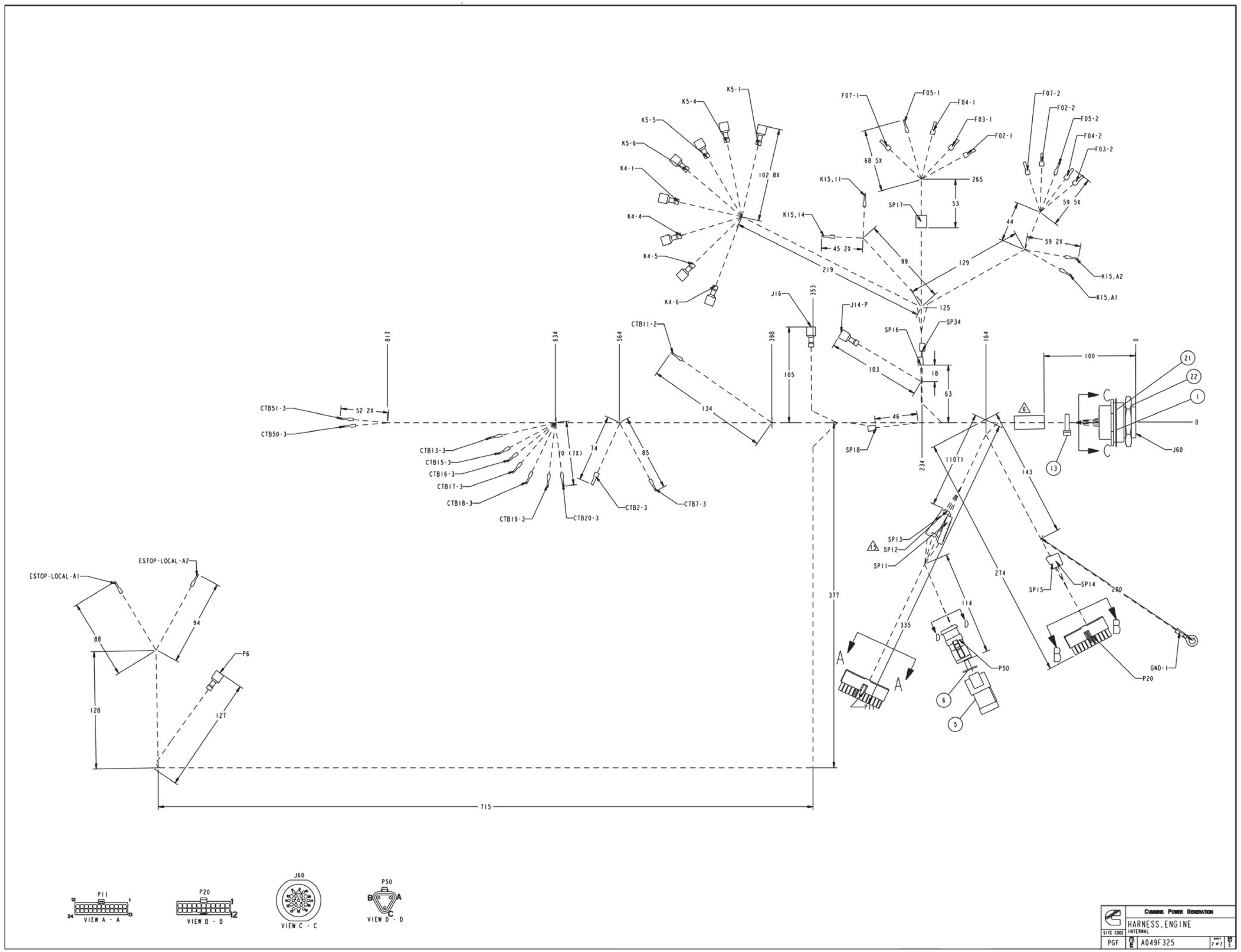


FIGURE 72. A049F325 ENGINE HARNESS (SHEET 2)

TO/FROM TABLE

WIRE NAME	FROM	TERMINAL	TO	TERMINAL	WIRE	WIRE LENGTH (REF ONLY -MM)	WIRE COLOR
W-020 △17	P12-6	0323-1200	J21-2	A043U972	0334_0757	519	WHITE
W-021 △18	P12-5	0323-1200	J21-4	A043U972	0334_0757	522	WHITE
W-022 △19	P12-4	0323-1200	J21-6	A043U972	0334_0757	520	WHITE
W-024	P22-1	A034V373	J21-7	A043U972	0334_0757	482	WHITE
W-027	P22-2	A034V373	J21-8	A043U972	0334_0757	472	WHITE
W-030	P22-3	A034V373	J21-9	A043U972	0334_0757	465	WHITE
W-032	P18-2	0323-1200	F10B-1	SEE_REF_DES	0334_0758	710	WHITE
W-033	P18-1	0323-1200	F10A-1	SEE_REF_DES	0334_0758	701	WHITE
W-034	P18-3	0323-1200	J21-13	A043U972	0334_0758	531	WHITE
W-041	F10A-2	SEE_REF_DES	J21-11	A043U972	0334_0758	652	WHITE
W-042	P17-2	0323-1200	J21-15	A043U972	0334_0757	507	WHITE
W-043	P17-1	0323-1200	J21-14	A043U972	0334_0757	510	WHITE
W-054	J21-12	A043U972	F10B-2	SEE_REF_DES	0334_0758	647	WHITE
W-358	P22-4	A034V373	J21-10	A043U972	0334_0757	471	WHITE
W-361 △17	P12-3	0323-1200	J21-1	A043U972	0334_0757	511	WHITE
W-362 △18	P12-2	0323-1200	J21-3	A043U972	0334_0757	544	WHITE
W-364 △19	P12-1	0323-1200	J21-5	A043U972	0334_0757	524	WHITE

Reference Designators

REF_DES	PART NUMBER	DESCRIPTION
F10A-1	A030B219	TERMINAL,PIN
F10A-2	A030B219	TERMINAL,PIN
F10B-1	A030B219	TERMINAL,PIN
F10B-2	A030B219	TERMINAL,PIN
J21	A048Y021	CONNECTOR,RECEPTACLE
P12	0323_1932	PLUG,PIN
P17	0323_2098	CONNECTOR,PLUG
P18	0323_2444	CONNECTOR,PLUG
P22	0323_2226_03	CONNECTOR,PLUG

NOTES:

1. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER (CATEGORY ZPFW2). PACKAGING OR PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.
2. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.
3. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.
4. POINT TO POINT CONTINUITY TESTING SHALL BE PERFORMED ON THIS HARNESS ASSEMBLY.
5. HARNESS SHALL BE SHIPPED IN A PLASTIC BAG.

△6 ATTACH A MASTER HARNESS LABEL WITH THE FOLLOWING INFORMATION: CUMMINS PART NUMBER, CUMMINS PART REVISION LEVEL, MANUFACTURER'S NAME, MANUFACTURER'S LOCATION, AND MANUFACTURER'S DATE OF MANUFACTURE.

