Service Manual

Generator Set

QSJ8.9G Engine with PowerCommand® 2.3 Control

C125 N6 (Spec B)
C150 N6 (Spec B)

English
Original Instructions

6-2019

A062T546 (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 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 and maintenance can result in severe personal injury or death.

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

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

⚠ 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

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

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 store fuel, cleaners, oil, etc., near the generator set. Do not use combustible liquids like ether.

⚠ WARNING

Combustible Gases

Generator sets in operation have combustible gases under pressure, which if ignited can cause eye and ear damage.

Wear appropriate eye and ear protection at all times.

⚠ WARNING

Combustible Gases

Generator sets in operation have combustible gases under pressure, which if ignited can cause severe injury.

Do not operate the generator set with any doors open.

⚠ WARNING

Fire Hazard

Materials drawn into the generator set, as well as 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. Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.

⚠ 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

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.

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 Alternator Operating Areas

⚠ 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.***

Always wear suitable PPE when working in the hatched areas shown in the diagram or directly in-line with any air inlet/outlet.

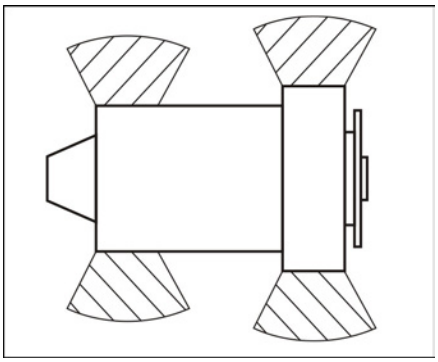

FIGURE 1. HATCHED AREAS

Make sure this consideration is captured in your risk assessment.

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.

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 Gaseous Fuels

Natural gas is lighter than air, and will tend to gather under covered areas.

1.5.2 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 The Hazards of Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless, tasteless and non-irritating gas. You cannot see it or smell it. Red blood cells, however, have a greater affinity for CO than for oxygen. Therefore, exposure even to low levels of CO for a prolonged period can lead to asphyxiation (lack of oxygen) resulting in death. Mild effects of CO poisoning include eye irritation, dizziness, headaches, fatigue and the inability to think clearly. More extreme symptoms include vomiting, seizures and collapse.

Engine-driven generator sets produce harmful levels of carbon monoxide that can injure or kill you.

1.7.1 Special Risks of CO near the Home

⚠ WARNING

Toxic Gases

Carbon monoxide (CO) gas can cause nausea, fainting, or death. Residents can be exposed to lethal levels of CO when the generator set is running. Depending on air temperature and wind, CO can accumulate in or near the home.

To protect yourself and others from the dangers of CO poisoning, it is recommended that reliable, approved, and operable CO detector alarms are installed in proper locations in the home as specified by their manufacturer.

1.7.2 Protecting Yourself from CO Poisoning

- Locate the generator set in an area where there are no windows, doors, or other access points into the home.
- Make sure all CO detectors are installed and working properly.
- Pay attention for signs of CO poisoning.
- Check the exhaust system for corrosion, obstruction, and leaks every time you start the generator set and every eight hours when you run it continuously.

1.8 Earth Ground Connection

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

NOTICE

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

NOTICE

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

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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.

The information contained within the manual is based on information available at the time of going to print. In line with the 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 does not include instructions for servicing printed circuit board assemblies. After determining that a printed circuit board assembly is faulty, replace it. Do not repair it. Attempts to repair a printed circuit board can lead to costly damage to the equipment.

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.

Operating and basic maintenance instructions are in the applicable generator set operator manual. Read 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)	MFM	Multifunction Monitor
ANSI	American National Standards Institute	Mil Std	Military Standard
ASOV	Automatic Shut Off Valve	MPU	Magnetic Pickup
ASTM	American Society for Testing and Materials (ASTM International)	NC	Normally Closed
ATS	Automatic Transfer Switch	NC	Not Connected
AVR	Automatic Voltage Regulator	NFPA	National Fire Protection Agency
AWG	American Wire Gauge	NO	Normally Open
CAN	Controlled Area Network	NWF	Network Failure
CB	Circuit Breaker	OEM	Original Equipment Manufacturer
CE	Conformité Européenne	OOR	Out Of Range
CCA	Cold Cranking Ampere	OORH/ ORH	Out Of Range High
CFM	Cubic Feet per Minute	OORL/ORL	Out Of Range Low
CGT	Cummins Generator Technologies	PB	Push Button
CMM	Cubic Meters per Minute	PCC	PowerCommand® Control
CT	Current Transformer	PGI	Power Generation Interface
DC	Direct Current	PGN	Parameter Group Number
DEF	Diesel Exhaust Fluid	PI	Proportional/Integral
DPF	Diesel Particulate Filter	PID	Proportional/Integral/ Derivative
EBS	Excitation Boost System	PLC	Programmable Logic Controller
ECM	Engine Control Module	PMG	Permanent Magnet Generator
ECS	Engine Control System	PPE	Personal Protective Equipment

Abbr.	Description	Abbr.	Description
EMI	Electromagnetic Interference	PT	Potential Transformer
EN	European Standard	PTC	Power Transfer Control
EPS	Engine Protection System	PWM	Pulse-Width Modulation
E-Stop	Emergency Stop	RFI	Radio Frequency Interference
FAE	Full Authority Electronic	RH	Relative Humidity
FMI	Failure Mode Identifier	RMS	Remote Monitoring System
FSO	Fuel Shutoff	RMS	Root Mean Square
Genset	Generator Set	RTU	Remote Terminal Unit
GCP	Generator Control Panel	SAE	Society of Automotive Engineers
GND	Ground	scfh	Standard Cubic Feet of gas per Hour
HMI	Human-Machine Interface	SCR	Selective Catalytic Reduction
IC	Integrated Circuit	SPN	Suspect Parameter Number
ISO	International Organization for Standardization	SW_B+	Switched B+
LBNG	Lean-Burn Natural Gas	UL	Underwriters Laboratories
LCD	Liquid Crystal Display	UPS	Uninterruptible Power Supply
LCT	Low Coolant Temperature		

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 familiarize themselves with the warnings and operating procedures.

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 Health and Safety manual must be read in conjunction with the Operator manual for the safe operation of the generator set.

The following documents are shipped with the generator set:

- Installation Manual for QSJ8.9G Engine with PowerCommand 2.3/3.3 Control (A062T541)
- Operator Manual for QSJ8.9G Engine with PowerCommand 2.3 Control (A062T543)
- Health and Safety Manual (0908-0110-00)
- Global Commercial Warranty Statement (A040H442)
- Emission Warranty Statement (Federal Emissions EPA Title 40 CFR Part 1048 Component Warranty) (A028X279)

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

- Generator Set Service Manual for QSJ8.9G Engine with PowerCommand 2.3 Control (A062T546)

- Engine Service Manual (5504157)
- Controller Service Manual for PowerCommand 2.3 Controller (0900-0666)
- Recommended Spares List (RSL) for each model:
  - C125 N6 (A057P648)
  - C150 N6 (A057P650)
- Parts Manual for QSJ8.9G Engine with PowerCommand 2.3 and 3.3 Control (A056K402)
- Universal Annunciator Owner Manual (0900-0301)
- Standard Repair Times - IB Family (A057P652)
- Service Tool Manual (A043D529)
- Failure Code Manual (F1115C)
- Engineering Application Manual T-030: Liquid Cooled Generator Sets (A040S369)

2.5 Specifications

2.5.1 Model Specifications

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

TABLE 1. 8.9L MODEL VARIATIONS

Models	Description
C125 N6, C150 N6	60 Hz, 1800 RPM

TABLE 2. COLD WEATHER SPECIFICATIONS (ALL MODELS)

Temperature	Description of Components	Battery Quantity	Group
Above 4 °C (40 °F)	Battery charger, oil heater	1	34
–17 - 4 °C (0 to 40 °F)	Battery charger, coolant heater (1500 W), CCV heater*, oil heater	1	34
Below –17 °C (0 °F)	Battery charger, coolant heater (2000 W), battery heater, CCV heater*, oil heater	2	34
*CCV heaters are provided as part of the cold and extreme cold coolant heater packages.			

NOTICE
For NFPA 110 applications, a coolant heater is required. A factory option is available.

TABLE 3. FUEL SPECIFICATIONS 60 HZ, 1800 RPM

Type	Unit	C125 N6	C150 N6
Natural Gas Full Load	scfh	1665.6	1915.3
	BTU/hr	1,590,182	1,828,620
Liquid Propane Full Load	scfh	674.1	783.0
	BTU/hr	1,598,738	1,857,009
Fuel Pressure	1.5 - 3.2 kPa (6 to 13 inches of water column) under any condition		

TABLE 4. ENGINE SPECIFICATIONS (ALL MODELS)

Type	Specification
Engine	6 cylinder in-line, single-cam, liquid-cooled, 4-stroke, spark ignited
Bore	114 mm (4.49 in)
Stroke	145 mm (5.69 in)
Displacement	8.9 L (543.1 in^3)
Compression Ratio	8.5:1
Firing Order	1-5-3-6-2-4
Spark Plug Gap	0.40 mm (.016 in)
Spark Plug Torque	38 Nm (28 ft-lb)
Crankshaft Rotation (Viewed from the Front of the Engine)	Clockwise
Engine Weight (Dry, Long Block Only)	693 kg (1527.8 lb)
Valve Clearance (Intake)	0.355 mm (0.014 in)
Valve Clearance (Exhaust)	0.6604 mm (0.026 in)
Coolant	• 50/50 coolant solution (50% pure water and 50% anti-freeze) • 11 L (2.9 gal) capacity
Oil Capacity	22 L (5.81 gal)

Type	Specification
Oil Standards	• Must adhere to Cummins® Engineering Standard (CES) 20074 • Use of improper oils can result in engine damage. Use only the required oils: ◦ 5W-40 (all ambient temperatures) ◦ 15W-40 (***above*** 4 °C [40 °F] ambient temperature) (use of GEO 15W-40 oil in ambient temperatures ***below*** 4 °C (40 °F] could result in engine turbocharger damage) • A sulfated ash limit of 0.6% mass has been placed on all engine lubricating oils recommended for use in Cummins® B, natural gas engines. Higher ash oils can cause valve and/or piston damage, cause spark plug fouling, and lead to excessive oil consumption and degradation of the catalyst.

TABLE 5. LUBRICATING OIL SYSTEM SPECIFICATIONS

Type	Specification
Lubricating Oil Pressure at Idle (Minimum)	69 kPa (10 psi)
Lubricating Oil Pressure at Rated Speed (Minimum)	138 kPa (20 psi)
Filter Bypass Valve-Opening Pressure	345 kPa (50 psi)
Pressure Regulator Valve-Opening Pressure	417 kPa (60 psi)
Lubricating Oil Capacity (Standard Sump):	
--High	19 L (20 qt)
--Low	15 L (16 qt)
--Total System	20.8 L (22 qt)

TABLE 6. GENERATOR SET SIZE SPECIFICATIONS

Enclosure Type	Size (L x W x H)
Open/Weather	2867 x 1016 x 1666 mm (113 x 40 x 65.6 in); does not include exhaust discharge elbow
Sound Level 1	3621 x 1016 x 1666 mm (143 x 40 x 65.6 in)
Sound Level 2	4061 x 1016 x 1666 mm (160 x 40 x 65.6 in)

TABLE 7. GENERATOR SET WET WEIGHT (ALL MODELS) (60 HZ, 1800 RPM)

Configuration	lbs	kg
Open	3475	1576
Weather	3801	1724
Sound Level 1	3907	1772
Sound Level 2	3940	1787

NOTICE
Weights are approximate and can be affected by selected options. Refer to outline drawings for specific weight information.

TABLE 8. ALTERNATOR SPECIFICATIONS 60 HZ, 1800 RPM

Type	C125 N6	C150 N6
Generator	Brushless, 4-pole rotating field, single bearing	
Power (kVA) 1 Phase	125	150
Power (kVA) 3 Phase	156.25	187.5
Rated Voltages (V)	120/240, 1 Ph (Reconnectable)	
	227/480, 3 Ph WYE	
	347/600, 3 Ph WYE	
	120/240, 3 Ph DELTA	
	120/208, 3 Ph WYE	
	127/220, 3 Ph WYE	

NOTICE
Maximum I_2 = 8%. Generator set load unbalance must not exceed 25% between any phases.

TABLE 9. GENERATOR SET DERATING GUIDELINES

Model	Phase	Engine Power Available Up To...		Derate At…	
		Elevation	Ambient Temperature	Elevation	Temperature
C125 N6	1 & 3	1800 m (5900 ft)	40 °C (104 °F)	4.25% per 300 m (985 ft)	2% per 10 °C (18 °F)
C150 N6	1 & 3	775 m (2540 ft)			

TABLE 10. CONTROL SPECIFICATIONS (ALL MODELS)

Control	Purpose
PowerCommand 2.3	Generator Set
PowerCommand 3.3	Generator Set
Enovation 4G LDI	Engine (125, 150 kW Generator Sets)

TABLE 11. DC SYSTEM SPECIFICATIONS (ALL MODELS)

Type	Specification
Nominal Battery Voltage	12 VDC
Battery Group	34 (1 standard; 2 optional)
Battery Type	Lead acid, maintenance-free
Minimum Cold Crank Amps	850 standard, 1080 high capacity

TABLE 12. FUSE SPECIFICATIONS

Fuse	Amps	Volts	Comment
F1	20	32	¼" x 1¼" cylindrical glass cartridge, fast acting
F2	10		
F3	20		
F4	5		
F5	20		
F6	10		
F7	10	600	Class G size-rejecting, current limiting
F8	10		

2.5.2 UC Winding Resistances

NOTICE

Resistance of windings at 20 °C (68 °F); measured values should be within 10%.

TABLE 13. AVR-CONTROLLED ALTERNATORS RESISTANCE (OHMS)

Name	Main Stator Windings, L-N (leads)				Exciter Stator	Exciter Rotor, L-L	Main Rotor	PMG Stator, L-l
	311 (1 & 2) (5 & 6)	5 (1 & 2)	6 (1 & 2)	17 (1 & 2) (5 & 6)				
UC22C	0.090	0.045	0.030	0.140	21	0.142	0.59	2.6
UC22D	0.065	0.033	0.025	0.100	21	0.142	0.64	2.6
UC22E	0.050	0.028	0.020	0.075	20	0.156	0.69	2.6
UC22F	0.033	0.018	0.012	0.051	20	0.156	0.83	2.6
UC22G	0.028	0.014	0.010	0.043	20	0.156	0.94	2.6
UC27C	0.030	0.016	0.011	0.044	20	0.156	1.12	2.6
UC27D	0.019	0.010	0.007	0.026	20	0.156	1.26	2.6

Name	Main Stator Windings, L-N (leads)				Exciter Stator	Exciter Rotor, L-L	Main Rotor	PMG Stator, L-l
	311 (1 & 2) (5 & 6)	5 (1 & 2)	6 (1 & 2)	17 (1 & 2) (5 & 6)				
UC27E	0.016	0.009	0.008	0.0025	20	0.182	1.34	2.6
UC27F	0.012	0.007	0.005	0.019	20	0.182	1.52	2.6
UC27G	0.010	0.006	0.004	0.013	20	0.182	1.69	2.6
UC27H	0.008	0.004	0.004	0.014	20	0.182	1.82	2.6
UCD27J	0.006	N/A	N/A	0.009	20	0.182	2.08	2.6
UCD27K	0.006	N/A	N/A	0.009	20	0.182	2.08	2.6

2.6 After Sales Services

Cummins offers a full range of maintenance and warranty services.

2.6.1 Maintenance

⚠ WARNING

Electrical Generating Equipment

Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage.

Make sure service personnel are qualified to perform electrical and mechanical service.

For expert generator set service at regular intervals, contact your Cummins service provider. See power.cummins.com/sales-service-locator for service locations that service this application. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your Cummins service provider.

2.6.2 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.

2.6.2.1 Warranty Limitations

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

2.6.3 How to Obtain Service

When a product requires service, contact the nearest authorized Cummins service provider. To locate the service provider, refer to **www.cummins.com/support** and select Sales & Service Locator. When contacting the service provider, always supply the complete model, specification, and serial number as shown on the nameplate.

2.6.3.1 Service Technician Support

For technical support for service technicians, call 1-800-CUMMINS™ (1-800-286-6467) in the U.S. or Canada. Distributors should contact their Cummins service contact.

2.6.4 Manufacturing Facilities

Facility	Address	Phone Numbers
U.S. and CANADA	Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Toll Free 1-800-CUMMINS™ (1-800-286-6467) Phone +1 763-574-5000 Fax +1 763-574-5298
EMEA, CIS	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	Phone +44 1843 255000 Fax +44 1843 255902
ASIA PACIFIC	Cummins Inc. 10 Toh Guan Road #07-01 TT International Tradepark Singapore 608838	Phone +65 6417 2388 Fax +65 6417 2399
BRAZIL	Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 Brazil	Phone +55 11 2186 4195 Fax +55 11 2186 4729
CHINA	Cummins Inc. 2 Rongchang East Street, Beijing Economic – Technological Development Area Beijing 100176, P.R. China	Phone 86 10 59023001 Fax +86 10 5902 3199
INDIA	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka- Phaltan Dist- Satara, Maharashtra 415523 India	Phone +91 021 66305514
LATIN AMERICA	3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Phone +1 954 431 551 Fax +1 954 433 5797
MEXICO	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	Phone +52 444 870 6700 Fax +52 444 824 0082

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3 Maintenance

3.1 Maintenance Safety

⚠ 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

Hydrogen Gas

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

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

⚠ WARNING

Explosive Fumes

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

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

⚠ WARNING

Working at Heights

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

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

⚠ WARNING

Access

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

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

⚠ WARNING

Exposed Terminations

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

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

NOTICE

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

NOTICE

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

NOTICE

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

All maintenance tasks must be performed, but be sure to assess them for health and safety risks before starting. For example, perform a task with someone present if doing so will add significantly to the safety of the task.

Read, understand, and comply with all Caution, Warning, and Danger notes in this section, the Important Safety Instructions section, and the documentation supplied with the generator set.

Make sure that adequate lighting is available.

3.1.1 Locking the Generator Set Out of Service

NOTICE

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 (–) cable first.

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 (or the STOP button if applicable), the generator set cannot be considered safe to work on until the engine is properly immobilized, as detailed in the following procedure.

NOTICE

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

To immobilize the generator set:

1. Press the Off switch from the display and then press the E-Stop button to shut down the engine. This will prevent the starting of the generator set regardless of the Start signal source and will therefore provide an additional safety step for immobilizing the generator set. Alternatively, make sure the generator set is in manual mode (which allows it to be started by manually pushing the buttons).

NOTICE
When the E-Stop button is pressed, the Operator Panel indicates the Shutdown condition by illuminating the red Shutdown status LED and displaying a message on the graphical LCD display.

2. Thoroughly ventilate the generator set before disconnecting any leads.
3. Turn off and disconnect the heater (where fitted) from the AC source before disconnecting the battery cables.
4. Turn off and disconnect the battery charger (where fitted) from the AC source before disconnecting the battery cables.
5. Turn off the fuel supply to the engine.
6. Disconnect the battery. Disconnect the negative (**–**) cable first, using an insulated wrench.
7. Place warning notices at each of the above locations that state, "Maintenance in Progress – Immobilized for Safe Working."

3.2 Periodic Maintenance

⚠ WARNING
Electrical Generating Equipment ***Accidental or remote starting of the generator set can cause severe personal injury or death.*** ***Before working on the generator set, make sure that the generator set is in Off mode, disable the battery charger, and remove the negative (–) battery cable from the battery to prevent starting.***

The table(s) that follow show the recommended service intervals for a generator set on standby service. If the generator set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly.

At each scheduled maintenance interval, perform all previous maintenance checks that are due for scheduled maintenance.

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

- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

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

Repair or replace worn, damaged, or improperly functioning components identified during periodic maintenance procedures.

3.2.1 Periodic Maintenance Guidelines

Regularly performing the following periodic maintenance tasks greatly reduces the chances of a generator set shutdown:

- Maintain an appropriate oil level.
- Keep battery connections clean and tight.
- Do not overload the generator set.
- Keep the air inlet and outlet openings clear.

3.2.2 Periodic Maintenance Schedule

NOTICE
Perform maintenance tasks as specified using daily or hourly periods, whichever is sooner.

TABLE 14. PERIODIC MAINTENANCE SCHEDULE

Maintenance Items	After Every 24 Hours of Run Time[1]	After Every 50 Hours of Run Time	12 Months or After 250 Hours[2]	2 Years or After 500 Hours[2]
Check air cleaner restriction indicator (where fitted): If the indicator shows red, replace air cleaner element and reset the indicator.	■			
Check air intake system for leaks: Visually inspect for signs of wear or damage. Check audibly when the generator set is running. Replace worn or damaged components.	■			
Check coolant level of radiator: If low, top up to coolant system specifications level, with Cummins recommended coolant mix.	■			
Check cooling fan blades: Visually inspect the blades through the guarding for signs of wear or damage. To replace, contact your authorized distributor.	■			
Checking drive belt condition and tension: Visually check belt for evidence of wear or slippage. To replace, contact your authorized distributor.	■			

Maintenance Items	After Every 24 Hours of Run Time[1]	After Every 50 Hours of Run Time	12 Months or After 250 Hours[2]	2 Years or After 500 Hours[2]
Check radiator airflow: Visually inspect the radiator through the guarding for blockage, debris or signs of wear or damage. To clean or replace, contact your authorized distributor.	■			
Check fuel lines and hoses: Visually check for leaks, worn or damaged hoses. To replace, contact your authorized distributor.	■			
Check engine oil level: If low, top up to engine specifications level with recommended oil.	■			
Check charge alternator: Check visually and audibly when the generator set is running. To replace, contact your authorized distributor.	■			
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.	■			
Check generator set enclosure: Visually check enclosure. Make sure no inlets/outlets are restricted, service access doors are operational. To replace damaged parts, contact your authorized distributor.	■			
Check operation of operator panel: Check display (the system will perform a control panel test on initial activation). Replace component if not functioning properly.	■			
Check operation of Emergency Stop Button (where fitted): With the generator set running, press the Emergency Stop button. Check all systems before resetting the fault.		■		
Replace air cleaner.			■[3]	
Check coolant lines and radiator hoses for leaks, wear and cracks: Visually check the hoses. Replace worn or damaged components.			■	
Clean radiator core.			■[3]	

Maintenance Items	After Every 24 Hours of Run Time[1]	After Every 50 Hours of Run Time	12 Months or After 250 Hours[2]	2 Years or After 500 Hours[2]
Check water pump for leaks. Check weep holes for evidence of leaks. Replace if leaking.			■	
Verify that the coolant heater has power and is running (where fitted). Check for evidence of leaks. Remove any corrosion from fittings.			■	
Check CCV heater (where fitted). Check for evidence of leaks. Remove any corrosion from fittings.			■	
Check alternator heater (where fitted). Check general condition and wiring connections.			■	
Check battery heater (where fitted). Check general condition and wiring connections.			■	
Check engine oil heater. Check general condition and wiring connections.			■	
Check battery: Check connections to verify that they are secure.			■	
Check battery for general condition. Remove any corrosion on terminals with wire brush.			■	
Check electrical connections (battery, starter motor, alternator connections). Check for tight connections, general condition and remove any corrosion.			■	
Replace engine oil and filters. Refer to the Engine Oil section for the procedure.		■[4]	■[4]	
Check engine ground. Clean as necessary.			■	
Check engine mounts for general condition and for signs of excessive wear.			■	
Check starting motor.			■	
Check turbocharger for signs of leakage. Listen for excessive noise when test running the generator set.			■	
Inspect spark plugs. Replace if showing signs of excessive wear, carbon deposits, oil accumulation or damaged.			■	
Replace spark plugs and spark plug wires.				■

Maintenance Items	After Every 24 Hours of Run Time[1]	After Every 50 Hours of Run Time	12 Months or After 250 Hours[2]	2 Years or After 500 Hours[2]
Check charge air cooler for damage and debris.			■	
Check valve lash and adjust if required. See the Valve Clearance Adjustment procedure (service manual only).				■
Check fan drive idler arm and fan belt tensioner for general condition, as well as for excessive play in both.				■
Replace cooling system coolant. Check coolant sensor for damage and debris.				■

[1] This interval is based on generator run time: daily in an outage or after every 24 hours of run time.

[2] To be performed by a qualified Service Technician.

[3] Cleaning schedule may be reduced depending on operating conditions/environment.

[4] After the initial 50 hour interval and every 250 hours thereafter.

3.3 Engine Oil

3.3.1 Recommended Engine Oil

Check the oil level prior to starting the generator set to verify that the oil level is between the High and Low marks. The generator set is shipped with engine oil.

The use of quality engine oils combined with appropriate oil and filter change intervals are critical factors in maintaining engine performance and durability.

Cummins Inc. recommends the use of a high quality SAE 5W-40 GEO (all ambients) or SAE 15W-40 GEO (above 40 °F [4 °C]) engine oil for natural gas engines. In addition, oil needs to conform with CES 20074. Refer to the Model Specifications section for oil specification details.

NOTICE

Use of improper oils can result in engine damage. Use only the recommended oils.

NOTICE

Use of GEO 15W-40 oil in ambient temperatures below 40 °F (4 °C) could result in engine turbocharger damage.

3.3.2 Checking Engine Oil Level

⚠ 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 (–) cable first.

⚠ 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.

⚠ WARNING

Toxic Hazard

State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity.

Avoid skin contact and breathing of vapors. Use rubber gloves and wash exposed skin.

⚠ WARNING

Toxic Hazard

Crankcase pressure can blow out hot oil and cause severe burns.

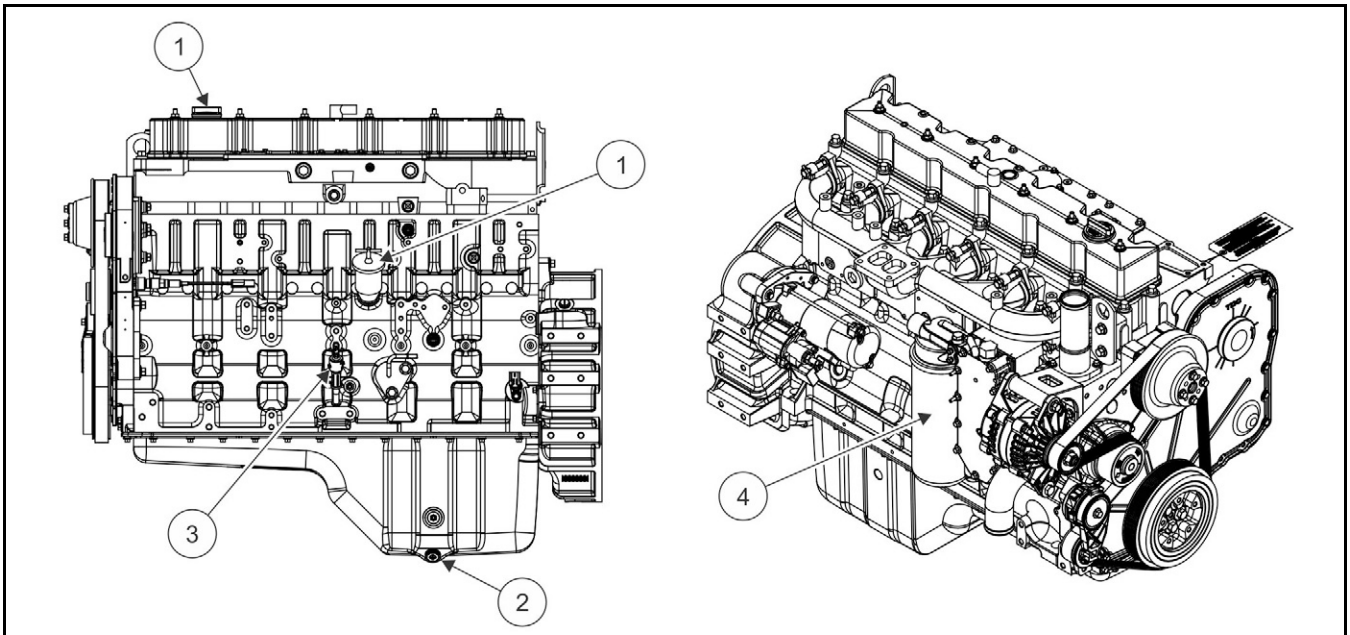
Do NOT check oil while the engine is operating.

NOTICE

Check the engine oil level when the engine is not running and is out of Auto mode.

NOTICE

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



No.	Description	No.	Description
1	Oil Fill	3	Dipstick
2	Oil Drain	4	Oil Filter

FIGURE 2. ENGINE OIL COMPONENTS

1. Make sure the generator set is shut down and disabled:
   a. Press the Off switch from the display and then press the E-Stop button to stop the generator set. Allow the generator set to thoroughly cool to the touch.
   b. Turn off and disconnect the battery charger from the AC source before disconnecting the battery cables.
   c. Disconnect the negative (–) cable from the battery and secure it from contacting the battery terminals to prevent accidental starting.
2. To check the engine oil level:
   a. Make sure that the engine has not been running for approximately five minutes.
   b. Clean off the area surrounding the dipstick port to prevent entry of debris into the oil pan.
   c. Pull out the dipstick and wipe it clean.
   d. Reinsert and fully seat the dipstick.
   e. Remove the dipstick and check the oil level.

NOTICE
The engine oil level indicated on the dipstick should be between the High (18.9 L [20 qt]) and Low (15.1 L [16 qt]) marks.

   f. Reinsert and fully seat the dipstick.

If the engine oil level check shows excessive or insufficient levels of oil (that is, oil level line above the High mark or below the Low mark), oil must be drained or added. Refer to the following sections for instructions and guidelines for draining and adding oil.

3.3.3 Adding or Draining Oil

⚠ 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.

⚠ WARNING

Hot Engines

Contact with hot engines can cause severe burns. Ensure that the generator set engine has cooled down before adding or draining the oil.

NOTICE

Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the High and Low marks on the dipstick.

3.3.3.1 Adding Oil

If the oil level is found to be insufficient, oil must be added.

1. Ensure that the oil fill cap area is clean, and prevent debris from entering the engine.
2. Add the appropriate amount of oil, based on the engine oil level check. Refer to the Checking Engine Oil Level section and the Model Specifications section.
3. Recheck the engine oil level. Based on the results, add or drain oil.
4. Clean up and dispose of any oil in accordance with local/state regulations.

3.3.3.2 Draining Oil

If the oil level is found to be excessive, oil must be drained from the engine.

1. Detach the oil drain hose from the side of the engine.
2. Place the end of the drain hose into an appropriate container.

Refer to local regulations to determine the appropriate container for used oil.

- Open the oil drain valve to release oil from the engine into the appropriate container.
- Recheck the engine oil level. Based on the results, add or drain oil.
- When a sufficient amount of oil has been drained from the system:
    1. Close the oil drain valve.
    2. Wipe the oil drain valve clean.
    3. Re-attach the drain hose to the side of the engine.
    4. Dispose of the used oil in accordance with local/state regulations.

3.3.4 Changing Engine Oil and Oil Filter

NOTICE

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 (–) cable first.

⚠ WARNING

Toxic Hazard

State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity.

Avoid skin contact and breathing of vapors. Use rubber gloves and wash exposed skin.

NOTICE

If the oil and/or oil filter are not reused, dispose of them in accordance with local environmental regulations.

NOTICE

Change the engine oil and filter when the generator set is not running and is out of Remote mode.

NOTICE

Change the oil more often in hot and dusty environments.

NOTICE

Cummins highly recommends that any service or maintenance work be performed by qualified technicians.