7. ALL WIRES TO BE HOT STAMPED WITH BOTH STATION NUMBERS LISTED IN THE TABULATION. MARKING SHALL APPEAR AT A MAXIMUM OF 75mm FROM EACH END AND EVERY 305mm.
8. APPLY TIE WRAP 0332-3388 ALONG ALL PORTIONS OF HARNESS AT A MAXIMUM OF 100mm INTERVALS.
9. APPLY TIE WRAP 0332-3388 SO AS TO MAINTAIN BREAKOUTS IN THEIR INTENDED LOCATIONS.
11. NOTE! UNLESS OTHERWISE INDICATED, ALL SPLICES HAVE CONNECTIONS AT BOTH ENDS.
12. COVER ALL SPLICES WITH THE THE APPROPRIATE SHRINK WRAP.
13. (NOTE REMOVED)
14. IF A VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANTITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.

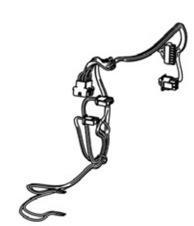
△15 TORQUE: .6-.8 Nm.

16. TWISTED PAIRS SHALL HAVE 5 OR MORE 360° TWISTS FOR EVERY 300mm OF LENGTH.

△17 TWISTED PAIR 1: W-361,W020

△18 TWISTED PAIR 2: W-362,W021

△19 TWISTED PAIR 3: W-364,W022



-THIS IS A CONTROLLED ITEM-
PER POLICY-PROCEDURE PGG 1-01-01-116

TO MAINTAIN COMPLIANCE WITH REQUIREMENTS OF THE CODES, STANDARDS, OR AGENCIES LISTED BELOW

[X] CSA [X] UL [ ] CE [ ] RVIA [ ] ABYC
[ ] IBC [ ] OTHER ______ [ ] OTHER ______

CHANGES, DEVIATIONS, OR SUBSTITUTIONS OF MATERIAL, PROCESS, OR PERFORMANCE FOR THIS ITEM MUST BE APPROVED BY THE FOLLOWING CONTROLLED ITEM APPROVER

RESPONSIBLE CIA ROLE STATIONARY GENSET CIA
RESPONSIBLE CIA ROLE ______
RESPONSIBLE CIA ROLE ______

TABULATION	
UNSPECIFIED TOLERANCES	
< 600	±6.25
600 - 1500	±9.5
> 1500	±12.5

CUMMINS POWER GENERATION
HARNESS,ALTERNATOR
INTERNAL
SITE CODE PGF | DWG SIZE D | A049F329 | SHEET 1 OF 2 | DWG REV E

FIGURE 73. A049F329 ALTERNATOR HARNESS (SHEET 1)

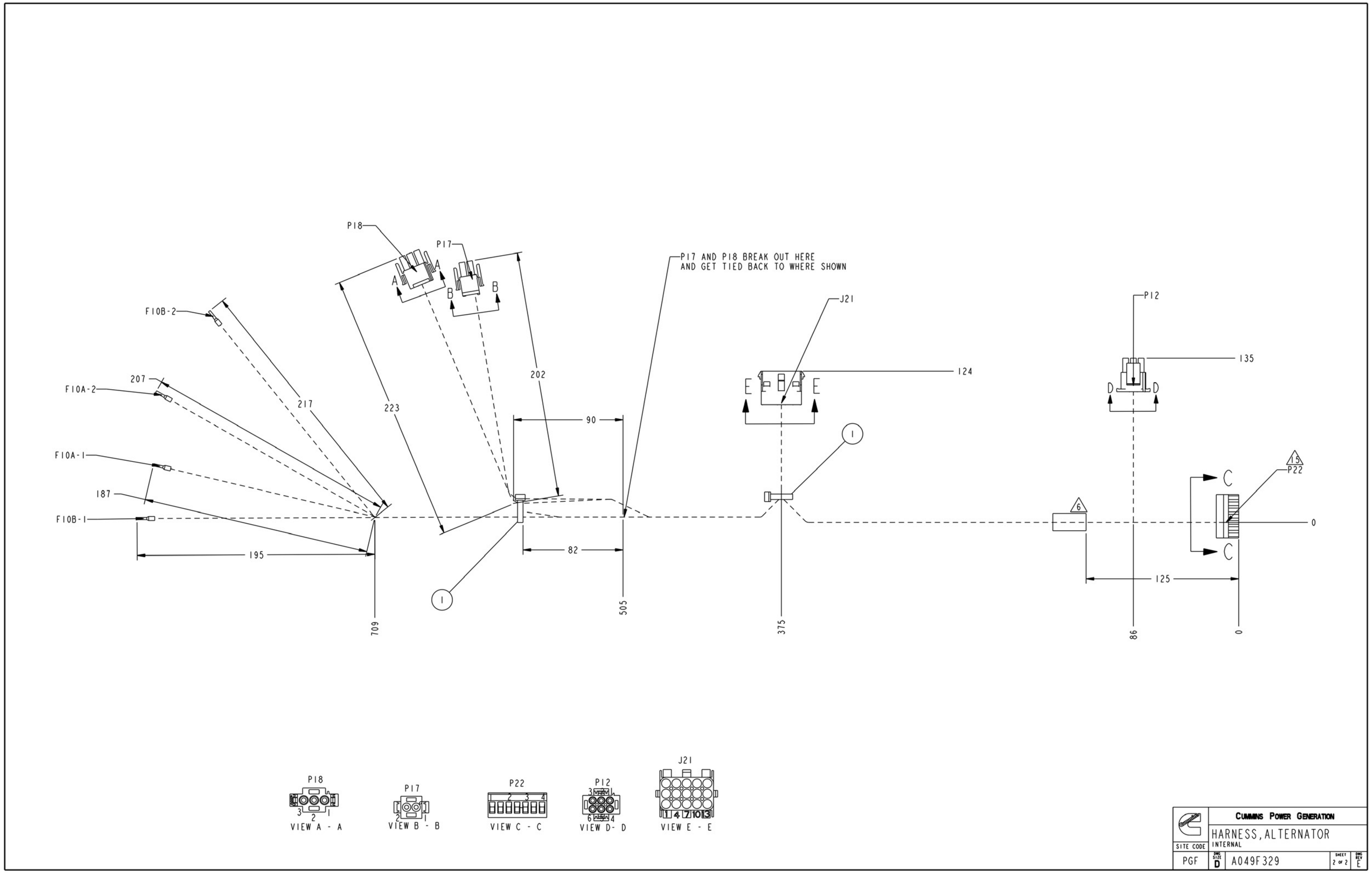


FIGURE 74. A049F329 ALTERNATOR HARNESS (SHEET 2)