1. Open the generator set's circuit breaker to prevent the ATS from transferring to generator set source when manually starting.
2. Before changing the oil, manually start the generator set.
3. Allow the generator set to run for 2 to 5 minutes to warm the engine oil.
4. Make sure the generator set is shut down and disabled:
    a. Press the generator set's "O" (Off) button to stop the generator set. Allow the generator set to thoroughly cool to the touch.
    b. Turn off and disconnect the battery charger from the AC source before disconnecting the battery cables.
    c. Disconnect the negative (–) cable from the battery and secure it from contacting the battery terminals to prevent accidental starting.
    d. If applicable, disconnect the oil heater from its AC power source (or turn off power).
5. Remove the access panels to get to the drain hose.
6. Open the oil drain cap to release oil from the engine into the appropriate container.

NOTICE

Refer to local regulations to determine the appropriate container for used oil.

7. Close the oil drain cap.
8. Wipe the oil drain cap clean.
9. Place an appropriate container below the oil filter to collect oil as the filter is being removed.
10. Remove the oil filter by turning it counterclockwise.
11. Remove the old gasket if it remains on the engine.
12. Clean the filter mounting surface on the engine block.
13. Make sure the gasket is in place on the new filter and apply a thin film of clean oil to the gasket.
14. Install the new filter until the gasket just touches the block. Turn it an additional 1/2 to 3/4 turn. Do not over-tighten.
15. Remove the container used to collect oil when removing the oil filter.
16. Add the appropriate amount of oil.

NOTICE

Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the High and Low marks.

17. Check the engine oil level. Based on the results, add or drain oil.
18. Remove any oil that has spilled on the generator set during this procedure.
19. Make sure the generator set breaker is open.
20. Reconnect the cables and battery charger:
    a. Reconnect the engine battery cables, positive (+) cable first.
    b. Reconnect the battery charger to its AC power source.
21. Reconnect the oil heater AC power or energize its AC circuit.
22. Operate the generator set with no load for approximately 5 minutes to check for leaks at the oil filter or oil drain hose.
23. Shut down the generator set, wait 5 minutes, and then confirm that the correct oil level is in the pan.
24. Check for leaks and repair any that are identified.
25. Dispose of the used oil and oil filter according to local environmental regulations.
26. Re-install the access panels. Torque the fasteners 5.0–6.6 Nm (3.5–5.0 ft-lb).
27. Restore the original generator set settings.
28. Close the generator set breaker.

3.4 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.

3.4.1 Cooling Fan Drive Belt Maintenance

⚠ CAUTION

The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

1. Lift the tensioner to remove the drive belt.

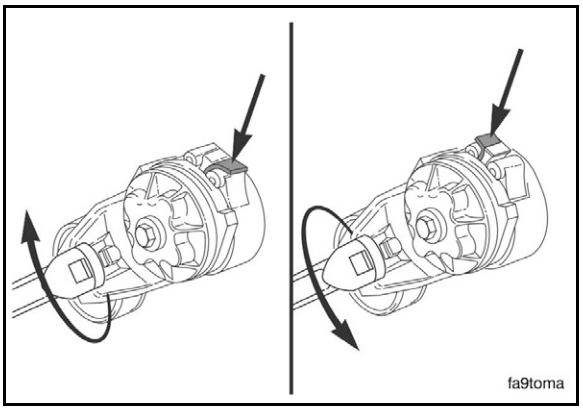


FIGURE 3. LIFT THE TENSIONER TO REMOVE THE BELT

2. The belt tensioner winds in the direction that the spring tang is bent over the tensioner body. Loosen the tension on the belt by rotating the tensioner to wind the spring tighter.

⚠ CAUTION

Applying excessive force in the opposite direction of windup or after the tensioner has been wound up to the positive stop can cause the tensioner arm to break.

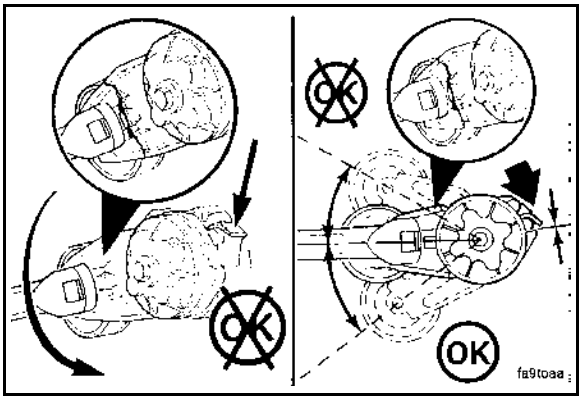


FIGURE 4. DO NOT USE EXCESSIVE FORCE

3. Inspect the drive belt for:
   - Cracks
   - Glazing
   - Tears or cuts
   - Hardening
   - Excessive wear

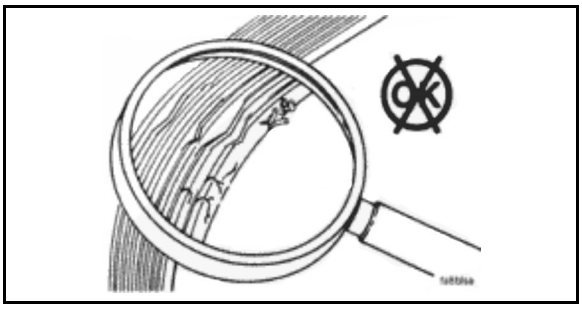


FIGURE 5. INSPECT THE DRIVE BELT

4. Lift the tensioner to install the drive belt.

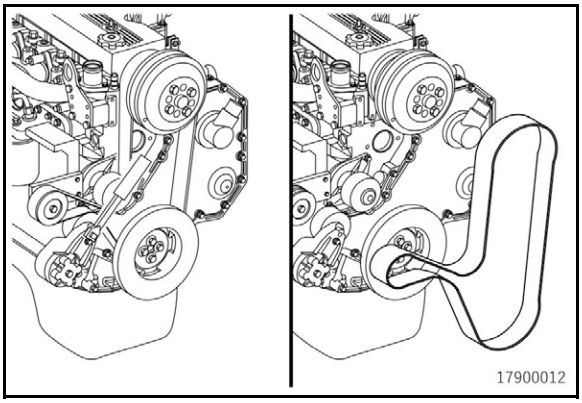


FIGURE 6. LIFT THE TENSIONER

3.4.2 Cleaning

3.4.2.1 Cleaning Radiator Cores Using Pressurized Water Equipment

NOTICE
In specific dust-laden environments, this procedure should not be used as the initial cleaning operation. Instead, follow the procedure in the *Dust Laden Environments* section.

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator. Refer to the Remove Enclosure End Panel sub-section in the Exhaust System section.

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 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.

⚠ CAUTION

Do not use cleaners that contain ammonia to clean the radiator or charge air cooler. Ammonia will damage the core.

The recommended equipment for cleaning a radiator core is an industrial pressure washer, but it must be used in the correct manner because 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.

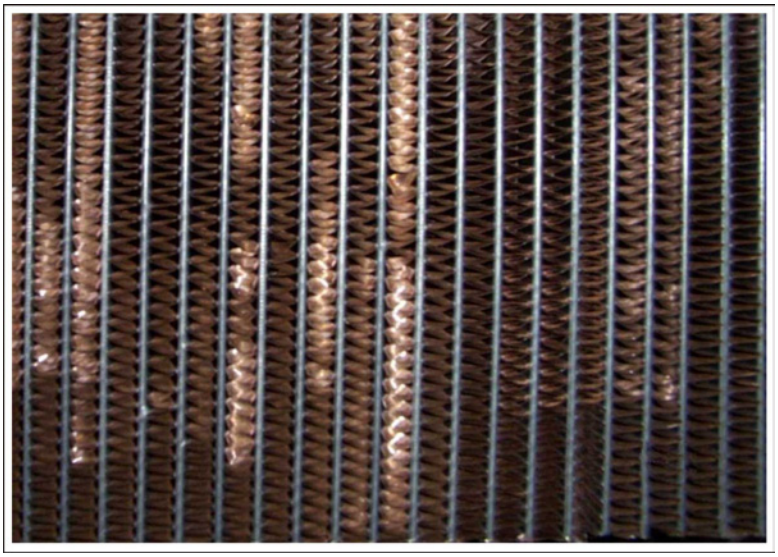


FIGURE 7. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE

⚠ WARNING

Wear PPE when cleaning the radiator core with a pressure washer or compressed air. Verify appropriate PPE is worn for the cleaning materials being used. Respiratory protection must be worn when cleaning the radiator with compressed air.

⚠ CAUTION

Follow all codes and standards regarding collection and disposal of cleaning materials used to clean the radiator.

⚠ CAUTION

With the pressures involved, it is important that the distance between the core face and the nozzle is a minimum of 18 inches (450 mm); otherwise, damage may occur.

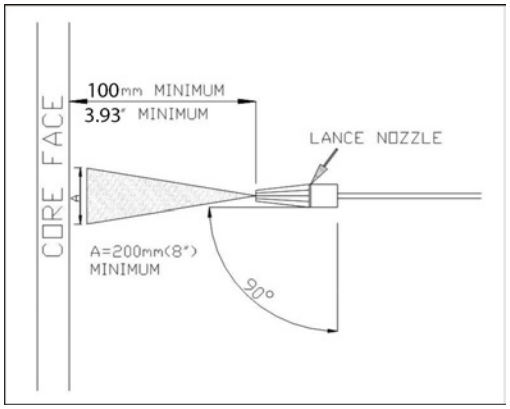


FIGURE 8. PRESSURE WASHER NOZZLE POSITIONING

⚠ CAUTION

Most industrial pressure washers work at pressures of around 1500 psi to 3000 psi (103 bar to 206 bar). It is very important that, when washing a core in this way, the lance is kept at a right angle to the core.

⚠ CAUTION

If your pressure washer works above 3000 psi, make sure the gap between the nozzle and the core face is increased; otherwise, fin damage will occur.

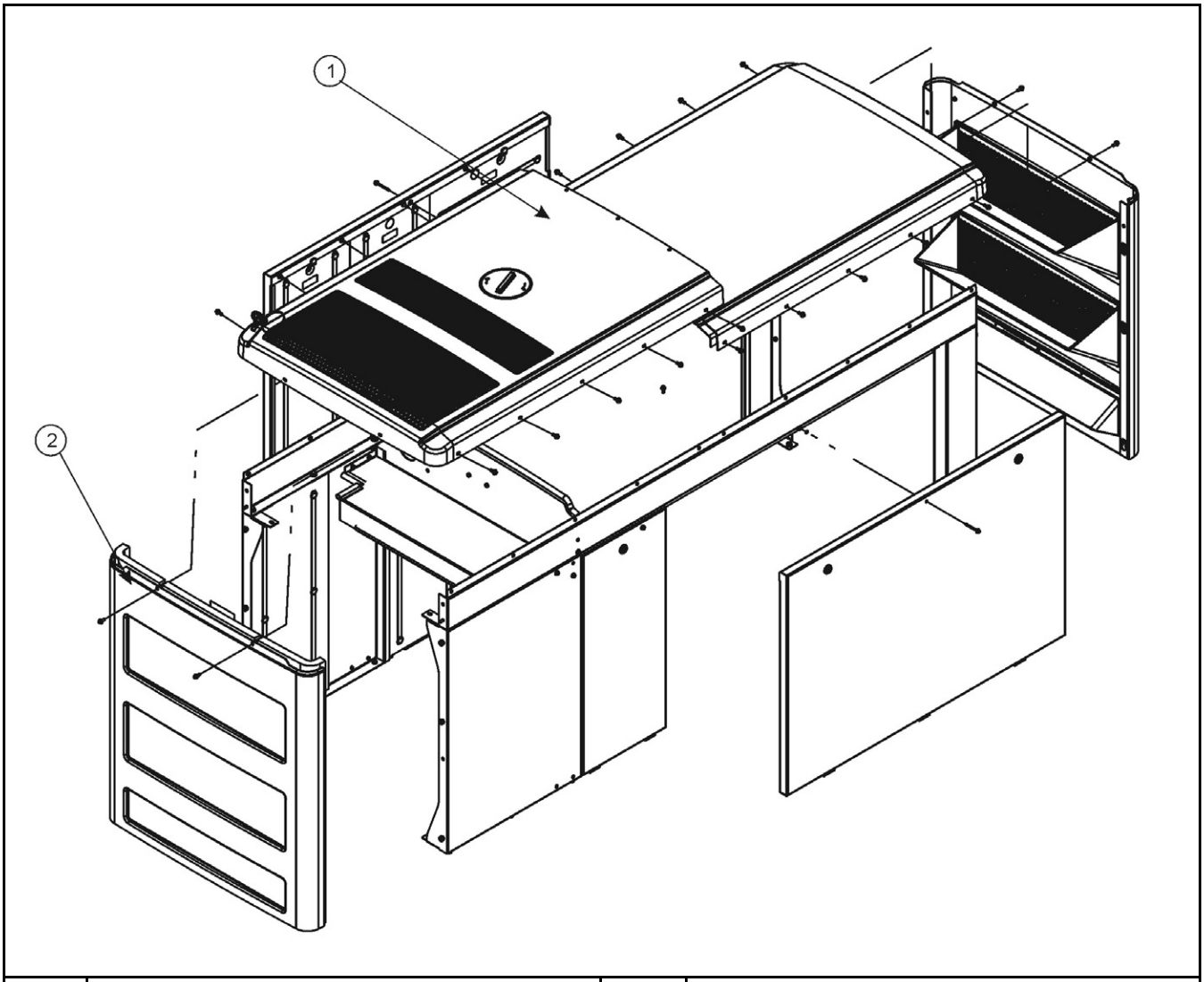
NOTICE

Always follow the pressure washer manufacturer's Health and Safety Guidelines.

Replace the end panel(s) where necessary. Refer to the Install Enclosure End Panel sub-section in the Exhaust System section.

3.4.2.1.1 Remove Enclosure End Panel

1. Remove bolts from top panel (1). Torque 9.8 to 11.9 Nm (7.3 to 8.8 ft-lb).



No.	Description	No.	Description
1	Top Panel	2	End Panel

FIGURE 9. ENCLOSURE END PANEL REMOVAL

2. Remove top panel (1).
3. Slide end panel (2) up to unlatch the panel, then pull the end panel off.

3.4.2.1.2 Install Enclosure End Panel

1. Place the end panel (2) on each side panel locating pin. Refer to **Figure 9**.
2. Slide the end panel (2) down to latch the panel onto the locating pins.
3. Attach the top panel (1) with bolts on three sides and the top.

3.4.2.2 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.

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.

3.4.3 Radiator Check

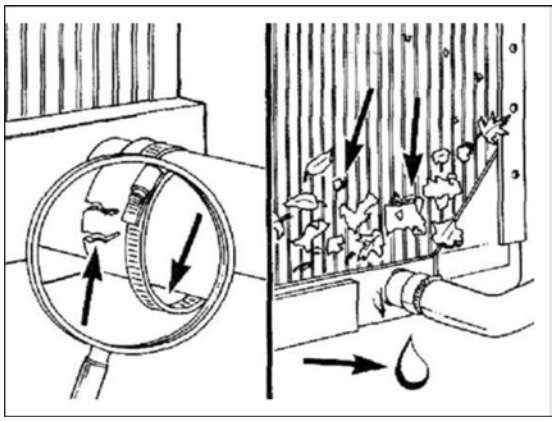


FIGURE 10. RADIATOR CHECK

Check for damaged hoses and loose and damaged hose clamps.

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

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

3.4.4 Fan Spacer and Pulley Maintenance

⚠ WARNING

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

⚠ WARNING

Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

1. Remove the cooling fan drive belt. Refer to the Cooling Fan Drive Belt section.
2. Remove the four fan capscrews, fan, and spacer.
3. Remove the fan pulley.

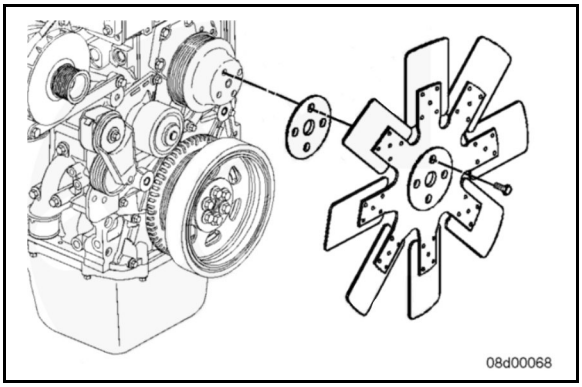


FIGURE 11. EXAMPLE OF FAN PULLEY REMOVAL

4. Clean the fan pulley with solvent and dry with compressed air.

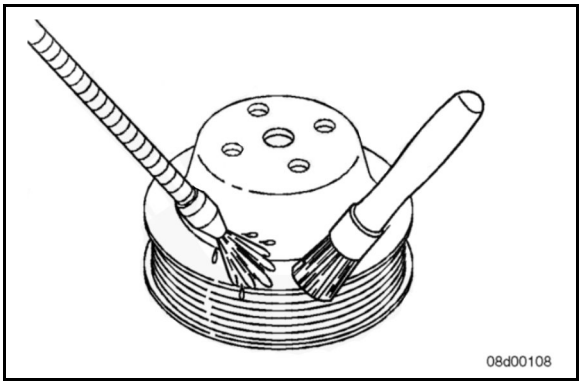


FIGURE 12. CLEAN THE FAN PULLEY

5. Inspect the fan pulley for cracks near the bolt holes and for damage at the drive belt contact surface.
   - If damage is found on the fan pulley, the fan hub must also be inspected.

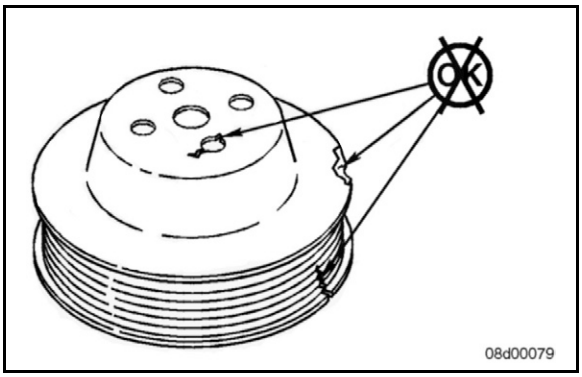


FIGURE 13. INSPECT THE FAN PULLEY

6. Install the fan pulley.
7. Install the spacer, fan, and fan capscrews. Torque value: 34.7 - 42.0 ft-lb (47 - 57 Nm).
8. Install the drive belt. Refer to the Cooling Fan Drive Belt section.
9. Operate the engine and check for proper operation.

3.5 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.

3.5.1 Normal Duty Air Cleaner

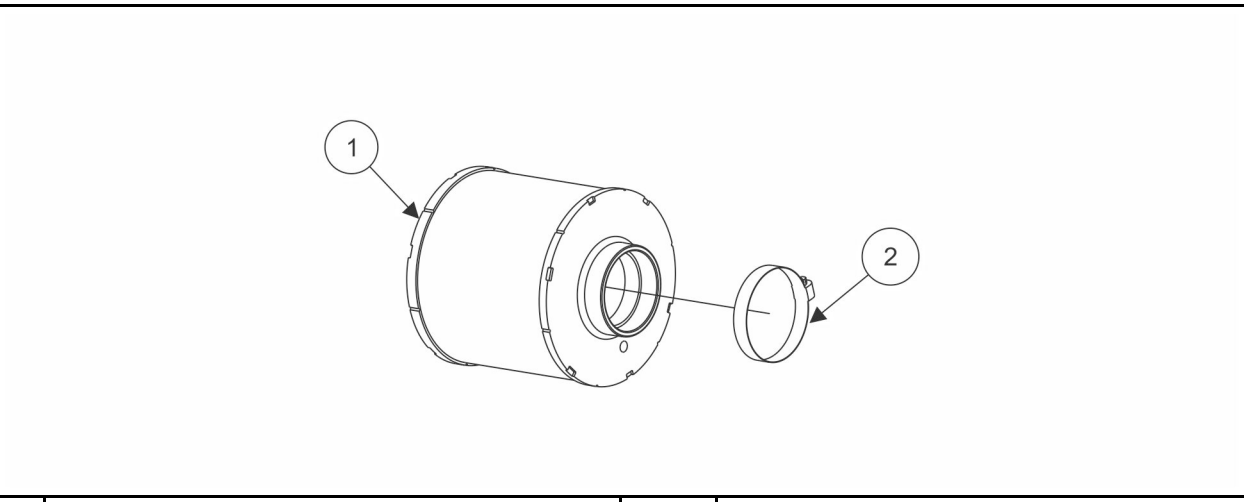
3.5.1.1 Normal Duty Air Cleaner Element Replacement

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.

1. Remove the existing air cleaner:
   a. Loosen the strap clamp (2).
   b. Wipe away any debris accumulated around the air cleaner connection to the engine. Ensure that no debris is allowed to enter the body of the air cleaner or the connection on the engine.
   c. Remove the dirty air cleaner (1).
   d. Dispose of the dirty element in accordance with local environmental agency requirements.
2. Install the replacement air cleaner (1) as follows:
   a. Install the air cleaner (1).

b. Tighten strap clamp (2). Torque to 2.5 - 3.3 ft-lb (4.3 - 4.65 Nm).



No.	Description	No.	Description
1	Air Cleaner	2	Strap Clamp

FIGURE 14. EXAMPLE OF NORMAL DUTY AIR CLEANER

3.5.2 Heavy Duty Air Cleaner

3.5.2.1 Air Cleaner Service Indicator

⚠ WARNING

Hot exhaust components.

Exhaust components become very hot when the generator set is in use and remain hot for a period of time after the generator set has been shut down. These components can cause severe personal injury or death from contact.

Allow these components to cool completely before performing any maintenance tasks.

⚠ WARNING

Moving parts.

Moving parts can cause severe personal injury or death.

Use extreme caution around hot manifolds, moving parts, etc.

The air cleaner service indicator, available only on heavy duty air cleaners, is located on the air cleaner assembly.

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

3.5.2.2 Heavy Duty Air Cleaner Maintenance

⚠ 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.

There is a dust ejector valve (DEV) on the bottom of each filter pre-cleaner that should be checked periodically to make sure it is free of dust and dirt.

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

3.5.2.3 Heavy Duty Air Cleaner Element Replacement

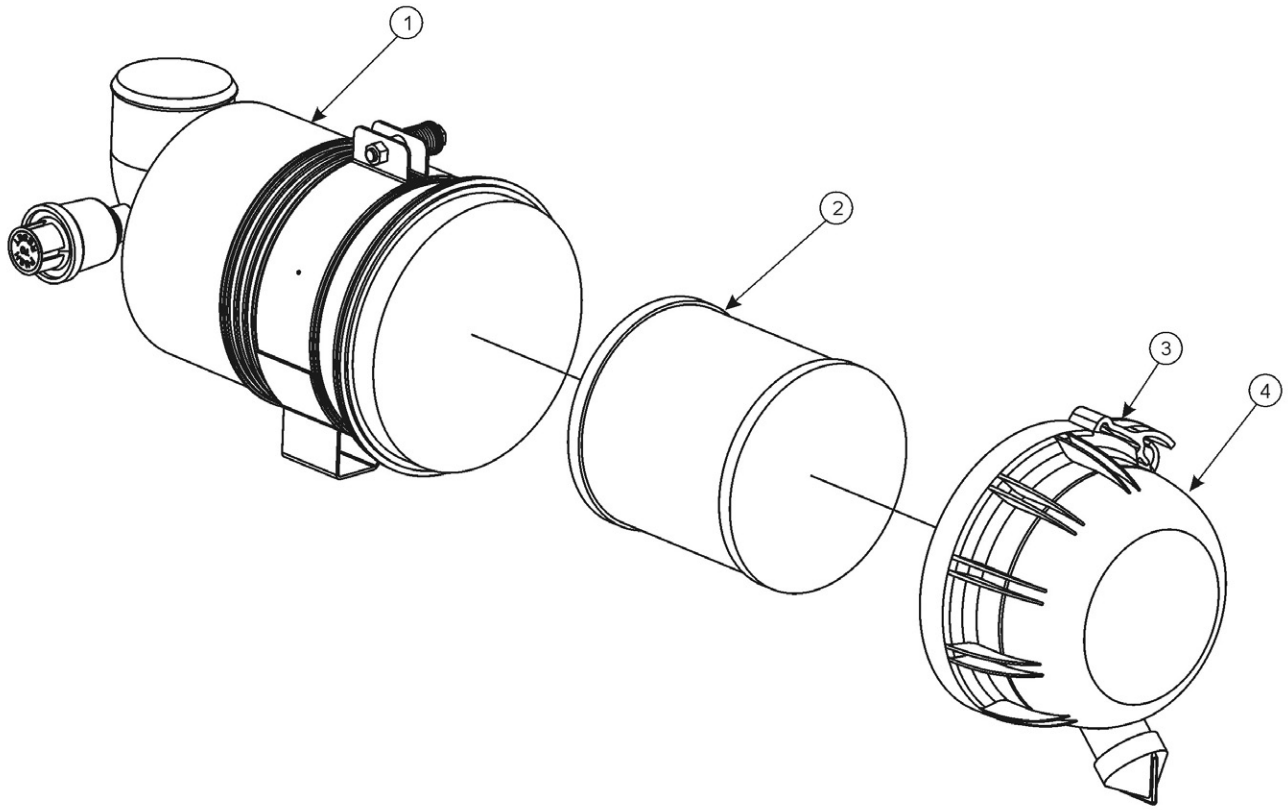
⚠ CAUTION

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.

1. To remove the existing air cleaner element:
   a. Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner.
   b. Lift the latch (3) and turn the end cover (4) counterclockwise.
   c. Pull the end cover (4) away from the housing (1).
   d. Remove the air filter element (2) from the housing (1).
   e. Dispose of the dirty element in accordance with local environmental agency requirements.
2. To install the replacement air cleaner element:
   a. Ensure that no debris enters the filter element or connection point on the air cleaner housing.
   b. Insert the air filter element (2) into the housing (1).
   c. Install the end cover (4) onto the housing (1).
   d. Turn the end cover (4) clockwise until the latch (3) snaps into place.



No.	Description	No.	Description
1	Housing	3	Latch
2	Air Filter Element	4	End Cover

FIGURE 15. EXAMPLE OF HEAVY DUTY AIR CLEANER

3.6 Exhaust System Maintenance

⚠ WARNING

Hot Exhaust Components

Exhaust components become very hot when the generator set is in use and remain hot for a period of time after the generator set has been shut down. These components can cause severe personal injury or death from contact.

Allow these components to cool completely before performing any maintenance tasks.

⚠ WARNING

Inhalation of Exhaust Gases

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

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

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury or death.

Use extreme caution around moving parts, etc.

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler, and exhaust pipe without removing guarding and panels. Check for leaks at all connections, welds, gaskets and joints, and ensure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the generator set (if possible). Contact your authorized dealer and have the leaks corrected immediately.

3.7 Generator Set Output - AC Electric System Checks

1. Check the following while the generator set is operating.

TABLE 15. AC ELECTRIC SYSTEM CHECKS

Check	Description
Frequency	The generator set frequency should be stable and the reading should be the same as the generator set nameplate rating. See the Model Specifications section.
AC Voltage	At no load, the line-to-line voltage, or voltages, should be the same as the generator set nameplate rating.
AC Ammeter	At no load, the current readings should be zero. With a load applied, each line current should be similar.
Panel Lamps	When the operating panel is first connected to the DC supply, the system runs a check by illuminating each of the indicator lamps in turn.

2. If all of the LEDs do not illuminate, replace the operator panel.

3.8 DC Electrical System

⚠ WARNING

Combustible Gases

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

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

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

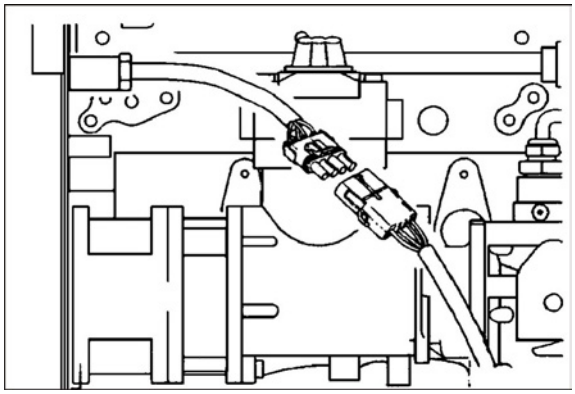


FIGURE 16. CHECK HARNESS CONNECTIONS

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

3.9 Batteries

Batteries are an essential part of any standby generator set system. A significant amount of generator set failures are due to battery issues.

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

Maintenance free batteries (if supplied with the generator set) need no maintenance for commissioning.

3.9.1 Storage

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

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

3.9.2 General Precautions for Maintenance-Free Batteries

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

⚠ WARNING

Arcing Hazard

Laying tools or metal objects across the battery can cause arcing that may ignite battery gases causing explosions resulting in personal injury.

Never lay tools or metal objects across the top of the battery.

⚠ WARNING

Electric Shock Hazard

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

Use tools with insulated handles to prevent the risk of electric shock.

⚠ CAUTION

Toxic Hazard

Electrolyte is a dilute sulphuric acid that is harmful to the skin and eyes. It is electrically conductive and corrosive.

Wear full eye protection and protective clothing. If electrolyte contacts the skins, wash it off immediately with water. If electrolyte contacts the eyes, flush thoroughly and immediately with water and seek medical attention. Wash spilled electrolyte with an acid neutralizing agent.

NOTICE

Keep batteries upright to prevent spillage.

3.9.2.1 Fire Hazard

⚠ WARNING

Combustible Gases

Lead acid batteries present a risk of fire because they generate hydrogen gas.

Do not smoke near the batteries. Do not cause flame or spark in the battery area. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface.

⚠ WARNING

Before disconnecting a battery, always remove power from the AC powered battery charger.

⚠ WARNING

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

3.9.2.2 Vented Batteries

⚠ WARNING

Toxic Hazard

The electrolyte in vented batteries is a dilute sulfuric acid that is harmful to the skin and eyes. It is also electrically conductive and corrosive.

Always:

1. ***Wear full eye protection and protective clothing;***
2. ***If the electrolyte contacts the skin, wash it off immediately with water;***
3. ***If the electrolyte contacts the eyes, flush them thoroughly and immediately with water and seek medical attention; and***
4. ***Wash spilled electrolyte down with an acid neutralizing agent. A common practice is to use a solution of one pound (500 grams) bicarbonate of soda (also known as baking soda or sodium bicarbonate) to one gallon (4 liters) of water.***
5. ***Continue to add the bicarbonate of soda solution until the evidence of reaction (that is, foaming) has stopped.***
6. ***Flush the resulting liquid with water and dry the area.***

3.9.3 Battery Maintenance

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death. Arcing at battery terminals or in light switches or other equipment, and flames or sparks can ignite battery gas causing severe personal injury.

Always follow these procedures to avoid injury and/or damage:

- ***Ventilate the battery area before working on or near the battery.***
- ***Wear safety glasses.***
- ***Do not smoke.***
- ***Switch a work light on or off away from the battery.***

Make sure the generator set is shut down and disabled:

1. ***Press the generator set's red STOP button on the local display to stop the generator set. Allow the generator set to thoroughly cool to the touch.***
2. ***Turn off and disconnect the battery charger from the AC source before disconnecting the battery cables.***
3. ***Disconnect the negative (–) cable from the battery and secure it from contacting the battery terminals to prevent accidental starting.***
4. ***Once work is complete, reconnect the negative (–) battery cable last.***

Always:

- Keep the battery case and terminals clean and dry and the terminals tight.
- Remove battery cables with an insulated wrench or battery terminal puller.
- Make sure which terminal is positive (+) and which is negative (–) before making battery connections, always removing the negative (–) cable first and reconnecting it last to reduce arcing.

NOTICE

If the battery needs to be replaced, make sure that the replacement battery specifications match those found in the Model Specifications in this manual.

3.9.4 Charging

Where a consistent source of AC power is available, Cummins recommends the use of a battery charger to maintain battery condition and charge. Cummins offers several battery chargers.

Where generator sets are used infrequently and a consistent source of AC power is not available, battery recharging must be put on a recharge schedule to ensure that a fully charged condition is maintained.

NOTICE

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

Follow the battery charger operating instructions for proper use.

3.9.5 Battery Replacement

⚠ WARNING

Combustible Liquid

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

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

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

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

3.9.6 Battery Charger Maintenance

Operating the Charger

Charge Cycle:

1. Soft Start: the charger verifies connections are good and the battery is capable of accepting a charge. Batteries with very low voltage will be slowly charged to not harm the battery. When the battery voltage reaches 10V for 30 seconds the charger switches to the next stage.
2. Bulk Stage: the charger uses constant current and charges the battery to 14.3 volts. When the battery holds the voltage of 14.3 volts for 30 seconds the charger switches to the next stage.
3. Absorption Stage: the charger uses constant voltage to charge the battery until the charge current drops. At this point the charger will switch to the next stage.
4. Float Stage: the charger finishes the charge cycle by keeping the battery at 13.3 volts for a period of time and then moves to the next stage.
5. Maintenance: the charger will monitor the battery and if the battery voltage drops below 12.8 volts or if 14 days have passed since the last charge, the charge cycle will start automatically.

TABLE 16. LED INDICATORS

ON	OFF	Condition
Red	Green	The charger is in the “Soft Start” or “Bulk Stage” and the battery is being charged. If the red LED stays on for more than 24 hours refer to Problem 1 in the troubleshooting section.
Red and Green	None	The charger is in the “Absorption Stage” and delivering constant voltage to the battery. If the red and green light stay on for more than 24 hours refer to problem 2 in the troubleshooting section.
Green	Red	The charger has moved to the “Float Stage” and is topping off the charge to the battery and keeping the battery ready to use. The green light indicates your battery is ready to use. If the green light stays on when your battery is known to be low, refer to Problem 3 in the troubleshooting section.

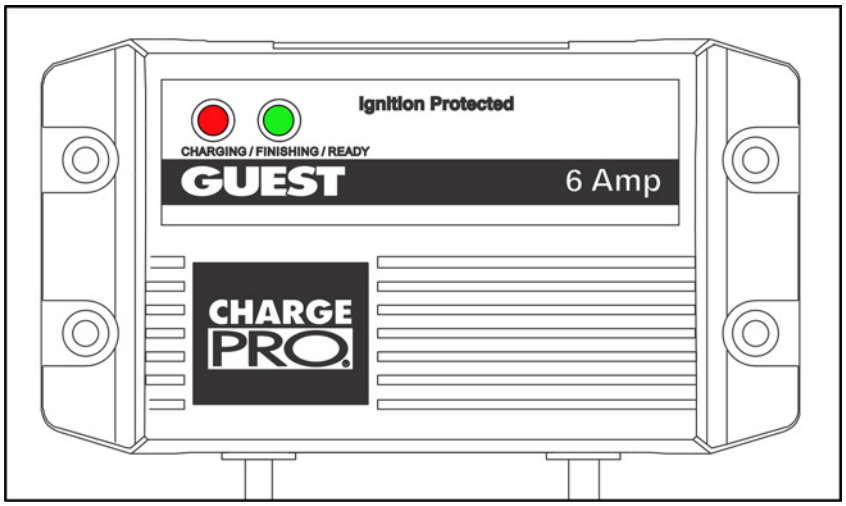


FIGURE 17. LED INDICATORS

TABLE 17. TROUBLESHOOTING THE CHARGER

Display	Operating Condition	Solution
Red LED stays on for more than 24 Hrs.	1. One or more defective or damaged battery cells. 2. Charger has reduced its output voltage below the normal level due to a DC overload or a DC short. 3. On-board DC systems are drawing more current than the charger can replace.	1. Load test the battery and replace if necessary. 2. Remove the source of the overload or short. Disconnect the charger's black (NEGATIVE) terminal from the battery. Reapply AC power and the green LED only should now light. 3. Turn off all DC equipment while charging.
The red and green LED's stay on for more than 24 Hrs.	1. On-board DC systems are drawing more than 2 amps. 2. One or more defective or damaged battery cells. 3. Extremely low AC voltage at the battery charger.	1. Turn off all excess DC equipment while charging. 2. Load test the battery and replace if necessary. 3. Apply a higher AC voltage source or reduce the length of the extension cord. 4. Check battery manufacturer's specs on battery charging.
Green LED stays on when the battery is known to be low	1. Open DC output fuse. 2. Faulty or contaminated terminal connections. 3. One or more defective or damaged battery cells.	1. Replace DC output fuse with a 10 amp fuse. 2. Clean and tighten or repair all terminal connections. 3. Load test the battery and replace if necessary.
Neither of the LED's turn on when the AC power is applied	1. No AC power available at the charger 2. Component failure	1. Clean and tighten or repair all terminal connections. 2. Load test the battery and replace if necessary.
Red and Green blink	1. Charger is not charging the battery	1. Charger cannot get the battery to charge. Check to see if the battery is too large for the charger or if there is a problem with the battery. Unplug the charger from the AC power to start the charger again.
Note: If all of the above steps have been considered, and no solution is found, replace the charger.		

3.10 Spark Plugs

NOTICE
Make sure service personnel are qualified to perform electrical and mechanical service.

The generator set has six spark plugs, all accessible from the top of the engine. The spark plugs must be in good condition for proper engine starting and performance. A spark plug that fouls frequently or has heavy soot deposits indicates the need for engine service.

1. Set the generator set control to the Off position before checking the spark plugs.

2. To prevent cross-threading a spark plug, always thread it in by hand until it seats. Torque the spark plug to 38 Nm (28 lb-ft).
3. Return the generator set control to the desired setting when finished performing maintenance.

3.11 Ignition Coils/Ignition Wires

NOTICE
Make sure service personnel are qualified to perform electrical and mechanical service.

The generator set has six ignition coils and wires, all accessible from the top of the engine. The parts must be in good condition for proper engine starting and performance. Any parts that are broken or have exposed wires, indicates the need for the them to be replaced.

1. Set the generator set control to the Off position before checking the ignition system.
2. When removing the ignition wire you must turn the boot 180 degrees, and you should hear it release.
3. Inspect and clean the insulator of the spark plugs.
4. Replace ignition coils and wires.
5. Return the generator set control to the desired setting when finished performing maintenance.

3.12 Cleaning the Generator Set Housing

The housing of the generator set housing can be damaged by pressure washing or solvents and other cleaning agents. Only use soap and water or an “all citrus degreaser" to clean the housing.

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4 Service

4.1 Control System

4.1.1 Overview

Refer to the controller service manual for additional information.

4.1.1.1 PowerCommand 2.x

The PowerCommand 2.x is suitable for non-paralleling generator sets in standby or prime-power applications.

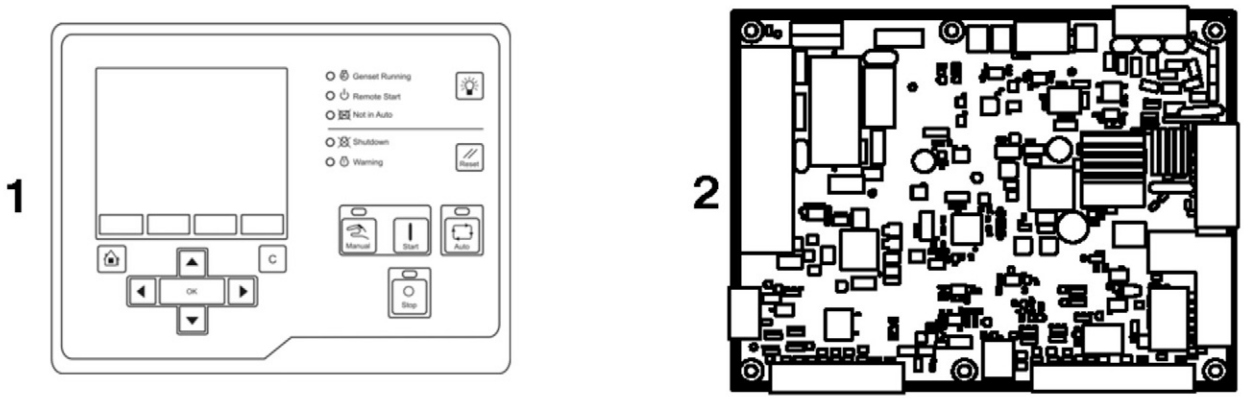
The PCC is a microprocessor-based controller that has these abilities:

- Controls the generator set to maintain a specified generator set voltage and frequency
- Warns the operator when unsafe conditions are occurring
- Shuts down the generator set to prevent damage
- Provides a way for other devices (such as the operator panel) to monitor, manage, and control the generator set

NOTICE
The PCC should be installed where it can be accessed only by authorized service representatives. Unauthorized personnel, including an operator, should not have access to it.

4.1.1.2 Components (PC 2.3)

The PowerCommand 2.3 consists of the following parts:



No.	Description	No.	Description
1	HMI 320 ("Operator Panel") (Part Number 0300-6315-01)	2	PCC 2300 Controller ("PCC") (A053T067)

FIGURE 18. PC 2.3 COMPONENTS

4.1.1.3 Operator Panel

The Operator Panel is one way to monitor, manage, and control the generator set. An operator can use the Operator Panel to do these things:

- Look at the status of the generator set
- Adjust settings that affect generator set behavior
- Start and stop the generator set

NOTICE
In addition to the Operator Panel, other devices can monitor, manage, and control the generator set too. Such devices might be as simple as a switch or a push button or as sophisticated as other controllers or computers. This manual introduces the ways the PCC can interact with other devices, but this manual cannot identify all of the devices that might be used in every application.

4.1.1.4 Remote HMI Operator Panel (Optional)

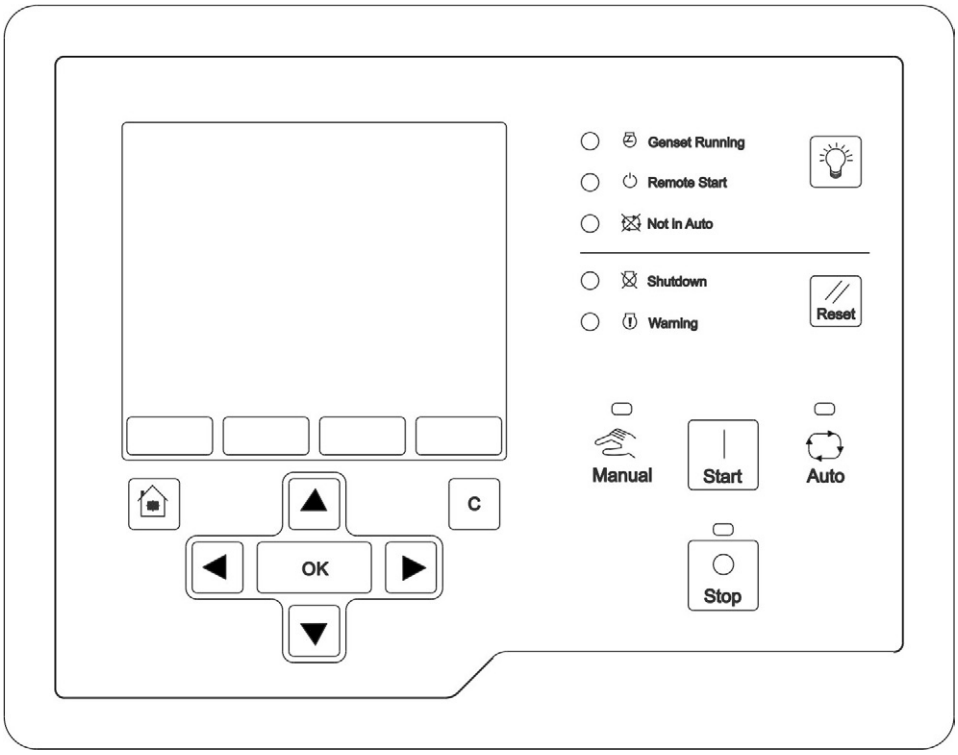


FIGURE 19. REMOTE HMI 320 OPERATOR PANEL (PART #0300-6315-03) (OPTIONAL)

4.1.2 Engine Control Module (ECM)

4.1.2.1 Engine Control Module (ECM)

The Engine Control Module (ECM) monitors signal inputs from engine sensors to control the fuel metering and speed of the engine (see the figure below). The ECM also provides diagnostic control over the engine and fuel system. The PCC controls the starting and stopping sequence of the engine through the ECM.

In the event of an engine fault, the ECM provides a signal output via the CAN datalink to the PCC. If the ECM triggers an engine shutdown, the PCC displays an engine shutdown or service fault. The PCC will display an additional fault to determine the root cause of the engine shutdown. If no additional fault is displayed in the PCC, the engine fault code can be determined by connecting to the ECM with the 4G service tool. For service tool information, see the Service Tool Manual (A043D529).

For more information, see the following EControls, Inc. publications:

- 4G Software Operator Manual (A052G024)
- EControls 4G Diagnostic Support Manual & Trouble Code Definitions (A052G032)

These manuals can be found in QuickServe OnLine (QSOL).

The wiring harness and 4G Display software required to perform engine diagnostics are available from your authorized distributor.

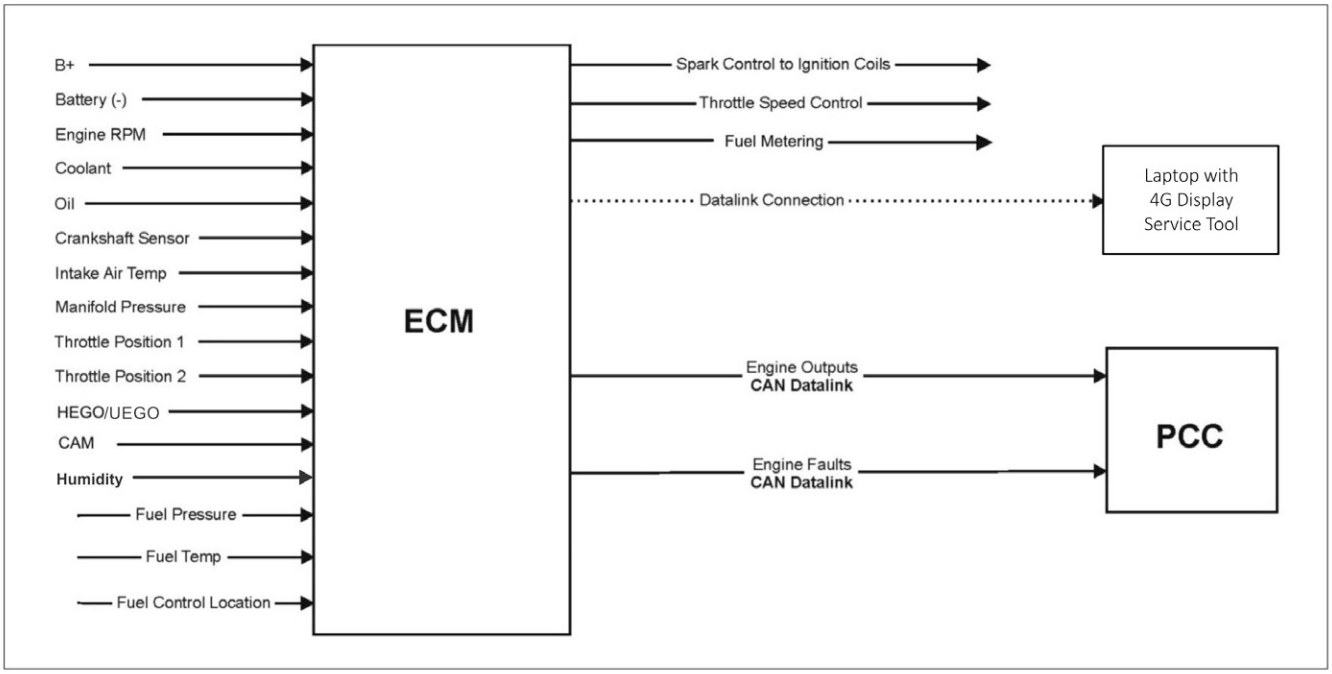


FIGURE 20. ECM INPUTS AND OUTPUTS

4.1.2.2 Keyswitch Control

The keyswitch input to the ECM remains active during all controller modes other than when the Sleep Mode is active or the Emergency Stop is engaged. The PCC sends a start signal to the ECM via the Keyswitch Relay and the Start Relay. When the PCC detects a start command, both relays become charged, sending the start signal to the ECM, causing the engine to crank.

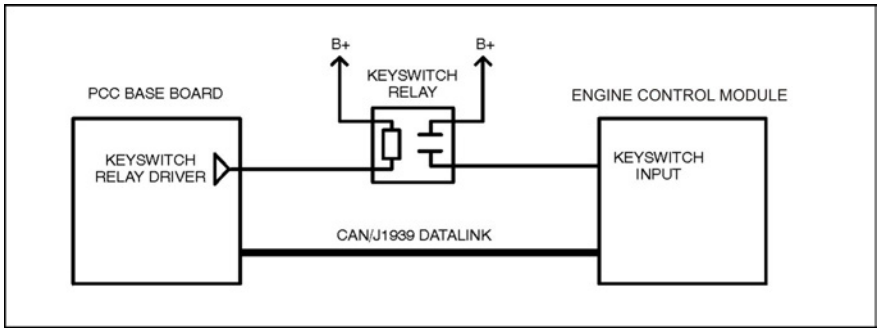


FIGURE 21. CONTROL SYSTEM BLOCK DIAGRAM

4.1.2.3 Reprogram ECM

1. Obtain the latest revision of ECM calibration from the InCal website at *www.cumminspower.com/en/services*. Refer to Instruction Sheet G755.
2. Save the file on a laptop.
3. Make sure the generator set is stopped, is off (that is, in Off mode), and the breaker is in the open position.
4. If the unit is connected to a fuel supply, shut off the fuel supply.
5. Connect the ECM to the laptop.
6. Log in using one of the following passwords:

Tool	Password
4G	GLTX-0BIS-534R-SVUX

7. Open the 4G service tool.
8. Use the pull-down **File** menu on the upper left of 4G screen and select **Reprogram Target**. See the figure below.

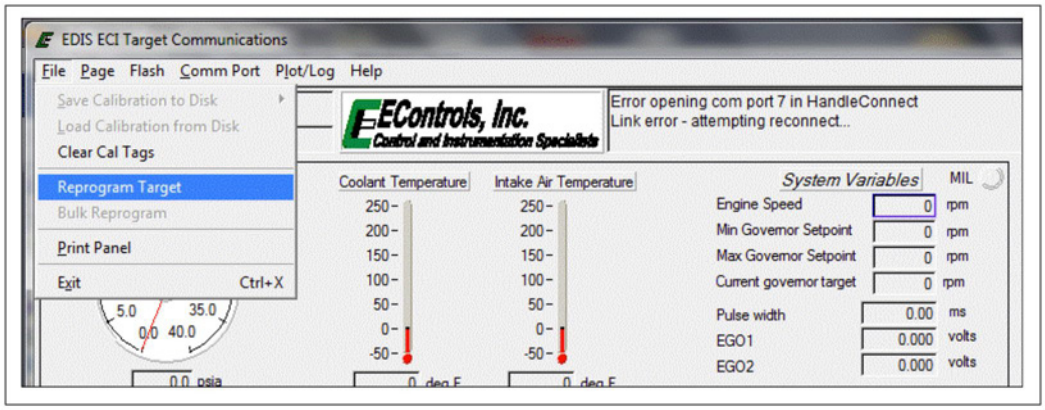


FIGURE 22. PULL DOWN REPROGRAM TARGET SELECTION

9. Select file to download (.MOT file). See the figure below.

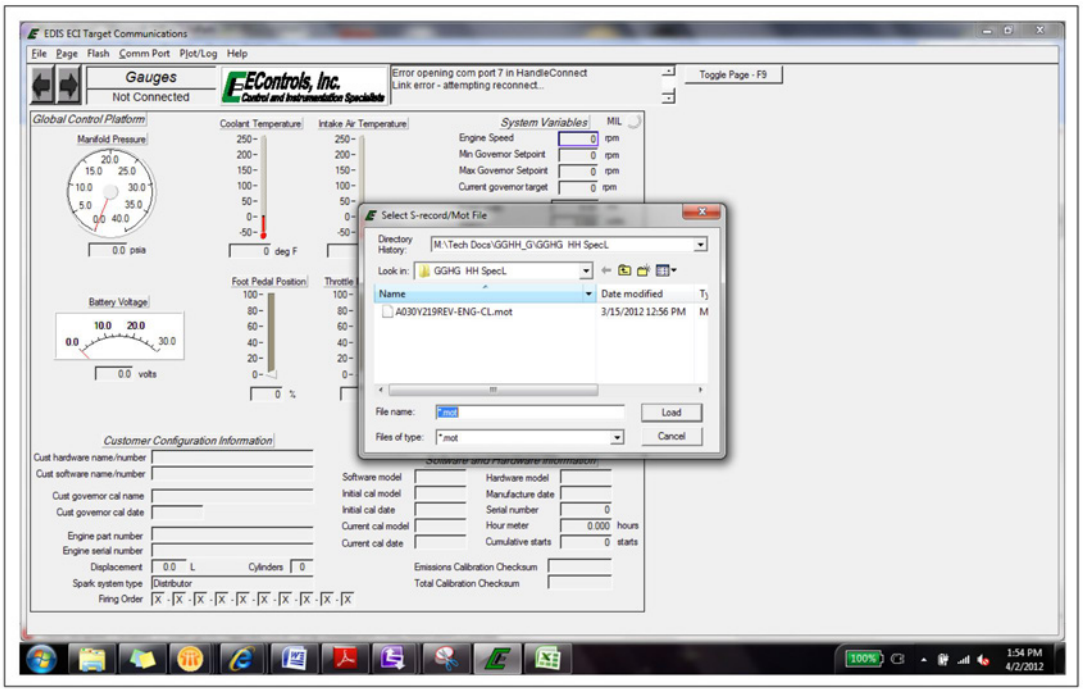


FIGURE 23. MOT FILE

10. The status bar displays the calibration status.
11. Confirm in the lower left hand corner of the "Gauges" page that the new calibration is loaded. See the figure below.

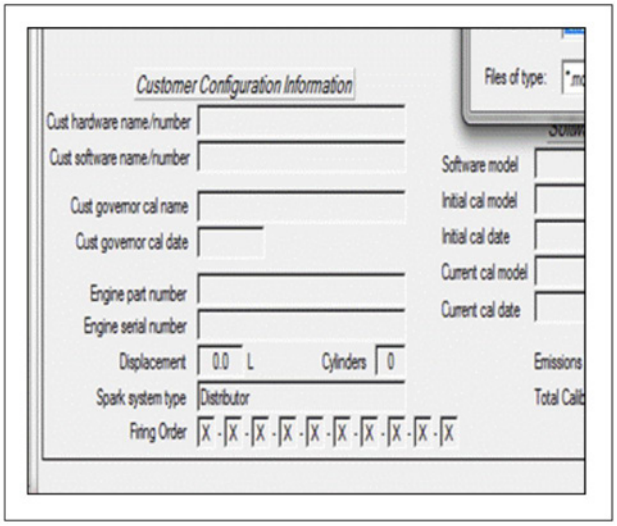


FIGURE 24. ECM UPDATE DOWNLOAD CONFIRMATION

4.1.2.4 Viewing Engine Faults

Fault information can be viewed using the 4G service tool. See the Reprogram ECM section for login information. The 4G service tool is available from Cummins. The 4G software consists of several pages of display information. All fault and diagnostic information is managed through the Faults page. Interaction includes viewing fault messages, downloading fault data (fault snapshot and flight data recorder), and erasing faults from memory.

Faults are separated into two categories, Active and Historic. Active faults are active in real-time and historic faults have been generated at some instance in time that may or may not be active in real-time. When a fault becomes active, it is immediately logged as historic and a snapshot and flight data log is saved. The first image below shows an example of the fault page when an active fault has been generated. Notice that the fault is present in both the active and historic lists and the malfunction indicator lamp (MIL) has been illuminated. The second image below shows an example of the fault page with a historic fault stored in memory.

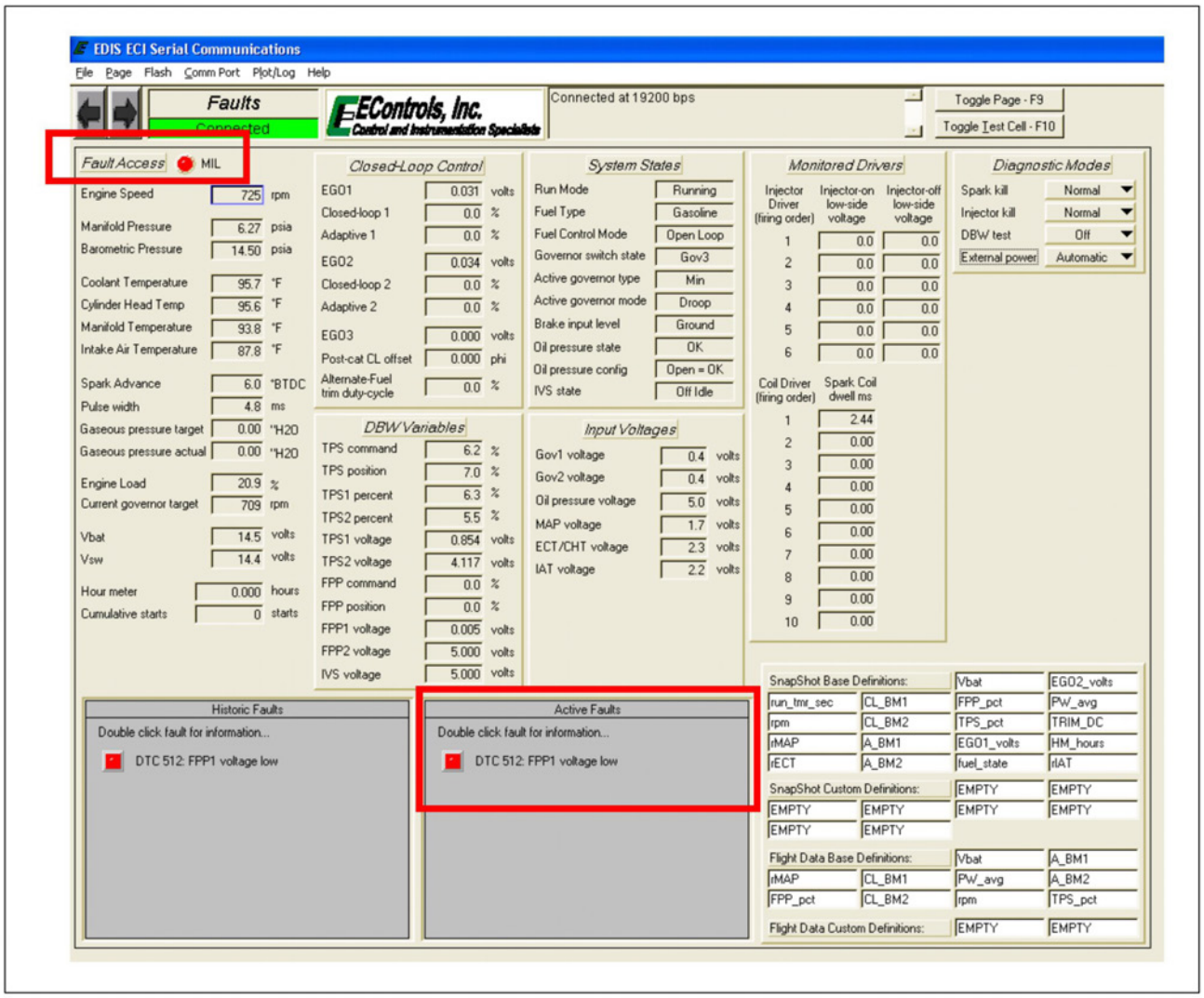


FIGURE 25. FAULTS PAGE WITH ACTIVE FAULT MESSAGE

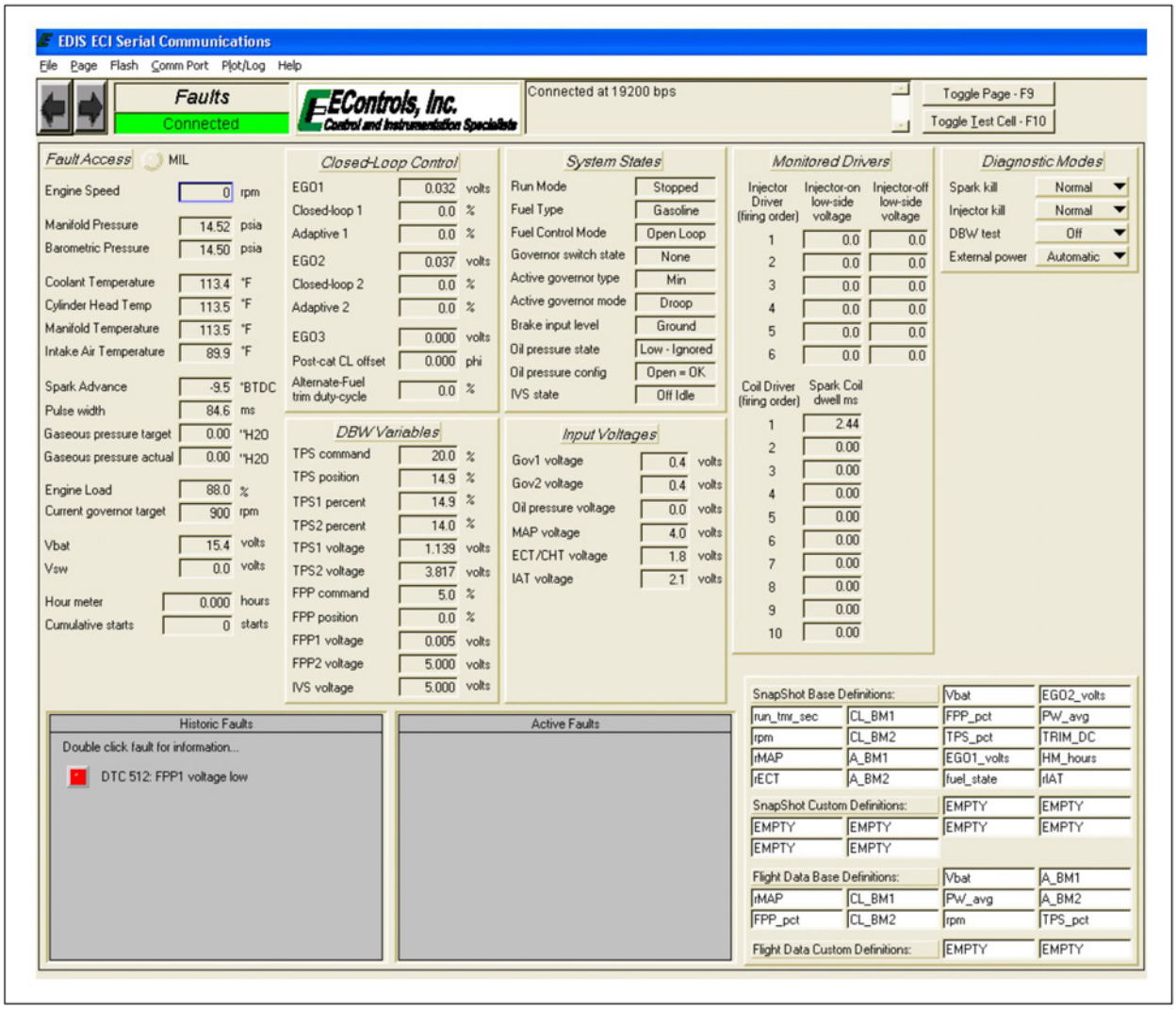


FIGURE 26. FAULTS PAGE WITH HISTORIC FAULT MESSAGE

When an engine fault occurs, a fault snapshot (FSS) and flight data recorder (FDR) are logged within the ECM.