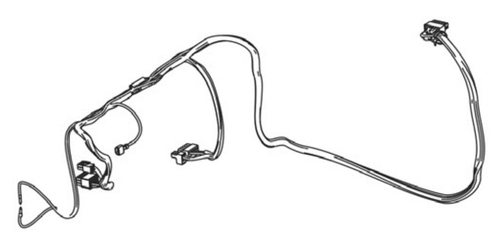
TO/FROM TABLE

WIRE NAME	FROM	TERMINAL	TO	TERMINAL	WIRE	WIRE LENGTH (REF ONLY -MM)	WIRE COLOR
C-3C-001	SP3-2	SEE_REF_DES	~~P1-114-5~~		A040H594	328	SHIELD
C-3C-002	SP4-2	SEE_REF_DES	P1-114-4	A034V373	A040H594	328	BLACK
C-3C-003	SP5-2	SEE_REF_DES	P1-114-3	A034V373	A040H594	328	WHITE
C-4C-001	~~SP5-2~~		SP3-1	SEE_REF_DES	A040H594	330	SHIELD
C-4C-002	P29-320-2	0323-2466	SP4-1	SEE_REF_DES	A040H594	330	BLACK
C-4C-003	P29-320-1	0323-2466	SP5-1	SEE_REF_DES	A040H594	330	WHITE
C-10C-001	SP3-2	SEE_REF_DES	P25-9	0323-2466	A040H594	1139	SHIELD
C-10C-002	SP4-2	SEE_REF_DES	P25-3	0323-2466	A040H594	1139	BLACK
C-10C-003	SP5-2	SEE_REF_DES	P25-4	0323-2466	A040H594	1139	WHITE
W-001	P28-320-1	0323-2466	SP1-1	SEE_REF_DES	0334_0757	268	WHITE
W-004	P28-320-3	0323-2466	SP2-1	SEE_REF_DES	0334_0757	201	WHITE
W-005	P25-8	0323-2466	SP2-2	SEE_REF_DES	0334_0757	1256	WHITE
W-006	P6-114-2	A034V373	SP2-2	SEE_REF_DES	0334_0757	461	WHITE
W-007	P25-10	0323-2466	P29-320-6	0323-2466	0334_0757	1474	WHITE
W-008	P25-11	0323-2466	P29-320-4	0323-2466	0334_0757	1493	WHITE
W-010	P29-320-3	0323-2466	SP6-1	SEE_REF_DES	0334_0757	326	WHITE
W-011	P25-5	0323-2466	SP6-2	SEE_REF_DES	0334_0757	1129	WHITE
W-017	J6	SEE_REF_DES	SP1-2	SEE_REF_DES	0334_0758	104	WHITE
W-205	P6-114-1	A034V373	SP1-2	SEE_REF_DES	0334_0757	426	WHITE
W-225	P25-6	0323-2466	ESTOP-B-2	SEE_REF_DES	0334_0757	1673	WHITE
W-226	P25-2	0323-2466	ESTOP-B-1	SEE_REF_DES	0334_0757	1665	WHITE
W-245	SP6-2	SEE_REF_DES	P1-114-5	A034V373	0334_0757	318	WHITE

REFERENCE DESIGNATORS		
REF_DES	PART NUMBER	DESCRIPTION
ESTOP-B-1	A034V373	TERMINAL,PIN
ESTOP-B-2	A034V373	TERMINAL,PIN
J6	0332_2431	TERMINAL-BLADE
P1-114	0323_2192_04	CONNECTOR,PLUG
P25	0323_2445	CONNECTOR,PLUG
P28-320	0323_2091	CONNECTOR,PLUG
P29-320	0323_2456	CONNECTOR,PLUG
P6-114	0323_2192_01	CONNECTOR,PLUG
SP1	0332_0417	CONNECTOR,PARALLEL
SP2	0332_0430	SPLICE-BUTT
SP3	0332_4173	SPLICE-BUTT
SP4	0332_3058	SPLICE,BUTT
SP5	0332_3058	SPLICE,BUTT
SP6	0332_0430	SPLICE-BUTT

NOTES

1. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER (CATEGORY ZPFW2). PACKAGING OR PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.
2. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.
3. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.
4. POINT TO POINT CONTINUITY TESTING SHALL BE PERFORMED ON THIS HARNESS ASSEMBLY.
5. HARNESS SHALL BE SHIPPED IN A PLASTIC BAG.
6. ATTACH A MASTER HARNESS LABEL WITH THE FOLLOWING INFORMATION: CUMMINS PART NUMBER, CUMMINS PART REVISION LEVEL, MANUFACTURER'S NAME, MANUFACTURER'S LOCATION, AND MANUFACTURER'S DATE OF MANUFACTURE.
7. ALL WIRES TO BE HOT STAMPED WITH BOTH STATION NUMBERS LISTED IN THE TABULATION. MARKING SHALL APPEAR AT A MAXIMUM OF 75mm FROM EACH END AND EVERY 305mm.
8. APPLY TIE WRAP 0332-3388 ALONG ALL PORTIONS OF HARNESS AT A MAXIMUM OF 100mm INTERVALS.
9. APPLY TIE WRAP 0332-3388 SO AS TO MAINTAIN BREAKOUTS IN THEIR INTENDED LOCATIONS.
10. NOTE! UNLESS OTHERWISE INDICATED, ALL SPLICES HAVE CONNECTIONS AT BOTH ENDS.
11. COVER ALL SPLICES WITH THE APPROPRIATE SHRINK WRAP.
12. COVER ALL CABLE CONDUCTORS WITH THE APPROPRIATE SHRINK WRAP. UL APPROVED CLEAR TUBING MAY BE USED FOR DRAIN WIRES.
13. IF A VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANTITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.
14. STAGGER SPLICES TO AVOID EXCESSIVE BULGING.
15. TORQUE TERMINAL BLOCK SCREWS TO .5-.6 Nm



-THIS IS A CONTROLLED ITEM-

RESPONSIBLE CIA ROLE STATIONARY GENSET CIA

TABULATION	
UNSPECIFIED TOLERANCES	
< 600	±6.25
600 - 1500	±9.5
> 1500	±12.5

CUMMINS POWER GENERATION

HARNESS, INTERFACE

HMI

SITE CODE PGF E A049F334 SHEET 1 OF 2 F

FIGURE 75. A049F344 RELAY HARNESS (SHEET 1)