Fault snapshot is data recorded at the instant the fault is triggered. This data is only logged for the first eight (8) faults on the first occurrence of each fault. The fault snapshot is a sample of data taken at the instance the fault triggered. The fault snapshot is stored in the EEPROM and is retained even when battery power has been lost.

The flight data recorder is ten seconds of recorded data, eight (8) seconds prior to the fault and two (2) seconds following the fault. This data is saved for the first two occurrences of the fault. Flight data recorder data is saved in the RAM, and will be erased if the ECM loses battery power.

Both sets of data are accessed from the Historic Fault Information interface and can be saved to the PC upon retrieval.

4.1.2.5 Accessing Fault Information

Fault information can be accessed by double left-clicking the fault LED in the historic fault list. This produces the Historic Fault Information interface shown in the image below. From this interface the user can interpret a diagnostic trouble code (DTC) message, identify whether or not the fault occurred during the current start cycle, identify if the fault caused the engine to shut down, determine how many start cycles have occurred since the fault was last active, and view snapshot and flight data.

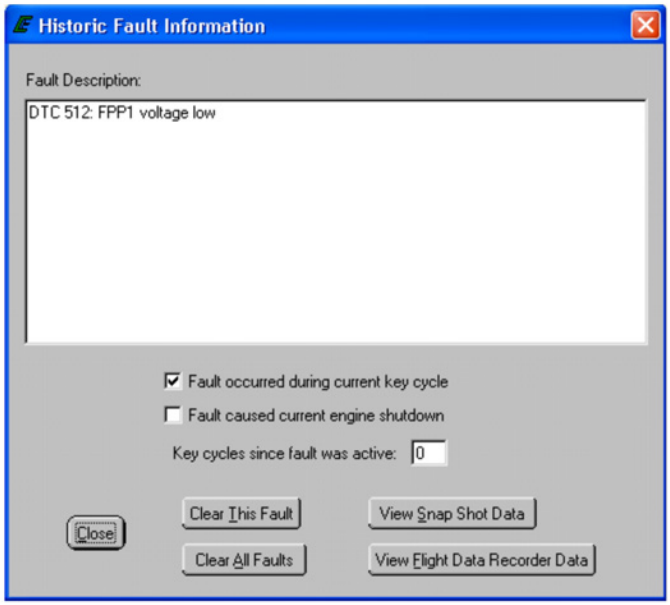


FIGURE 27. HISTORIC FAULT INFORMATION INTERFACE

The table below outlines the options displayed in the Historic Fault Information screen. Historic faults are not overwritten if the same fault becomes active, storing data from the original active fault.

TABLE 18. HISTORIC FAULT INFORMATION INTERFACE FUNCTIONS

Fault Description Message Box	Customized Text that References the DTC Flash Code and Describes the Fault
Fault During Key Cycle Checkbox	Informs that the fault occurred during the current key-on event.
Fault Caused Engine Shutdown Checkbox	Informs that the fault caused the engine to shutdown.
Key Cycles Since Fault Active Indicator	Displays the amount of key-on events since the fault was last active.
Clear This Fault Button*	Erases the selected historic fault from the ECM.
Clear All Faults Button*	Erases all historic faults from the ECM.
View Snap Shot Data Button	Retrieves a data “snap shot” from the ECM for variables defined in the base and custom snapshot variable definition lists.
View Flight Data Recorder Data Button	Retrieves a 10-second data strip chart (8 seconds prior, 2 seconds after fault trigger) from the ECM for variables defined in the base and custom flight data recorder definition lists. An example.
Close Button	Exits the Historic Fault Information interface. DOES NOT cancel or clear any faults.

Fault Description Message Box	Customized Text that References the DTC Flash Code and Describes the Fault
* Snapshot and flight data recorder data for historic faults is erased if the fault is cleared from memory.	

The image below is an example of a fault snapshot after View Fault Snapshot is selected. Data is presented in two columns, base and custom variables. When retrieved, the FSS data may be saved to the PC in text format with an *.fss* extension. A FSS saved to a PC may be reviewed in any ASCII based software program.

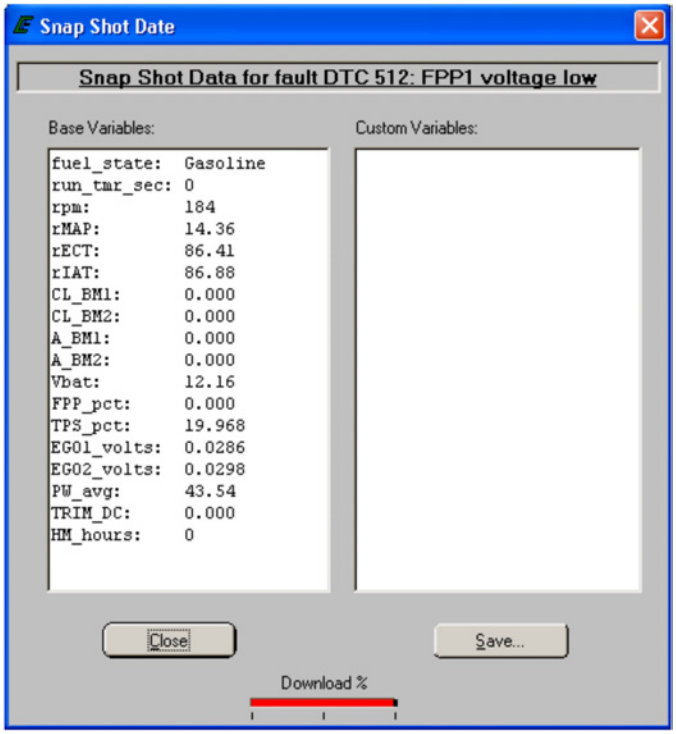


FIGURE 28. SNAPSHOT DATA INTERFACE

The image below shows the Flight Data Recorder interface after View Flight Data Recorder is selected. The FDR captures a ten second (eight seconds prior and two seconds after generating the fault) strip of data for base and custom variables. FDR data is presented in an interface similar to the Plot interface for a quick graphical presentation. From this interface, the FDR data may be saved to the PC in text, tab-delimited format with an *.fdr* file extension. When saved to a PC, FDR data may be reviewed using any graphical post-processing software capable of handling tab-delimited formatting.

FIGURE 29. FLIGHT DATA RECORDER INTERFACE

For more information regarding the 4G service tool, refer to the following document:

- *If applicable:* 4G Software Operator Manual (A052G024)

4.1.2.6 Engine Control Module (ECM) Software

EControls ECM display software (4G Display) is required to service all of the models this manual covers, as shown below:

Display Software	Version	Models	Service Password
4G	391 or newer	C70 N6	GLTX-0BIS-534R-SVUX
		C80 N6	
		C100 N6	
		C125 N6	
		C150 N6	

The software enables the user to view ECM faults, reprogram ECM software, and view gauges.

4.1.2.7 ECM Fault Codes

NOTICE
The EControls manual applies to several applications. See the wiring diagrams provided with the generator set or the Wiring Diagrams appendix for appropriate pin numbers.

DTC Code	Description	Models
		C125 N6, C150 N6
7	Lockoff short to power	■
16	Crank and/or Cam Could Not Synchronize During Start[1]	■

DTC Code	Description	Models
		C125 N6, C150 N6
107	MAP low voltage	■
108	MAP High Pressure	■
111	IAT higher than expected Stage 1	■
112	IAT low voltage	■
113	IAT high voltage	■
116	ECT higher than expected Stage 1	■
117	ECT / CHT low voltage	■
118	ECT / CHT high voltage	■
120E	DBW drive current high	■
121	TPS1 % lower than TPS2 %[2]	■
122	TPS1 Signal Voltage Low[2]	■
123	TPS1 Signal Voltage High[2]	■
127	IAT higher than expected Stage 2	■
187	FT gaseous fuel extremely low	■
187	FT gaseous fuel low	■
188	FT gaseous fuel high	■
217	ECT higher than expected 2	■
219	Max govern speed override	■
221	TPS1 % higher than TPS2 %[2]	■
222	TPS2 Signal Voltage Low[2]	■
223	TPS2 Signal Voltage High[2]	■
301A	UEGO1 internal supply voltage low	■
336	Crank Input Signal Noise[3]	■
337	Loss of Crankshaft Input Signal[3]	■
341	Camshaft Input Signal Noise	■
342	Loss of Camshaft Input Signal	■
520	Oil pressure low stage 1 (sender)	■
521	Oil pressure high (sender)	■

DTC Code	Description	Models
		C125 N6, C150 N6
522	Oil pressure sender low voltage	■
523	Oil pressure sender high voltage	■
524	Oil Pressure Low[4]	■
562	Battery Voltage (VBat) Low[5]	■
563	Battery Voltage (VBat) High[5]	■
601	Microprocessor Failure - Flash	■
604	Microprocessor Failure - RAM	■
606	Microprocessor Failure - COP	■
642	Sensor Supply Voltage 1 Low (5Vext1)	■
643	Sensor Supply Voltage 1 High (5Vext1)	■
685	Relay coil open	■
686	Relay control ground short	■
687	Relay coil short to power	■
1089	Fuel run-out longer than expected	■
1111	Fuel rev limit	■
1112	Spark rev limit	■
1113	RPM higher than expected	■
1151	Closed Loop High (LPG)	■
1152	Closed Loop Low (LPG)	■
1153	Closed Loop High (Natural Gas)	■
1154	Closed Loop Low (Natural Gas)	■
1161	Adaptive Learn High (LPG)	■
1162	Adaptive Learn Low (LPG)	■
1163	Adaptive Learn High (NG)	■
1164	Adaptive Learn Low (NG)	■
1171	MegaJector/EPR delivery pressure higher than expected[6]	■
1172	MegaJector/EPR delivery pressure lower than expected[6]	■
1173	MegaJector/EPR comm lost[7]	■
1174	MegaJector/EPR voltage supply high[8]	■

DTC Code	Description	Models
		C125 N6, C150 N6
1175	MegaJector/EPR voltage supply low[8]	■
1176	MegaJector/EPR internal actuator fault detection	■
1177	MegaJector/EPR internal circuitry fault detection	■
1178	MegaJector/EPR internal comm fault detection	■
1601	Envirotech receipt lost[10]	■
1612	Microprocessor Failure - RTI 1	■
1613	Microprocessor Failure - RTI 2	■
1614	Microprocessor Failure - RTI 3	■
1615	Microprocessor Failure - A/D	■
1616	Microprocessor Failure - Interrupt	■
1626	CAN1 Tx failure	■
1627	CAN1 Rx failure	■
1628	CAN1 address conflict failure	■
1673	Calibration Configuration Error	■
1674	Hardware ID Failure	■
2111	Unable to reach lower TPS	■
2112	Unable to reach higher TPS	■
2135	TPS1/2 simultaneous voltages out of range	■
2228	BP low pressure	■
2229	BP high pressure[9]	■
3011	UEGO1 internal processor fault	■
3012	UEGO1 heater supply high voltage	■
3014	UEGO1 cal resistor voltage high	■
3020	UEGO1 sense cell voltage high	■
3024	UEGO1 sense cell slow to warm up	■
3026	UEGO1 sense cell impedance high	■

DTC Code	Description	Models
		C125 N6, C150 N6
3031	UEGO1 heater open / ground short	■
3032	UEGO1 heater short to power	■

[1]Mag Pickup sensor on camshaft. Hall-Effect sensor on crankshaft.
[2]TPSs are potentiometers, with 1 starting "low" at 0 Ohms
[3]Hall-Effect sensor used
[4]Inspect the sensor
[5]VDC
[6]EPR is integrated in the ECM in some units.
[7]EPR is integrated in the ECM in some units. If this fault occurs, replace the ECM/EPR module.
[8]Make sure the pressure regulator valve moves freely. If so, replace the ECM/EPR module.
[9]psig
[10]Humidity sensor used

4.1.3 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.

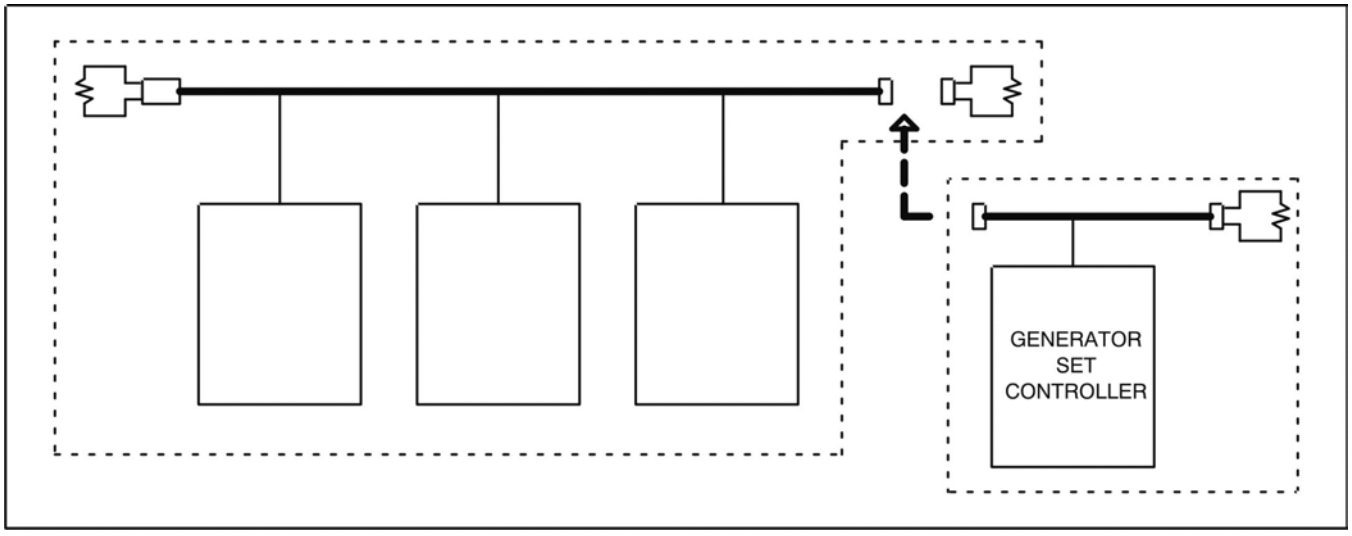


FIGURE 30. CAN DATALINK

4.1.3.1 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 19. 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).

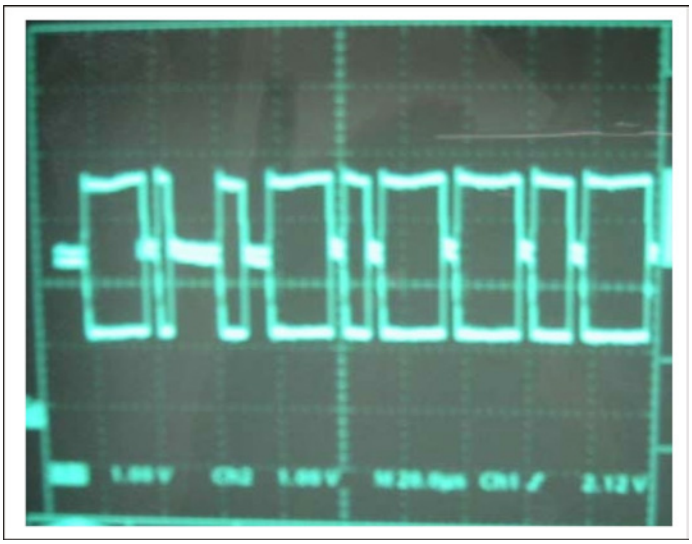


FIGURE 31. CAN DATALINK: GOOD SIGNAL

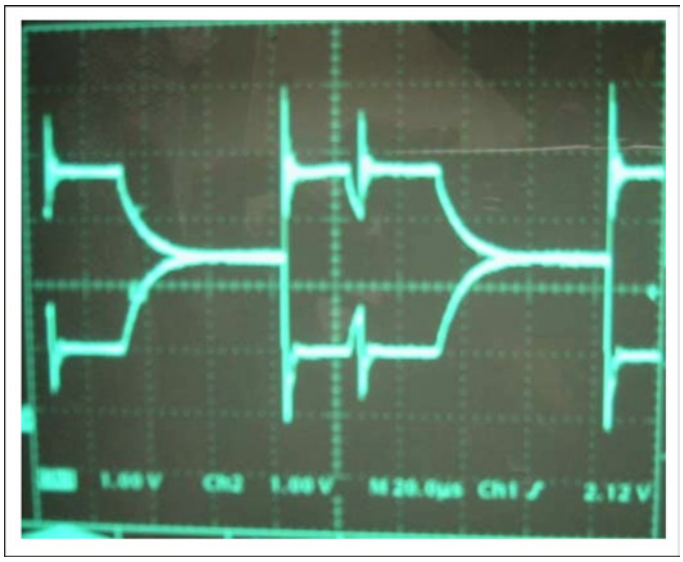


FIGURE 32. CAN DATALINK: BAD SIGNAL

4.1.3.2 J10 Connections

The CAN datalink connects to the PCC baseboard via connector J10. J10 pin connections are identified in the following table.

TABLE 20. CONNECTOR J10

Description	Pin
CAN +	1
CAN -	2
CAN Shield	3
Keyswitch +	4
Keyswitch -	5

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.

4.1.3.3 J11 Connections

The CAN datalink connects to the PCC baseboard via connector J11. J11 pin connections are identified in the table below.

TABLE 21. CONNECTOR J11

Description	Pin
CAN +	20
CAN -	19
CAN Shield	17
Keyswitch +	22
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.

4.1.4 PCC Base Board

The PCC 2300 controller (Part Number 0327-1636) circuit board (shown in the figure below) contains the microprocessor and the operational software for the PCC.

This circuit board is potted to provide resistance to dust and moisture. It is specifically designed and tested for resistance to RFI/EMI. In addition, it includes transient voltage surge suppression to provide compliance with referenced standards.

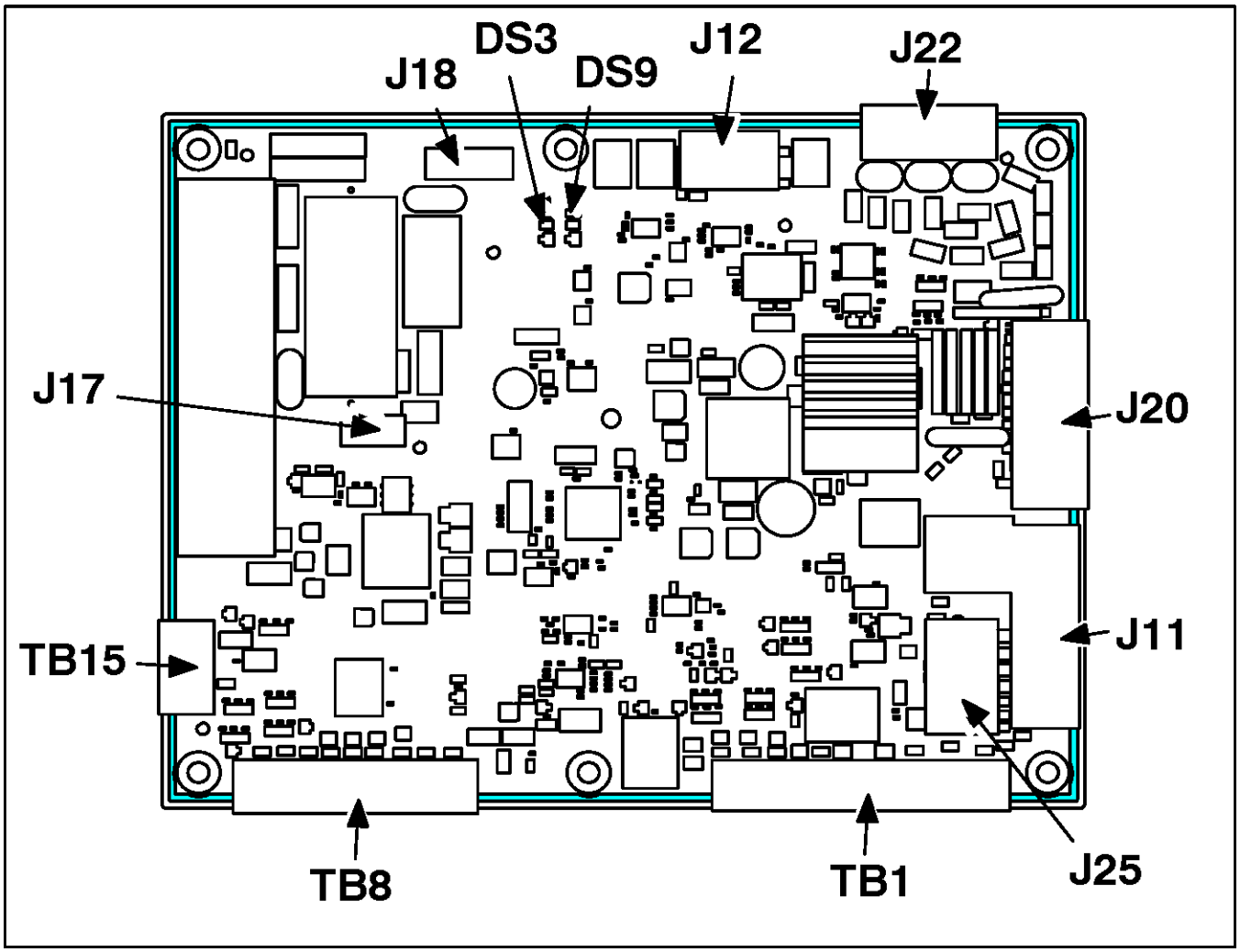


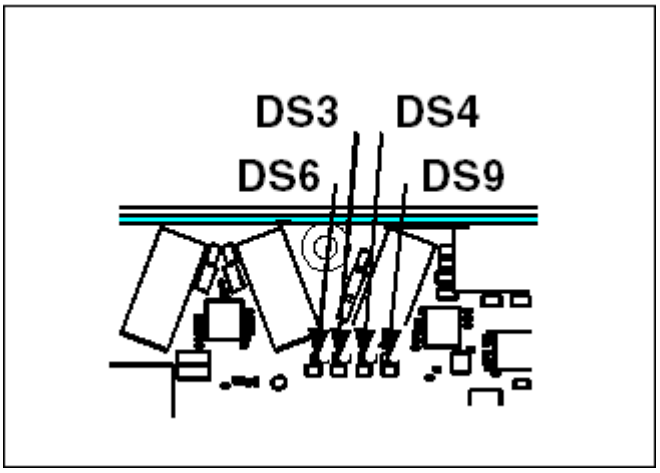
FIGURE 33. PCC BASE BOARD

4.1.4.1 LEDs

NOTICE
DSx, where x is a number, is the typical way to indicate that a hardware component is a light (LED or incandescent).

The LEDs are located next to CT2 and CT3.

TABLE 22. PCC BASE BOARD LEDS



LED	Color	Description
DS3 (Heartbeat)	Green	This LED blinks regularly (once every two seconds) when the PCC has power and is not in power-down mode.
DS4		This is reserved for future use.
DS6	Amber	This LED is on if event 1483 (Common Alarm) is active.
DS9	Amber	This LED is on while the PCC is changing between MON protocol and Modbus protocol on TB15. • If the *Protocol Mode* is Modbus, this LED is on when the PCC is receiving or transmitting data through the Modbus connection. • If the *Protocol Mode* is MON, this LED is off. • If the PCC is using Modbus on TB15, this LED is on when the PCC is receiving or transmitting data through the Modbus connection. • If the PCC is using MON on TB15, this LED is off.

FIGURE 34. PCC BASE BOARD LEDS

4.1.4.2 Connecting to the PCC2300

The PCC2300 control requires an RS-232 to RS-485 data converter and a unique cable. The figure below shows the PCC2300 InPower connection.

Kit number 541-1199 is available for use with the PCC2300. The kit includes the RS-232 to RS-485 converter and the cable used for these applications. The 5-pin connector is used to connect either to the control board or the display.

For specific instructions on how to update the PowerCommand calibration, refer to the InPower user manual.

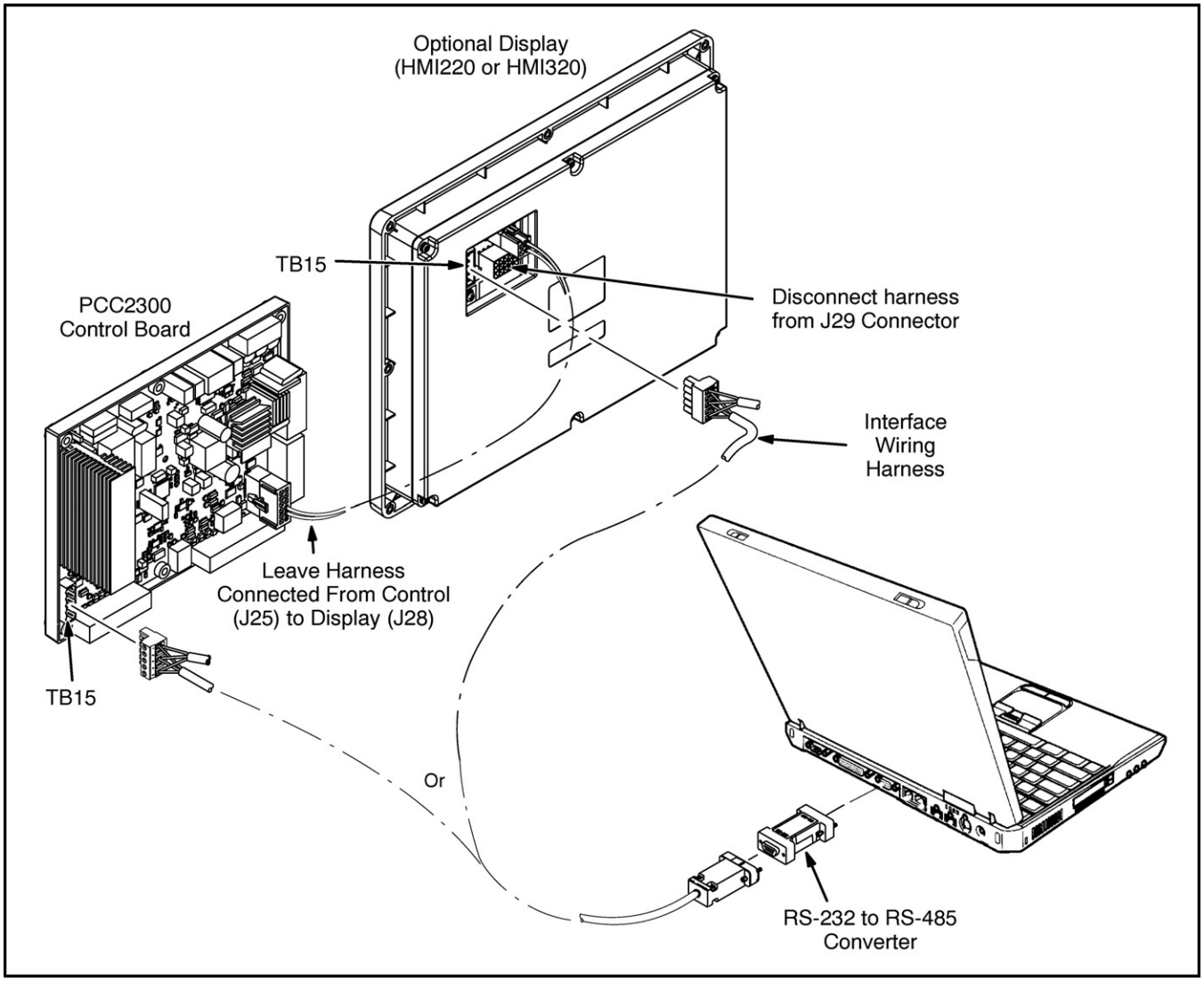


FIGURE 35. KIT INSTALLATION FOR PCC2300 WITH HMI220 OR HMI320 DISPLAY

4.1.5 Human Machine Interface (HMI) Operator Panel

The PC 2.3 Operator Panel has a membrane that is impervious to dust, moisture, oil, and exhaust fumes. The front panel of the Operator Panel is also called the control panel. The HMI 320 graphical display is 320 x 320 pixels. Its part numbers and environmental specifications are shown in the tables below.

TABLE 23. OPERATOR PANEL PART NUMBERS

Part Description	Part Number
HMI 320 (Operator Panel)	0300-6315-01
HMI 320 Operator Panel Software	0326-7431
HMI 320 Operator Panel Language Software	0326-7449 0326-7450
Remote HMI 320 (Operator Panel)	0300-6315-03

Part Description	Part Number
Remote HMI 320 Operator Panel Software	0326-7431
Remote HMI 320 Operator Panel Language Software	0326-7449 0326-7450

TABLE 24. OPERATOR PANEL ENVIRONMENTAL SPECIFICATIONS

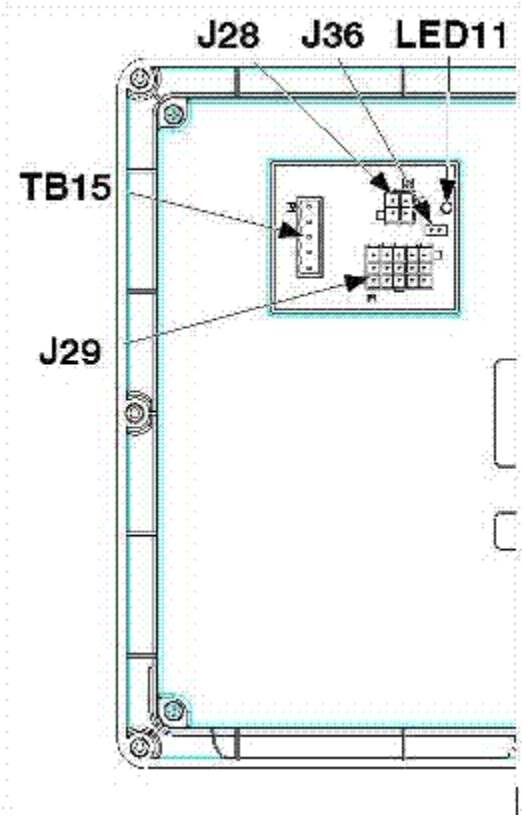
Description	Specification
Operating Temperature	-20 ~ 70 °C (-4 ~ 158 °F)
Storage Temperature	-40 ~ 70 °C (-40 ~ 158 °F)
Operating Humidity	0 ~ 85% (non-condensing)
Storage Humidity	0 ~ 95% (non-condensing)
Vibration Tolerance at:	
• 20 ~ 100 Hz	0.15 mm displacement
• 100 ~ 500 Hz	6 g

The rear panel contains an LED and the connections to the Operator Panel.

NOTICE

Internally, J29 and TB15 use the same connection, so J29 must be disconnected to connect the PC-based service tool on TB15.

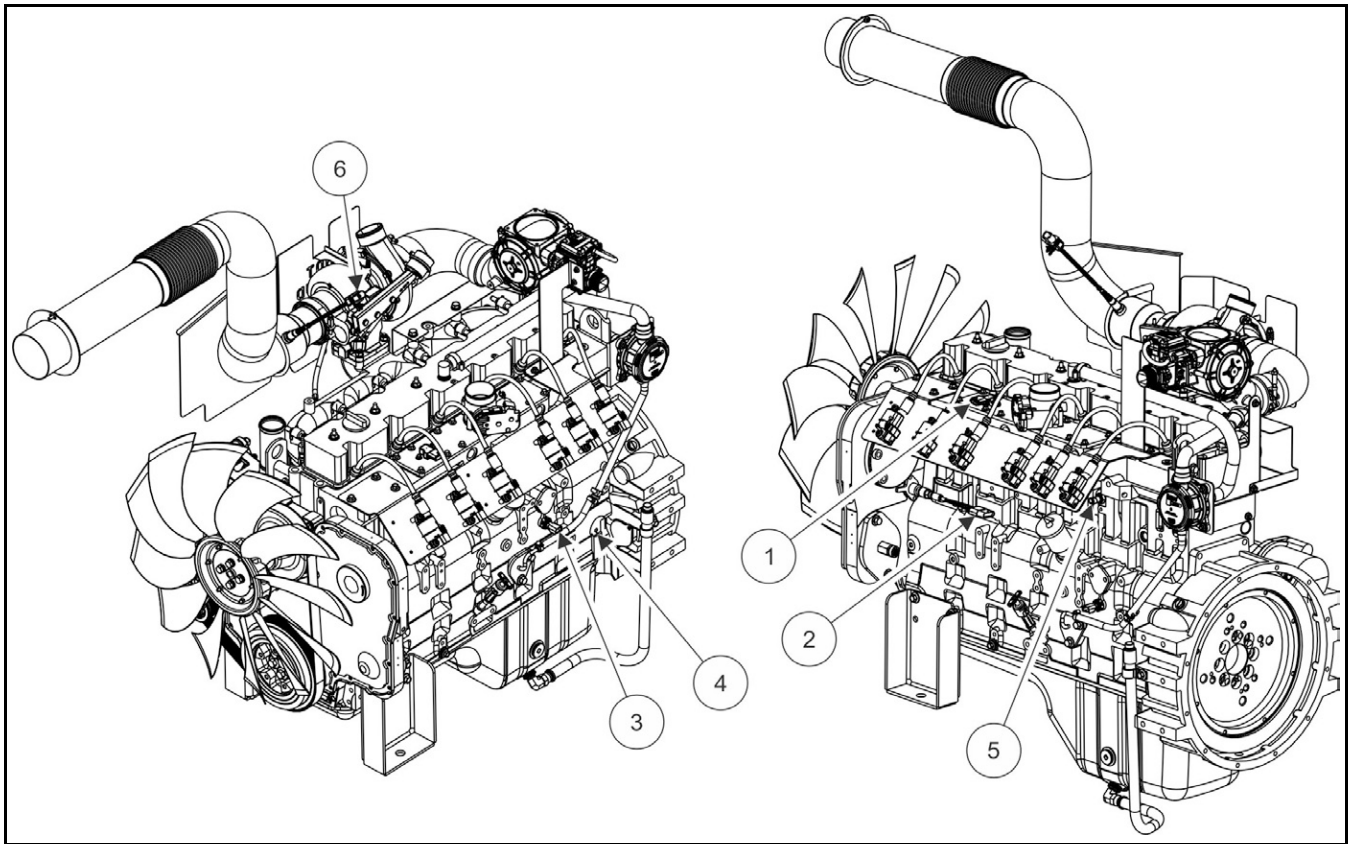
TABLE 25. OPERATOR REAR PANEL LED AND CONNECTIONS



No.	Description	No.	Description
J29	Local Installations (housing 0323-2091, pins 0323-2466)	J36	Power-Down Mode Disable
TB15	Remote Installations, PC-Based Service Tool (housing 0323-2456, pins 0323-2466)	LED11	This green LED blinks regularly when the Operator Panel has power and is not in power-down mode.
J28	Power (housing 0323-2191-04, 0323-2192-04)		

4.2 Sensors

The following figures shows the location of the sensors or senders to which the PCC responds.



No.	Description	No.	Description
1	Temperature Manifold Absolute Pressure (TMAP) Sensor	5	Engine Coolant Temperature (ECT) Sensor
2	Camshaft Position (CMP) Sensor	6	Universal Exhaust Gas Oxygen (UEGO) Sensor
3	Oil Pressure Sensor		Humidity Sensor located on air filter assembly (not shown)
4	Crankshaft Position (CKP) Sensor		

FIGURE 36. SENSOR LOCATIONS

4.2.2 Oil Pressure Sensor

The oil pressure sensor is an analog sender that detects oil pressure from 0 psi to 100 psi and converts it to a voltage between .5 VDC to 4.5 VDC respectively. This voltage is sensed by the PCC and converted to a pressure to be used for display and engine protection. When engine oil pressure falls below the user-defined LOP Warning Threshold for the user-defined LOP Warning Delay, the PCC will activate a warning fault. When engine oil pressure falls below the user-defined LOP Shutdown Threshold for a user-defined LOP Shutdown Delay, the PCC will activate a shutdown fault that will shut down the generator set.

4.2.3 Engine Coolant Temperature (ECT) Sensor

The ECM monitors the engine coolant temperature though the ECT sensor mounted on the engine. The ECM uses this sensor input to make corrections in fueling and to protect the engine from overheating during normal operation.

TABLE 26. COOLANT TEMPERATURE SENSOR RESISTANCE

Temperature (°F)	Temperature (°C)	Resistance (Ohms)
266	130	278
248	120	375
230	110	494
221	105	568
212	100	657
203	95	764
194	90	892
185	85	1,045
176	80	1,229
158	70	1,720
140	60	2,450
122	50	3,560
77	25	10,000
32	0	33,650
-13	-25	138,100
-40	-40	361,100

4.2.4 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.

4.2.5 Camshaft Position (CMP) Sensor

The camshaft position sensor (CMP) is a Mag Pickup type 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.

4.2.6 Universal Exhaust Gas Oxygen (UEGO) Sensor

The Universal Exhaust Gas Oxygen Sensor (UEGO), also referred to as an O_2 sensor, is mounted in the exhaust system after the turbocharger and before a catalyst if equipped. The UEGO monitors the amount of oxygen in the exhaust system versus ambient conditions by determining the pumping current needed to maintain a constant output voltage from a monitoring chamber. Positive pumping current indicates a lean air to fuel (AFR) ratio, and negative pumping current indicates a rich AFR. The scale of the pumping current indications of how lean or rich the operation is relative to a stoichiometric condition. The ECM uses the UEGO sensor output signal to adjust the fuel system to maintain the proper air to fuel mixture.

4.2.7 Additional Sensors

Name	Description
Throttle Position Sensor (TPS)	The ECM monitors the TPS (which is internal to the throttle body) and the TMAP sensor to maintain fuel control and emissions. For more information on the TPS, see the Electronic Throttle Body (ETB) section.
Temperature Manifold Absolute Pressure (TMAP) Sensor	
Humidity Sensor	This value is reported in the ECM where the calibration adjusts to optimize combustion performance for all ambient humidity conditions. The humidity sensor measures the relative humidity, inlet air temperature and barometric pressure of the intake air used for combustion, and sends this information to the ECM via the CAN network. The sensor is located on top of the air intake elbow. It uses four wires: two for 5V voltage supply and return, and two for CAN communication. If the sensor malfunctions, an error code will appear in the ECM as an unidentified engine fault on the generator display.
Direct Acting Pressure Regulator (DEPR)	See the DEPR section.
Low Fuel Pressure Sensor	This sensor is optional on single fuel system. When the fuel pressure falls below 5” w.c.: • *Single fuel system:* The switch will trigger a warning message on the generator display.
Current Transformer	This sensor measures the main alternator electrical current. Its output signal feeds into the control for calculating ampacity, and generator set power, as well as overload and short circuit safety shutdowns.
Ambient Air Temperature Sensor	This sensor senses the air temperature near the generator set. Its output signal feeds into the control to adjust cold start idle duration.

4.3 Fuses and Relays

4.3.1 Fuses and Relays

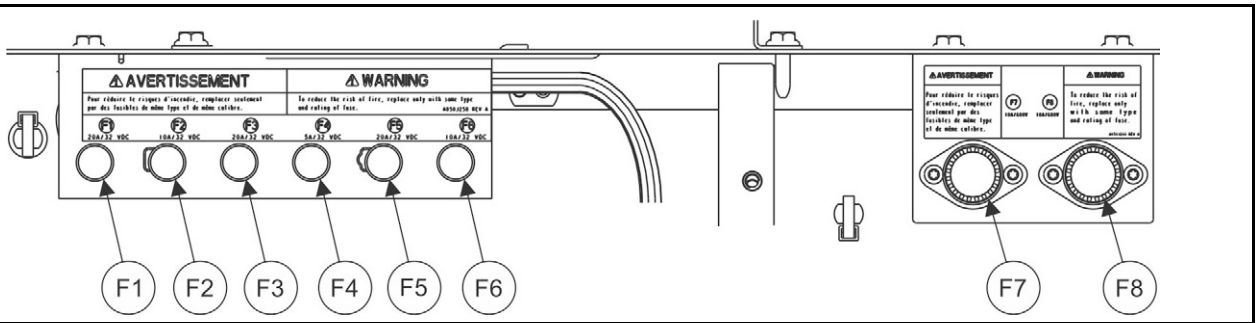
⚠ WARNING

Accidental starting of a generator set can cause severe personal injury or death. Be sure to isolate the battery to prevent accidental starting while working on the generator set.

⚠ CAUTION

Use of an incorrect fuse or relay can damage the generator set. Use replacement fuses and relays of the correct amperage.

4.3.2 Fuse and Relay Box



Fuse	Amps	Volts	Description
F1	20	32 VDC	2300 Control B+
F2	10	32 VDC	Key SW, Alt Flash, LCL, Fuel sol, HMI B+
F3	20	32 VDC	ECM Vbat B+
F4	5	32 VDC	Electronic Pressure Regulator
F5	20	32 VDC	Switched Ignition B+
F6	10	32 VDC	Customer Switched B+
F7	10	600 VAC	AC input, Shunt/PMG
F8	10	600 VAC	AC input, Shunt/PMG

4.3.3 Fuse and Relay Replacement

1. Disconnect the negative (-) cable from the battery first.
2. Remove the positive (+) cable from the battery.
3. Remove the fuse or relay box cover.
4. Remove the faulty fuse or relay.
5. Check the fuse or relay for continuity. If the fuse or relay shows an open circuit, replace the fuse or relay.
6. Install a new fuse or relay. The new fuse or relay must be of the same amperage and voltage as the old fuse or relay.
7. Replace the fuse or relay box cover.
8. Connect the positive (+) cable to the battery first.
9. Connect the negative (-) cable to the battery.
10. Start the generator set to see if the fault condition is fixed.
11. If the replaced fuse or relay becomes open again, troubleshoot to find the fault. Replace the fuse or relay after the fault has been repaired.

4.4 Fuel System

4.4.1 Fuel System Adjustments

NOTICE

Read the warranty statement provided with the generator set for US Environmental Protection Agency (EPA) restrictions on servicing specific components.

4.4.2 Adaptive Learn Function

Adaptive learn is an engine ECM function that allows the generator set to "learn" its environment. There are small differences in the performance of each engine and fuel system component, so the ECM uses inputs from the engine sensors to adjust running conditions to operate more consistently for each individual generator set.

NOTICE

The generator set must be run with no active faults under load (that is, transfer switch connected to maximum customer load available) until the engine reaches stable operating temperature to allow the adaptive learn function to initialize whenever changing the programming in an ECM or replacing any of the components below:

- **Engine internals (including cylinder head assembly, pistons, crankshaft, etc.)**
- **Throttle body**
- **ECM**
- **Universal Exhaust Gas Oxygen (UEGO) sensor**
- **Temperature Manifold Absolute Pressure (TMAP) sensor**
- **Turbocharger**
- **Humidity sensor**
- **Engine coolant temperature (ECT) sensor**
- **Fuel mixer**
- **Direct Electronic Pressure Regulator (DEPR)**

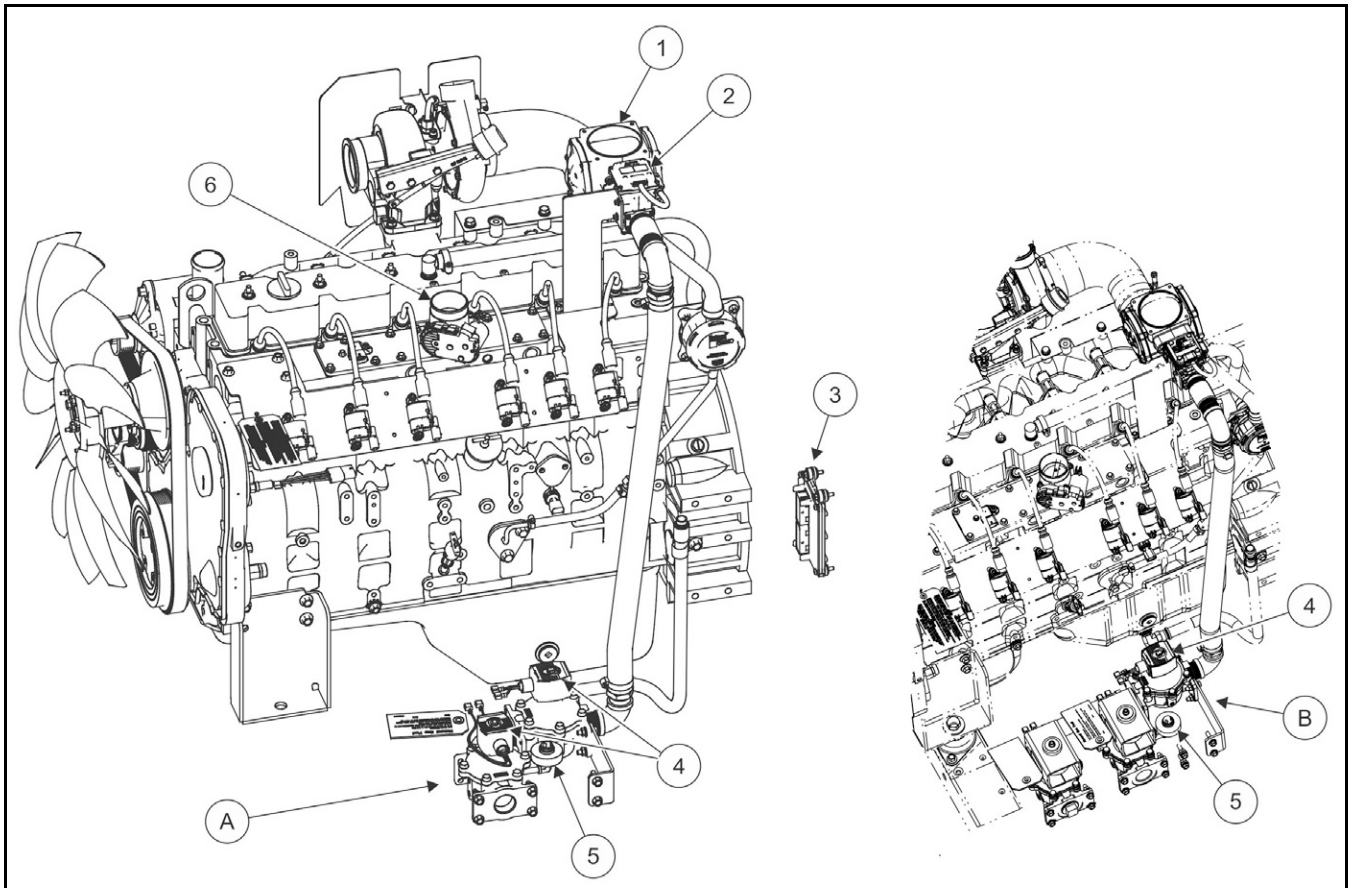
4.4.3 Fuel System Drawing

⚠ WARNING

Gaseous fuels are flammable and explosive. They can cause severe personal injury or death. Do not allow cigarettes, flame, pilot lights, arcing switches, or electrical equipment near gaseous fuel ventilations. Keep a multi-class ABC-type fire extinguisher available.

⚠ CAUTION

Do not attempt to correct power by adjusting the fuel system before determining that the engine and the ignition system are functioning properly. Be sure to check if there is an air cleaner restriction due to dirt accumulation.



No.	Description	No.	Description
A	Single Fuel System	3	ECM
B	Dual Fuel System	4	Fuel Solenoid
1	Mixer	5	Fuel Pressure Sensor (Option on Single Fuel)
2	Direct Acting Electronic Pressure Regulator (DEPR)	6	Throttle Body

FIGURE 37. FUEL SYSTEM

4.4.4 Fuel System Components and Operation

This generator set is equipped for natural gas.

4.4.4.1 Converting the Fuel System Type

For single-fuel systems, the generator set leaves the factory configured for natural gas. No mechanical parts are required for fuel conversion. To convert the fuel system type, configure the control.

1. Enter the Fuel System Menu.
    a. From any Info Menu, hold down the up and down arrows simultaneously for two seconds. The Service Menu appears.
    b. Select **Setup Menus**.
    c. Enter the password **574** on the Password screen. The Setup Menu appears.

d. Select **Genset Service**.

e. Select **Genset**.

f. Advance through the screens until the Fuel System Setup Menu appears.

2. Update the Fuel System Type on the Fuel System Setup Menu. See the figure below.

a. Press **Adjust** on the Fuel System Menu.

b. Edit the Fuel System using the horizontal arrow key. Change the field value by using the +/- keys.

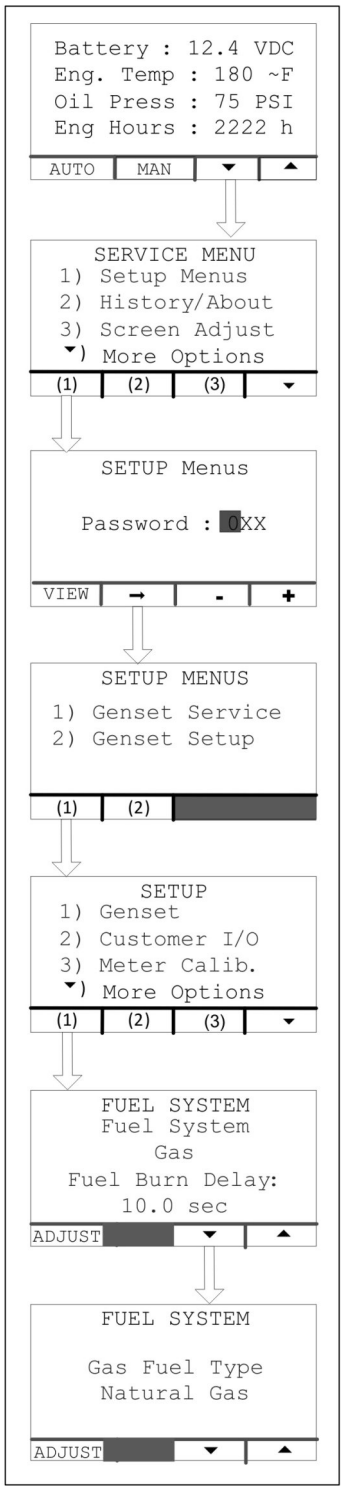


FIGURE 38. FUEL SYSTEM TYPE

3. Update the Gas Fuel Type on the Fuel System Menu.

    a. When changing the Fuel System, a second Fuel System Menu is enabled. Advance to this menu by pressing the down arrow after saving any changes.

b. Press **Adjust** on the Fuel System Menu.

c. Edit the Gas Fuel Type by using the horizontal arrow key. See the figure below.

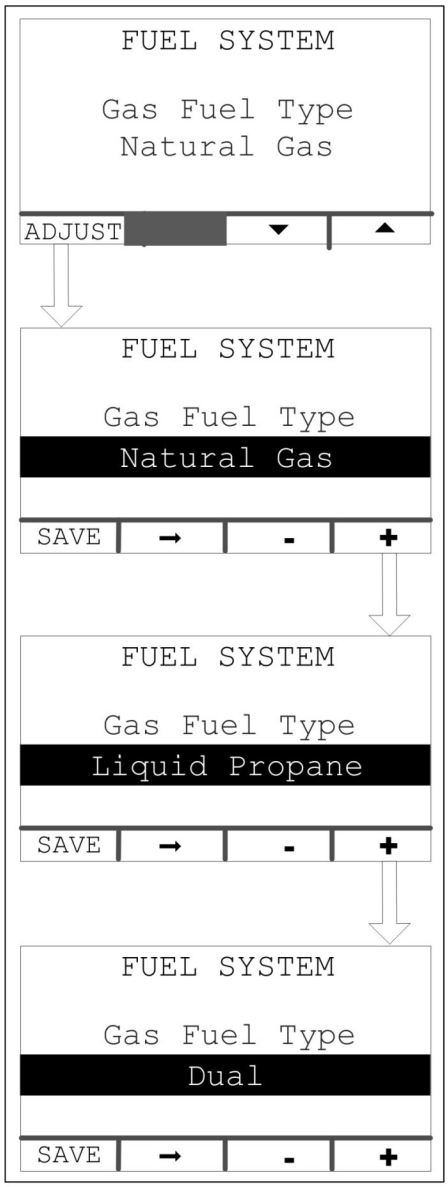


FIGURE 39. GAS FUEL TYPE

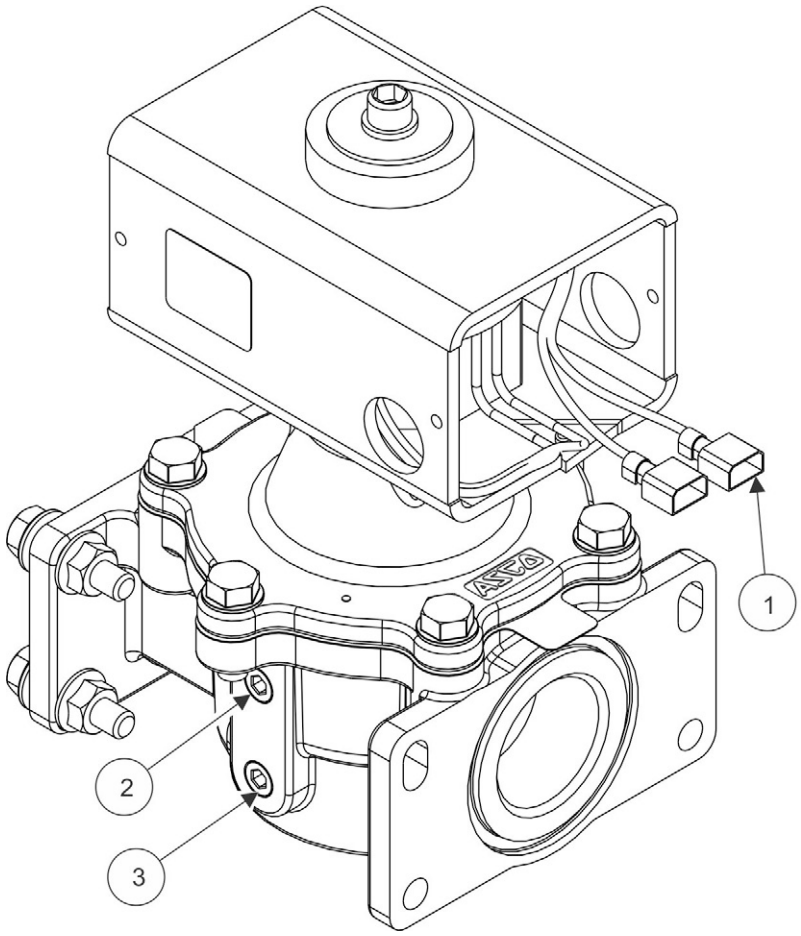
d. Change the field value to Natural Gas, Liquid Propane, or Dual by using the +/- keys.

e. Select **Save** to save the changes.

4.4.4.2 Fuel Shutoff Solenoid Valve

When the engine is cranking or running, an electronic signal is sent to the solenoid, which opens the valve permitting fuel to flow to the pressure regulator and mixer. When the engine is stopped, fuel is sealed off within the valve.

There are two pressure ports on each side of the solenoid. The top port on each side corresponds to the valve inlet. The bottom port on each side corresponds to the valve outlet. The outlet port can be used to determine if the valve is leaking.



No.	Description	No.	Description
1	Power Plug	3	Outlet Pressure Port
2	Inlet Pressure Port		
Note: Test port threads are 1/8" NPT.			

FIGURE 40. FUEL SHUTOFF SOLENOID VALVE

4.4.4.3 Fuel Shutoff Solenoid Troubleshooting

If the generator set does not start, first determine if both valves are in good condition before adjusting the fuel system.

1. Disconnect the terminals between the wire harness going to the valve assembly and the engine harness.
2. Check for voltage at the solenoid coils. Use a multi-meter to measure 12 VDC between the B+ wire and ground of the engine harness.
   - If no voltage is measured, check for blown fuses or bad wiring while cranking.
   - If voltage is less than or equal to 10.2 VDC, check for bad wiring or low battery voltage.
   - If voltage is greater than 10.2 VDC, check for correct solenoid operation
3. Check for solenoid operation.
   a. While holding onto the solenoid, apply 12 VDC to a coil on one of the solenoids.

b. Listen and feel for the solenoid to activate.

c. Repeat applying the voltage a few times to be sure the solenoid operates.

d. Repeat these steps for all solenoids.

e. If either solenoid does not activate, use a multi-meter to measure resistance of the coil. The resistance should be 11 Ohms.

- If the resistance is not 11 Ohms, replace the solenoid.
- If the resistance is 11 Ohms, replace the gas valve assembly.

4. Check for fuel leaks at the solenoid. With a soapy water solution, check pipe threads and areas around the base of the solenoid for gas leakage.

- If a pipe thread is showing bubbles, tighten the pipe connection.
- If anywhere on the gas valve shows bubbles or leakage, replace the complete gas valve assembly.

4.4.4.4 Coil Assembly Replacement

To remove the coil assembly:

1. Loosen the knob lock screw and remove the knob.
2. Loosen the power plug lock screw and remove the power plug.
3. Pull straight up to remove the coil assembly from the solenoid body.

To reinstall the coil assembly:

1. Insert the coil assembly into the solenoid body.
2. Replace the power plug and tighten the power plug lock screw.
3. Replace the knob and tighten the knob lock screw.

4.4.4.5 Direct Acting Pressure Regulator (DEPR)

The DEPR used on US emission certified engines is a critical part of the certified emissions system and does not require any periodic adjustment.

The DEPR is connected directly to the mixer on all certified engines. The DEPR is the primary fuel control device, used to maintain both performance and emissions control. The DEPR contains an internal computer, which communicates with the ECM via CAN datalink.

The DEPR precisely controls the fuel flow to deliver the correct Air Fuel ratio to the engine. The IEPR/DEPR also contains fuel pressure and temperature sensors, which provide input to the ECM for fuel calculation.

If the DEPR detects a fault within the system, it will send the information to the ECM. Depending on the type of fault, the ECM may command the DEPR to change fueling, limit fuel delivery or in some cases shut down the engine.

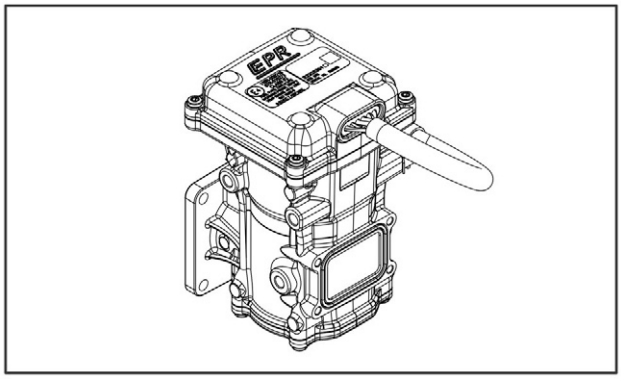


FIGURE 41. DIRECT ACTING PRESSURE REGULATOR (DEPR)

4.4.4.6 Mixer Assembly

The mixer acts as the secondary fuel metering device, and delivery device, in the emission control system. The mixer utilized on USA emission certified engines is a critical part of the certified emission system and does not require any periodic adjustment and does not have any external or internal adjustments.

The mixer is a completely self-controlled air-fuel metering device. It is an air valve design, utilizing a constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted to the air-inlet ahead of the throttle control device.

When the engine begins to crank, it draws in air. With the air valve covering the inlet, negative pressure builds. This creates a vacuum which is referred to as an air valve vacuum (AVV). The amount of AVV is a direct result of the throttle position. At low engine speed the AVV is low and the air valve position is low, thus creating a small venturi. The IEPR/DEPR maintains the precise fuel control to the mixer, despite the air valve position.

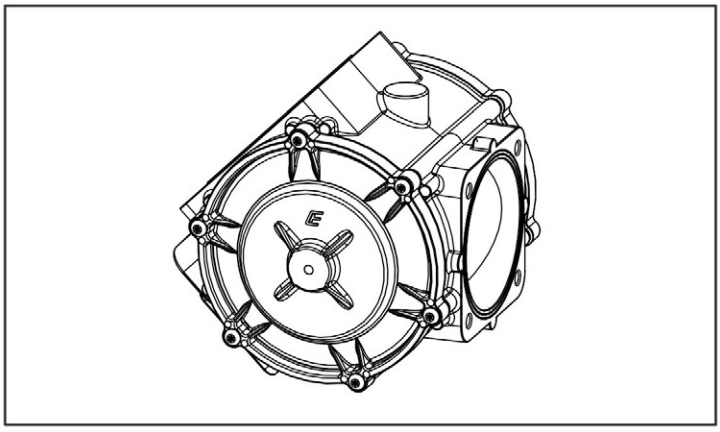


FIGURE 42. MIXER ASSEMBLY

4.4.4.7 Electronic Throttle Body (ETB)

The Electronic Throttle Body (ETB) is connected to the intake manifold of the engine. The ETB control device uses an electronic motor connected to the throttle shaft. When the engine is running, the ECM sends an electrical signal to the ETB motor, to increase or decrease the angle of the throttle blade, thus increasing or decreasing the air fuel mixture flow to the engine.

The fuel system uses an electronic signal, Drive By Wire (DBW), to control engine speed. The ECM determines speed and load control. Defaults programmed into the ECM software and the throttle position sensors allow the ECM to maintain safe operating control over the engine.

The ETB also incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM. The ECM uses TPS information to correct speed and load control, as well as emission control and engine protection.

The ETB used on US emission certified engines does not require any periodic adjustment.