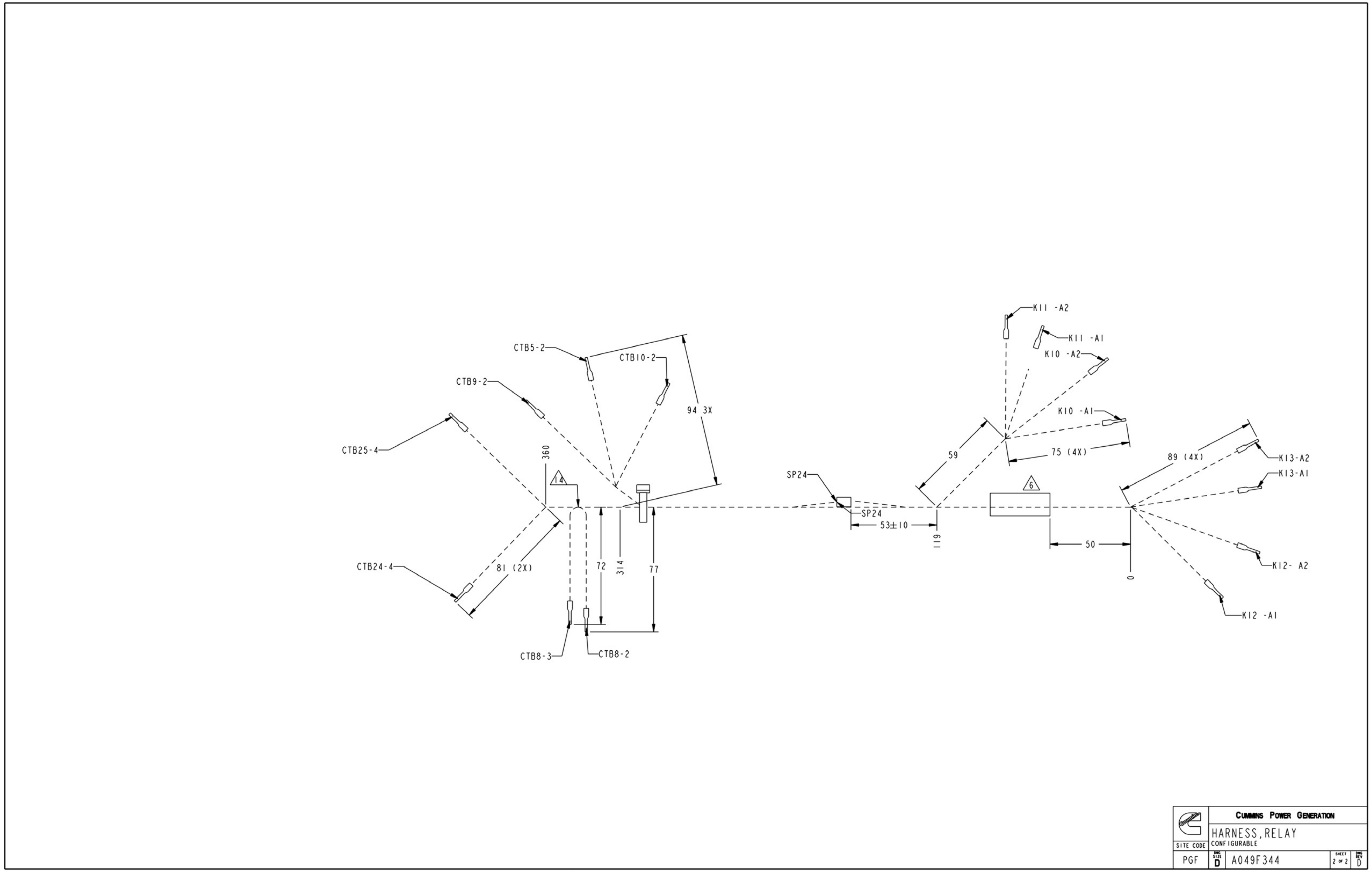


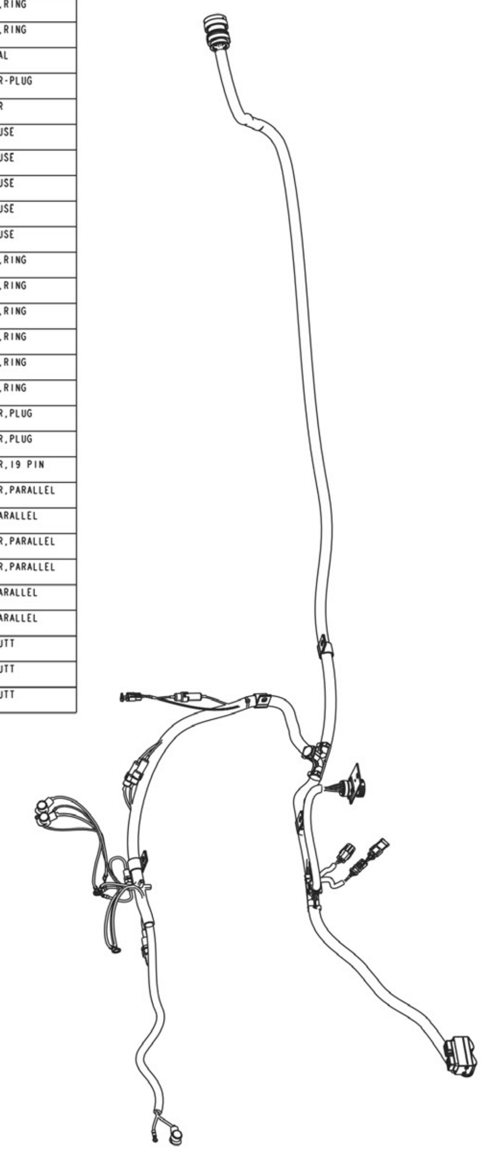
FIGURE 76. A049F344 RELAY HARNESS (SHEET 2)