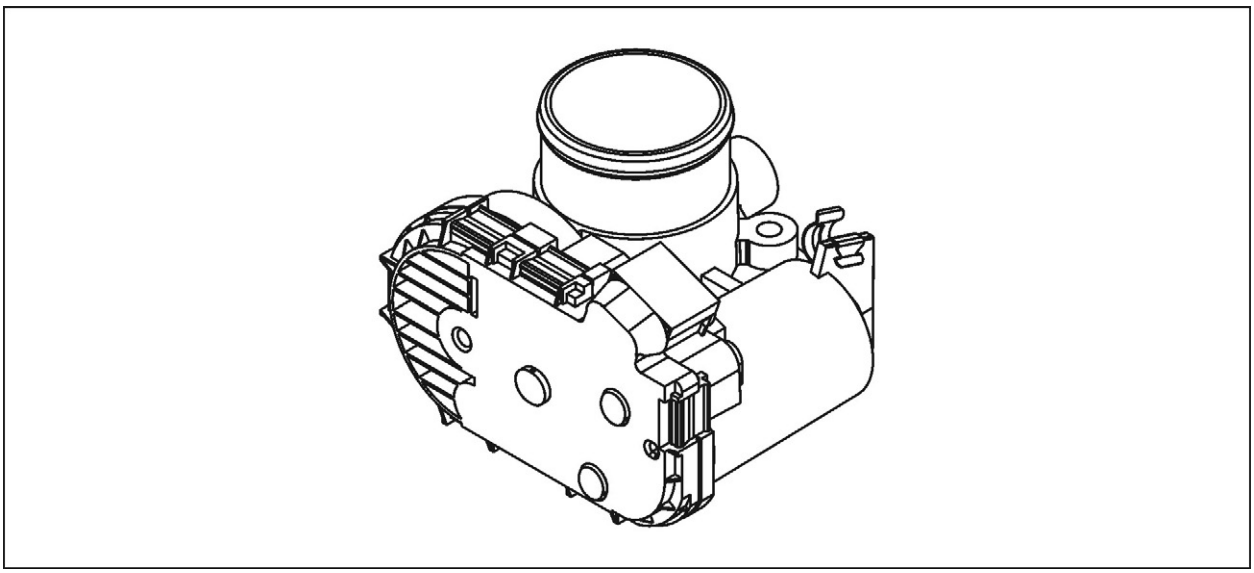
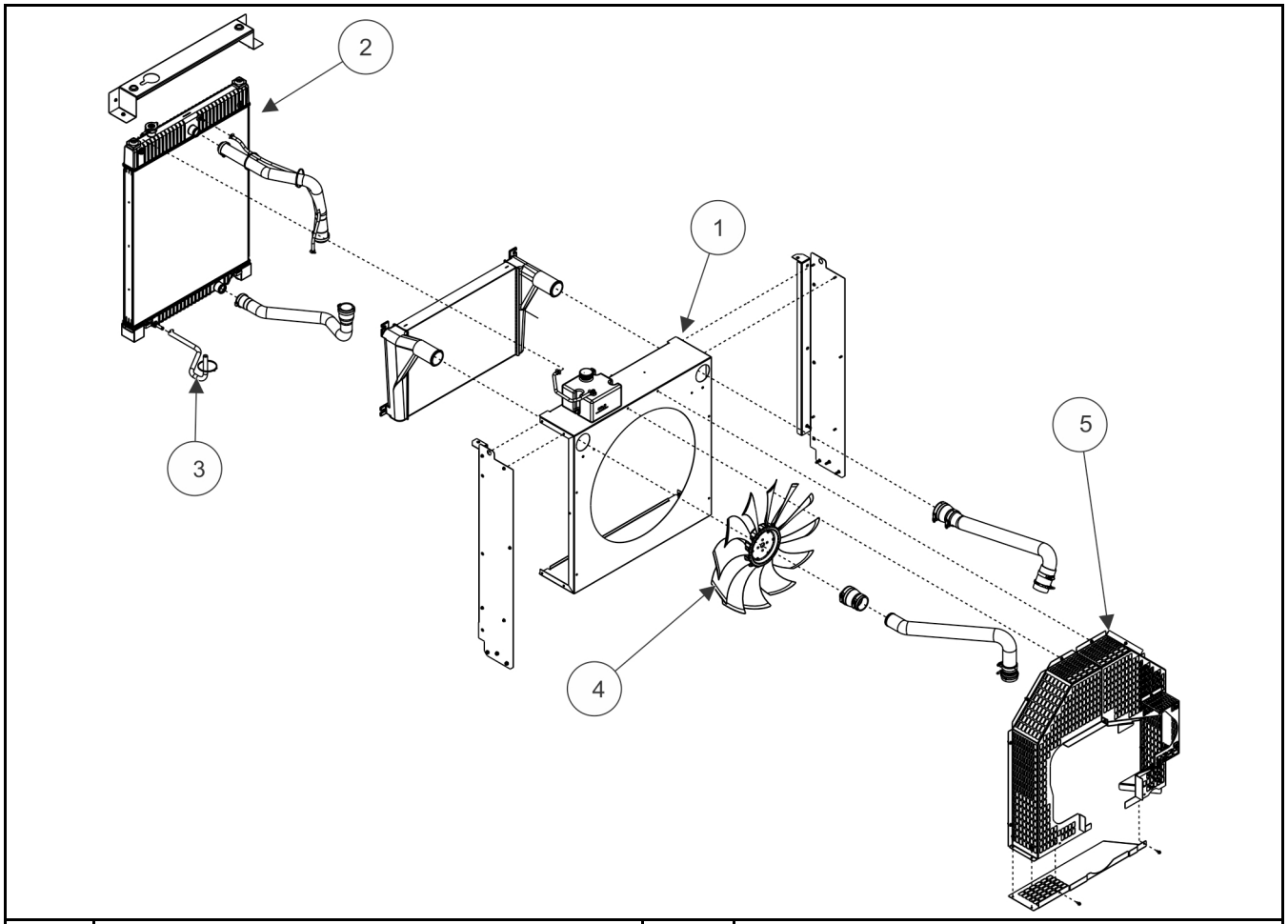


FIGURE 43. ELECTRONIC THROTTLE BODY (ETB)

4.5 Cooling System

4.5.1 Cooling System Components



No.	Description	No.	Description
1	Radiator Guard	4	Fan
2	Radiator	5	Fan Guard
3	Coolant Drain		

FIGURE 44. COOLING SYSTEM FOR GENERATOR SET WITH QSJ8.9G ENGINE

4.5.2 Radiator Assembly Removal and Installation

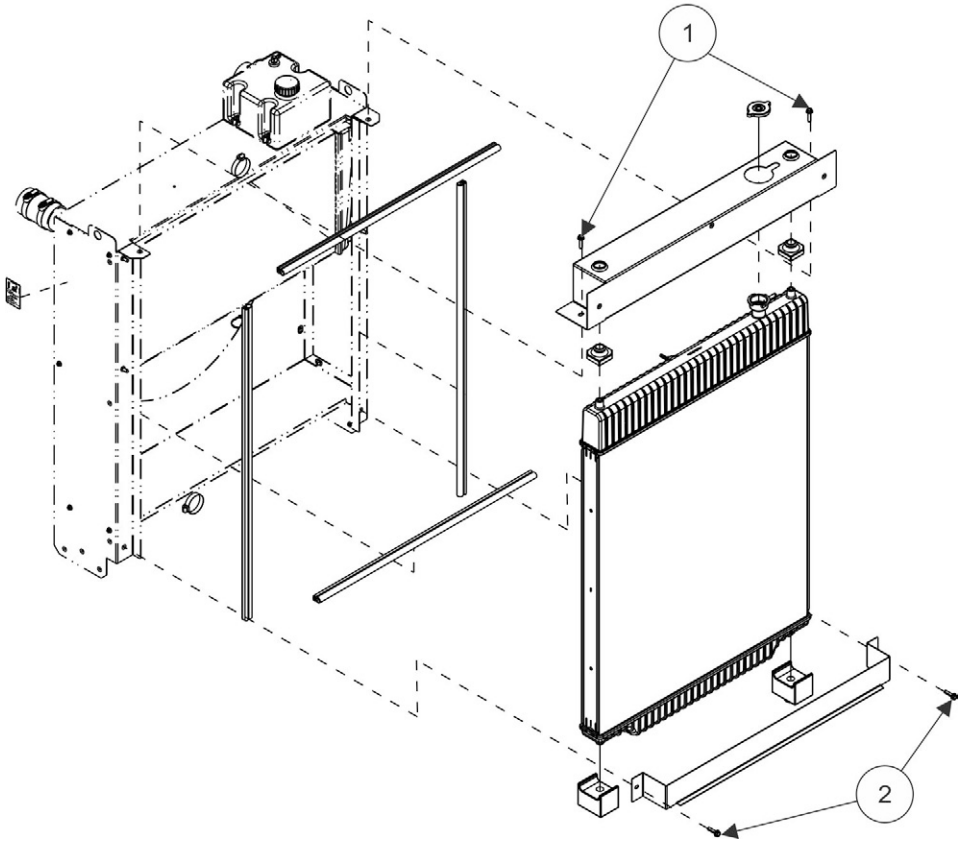
RADIATOR REMOVAL

1. Drain the coolant.
2. Remove the enclosure doors, roof panel above radiator, and exhaust end cap.

NOTICE

If you are removing the radiator as part of the Engine Removal and Installation section, also remove the second roof panel.

3. Remove the muffler and fan guards.
4. If required, remove the muffler braces from the skids before removing the alternator.
5. Remove the radiator.
    a. Remove the top two bolts as shown below.



No.	Description	No.	Description
1	Top Bolts	2	Bottom Bolts

FIGURE 45. REMOVE THE TOP TWO BOLTS

    b. Remove the 2 horizontal bottom bolts as shown above.
    c. Carefully pull the radiator away from the engine to prevent damage to the bottom seal.

RADIATOR INSTALLATION

1. Re-install the radiator.
    a. Carefully move the radiator back towards the engine to prevent damage to the bottom seal.
    b. Re-install the 2 horizontal bottom bolts as shown above.
    c. Re-install the 2 top bolts as shown above.

2. If required, re-install the muffler braces from the skids.
3. Re-install the muffler and fan guards.
4. Re-install the enclosure doors, roof panel above radiator, and exhaust endcap.
5. Re-fill the coolant.

4.5.3 Water Pump Removal and Installation

⚠ WARNING

Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.

1. Drain the coolant.
2. Remove the drive belt. Refer to the Cooling Fan Drive Belt section.

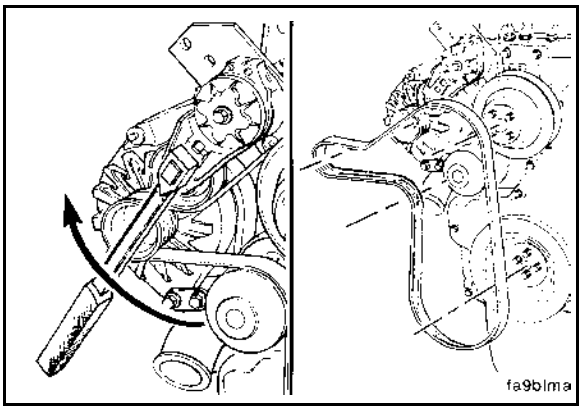


FIGURE 46. REMOVE THE DRIVE BELT

3. Remove the two 13 mm capscrews and water pump.

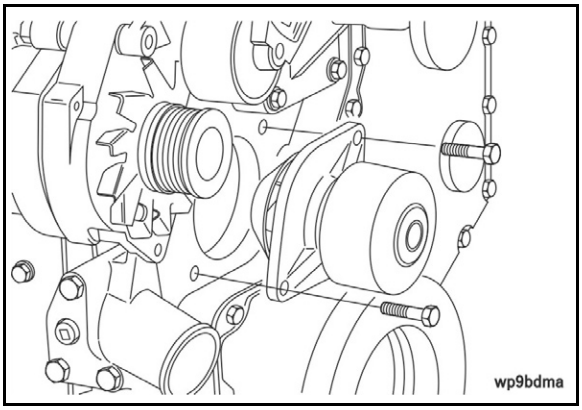


FIGURE 47. REMOVE THE CAPSCREWS AND WATER PUMP

4. Clean the sealing surface on the cylinder block.

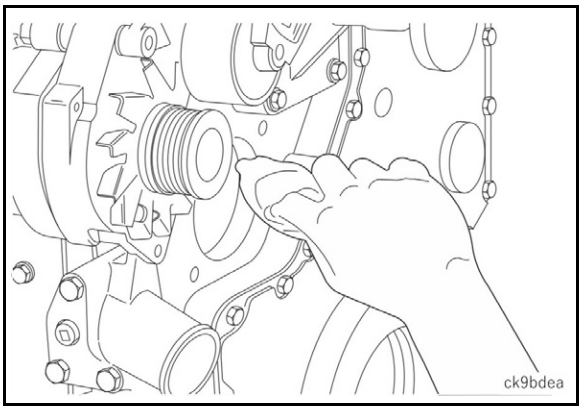


FIGURE 48. CLEAN THE CYLINDER BLOCK SEALING SURFACE

5. Clean the o-ring sealing surface on the water pump housing.

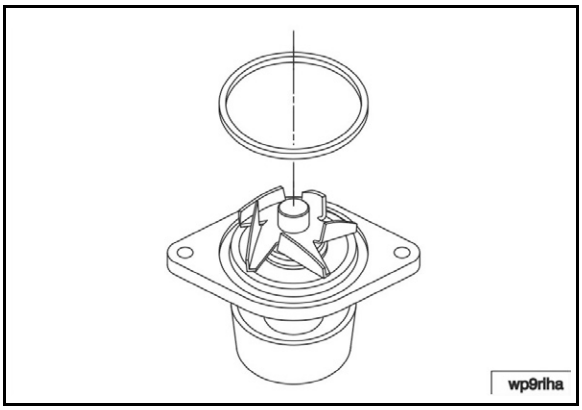


FIGURE 49. CLEAN THE O-RING SEALING SURFACE

6. Install the o-ring onto the water pump housing.
7. Install the new sealing ring into the pump groove. See **Figure 49**.
8. Install the water pump. See **Figure 47**. Torque value: 18 ft-lb (24 Nm), 13 mm.
9. Using a 3/8-in square drive, lift the tensioner and install the belt. Refer to the Cooling Fan Drive Belt section.

NOTICE
If it is difficult to install the drive belt (for example, the belt seems too short), position the belt over the grooved pulleys first. Then, while holding the tensioner up, slide the belt over the water pump pulley.

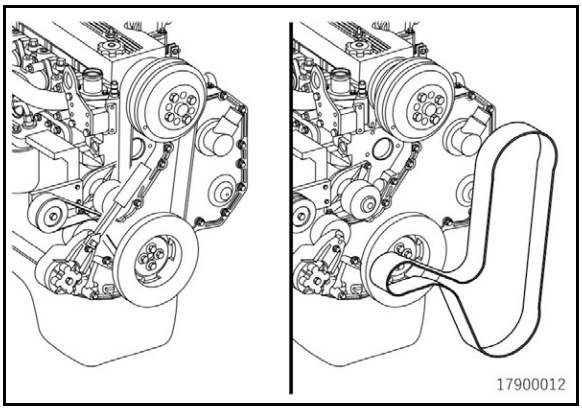


FIGURE 50. INSTALL THE BELT

10. Fill the cooling system.

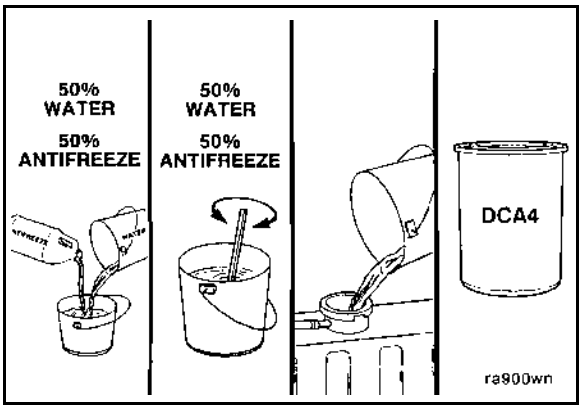


FIGURE 51. FILL THE COOLING SYSTEM

11. Install the pressure cap.
12. Operate the engine and check for coolant leaks. Engine temperature: 180 °F (80 °C).

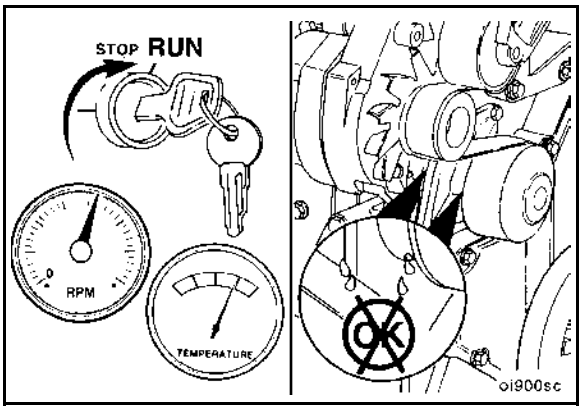


FIGURE 52. CHECK FOR COOLANT LEAKS

4.5.4 Thermostat Removal and Installation

1. Removal:
   a. Disconnect the negative battery cable.
   b. Remove the accessory drive belt.
   c. Drain the coolant.
   d. Disconnect the upper radiator hose.
   e. Remove the alternator mounting capscrew, loosen the alternator link capscrew and lower the alternator.
   f. Remove three capscrews, the thermostat housing, lifting bracket, thermostat, and thermostat seal.
   g. Clean the mating surfaces.
2. Installation:
   a. Make sure to position the rubber seal the same way it was removed.
   b. Install the thermostat, thermostat seal, thermostat housing, gasket, lifting bracket, and three capscrews. Torque to 17.7 ft-lb (24 Nm).
   c. Install the alternator.
      - Torque the mounting capscrew (upper) to 17.7 ft-lb (24 Nm).
      - Torque the alternator link capscrew (lower) to 32 ft-lb (43 Nm).
   d. Install the accessory drive belt.

4.6 Exhaust System

4.6.1 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.

4.6.2 Oxygen Sensor

During normal operation, the oxygen sensor monitors the oxygen content of the exhaust gases and sends a voltage signal to the ECM. The ECM monitors this voltage. The oxygen sensor has a heating element incorporated into the sensor to aid in the warm-up to the proper operating temperature and to maintain that temperature.

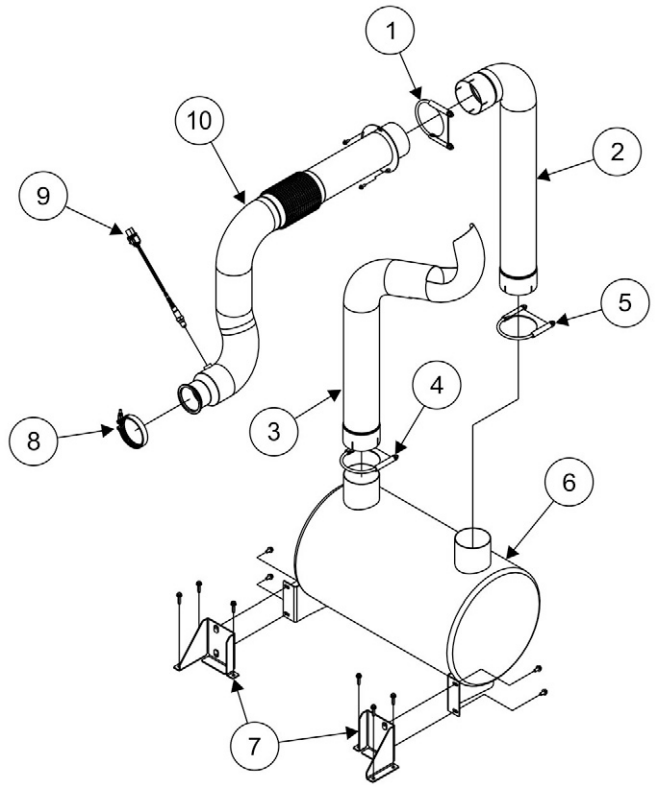
The oxygen sensor produces no voltage when it is below its normal operating temperature of about 600 °F (315.5 °C). During this warm-up period, the ECM operates in an open-loop fuel control mode. It does not use the oxygen sensor signal. Instead, the ECM controls fuel metering based on other inputs and its own program. Refer to the Sensors section for more information.

Proper operation of the oxygen sensor depends on three conditions:

- *Good electrical connections:* The low voltages generated by the sensor require good, clean connections which should be checked whenever a sensor problem is suspected or indicated.
- *Outside air supply:* The sensor needs proper exhaust circulation to the internal portion of the sensor and proper air circulation to the external portion of the sensor. Whenever the sensor is installed, make sure the air passages are not restricted.
- *Proper operating temperature:* The ECM will not react to the sensor signal until the sensor reaches approximately 600 °F (315.5 °C). This factor must be considered when evaluation the performance of the sensor.

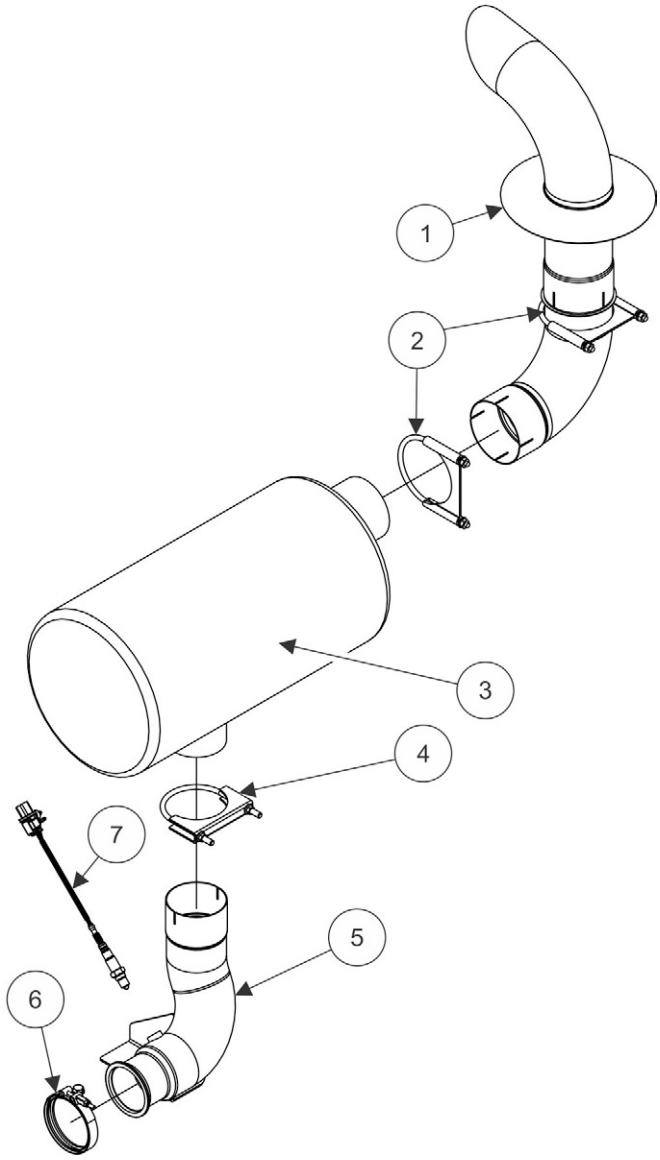
Your authorized Cummins Inc. distributor can monitor fuel system/oxygen sensor operation using the ECM.

4.6.3 Exhaust System Graphic



No.	Description	No.	Description
1	Exhaust Clamp	6	Muffler
2	Exhaust Pipe	7	Muffler Bracket
3	Exhaust Pipe	8	Vee Band Clamp
4	Clamp	9	Oxygen Sensor
5	Exhaust Clamp	10	Exhaust Pipe

FIGURE 53. EXHAUST SYSTEM FOR SOUND ENCLOSURE



No.	Description	No.	Description
1	Exhaust Stack	5	Exhaust Pipe
2	Exhaust Clamps 4 5/8 inch clamp	6	Vee Band Clamp
3	Muffler	7	Oxygen Sensor
4	Exhaust Clamp 4 inch clamp		

FIGURE 54. EXHAUST SYSTEM FOR WEATHER ENCLOSURE

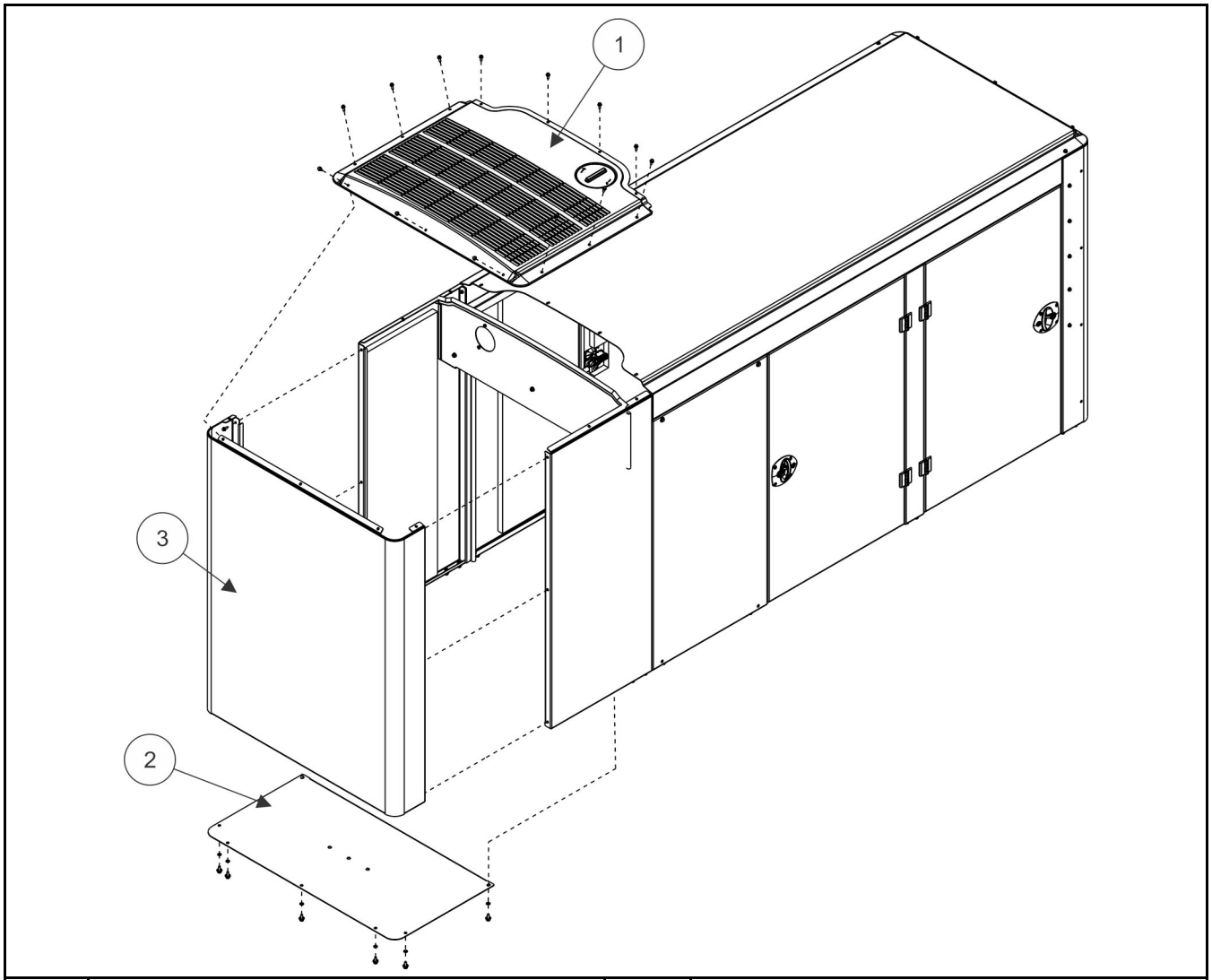
4.6.4 Muffler Removal and Installation

⚠ WARNING
Hot Exhaust Components

Exhaust pipes and mufflers are very hot and can cause severe personal injury or death from direct contact or from fire hazard.

Allow the muffler to cool down before removing.

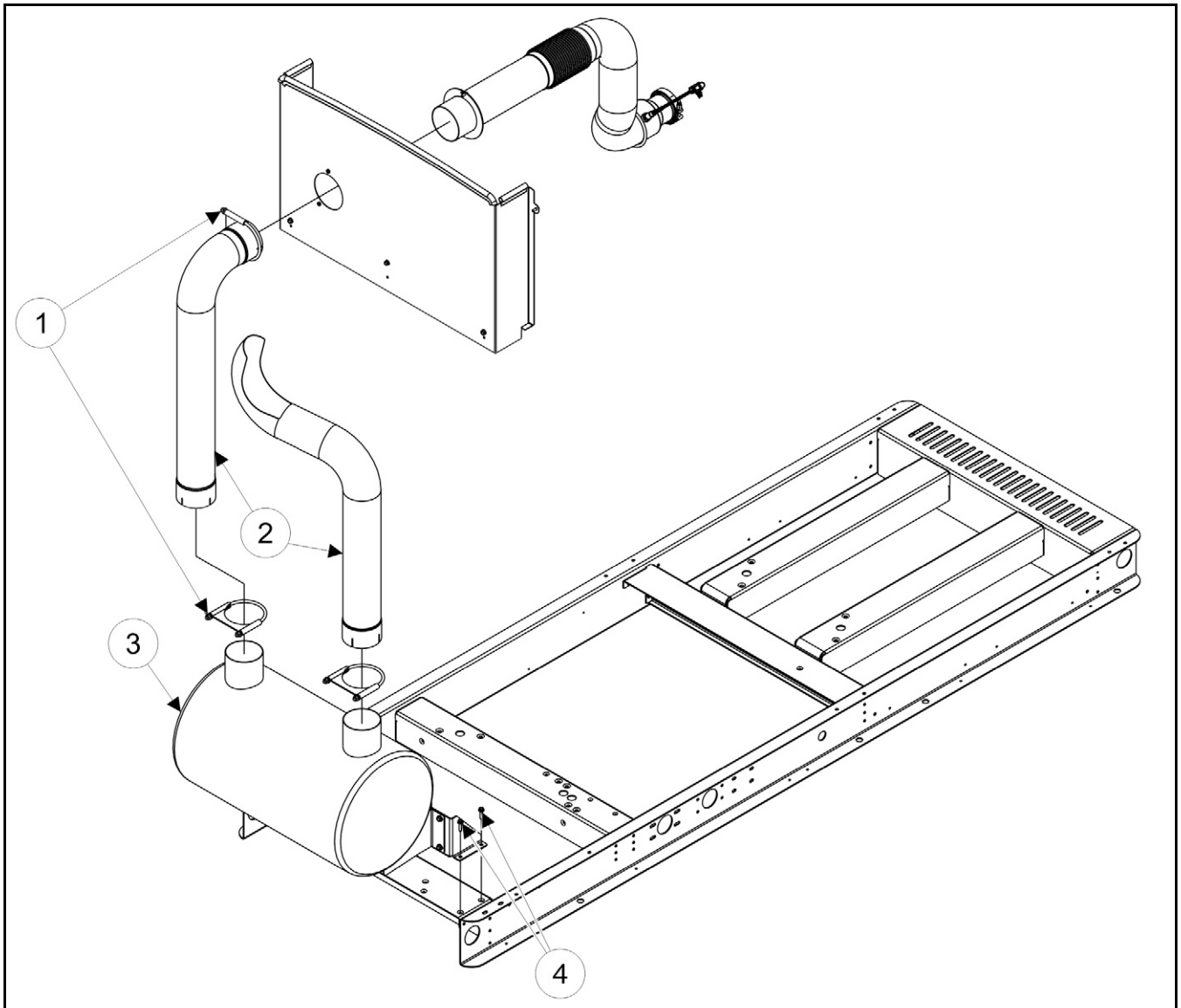
1. Remove the muffler:
    a. Remove the exhaust pipe coming from the bulkhead to the muffler.
    b. Remove the muffler.



No.	Description	No.	Description
1	Enclosure Roof	3	Outlet Cover
2	Enclosure Panel (Bottom)		

FIGURE 55. ENCLOSURE REMOVAL

2. Install the muffler:
    a. *Sound enclosure only:*
        i. Place the two mounting brackets on the skid and attach them with 3 bolts each. Torque values: 24 - 29 Nm (17.7 - 21.4 ft-lb)
        ii. Attach the exhaust pipe coming from the engine so that the muffler bolt holes line up with the mounting bracket bolt holes.
        iii. Attach the muffler to the mounting brackets with 2 bolts in each bracket. Torque values: 24 - 29 Nm (17.7 - 21.4 ft-lb).
    b. Attach the muffler exhaust pipe. Tighten the clamp. Torque values: 41 - 49 Nm (30 - 36 ft-lb).



No.	Description	No.	Description
1	Clamps (2)	3	Muffler (Silencer)
2	Exhaust Pipes (2)	4	Bolts

FIGURE 56. MUFFLER INSTALLATION

4.7 Engine and Accessories

See the *Engine Service Manual* (5504157) for engine component details.

4.7.1 Engine Removal and Installation Torque Specifications

TABLE 27. ENGINE REMOVAL AND INSTALLATION TORQUE SPECIFICATIONS

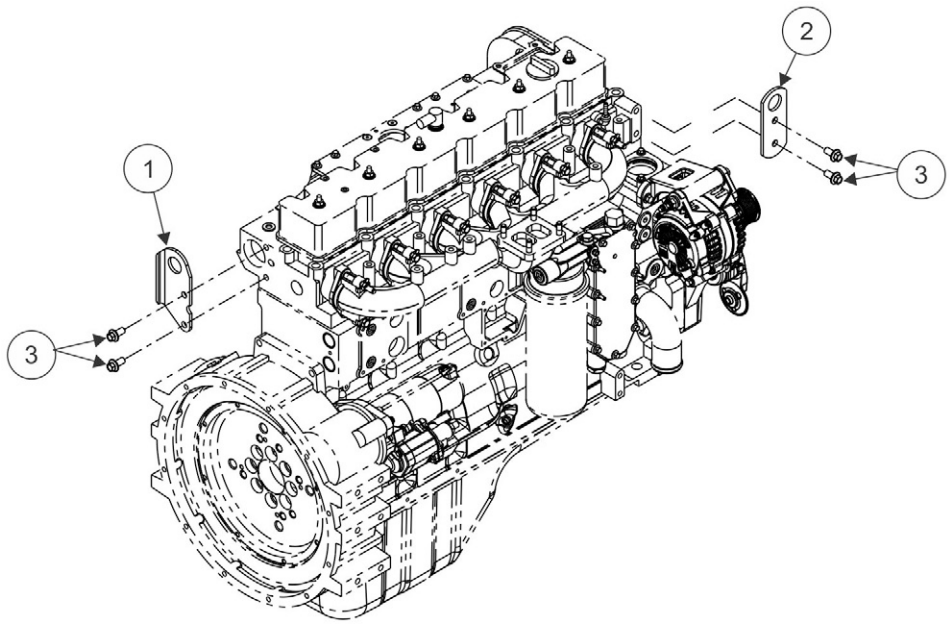
Components	Torque Value
Engine Lifting Bracket Service Part Bolts	82–100 Nm (60.5–73.8 ft-lb)
Coolant Heater Hose Fitting	Use sealant. Tighten to 1-1/2 to 2-1/2 turns past finger tight.
Engine Ground Strap Bolts	47–57 Nm (34.7–42 ft-lb)
Engine Isolator Mount to Engine Block Bolts	82–100 Nm (60.5–73.8 ft-lb)
Alternator Air Outlet Screen Bolts	8–9.7 Nm (5.9–7.2 ft-lb)
Alternator Cover Adaptor Bolts	8–9.7 Nm (5.9–7.2 ft-lb)
Alternator Drive Disc to Engine Flywheel Bolts	47–57 Nm (34.7–42 ft-lb)
Alternator Housing to Flywheel Housing Bolts	47–57 Nm (34.7–42 ft-lb)

4.7.2 Engine Removal

1. Make sure the generator set is disabled.
    a. Press the STOP button on the operator panel to make sure the control is in the Off mode.
    b. If equipped, activate the E-stop button.
    c. If equipped, disconnect the battery charger. Remove any other electrical supply sources.
    d. Remove AC power to the customer's AC connections.
    e. Disconnect the negative (-) cable from the battery and secure it from contacting the battery terminals to prevent accidental starting.
2. Drain engine oil and coolant.
3. Shut off the generator fuel supply.
4. Remove:
    - Enclosure doors, roof panels and exhaust endcap
    - Fan guards
    - Muffler
    - Radiator for access to fan hub
    - Fan and fan hub
    - Heavy-duty air cleaner assembly (if present) and brackets
    - Charge air cooler piping (if present)
    - Disconnect oxygen sensor from engine harness
    - Exhaust pipe from turbocharger to bulkhead
5. Disconnect:
    - Fuel hose from IEPR/DEPR
    - Mixer from turbocharger inlet
    - Crankshaft position sensor plug

- Camshaft sensor plug
- TMAP sensor plug from engine harness
- Humidity sensor plug
- Throttle body engine harness plug
- Crankcase breather hose between crankcase breather valve and air intake
- Crankcase breather drain hose from oil pan
- Crankcase breather intake hose from crankcase breather on crankcase cover
- Engine harness at DEPR plug

6. Remove the fuel system, air filter assembly (DEPR, mixer, throttle body), and brackets.
7. Remove the engine coolant heater hose.
8. Disconnect the spark plug wires.
9. Disconnect the ignition coils from the engine harness.
10. Remove the ignition coil and crankcase breather brackets.
11. Remove the throttle body from the intake manifold.
12. Disconnect the turbocharger oil drain and supply lines.
13. Disconnect and remove the turbocharger.
14. Remove the upper and lower radiator hoses from the engine.
15. Disconnect the coolant level switch (if present) from the engine harness.
16. Remove all wiring connections from the starter. Use zip ties (or something similar) to keep the multiple terminal connections together for reassembly.
17. Disconnect the following:
    - Coolant temperature sender
    - Oil pressure sender
    - Fuel solenoid connections
    - Any remaining engine harness to engine connections
18. Remove the engine harness from the engine.
19. Install the engine lifting bracket into the right-most intake manifold bolt holes in the engine block, as shown below.



No.	Description	No.	Description
1	Intake Side Engine Lifting Bracket	3	Flange Head Screw
2	Exhaust Side Engine Lifting Bracket		

FIGURE 57. INTAKE MANIFOLD BOLTS AND BOLT HOLES

20. Support the engine and alternator separately at the flywheel housing to alternator connection before disconnecting the engine from the alternator.

⚠ CAUTION
Alternator rotor to stator contact can damage windings and cause failure of the alternator. Protect rotor and stator windings by inserting a thin flexible spacer between the rotor and stator before disconnecting from the flywheel housing or flywheel.

21. Remove the alternator access guards from the flywheel housing.
22. Remove the bolts that connect the alternator drive disc to the flywheel.
23. Gently lower the rotor onto the stator.
24. Remove the bolts that connect the flywheel housing to the alternator housing.
25. Use the two engine lifting brackets to safely support the engine on a lift or hoist while removing the engine isolator brackets from the engine.
26. Remove one engine isolator bracket from the skid to allow the engine to swing away from the skid.
27. Lower the engine to a properly supported position.
28. Identify the components from the old engine block that will be needed to complete the new engine. Remove those components from the old engine and set aside to be installed on the new engine.

4.7.3 Engine Installation

1. On the new engine block, install the components that were previously removed:

2. Safely lift the engine onto the skid using the two engine lifting brackets.
3. Support the flywheel end of the engine to align it with the alternator rotor and housing.
4. Lift the rotor and align the drive disc bolt holes to the flywheel bolt holes, removing the spacer that was inserted between the rotor and the stator.
5. Install the bolts that connect the alternator drive disc to the flywheel. See the Generator Set Coupling section for the tightening procedure.
6. Install the bolts that connect the flywheel housing to the alternator housing.
7. Install the alternator access guards on the flywheel housing.
8. Remove the engine lifting bracket from the intake manifold bolt holes in the engine block.
9. Re-install the intake manifold bolts.
10. Attach the engine harness to the engine. Make sure that the harness routing is free from sharp edges and pinch points.
11. Connect the following:
    - Coolant temperature sender
    - Oil pressure sender
    - Fuel solenoid connections
12. Connect all starter wiring connections. (Remove any zip ties first.)
13. Connect the coolant level switch to the engine harness (if present).
14. Attach the upper and lower radiator hoses to the engine.
15. Install the turbocharger onto the exhaust manifold using a new gasket.
16. Connect the turbocharger oil drain and supply lines. Use a new oil drain gasket at the turbocharger. When connecting the turbo outlet to the expander hose clamp:
    a. Open the screw until it stops at the D-nut.

NOTICE
The minimum gap for a D-nut is 3 mm. A gap of 3 - 8 mm is typical for this product.

    b. Set the window latch to the tightest position. Three windows open is typical for this product.
17. Install the throttle body in the intake manifold. Install a new gasket between the throttle body and the intake manifold.
18. Install the ignition coil and crankcase breather brackets.
19. Connect the ignition coils to the engine harness.
20. Connect the spark plug wires.
21. Install the engine coolant heater hose.
22. Install the fuel system, air filter assembly (DEPR, crankcase breather, mixer, throttle body), and brackets.
23. Connect:
    - Fuel hose to DEPR
    - Mixer to turbocharger inlet
    - Crankshaft position sensor

- Camshaft sensor
- TMAP sensor plug to engine harness
- Humidity sensor plug
- Throttle body engine harness plug
- Crankcase breather hose between crankcase breather valve and air intake
- Crankcase breather drain hose to oil pan
- Crankcase breather intake hose to crankcase breather on crankcase cover
- Engine harness at DEPR plug
- Any remaining engine harness to engine connections

24. Install:
    - Enclosure doors, roof panels and exhaust endcap
    - Fan guards
    - Muffler
    - Radiator for access to the fan hub
    - Fan and fan hub
    - Heavy-duty air cleaner assembly (if present) and brackets
    - Charge air cooler piping (if present)
    - Oxygen sensor to the engine harness
    - Exhaust pipe from the turbocharger to the bulkhead
25. Turn on the generator fuel supply.
26. Fill with engine oil and coolant.
27. Connect the generator battery. Connect the negative terminal last.
28. Connect and turn on AC accessory power from customer AC connection terminals.
29. Test run the generator.

4.8 Alternator Service

4.8.1 General Description

The UC22/27 range of alternators has a brushless rotating field design, available from 240VAC to 600VAC, 60Hz, and built to meet BS5000 Part 3 and international standards.

All of the UC22/27 range are self-excited as standard with excitation power derived from the main output windings.

A permanent magnet generator (PMG) powered excitation system is available as an option.

4.8.2 Air Flow

Make sure that the air inlets and outlets are not obstructed when the alternator is running.

4.8.3 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.

4.8.4 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.

4.8.5 Alternator Removal and Installation

The following instructions describe alternator removal and installation.

1. Remove enclosure components:
    a. Remove the roof, side doors and end cap.

NOTICE

Torque enclosure panel fasteners 9.8 to 11.9 Nm.

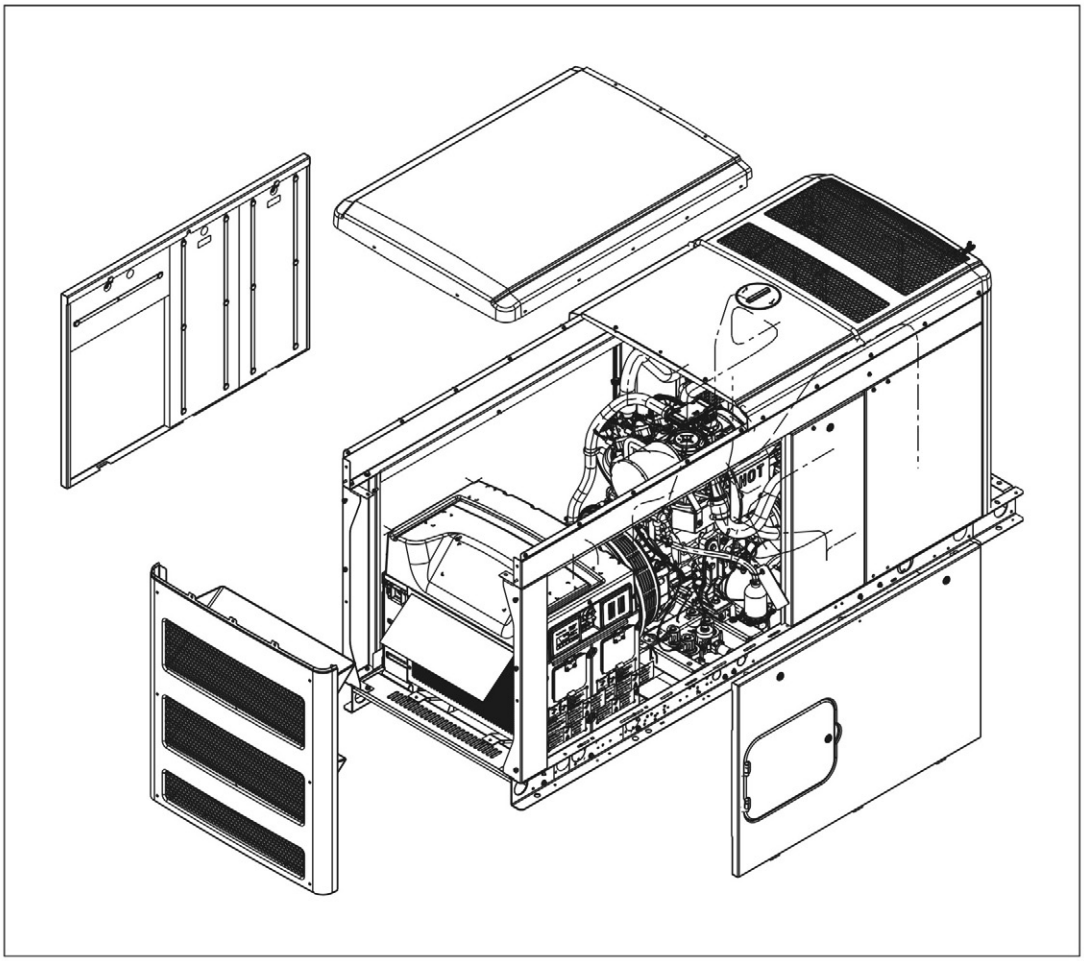


FIGURE 58. REMOVE ENCLOSURE EXAMPLE

b. Remove covers, panels and plates:

i. Remove the terminal box cover/dome and the covers attached to the dome on either side of the alternator facing the rear of the engine.

NOTICE
Torque M6 hex head bolt 4.5 to 5.7 Nm. Torque #8 star head bolt 4 to 5 Nm.

ii. Remove the cover panels (2 per side) from the terminal boxes (8 bolts on each side).

NOTICE
Torque 4.7 to 5.7 Nm.

iii. Ensure that all wires are labelled, marked or photographed so that they can be reconnected to the same points.

iv. Disconnect all wires in the circuit breaker box that are connected to the alternator (load, neutral and ground).

NOTICE
The load wire lug torque at the circuit breaker is listed on the breaker.

v. Push the wires through the terminal box to disconnect the terminal box from the alternator.

NOTICE
The ground lug torque to the terminal box is 4.7 to 5.7 Nm.

NOTICE
The neutral lug torque to the terminal box is 12.3 to 15 Nm.

vi. Disconnect connectors J17, J18 and J22 from the control board.

vii. Push the wires through the terminal box to disconnect the terminal box from the alternator.

viii. Remove the alternator air inlet grill and drip cover from the terminal box (3 bolts per side).

NOTICE
Torque the #8 star head bolt 4 to 5 Nm.

2. Remove the terminal box mounting bolts (6 bolts on each side) on both sides.

NOTICE
Torque 12.3 to 15 Nm.

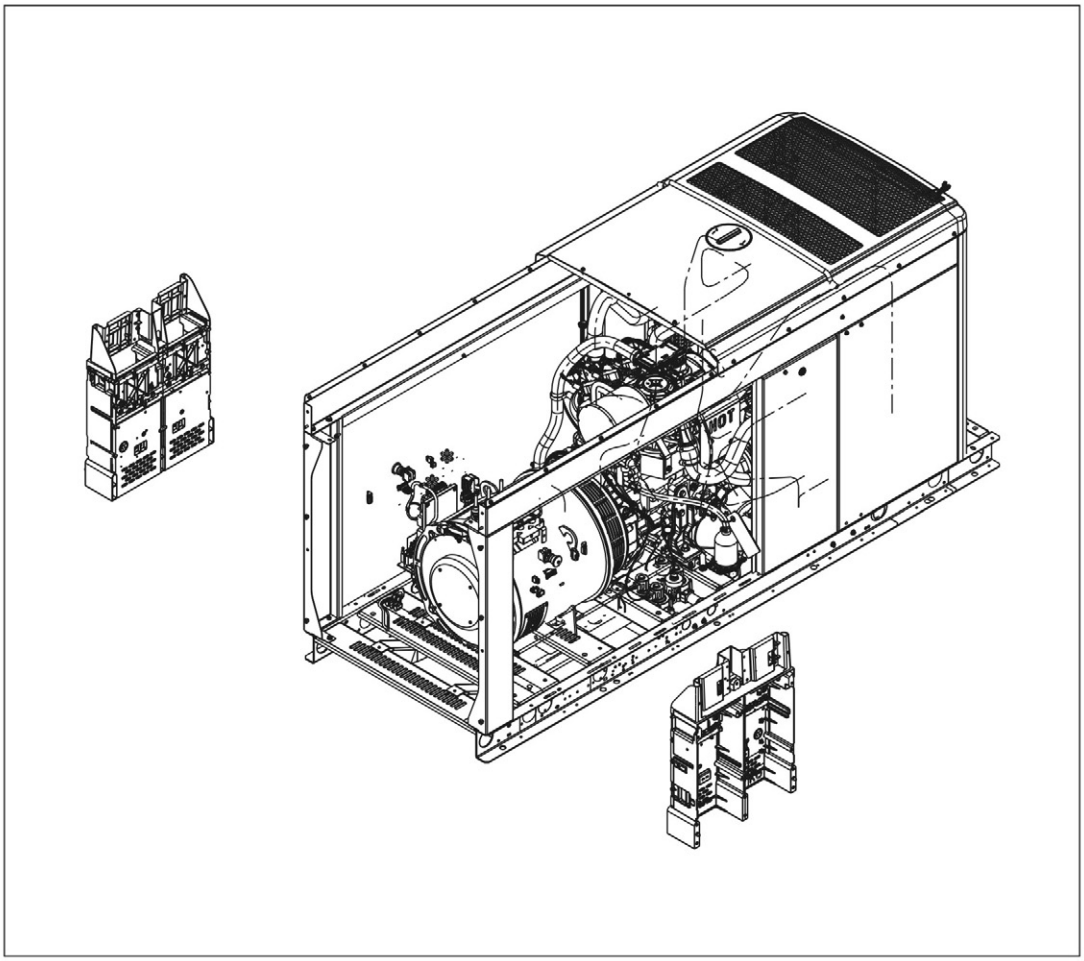


FIGURE 59. REMOVE TERMINAL BOX MOUNTING BOLTS EXAMPLE

3. Remove the terminal boxes as required. Disconnect the terminal box on the left hand side first and then reposition the terminal box. Doing this will reduce the amount of impact on the harness. To remove the left hand terminal box, the plug that connects the control harness to the engine harness must first be separated. This plug is near the terminal box.
4. Support the engine and alternator:
   a. Loosen the alternator and engine isolator nuts on both sides.

NOTICE
Torque each isolator nut 82 to 100 Nm.

   b. Securely support the engine with appropriate blocking which provides approximately 2° before and after the tilt of the engine/alternator (with the alternator end higher). This should be enough to allow removal of the alternator from the isolator studs.
   c. Secure the alternator with an appropriate lifting device. It is highly recommended to use a 3-point lift.

NOTICE
The alternator weighs up to 600 pounds.

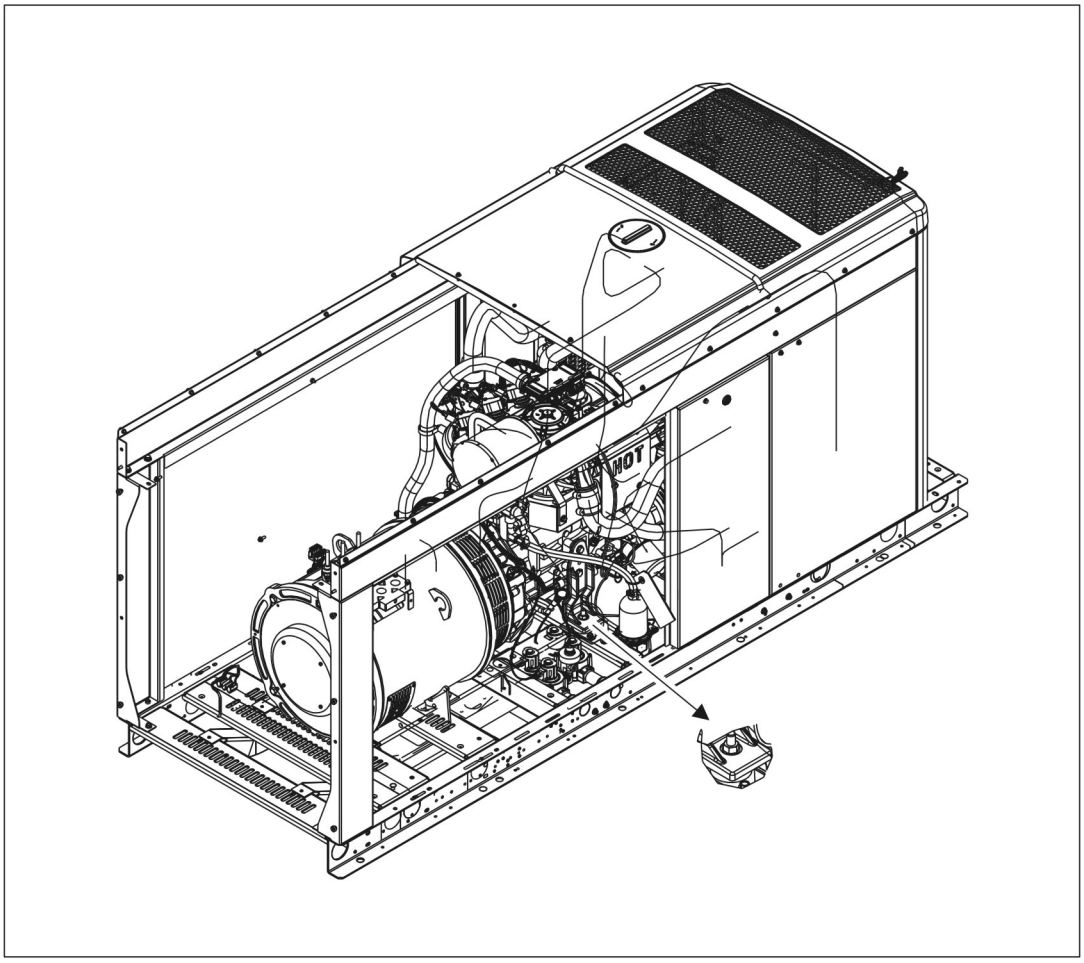


FIGURE 60. REMOVE AND SECURE THE ALTERNATOR (WITH DETAIL) EXAMPLE

5. Remove the alternator fan guard and bolts:
   a. Remove the alternator fan guard.
   b. Remove the alternator drive disc bolts first and then remove the alternator adaptor bolts.

⚠ CAUTION

Do not rotate the rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

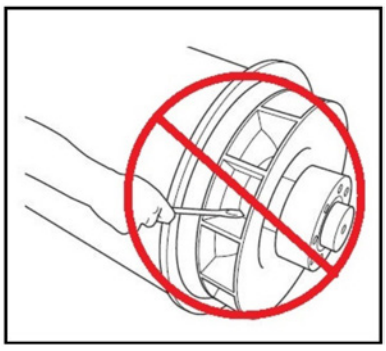


FIGURE 61. DO NOT ROTATE ROTOR USING FAN

⚠ CAUTION
The alternator drive disc fits into a relief cut into the engine flywheel. There is little clearance between the outside diameter of the drive disc and the wall of the flywheel relief. Extreme care is needed while the alternator is being removed and reattached to the engine to prevent damage to the drive disc. The drive disc must be fully seated into the flywheel relief during assembly.

NOTICE
Torque the alternator drive disc bolts and adaptor bolts to 52 Nm +/- 5 Nm.

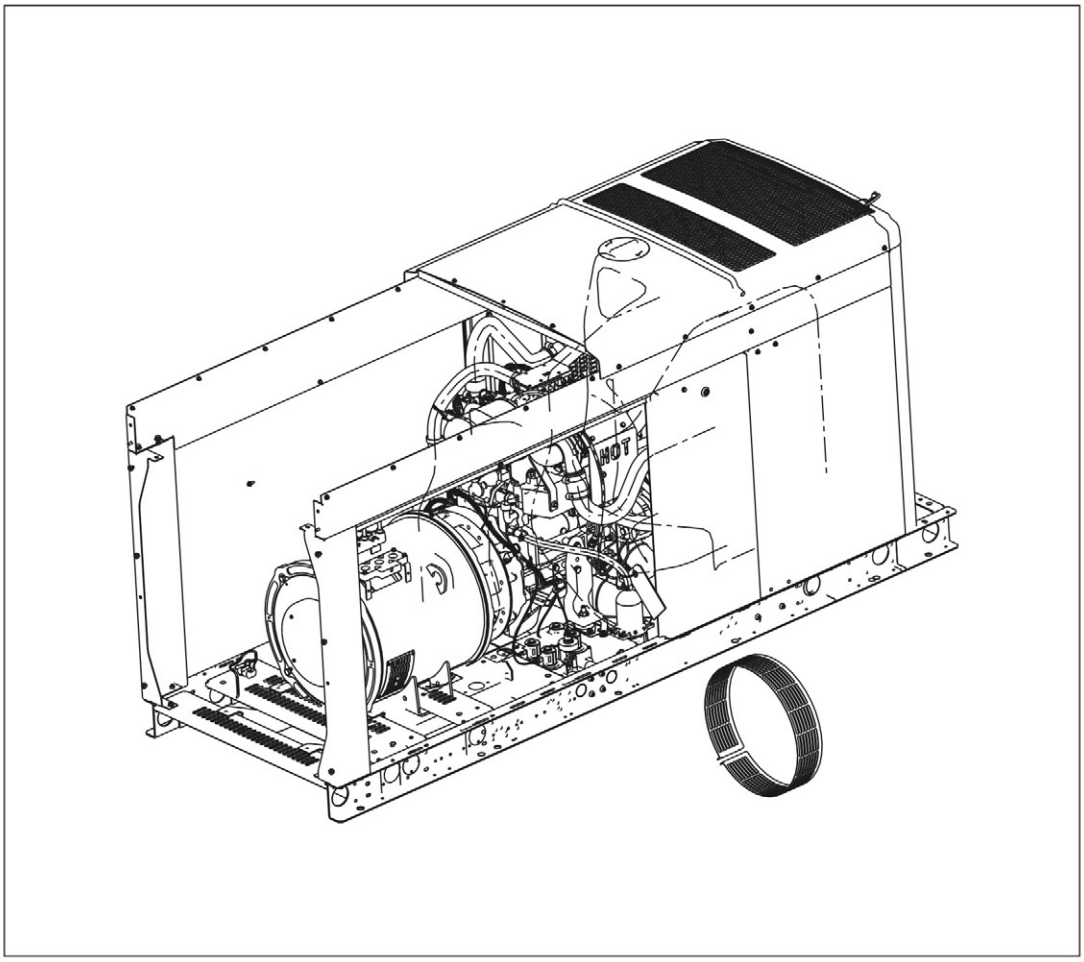


FIGURE 62. ALTERNATOR FAN GUARD (WITH DETAIL) EXAMPLE

6. Carefully move the alternator away from the engine. The alternator drive disks can be easily damaged during removal of the alternator. Make sure the alternator movement is controlled to prevent contact and damage to other components.

NOTICE
The alternator weighs up to 600 pounds.

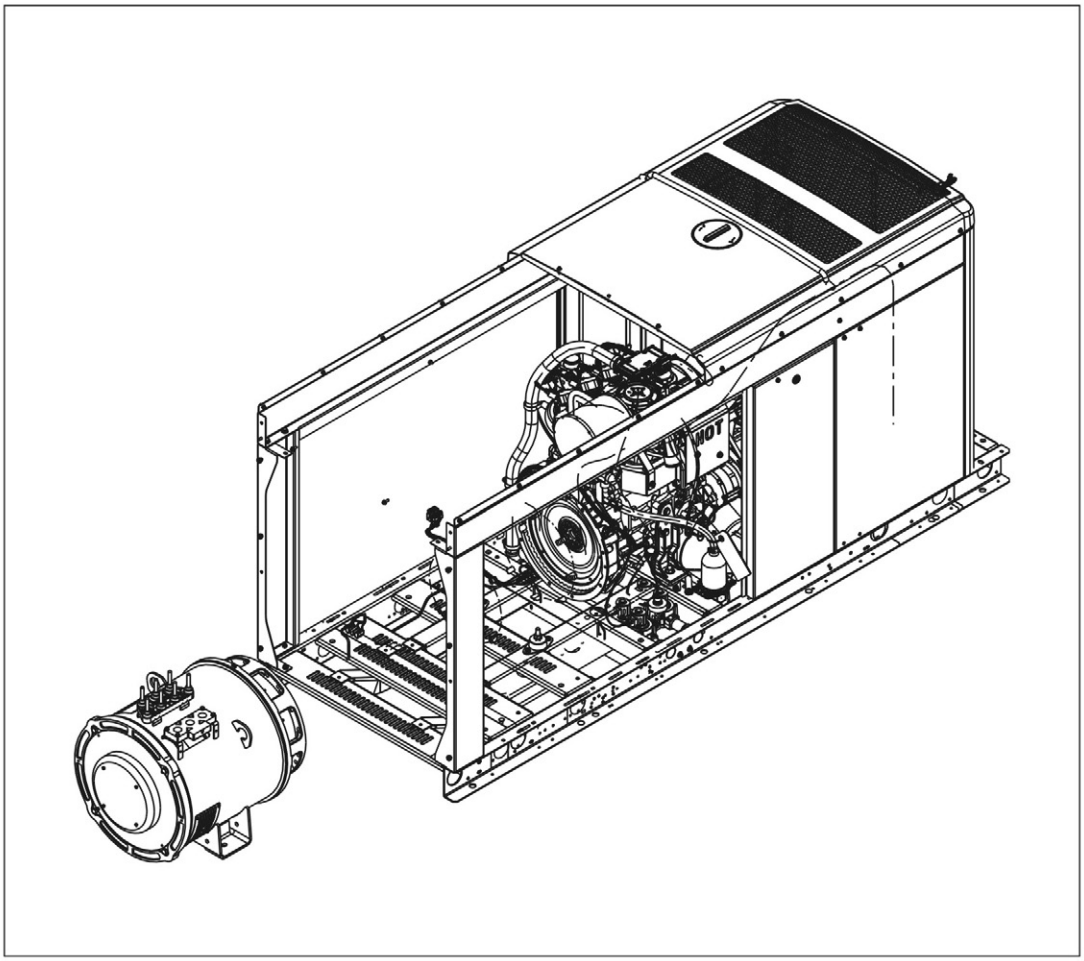


FIGURE 63. MOVING THE ALTERNATOR EXAMPLE

For alternator installation, follow the previous steps in reverse order.

4.8.6 Bearings

4.8.6.1 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.

4.8.6.2 Sealed Bearings

Inspect sealed-for-life bearings periodically. Check for signs of wear, fretting or other detrimental features. Damage to seals, grease leakage or discoloration of the bearing races indicate that the bearing may need to be replaced.

4.8.6.3 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.

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.

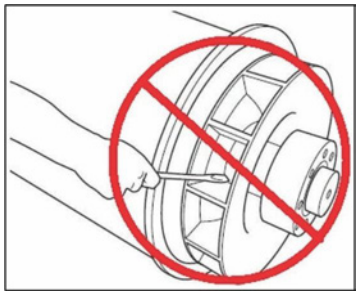


FIGURE 64. DO NOT ROTATE THE ALTERNATOR ROTOR USING THE COOLING FAN VANES.

Efficient operation and long component life depend 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.

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 a level base. 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 ft-lb). 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. The generator set builder must supply guarding for open-coupled applications.

To prevent rust during transit and storage, the alternator frame spigot, rotor coupling plates and shaft extension have been treated with a rust preventive coating. Remove this before coupling the generator set.

To prevent movement of the rotor during transport, single bearing alternators without a permanent magnet alternator (PMG) have a non-drive end (NDE) transit bracket fitted. Remove the NDE cover, remove the NDE transit bracket and fasteners, and then refit the NDE cover before coupling the generator set.

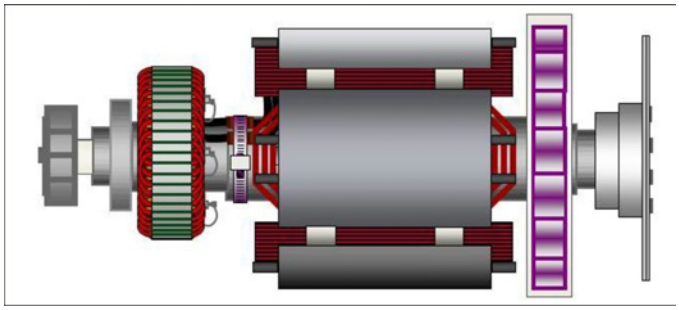


FIGURE 65. SINGLE BEARING ALTERNATOR ROTOR SHOWING COUPLING DISCS BOLTED TO DRIVE END COUPLING HUB (AT RIGHT)

4.8.6.4 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 spigot.
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 66 on page 114.