TO/FROM TABLE

WIRE NAME	FROM	TERMINAL	TO	TERMINAL	WIRE	WIRE LENGTH (REF ONLY -MM)	WIRE COLOR
C-001				SEE_REF_DES	A040H594	423	SHIELD
C-16C-002	P51-B	0323-2513	SP9-2	SEE_REF_DES	A040H594	423	BLACK
C-16C-003	P51-A	0323-2513	SP8-2	SEE_REF_DES	A040H594	423	WHITE
C-17C-001	C05-E	0323-1491	SP7-2	SEE_REF_DES	A040H594	489	SHIELD
C-17C-002	C05-D	0323-1491	SP9-2	SEE_REF_DES	A040H594	489	BLACK
C-17C-003	C05-C	0323-1491	SP8-2	SEE_REF_DES	A040H594	489	WHITE
C-18C-001	SP7-2	SEE_REF_DES	C01-36	0323-1752	A040H594	988	SHIELD
C-18C-002	SP9-2	SEE_REF_DES	C01-37	0323-1752	A040H594	988	BLACK
C-18C-003	SP8-2	SEE_REF_DES	C01-46	0323-1752	A040H594	988	WHITE
C-22C-001	P60-6	A034P512	SP7-1	SEE_REF_DES	A040H594	2421	SHIELD
C-22C-002	P60-3	0323-1492	SP9-1	SEE_REF_DES	A040H594	2421	BLACK
C-22C-003	P60-1	0323-1492	SP8-1	SEE_REF_DES	A040H594	2421	WHITE
W-044	SP28-1	SEE_REF_DES	SP31-2	SEE_REF_DES	0334_0757	1040	WHITE
W-045	SP28-1	SEE_REF_DES	SP31-2	SEE_REF_DES	0334_0757	1047	WHITE
W-050	SP10-1	SEE_REF_DES	P60-18	0323-2277	0334_0760	445	WHITE
W-057	K-CRANK(BAT	SEE_REF_DES	B1_BATT2	SEE_REF_DES	0334_0760	285	WHITE
W-069	B1_BATT3	SEE_REF_DES	F08-1	SEE_REF_DES	0334_0761	91	WHITE
W-070	F08-2	SEE_REF_DES	SP10-2	SEE_REF_DES	0334_0761	2904	WHITE
W-071	SP27-1	SEE_REF_DES	P60-14	0323-2277	0334_0760	329	WHITE
W-074	SP27-1	SEE_REF_DES	P60-12	0323-2277	0334_0760	329	WHITE
W-101	F11-2	6mm	C05-B	A045M982	0334_0759	1347	WHITE
W-102	SP29-1	SEE_REF_DES	F10-2	6mm	0334_0760	1568	WHITE
W-135	C01-17	0323-1752	SP29-2	SEE_REF_DES	0334_0757	297	WHITE
W-137	C01-18	0323-1752	SP29-2	SEE_REF_DES	0334_0757	300	WHITE
W-139	C01-28	0323-1752	SP29-2	SEE_REF_DES	0334_0757	292	WHITE
W-141	C01-8	0323-1752	SP29-2	SEE_REF_DES	0334_0757	306	WHITE
W-143	C01-7	0323-1752	SP29-2	SEE_REF_DES	0334_0757	303	WHITE
W-145	SP28-2	SEE_REF_DES	C01-39	0323-1752	0334_0757	304	WHITE
W-155	C01-40	0323-1752	SP28-2	SEE_REF_DES	0334_0757	284	WHITE
W-156	C01-50	0323-1752	SP28-2	SEE_REF_DES	0334_0757	288	WHITE
W-157	C01-30	0323-1752	SP28-2	SEE_REF_DES	0334_0757	304	WHITE
W-167	C01-29	0323-1752	SP28-2	SEE_REF_DES	0334_0757	295	WHITE
W-170	C05-A	0323-1491	SP28-1	SEE_REF_DES	0334_0757	863	WHITE
W-172	SP29-1	SEE_REF_DES	C07-A	0323-1718	0334_0757	746	WHITE
W-173	SP28-1	SEE_REF_DES	C07-B	0323-1718	0334_0757	750	WHITE
W-174	C05-G	0323-1491	C01-27	0323-1752	0334_0757	1146	WHITE
W-175	C01-26	0323-1752	C05-F	0323-1491	0334_0757	1152	WHITE
W-204	SP27-2	SEE_REF_DES	SP31-2	SEE_REF_DES	0334_0760	2018	WHITE
W-217	P60-19	0323-1492	K-CRANK(S1)	SEE_REF_DES	0334_0758	3454	WHITE
W-218	B1_GND2	SEE_REF_DES	K-CRANK(S2)	SEE_REF_DES	0334_0758	444	WHITE
W-229	K-CRANK(SW)	SEE_REF_DES	B1 SW	SEE_REF_DES	0334_0760	272	WHITE
W-247	SP10-2	SEE_REF_DES	F06-2	6mm	0334_0757	2227	WHITE
W-255	SP31-1	SEE_REF_DES	P13-C	0323-1492	0334_0757	479	WHITE
W-256	P60-13	0323-1492	P13-B	0323-1492	0334_0757	2820	WHITE
W-257	F06-1	6mm	P13-A	0323-1492	0334_0757	91	WHITE
W-258	F12-2	6mm	G1_B+(1)	SEE_REF_DES	0334_0761	729	WHITE
W-259	SP22-1	SEE_REF_DES	B1_BATT4	SEE_REF_DES	0334_0760	213	WHITE
W-260	F10-1	6mm	SP22-2	SEE_REF_DES	0334_0760	113	WHITE
W-261	F11-1	6mm	SP22-2	SEE_REF_DES	0334_0759	113	WHITE
W-343	SP10-1	SEE_REF_DES	P60-8	0323-2277	0334_0760	445	WHITE
W-344	P60-10	0323-2277	SP10-1	SEE_REF_DES	0334_0760	444	WHITE
W-352	G1_GND	SEE_REF_DES	B1_GND1	SEE_REF_DES	0334_0761	1051	WHITE
W-373	B1_GND2	SEE_REF_DES	SP31-1	SEE_REF_DES	0334_0761	993	WHITE
W-406	SP27-1	SEE_REF_DES	P60-16	0323-2277	0334_0760	329	WHITE
W-407	C01-38	0323-1752	P60-9	0323-1492	0334_0757	3426	WHITE
W-409	F12-1	6mm	B1_BATT1	SEE_REF_DES	0334_0761	224	WHITE

CONNECTORS AND TERMINALS

REF_DES	PART NUMBER	DESCRIPTION
B1 SW	0332_0543	TERMINAL-SPADE
B1_BATT1	0332_1046	TERMINAL,RING
B1_BATT2	0332_1046	TERMINAL,RING
B1_BATT3	0332_1046	TERMINAL,RING
B1_BATT4	0332_1046	TERMINAL,RING
B1_GND1	0332_1046	TERMINAL,RING
B1_GND2	0332_1046	TERMINAL,RING
C01	0323_1919	RECEPTICAL
C05	0323_1920	CONNECTOR-PLUG
C07	0323_1652	CONNECTOR
F06	0321_0371	HOLDER-FUSE
F08	0321_0450	HOLDER,FUSE
F10	0321_0371	HOLDER-FUSE
F11	0321_0371	HOLDER-FUSE
F12	0321_0452	HOLDER-FUSE
G1_B+(1)	0332_3082	TERMINAL,RING
G1_GND	0332_0350	TERMINAL,RING
K-CRANK(BATT)	0332_2944	TERMINAL,RING
K-CRANK(S1)	0332_0807	TERMINAL,RING
K-CRANK(S2)	0332_0807	TERMINAL,RING
K-CRANK(SW)	0332_2944	TERMINAL,RING
P13	0323_1493	CONNECTOR,PLUG
P51	0323_2514	CONNECTOR,PLUG
P60	A040V998	CONNECTOR,19 PIN
SP10	0332_0385_03	CONNECTOR,PARALLEL
SP22	0332_0418_01	SPLICE,PARALLEL
SP27	0332_0385_03	CONNECTOR,PARALLEL
SP28	0332_0385_03	CONNECTOR,PARALLEL
SP29	0332_0418_01	SPLICE,PARALLEL
SP31	0332_0418_01	SPLICE,PARALLEL
SP7	0332_4173	SPLICE-BUTT
SP8	0332_3058	SPLICE,BUTT
SP9	0332_3058	SPLICE,BUTT



NOTES:

1. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER (CATEGORY ZPFW2). PACKAGING OR PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.
2. ATTACH A MASTER HARNESS LABEL WITH THE FOLLOWING INFORMATION: CUMMINS PART NUMBER, CUMMINS PART REVISION LEVEL, MANUFACTURER'S NAME, MANUFACTURER'S LOCATION, AND MANUFACTURER'S DATE OF MANUFACTURE.
3. ALL WIRES TO BE HOT STAMPED WITH BOTH STATION NUMBERS LISTED IN THE TABULATION. MARKING SHALL APPEAR AT THE MAXIMUM OF 75mm FROM EACH END AND EVERY 305mm.
4. ALL CONVOLUTED TUBING ENDS SHALL BE WRAPPED WITH A MINIMUM OF 2 LAYERS OF ELECTRICAL TAPE. NO TAPE ON WIRES EXITING CONVOLUTED TUBING. APPLY TIE WRAPS AS NECESSARY TO KEEP WIRES INSIDE CONVOLUTED TUBING.
5. APPLY TIE WRAP 0332-3388 SO AS TO MAINTAIN BREAKOUTS IN THEIR INTENDED LOCATIONS.
6. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.
7. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.
8. POINT TO POINT CONTINUITY TESTING SHALL BE PERFORMED ON THIS HARNESS ASSEMBLY.
9. HARNESS SHALL BE SHIPPED IN A PLASTIC BAG.
10. JUNCTIOINS/INTERSECTIONS OF CONVOLUTED TUBING WITHOUT "TEES" OR "OUTLETS" SHALL BE SECURED TOGETHER WITH ELECTRICAL TAPE. A MAXIMUM OF 2 WRAPPING LAYERS, EXPOSED WIRE IS NOT ACCEPTABLE.
11. NOTE! UNLESS OTHERWISE INDICATED, ALL SPLICES HAVE CONNECTIONS AT BOTH ENDS.
12. COVER ALL SPLICES WITH THE THE APPROPRIATE SHRINK WRAP.
13. COVER ALL CABLE CONDUCTORS WITH THE APPROPRIATE SHRINK WRAP. UL APPROVED CLEAR TUBING MAY BE USED ON DRAIN WIRES.
14. IF A VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANTITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.
15. STAGGER SPLICES TO AVOID EXCESSIVE BULGING.
16. TORQUE: 2-4 Nm

TABULATION	
UNSPECIFIED TOLERANCES	
< 600	±6.25
600 - 1500	±9.5
> 1500	±12.5

-THIS IS A CONTROLLED ITEM-

RESPONSIBLE CIA ROLE STATIONARY GENSET CIA

Cummins Power Generation

HARNESS,ENGINE

EXTERNAL

SITE CODE PGF | E | A050N355 | SHEET 1 OF 3 | H

FIGURE 77. A050N355 ENGINE HARNESS (SHEET 1)

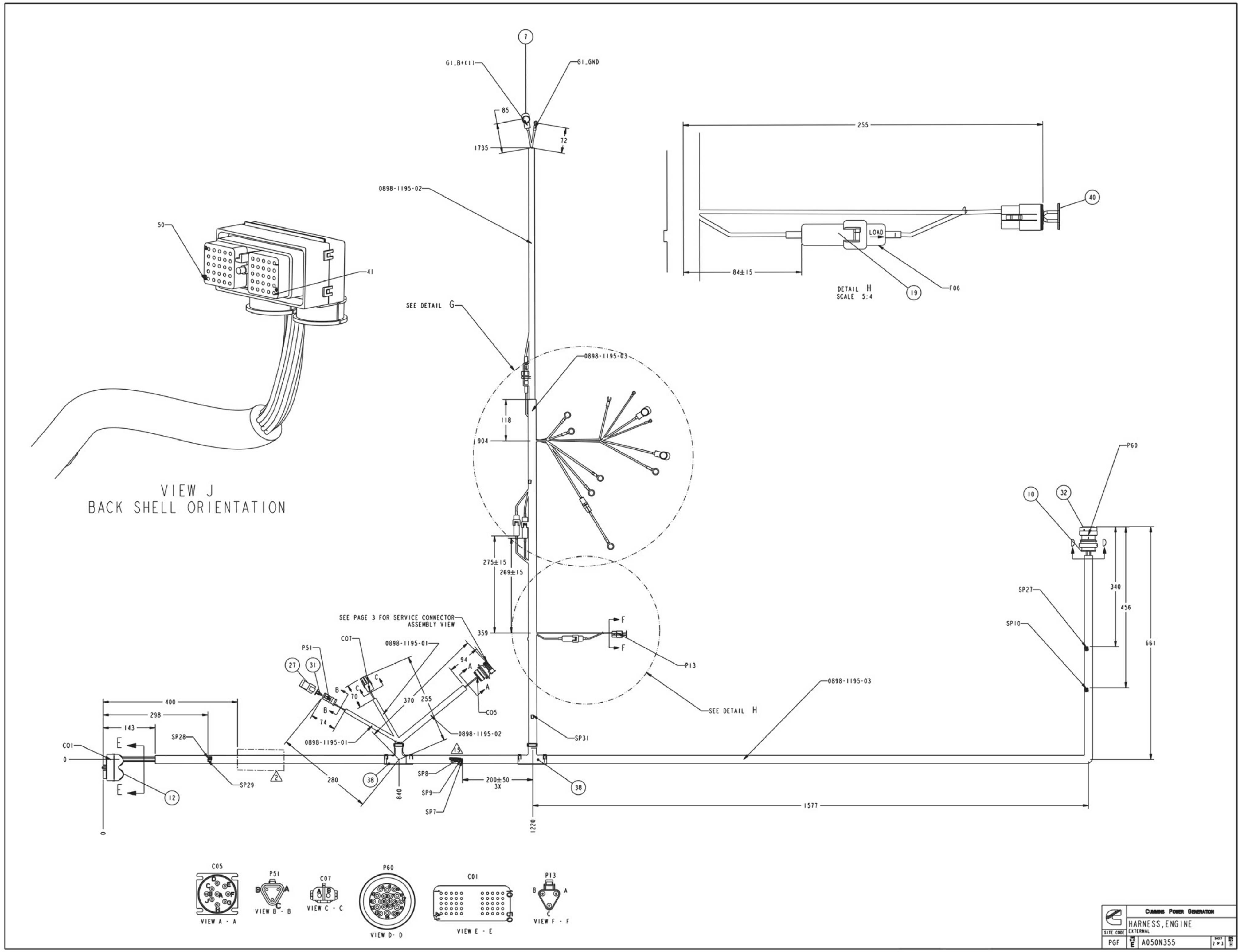


FIGURE 78. A050N355 ENGINE HARNESS (SHEET 2)

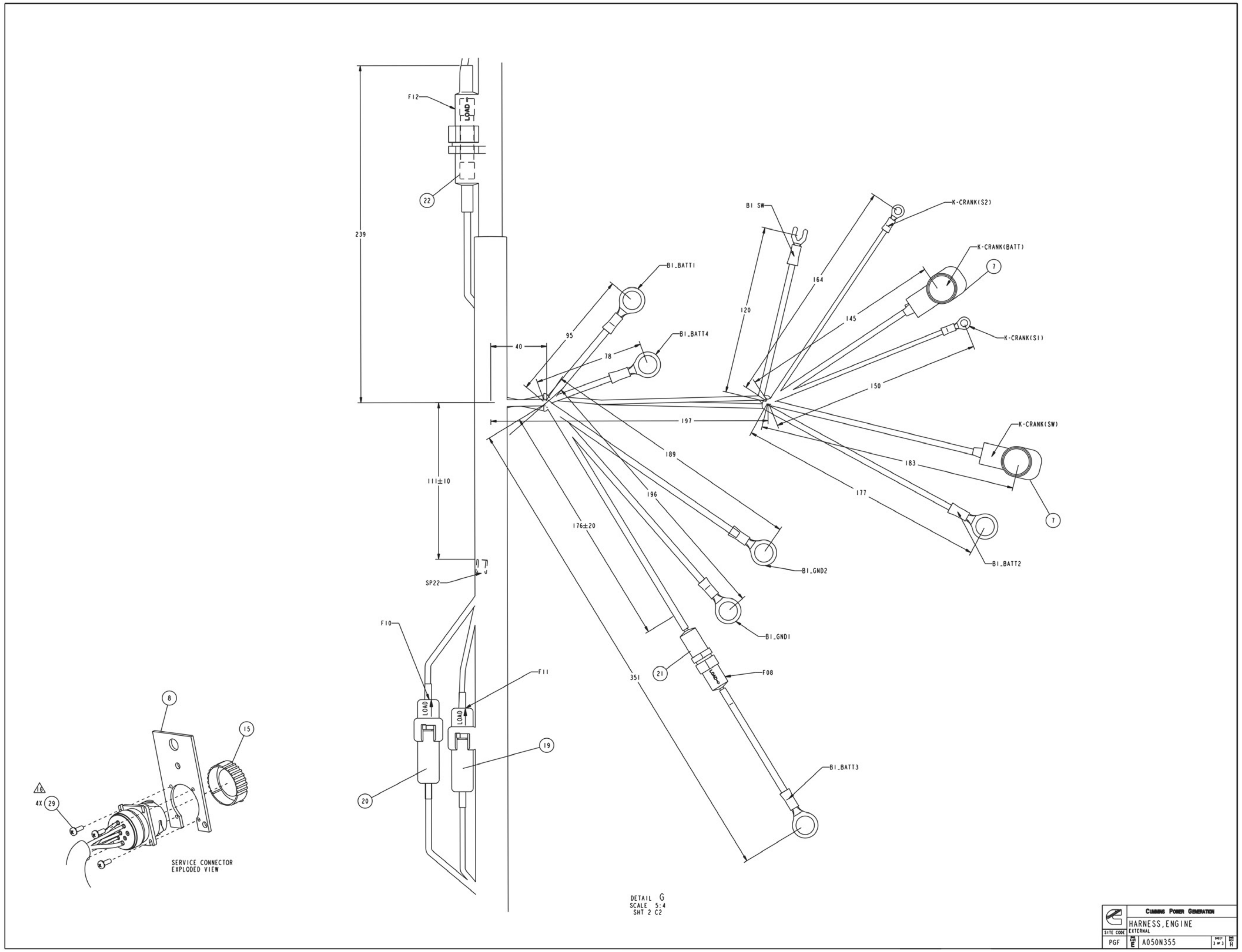


FIGURE 79. A050N355 ENGINE HARNESS (SHEET 3)

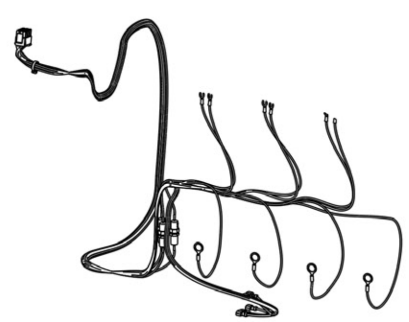
TO/FROM TABLE

WIRE NAME	FROM	TERMINAL	TO	TERMINAL	WIRE	WIRE LENGTH (REF ONLY -MM)	WIRE COLOR
W-025	F1U-1	6MM_STRIP	T-U	SEE_REF_DES	0334_0757	424	WHITE
W-028	F1V-1	6MM_STRIP	T-V	SEE_REF_DES	0334_0757	533	WHITE
W-031	F1W-1	6MM_STRIP	T-W	SEE_REF_DES	0334_0757	681	WHITE
W-046	P21-1	A040X720	CT3-1	SEE_REF_DES	0334_0757	2133	WHITE
W-047	P21-2	A040X720	CT3-2/3	SEE_REF_DES	0334_0757	2136	WHITE
W-063	P21-3	A040X720	CT2-1	SEE_REF_DES	0334_0757	2023	WHITE
W-093	P21-4	A040X720	CT2-2/3	SEE_REF_DES	0334_0757	2004	WHITE
W-171	P21-5	A040X720	CT1-1	SEE_REF_DES	0334_0757	1867	WHITE
W-262	P21-6	A040X720	CT1-2/3	SEE_REF_DES	0334_0757	1864	WHITE
W-263	P21-7	A040X720	F1U-2	6MM_STRIP	0334_0757	1465	WHITE
W-264	P21-8	A040X720	F1V-2	6MM_STRIP	0334_0757	1450	WHITE
W-265	P21-9	A040X720	F1W-2	6MM_STRIP	0334_0757	1417	WHITE
W-266	P21-11	A040X720	P2	SEE_REF_DES	0334_0758	2036	WHITE
W-267	P21-12	A040X720	P3	SEE_REF_DES	0334_0758	2042	WHITE
W-268	P21-13	A040X720	P4	SEE_REF_DES	0334_0758	2036	WHITE
W-269	P21-14	A040X720	X+F1	SEE_REF_DES	0334_0757	2020	WHITE
W-270	P21-15	A040X720	XX-F2	SEE_REF_DES	0334_0757	2088	WHITE
W-271	P21-10	A040X720	T-N	SEE_REF_DES	0334_0757	2265	WHITE

Reference Designators		
REF_DES	PART NUMBER	DESCRIPTION
CT1-1	0332_2569	TERMINAL-SPADE
CT1-2/3	0332_2569	TERMINAL-SPADE
CT2-1	0332_2569	TERMINAL-SPADE
CT2-2/3	0332_2569	TERMINAL-SPADE
CT3-1	0332_2569	TERMINAL-SPADE
CT3-2/3	0332_2569	TERMINAL-SPADE
F1U	A046B253	HOLDER,FUSE
F1V	A046B253	HOLDER,FUSE
F1W	A046B253	HOLDER,FUSE
P2	0332_2431	TERMINAL,RECEPTACLE
P21	A048Y025	CONNECTOR,PLUG
P3	0332_2431	TERMINAL,RECEPTACLE
P4	0332_2431	TERMINAL,RECEPTACLE
T-N	0332_4294	TERMINAL,RING
T-U	0332_4294	TERMINAL,RING
T-V	0332_4294	TERMINAL,RING
T-W	0332_4294	TERMINAL,RING
X+F1	0332_2430	TERMINAL,RECEPTACLE
XX-F2	0332_2430	TERMINAL,RECEPTACLE

NOTES:

1. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER (CATEGORY ZPFW2). PACKAGING OR PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.
2. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.
3. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.
4. POINT TO POINT CONTINUITY TESTING SHALL BE PERFORMED ON THIS HARNESS ASSEMBLY.
5. HARNESS SHALL BE SHIPPED IN A PLASTIC BAG.
6. ATTACH A MASTER HARNESS LABEL WITH THE FOLLOWING INFORMATION: CUMMINS PART NUMBER, CUMMINS PART REVISION LEVEL, MANUFACTURER'S NAME, MANUFACTURER'S LOCATION, AND MANUFACTURER'S DATE OF MANUFACTURE.
7. ALL WIRES TO BE HOT STAMPED WITH BOTH STATION NUMBERS LISTED IN THE TABULATION. MARKING SHALL APPEAR AT A MAXIMUM OF 75mm FROM EACH END AND EVERY 305mm.
8. APPLY TIE WRAP 0332-3388 ALONG ALL PORTIONS OF HARNESS AT A MAXIMUM OF 100mm INTERVALS.
9. APPLY TIE WRAP 0332-3388 SO AS TO MAINTAIN BREAKOUTS IN THEIR INTENDED LOCATIONS.
10. IF A VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANTITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.



TABULATION	
UNSPECIFIED TOLERANCES	
< 600	±6.25
600 - 1500	±9.5
> 1500	±12.5

-THIS IS A CONTROLLED ITEM-
PER POLICY-PROCEDURE PGG 1-01-01-116
TO MAINTAIN COMPLIANCE WITH REQUIREMENTS OF THE CODES, STANDARDS, OR AGENCIES LISTED BELOW
☒ CSA ☒ UL ☐ CE ☐ RVIA ☐ ABYC
☐ IBC ☐ OTHER ______ ☐ OTHER ______
CHANGES, DEVIATIONS, OR SUBSTITUTIONS OF MATERIAL, PROCESS, OR PERFORMANCE FOR THIS ITEM MUST BE APPROVED BY THE FOLLOWING CONTROLLED ITEM APPROVER
RESPONSIBLE CIA ROLE STATIONARY GENSET CIA
RESPONSIBLE CIA ROLE ______
RESPONSIBLE CIA ROLE ______

CUMMINS POWER GENERATION
HARNESS,ALTERNATOR
EXTERNAL
SITE CODE PGF | DWG SIZE D | A051P091 | SHEET 1 OF 2 | DWG REV C

FIGURE 80. A051P091 ALTERNATOR HARNESS (SHEET 1)

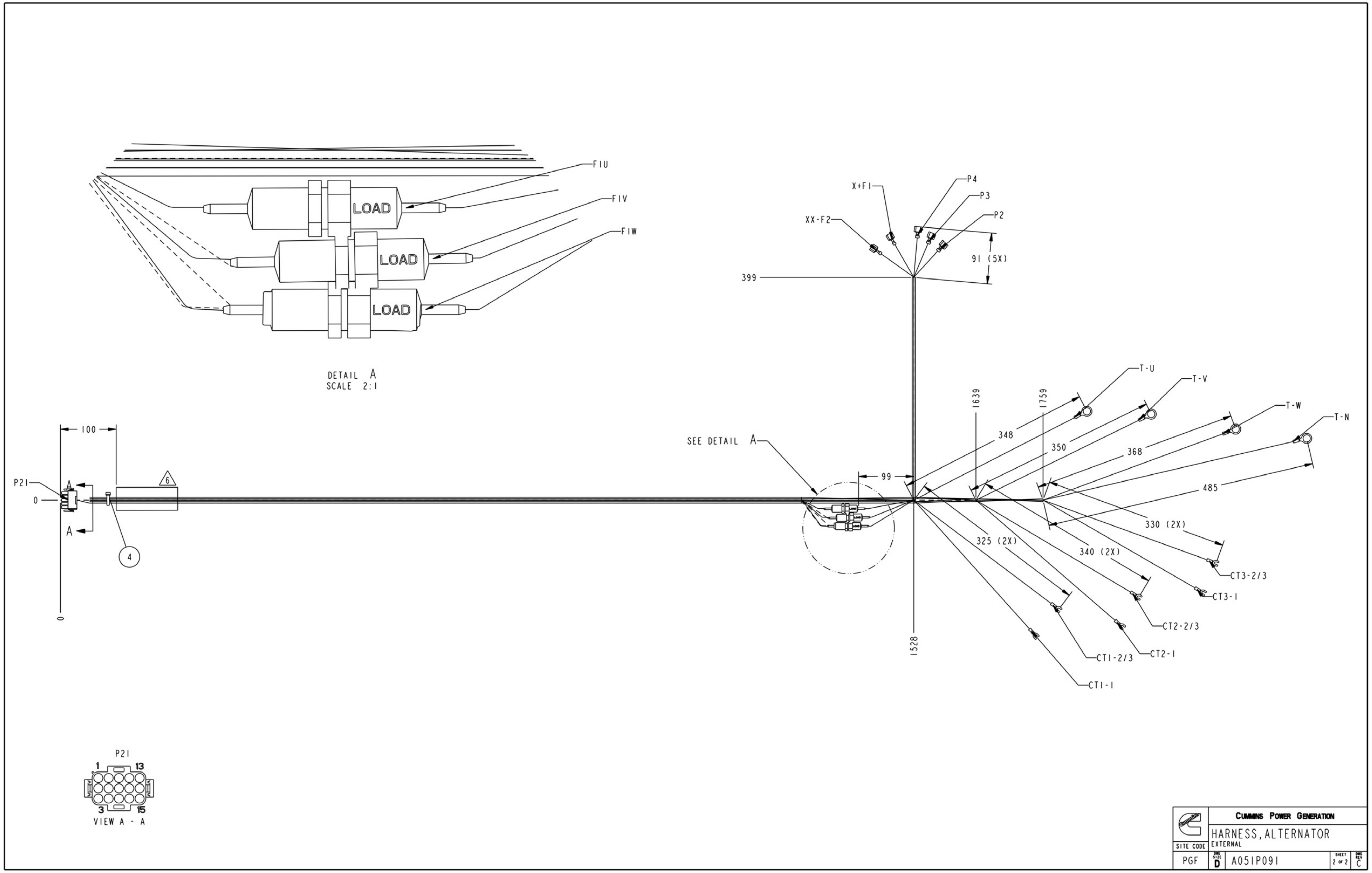


FIGURE 81. A051P091 ALTERNATOR HARNESS (SHEET 2)

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