11. Check the torque of each bolt in a clockwise direction around the bolt circle to ensure all the bolts are tight.
12. If a PMG is not fitted, remove the NDE transit bracket.
13. Replace all covers.

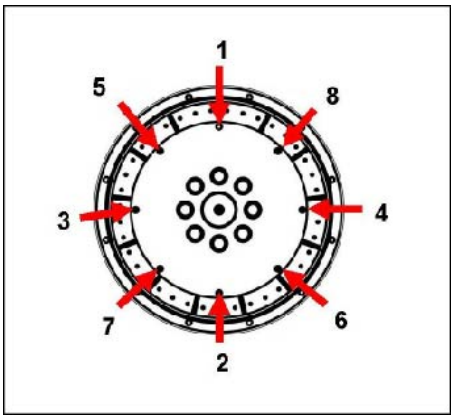
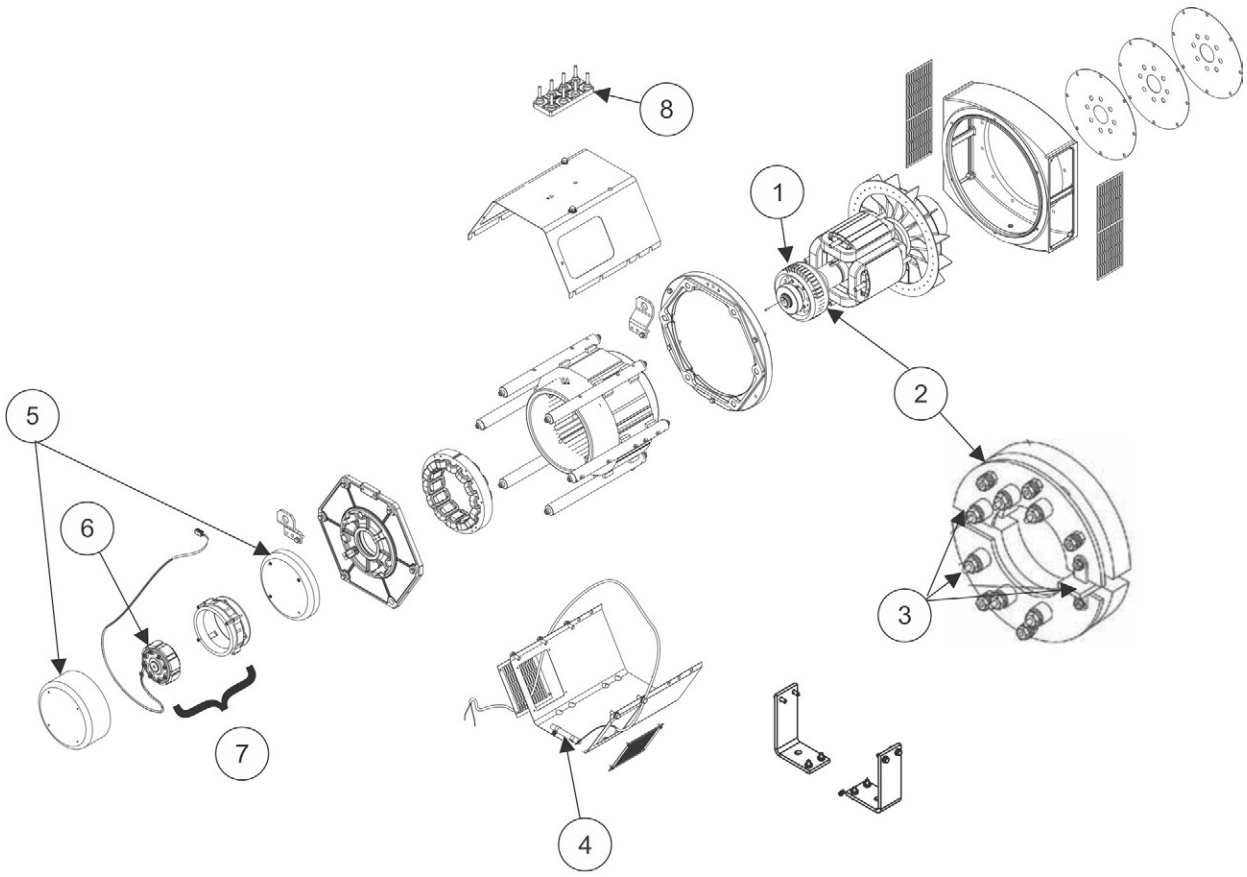


FIGURE 66. FIXING SEQUENCE

4.8.7 Parts Identification

NOTICE
The following image is for reference only.



No.	Description	No.	Description
1	NDE Bearing Kit	5	PMG Cover (Cover Included in Kit [#7])
2	Rotating Rectifier Assembly	6	Current PMG Rotor/Stator
3	Diode FRW/REV and Varistor Kit	7	Complete PMG Upfit
4	Heater	8	Main Terminal Board

FIGURE 67. UC SINGLE BEARING ALTERNATOR PARTS

4.8.8 Rectifier System

4.8.8.1 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 varistor. The varistor protects 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).

4.8.8.2 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.

4.8.8.3 Test and Replace Rectifier System Component Requirements

TABLE 28. RECIFIER SYSTEM TEST AND REPLACE REQUIREMENTS

Requirements	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) • One metal-oxide varistor
Tools	• Insulation tester • Multimeter • Torque wrench

4.8.8.4 Test and Replace Varistor

1. Inspect the varistor, (if fitted).
2. Record varistor as faulty if there are signs of overheating (discoloration, blisters, melting) or disintegration.
3. Disconnect one varistor lead. Store fastener and washers.
4. Measure the resistance across the varistor. Good varistors have a resistance greater than 100 MΩ.
5. Record the varistor as faulty if the resistance is short circuit or open circuit in either direction. (Some multimeters will read O.L. at high resistance levels. Please be aware of the limits of your tools.)
6. If the varistor is faulty, replace it and replace all diodes.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

4.8.8.5 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 the varistor.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

4.8.9 Windings

4.8.9.1 Introduction

NOTICE

To avoid equipment damage, disconnect all control wiring, ECM, and customer load leads from alternator winding connections before conducting these tests.

NOTICE

The integrated Automatic Voltage Regulator (AVR) on the generator set control contains electronic components which would be damaged by high voltage applied during insulation resistance tests. The generator set control must be disconnected before doing any insulation resistance test. Temperature sensors must be grounded to earth before doing any insulation resistance test.

Damp or dirty windings have a lower electrical resistance and could be damaged by insulation resistance tests at high voltage. If in doubt, test the resistance at low voltage (500 V) first.

Alternator performance depends on good electrical insulation of the windings. Electrical, mechanical and thermal stresses, and chemical and environmental contamination, cause the insulation to degrade. Various diagnostic tests indicate the condition of insulation by charging or discharging a test voltage on isolated windings, measuring current flow, and calculating the electrical resistance by Ohm's law.

When a DC test voltage is first applied, three currents can flow:

- **Capacitive Current:** To charge the winding to the test voltage (decays to zero in seconds),
- **Polarizing Current:** To align the insulation molecules to the applied electric field (decays to near-zero in ten minutes), and
- **Leakage Current:** Discharge to earth where the insulation resistance is lowered by moisture and contamination (increases to a constant in seconds).

For an insulation resistance test, a single measurement is made one minute after a DC test voltage is applied, when capacitive current has ended. For the polarization index test, a second measurement is made after ten minutes. An acceptable result is where the second insulation resistance measurement is at least double the first, because the polarization current has decayed. In poor insulation, where leakage current dominates, the two values are similar. A dedicated Insulation Tester takes accurate, reliable measurements and may automate some tests.

4.8.9.2 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

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.

4.8.9.3 Requirements

TABLE 29. 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

4.8.9.4 Test the Insulation Resistance of Windings

NOTICE
The alternator must not be put into service until the minimum insulation resistance is achieved.

TABLE 30. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

Component	Test Voltage (V)	Minimum Insulation Resistance at 1 Minute (MΩ)	
		New	In-Service
Main Stator	500	10	5
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 equipped).
   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 winding insulation resistance after 1 minute (IR_{1min}). Disconnect all control wiring and customer load leads from the alternator winding connections before conducting these tests.
   e. Discharge the test voltage with an earth rod for 5 minutes.
   f. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, and then repeat the method.
   g. If minimum resistance is not above listed, replace the main stator.
   h. Reconnect neutral to earth conductor (if equipped).
3. For 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 winding insulation resistance after 1 minute, IR_{1min}. Insulation should be measured with winding temperatures of 20 °C.
   d. Discharge the test voltage with an earth rod for 5 minutes.
   e. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, and then repeat the method.
   f. Repeat the method for each winding.
   g. If minimum resistance is not above listed, replace the exciter stator.
   h. Remove the connections made for testing.

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5 Troubleshooting

5.1 Avoiding Generator Set Shutdowns

By regularly performing the following periodic maintenance and guidelines, you will greatly reduce the chances of a generator set shutdown:

- Maintain an appropriate oil level.
- Keep battery connections clean and tight.
- Do not overload the generator set.
- Keep the air inlet and outlet openings clear.

Refer to the Maintenance section for more information.

5.2 Fault Code Introduction

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

Refer also to the engine-specific operator manual, if it exists. The engine operator manual contains additional information regarding the running and care of the generator set as well as specific equipment instructions that may differ from the standard generator set.

For any fault codes that occur but are not listed, contact your Cummins service representative.

5.3 GATRR Troubleshooting Approach

Cummins recommends Service Training based on the GATRR (Gather, Analyze, Test, Repair, Retest) troubleshooting approach.

TABLE 31. GATRR TROUBLESHOOTING APPROACH

Icon	Description
	**G - Gather**: Gather customer information, review service history, complete visual inspection, and perform system operation check. Attempt to safely recreate the issue.
	**A - Analyze**: Narrow down the possibilities by system and identify likely problem components.

Icon	Description
	**T - Test**: Perform tests in order of likelihood based on troubleshooting tees and symptoms present.
	**R - Repair**: If necessary, perform repair per manufacturing guidelines and document all of the steps taken.
	**R - Re-test**: Re-test the component, verify that the unit operates properly, and ensure that the documentation is complete.

5.4 Service Repair Levels

The following table lists the differences in Repair Level (dealers) versus Full Service Level (distributors).

TABLE 32. SERVICE BILL OF MATERIAL GUIDE

Service Type	Description
Repair Level (Dealer)	• Maintenance items • Water pumps • Exhaust manifold • Starter • Alternator and bracket • Fan hub • Belt tensioner • Valve cover and gasket • Vibration damper • Front cover and front cover gasket • Thermostat • Oil fill cap • Dipstick and dipstick holder • Filters and filter heads • Belts • Spark plugs and wire • Gaskets associated with major components on this list (e.g. water pump gaskets, exhaust manifold gaskets, etc.) • Everything external on a long block (includes electronics and fuel systems)
Full Service (Distributor)	• Maintenance items • Repair items plus internal engine components (internal wear/failure items plus head gaskets, rod/main bearings, rings, and lube pumps) • Component rebuild parts, such as fuel system sub components, turbocharger sub components, and air compressor sub components

5.5 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.

5.6 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.

5.7 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.

5.8 Mechanical Service Tools List

Most of the maintenance operations described in this manual can be performed with common hand tools (metric and S.A.E. wrenches, sockets, and screwdrivers). A list of special service tools required is available in QSOL.

5.9 Engine Control Module (ECM) Software

EControls ECM display software (4G Display) is required to service all of the models this manual covers, as shown below:

Display Software	Version	Models	Service Password
4G	391 or newer	C70 N6	GLTX-0BIS-534R-SVUX
		C80 N6	
		C100 N6	
		C125 N6	
		C150 N6	

The software enables the user to view ECM faults, reprogram ECM software, and view gauges.

5.10 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.

5.11 Display Text or Symbolic Version

The operator panel graphical display can be set to show text (English only) or symbols for fault messages, operator menus, and the Mode Change Menu. Descriptions of commonly used symbols are included in the following table. Combinations of symbols are used to display some fault conditions.

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

TABLE 33. SYMBOLS

Symbol	Text
	Generator Warning Fault
	Generator Shutdown Fault
	Coolant Temperature
	Oil Pressure

Symbol	Text
	Voltage Alternating Current (VAC)
	Voltage Direct Current (VDC)
	AC Current
Hz	Frequency
	Battery
	Out of Range
	High or Pre-High
	Low or Pre-Low
	Annunciator
	Over Speed
	Crank Fail
	Emergency Stop

5.12 Coolant Thermostat Troubleshooting

⚠ WARNING

Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

⚠ WARNING

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 120 °F (50 °C) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

⚠ WARNING

Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

NOTICE

Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

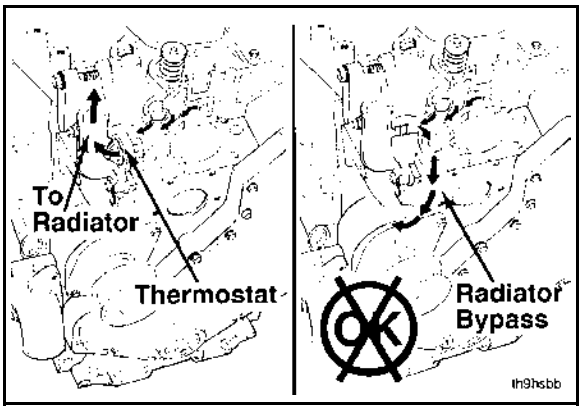


FIGURE 68. ALWAYS USE THE CORRECT THERMOSTAT

NOTICE
Always vent the engine during filling to remove air from the coolant system, or overheating will result.

1. Make sure the generator set is disabled.
   a. Press the STOP button on the operator panel to make sure the control is in the Off mode.
   b. If equipped, activate the E-stop button.
   c. If equipped, disconnect the battery charger. Remove any other electrical supply sources.
   d. Disconnect the negative (-) cable from the battery and secure it from contacting the battery terminals to prevent accidental starting.
2. Drain the coolant.
3. Remove the drive belt.
4. Disconnect the upper radiator hose.
5. Remove the alternator mounting capscrew, loosen the alternator link capscrew, and lower the alternator.
6. Remove three capscrews, the thermostat housing, lifting bracket, thermostat, and thermostat seal.

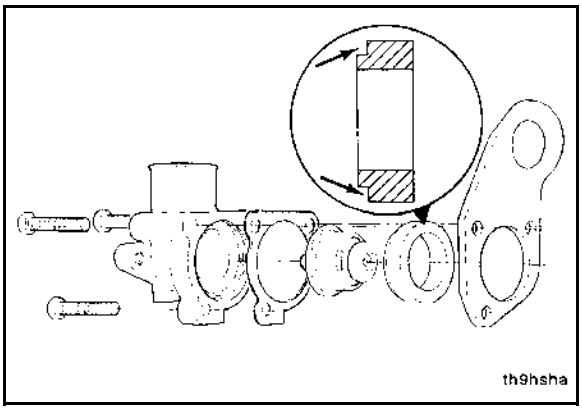


FIGURE 69. REMOVE THREE CAPSCREWS, THE THERMOSTAT HOUSING, LIFTING BRACKET, THERMOSTAT, AND THERMOSTAT SEAL

7. Clean the mating surfaces.

NOTICE
Do not let any debris fall into the thermostat cavity when cleaning the gasket surfaces.

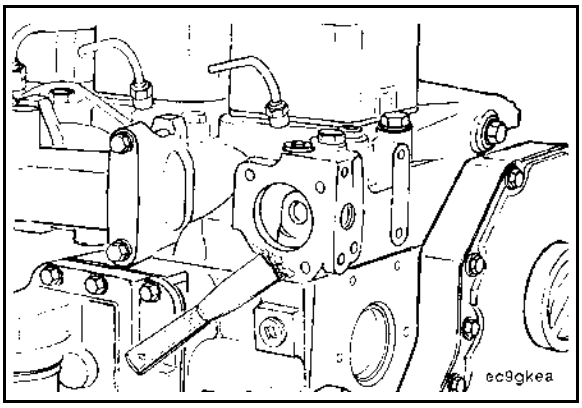


FIGURE 70. CLEAN THE MATING SURFACES

8. Inspect the thermostat for obvious damage, such as obstructions caused by debris, broken springs, or stuck or missing vent pins.
9. Make sure the thermostat is clean and free from corrosion.
10. Suspend the thermostat and a 212 °F (100 °C) thermometer in a container of well-mixed water.

NOTICE
Do not allow the thermostat or thermometer to touch the side of the container.

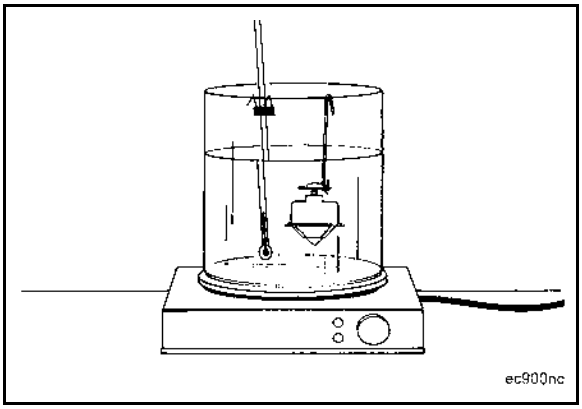


FIGURE 71. SUSPEND THE THERMOSTAT AND THERMOMETER IN WATER

11. Heat the water slowly so the wax element in the thermostat has sufficient time to react to the rising water temperature.
12. Check the thermostat to make sure it meets the following specifications:
    - Starts to open within 2 °F (1 °C) of 180 °F (82 °C)

- Fully open within 2 °F (1 °C) of 203 °F (95 °C)
- There is a full-open clearance between the thermostat flow valve and flange.
- Flow valve and flange clearance (minimum): 0.26 in (6.6 mm)

13. Position the rubber seal as shown for reassembly.

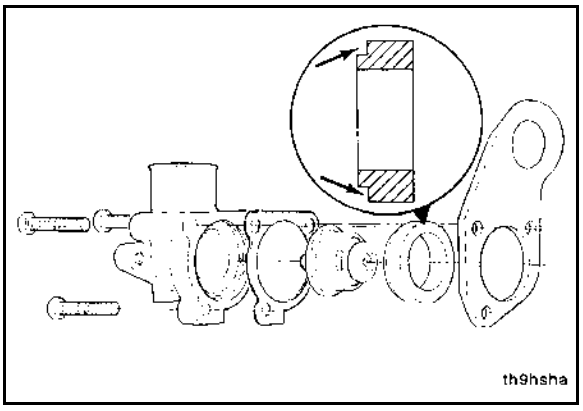


FIGURE 72. POSITION THE RUBBER SEAL

14. Install the thermostat, thermostat seal, thermostat housing, gasket, lifting bracket, and three capscrews. Torque value: 17.8 ft-lb (24 Nm).

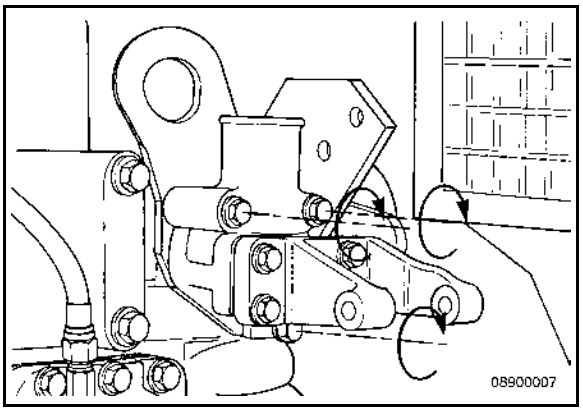


FIGURE 73. INSTALL THE THERMOSTAT, THERMOSTAT SEAL, THERMOSTAT HOUSING, GASKET, LIFTING BRACKET, AND THREE CAPSCREWS

15. Install the alternator. Torque values for A and B in the image below:
    - A: 17.8 ft-lb (24 Nm)
    - B: 32 ft-lb (43 Nm)

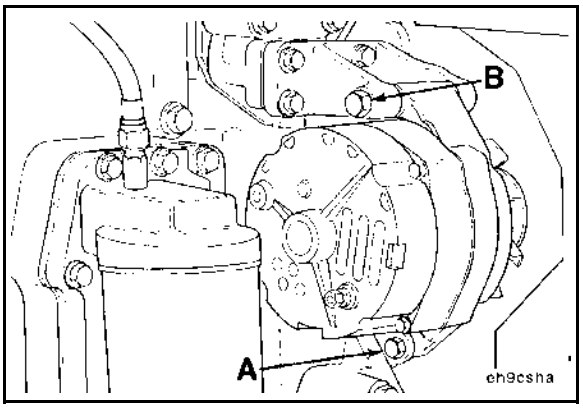


FIGURE 74. INSTALL THE ALTERNATOR

16. Install the drive belt. Refer to the Cooling Fan Drive Belt Maintenance section.

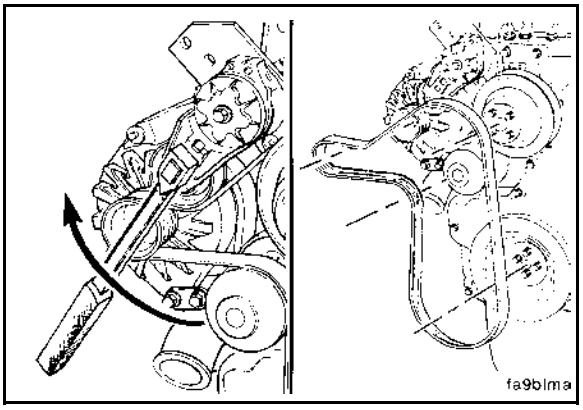


FIGURE 75. INSTALL THE DRIVE BELT

17. After the belt tensioner has been raised to remove/install the belt, check the torque of the tensioner capscrew. Torque value: 32 ft-lb (43 Nm).
18. Fill the cooling system.

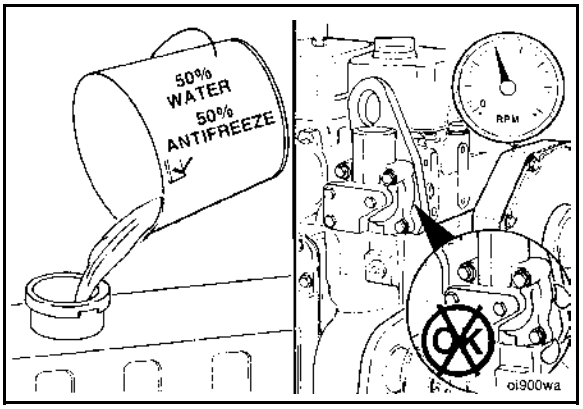


FIGURE 76. FILL THE COOLING SYSTEM

19. Connect the negative (–) cable to the battery.
20. Operate the engine, and check for leaks.

5.13 Alternator Performance Troubleshooting

5.13.1 Low AC Voltage at Startup

Possible Causes:

1. Loss of residual magnetism in the exciter stator lamination

Diagnosis and Repair:

1. Loss of residual magnetism in the exciter stator lamination

   This can be caused by:

   - Extended storage
   - Reversed magnetic field by flashing with wrong battery polarity
   - Exciter stator rewind
   - Mechanical shock (replacement)

   a. Restore magnetism.

      i. Attach leads to a 12VDC battery with a diode in one lead.

NOTICE
The control board will be destroyed if connected with the wrong polarity and no diode.

      ii. Run the generator at rated speed, no load.

      iii. Briefly (maximum one second) connect positive lead to control board terminal F1: P17-1 and negative lead to control board terminal F2: P17-2.

5.13.2 Unstable Voltage (No Load)

Possible Causes:

1. Engine governing unstable
2. Loose or corroded connections
3. Intermittent ground on machine

Diagnosis and Repair:

1. Engine governing unstable

   - Check for engine governor hunting with a frequency meter or tachometer, or cyclic irregularities in the engine with InPower.
   - If any engine DTC fault codes are present, troubleshoot them using the E-Controls manual.
   - Check fuel supply pressure to ensure that it is consistent.
   - Ensure that the throttle assembly moves freely. Clean it if necessary.
   - Check the spark plugs for buildup; ensure that a spark is present at each cylinder. Repair or replace them if necessary.
   - Check for any exhaust restriction. Clean or replace components as necessary.
   - Check for an intake leak. Repair or replace components as necessary.

- Check for proper function of the crankshaft and camshaft position sensors, and the wiring to the ECM from the sensors. Repair or replace components as necessary.
- Check the fuel mix control valve for proper operation, such that it can move freely and easily. Clean or replace the valve if necessary.

2. Loose or corroded connections
   - Check electrical connectors on terminals on the control board. Check auxiliary terminals for loose connections. Repair or replace as necessary.
3. Intermittent earth on machine

NOTICE
Voltage induced during megger test may damage the PCC. Disconnect the PCC before megger test.

   - Megger test all the windings, including the exciter stator. Low insulation resistance can affect the PCC.

5.13.3 Unbalanced Voltage (With Load)

NOTICE
Maximum I_2 = 8%. Generator set load unbalance must not exceed 25% between any phases.

Possible Causes:

1. Alternator loads unbalanced
2. Engine governing unstable

Diagnosis and Repair:

1. Alternator loads unbalanced
   a. Check that loads are balanced on each leg of alternator output (L1, L2, L3).
2. Engine governing unstable
   - Check for engine governor hunting with a frequency meter or tachometer, or cyclic irregularities in the engine with InPower.
   - If any engine DTC fault codes are present, troubleshoot them using the E-Controls manual.
   - Check fuel supply pressure to ensure that it is consistent.
   - Ensure that the throttle assembly moves freely. Clean it if necessary.
   - Check the spark plugs for buildup; ensure that a spark is present at each cylinder. Repair or replace components as necessary.
   - Check for any exhaust restriction. Clean or replace components as necessary.
   - Check for an intake leak. Repair or replace components as necessary.
   - Check for proper function of the crankshaft and camshaft position sensors, and the wiring to the ECM from the sensors. Repair or replace components as necessary.
   - Check the fuel mix control valve for proper operation, such that it can move freely and easily. Clean or replace the valve if necessary.

5.13.4 Unstable Voltage (With Load)

Possible Causes:

1. Engine governing unstable
2. Leading power factor load created by power factor correction capacitors
3. Fluctuations in load current (motor starting or reciprocating loads)
4. Automatic voltage regulator parameters configured incorrectly

Diagnosis and Repair:

1. Engine governing unstable
    - Refer to the engine service manual (if applicable) or E-Controls service manual.
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. Adjust as required if corrects the issue.
3. 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.
4. Automatic voltage regulator parameters configured incorrectly
    - Contact your local Cummins distributor.

5.13.5 Poor Voltage Regulation (With Load)

Possible Causes:

1. Unbalanced load
2. Voltage drop between alternator and load, caused by losses in supply cable (power losses)
3. Fault on main rectifier or excitation winding
4. Under frequency roll-off protection activated

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. 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.
3. 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.
4. Under frequency roll-off protection activated.
    - Under frequency roll-off protection is activated, indicating excessive load. Check that under frequency roll-off set point and slope are correct.

- Load on generator is in excess of rated. Ensure that the load on the generator set does not exceed the generator 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.

5.13.6 Poor Response to Load Surges or Motor Starting (With Load)

Possible Causes:

1. Engine performance
2. Load current surges
3. Active under-frequency roll-off protection on automatic voltage regulator
4. Voltage drop between alternator and load
5. Fault on windings or rotating rectifier
6. Fault in automatic voltage regulator

Diagnosis and Repair:

1. Engine performance
    - Check performance of the engine during the application of load.
2. Load current surges
    - When surges significantly exceed the full load of the generator, check surges with a clip-on ammeter.
        - Check with factory for advice on voltage dips for motor starting.
3. Active under-frequency roll-off protection on automatic voltage regulator
    - Low engine speed will activate under frequency roll-off protection circuit. Check the engine speed dip on load application.
4. Voltage drop between alternator and load
    - The drop is caused by power losses in the supply cable, which 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 volts drop along the cable.
        - A larger diameter cable may be required in severe cases.
        - This will be worse during current surges (motor starting, etc.).
5. Fault on windings or rotating rectifier
    - Check the no load excitation voltage across automatic voltage regulator X+ (F1) and XX- (F2). Voltage should be no higher than 12 VDC.
6. Fault in automatic voltage regulator
    - Replace the automatic voltage regulator and re-test when loaded.

5.13.7 High Voltage (With Load)

Possible Causes:

1. Unbalanced load
2. Leading power factor

Diagnosis and Repair:

1. Unbalanced load.
    - Check voltage on all three phases. If 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).

5.13.8 Low Voltage (With Load)

Possible Causes:

1. Under frequency roll-off protection activated
2. Faulty permanent magnet generator (PMG) (if used)
3. Fault on winding or rotating diodes
4. Voltage drop between alternator and load, due to power losses in the cable

Diagnosis and Repair:

1. Under frequency roll-off protection activated
    - Under frequency roll-off protection is activated, indicating excessive load. Check that under frequency roll-off set point and slope are correct.
    - Load on generator is in excess of rated. Ensure that the load on the generator set does not exceed the generator 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.
2. Faulty permanent magnet generator (PMG) (if used)
    - Start the generator set and run at rated speed. Measure the voltages at the terminals P2 (J18-1) and P3 (J18-2). These should be balanced and within the range of 60 Hz generators 190 to 220 V.
3. Fault on winding or rotating diodes
    - Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2).
        a. Remove external leads from the alternator.
        b. Use appropriate metering equipment (Wheatstone bridge or Kelvin bridge). Measure the winding resistance of the main rotor and stator.
        c. Check diodes.
        d. Test diodes on the main rotating rectifier assembly with a multimeter.
4. 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, etc.).

5.13.9 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**.

NOTICE
Perform the tests in order, unless stated otherwise. Perform the method steps in order. Achieve a result before doing the next step.

1. Disconnect the exciter stator leads X+ (F1) and XX- (F2) from the PCC 2300 control board, then do the tests in the table below.

TABLE 34. FAULTFINDING

Test		Result	Action
1	Disconnect the sensing leads from the control (6, 7, and 8), the ground cable, and customer connection from the terminal block. Use a MΩ meter to measure resistance from the leads to ground.	Resistance is less than 1 MΩ.	Clean the main stator, allow it to dry, and repeat the test. If the same result is achieved, replace the alternator/main stator.
		Resistance is greater than 1 MΩ.	Proceed to test 2.
2	Use a multimeter to measure the exciter stator resistance across the leads X+ (F1) and XX- (F2).	Resistance is not with 10% of the relevant value in **Section 2.5 on page 14**.	Stator windings damaged; replace exciter stator.
		Resistance is within 10% of the relevant value in **Section 2.5 on page 14**.	Proceed to test 3.
3	Use an insulation tester to megger from the XX- (F2) to ground.	Resistance value is less than 1 MΩ.	Clean the exciter stator, allow it to dry, and repeat the test. If the same result is achieved, replace the exciter stator.
		Resistance value is greater than 1 MΩ.	Exciter stator is good. Proceed to test 4.
4	Connect a 12V battery to the exciter stator windings, positive terminal to X+ (F1), negative terminal to XX- (F2). Disconnect all loads. Run the generator at nominal speed. Measure AC output voltage.	Voltage is balanced between phases within 1%, and within 10% of nominal.	Main stator, main rotor, exciter stator, exciter rotor, and rectifier are functioning properly. Proceed to test 10.
		Voltage is balanced between phases within 1%, but greater than 10% below nominal.	Main stator is functioning properly. Proceed to test 6. If tests 6 and 7 already completed, proceed to test 8.
		Voltage is unbalanced by greater than 1%.	Main stator windings are faulty. Proceed to test 5.

Test		Result	Action
5	At the terminal block, disconnect all leads. Use a μΩ meter/kelvin bridge to measure each winding resistance.	Resistances are not within 10% of the relevant value from **Section 2.5 on page 14**, or are not balanced within 1%.	Replace the alternator.
		Resistances are within 10% of the relevant value from **Section 2.5 on page 14**, and are balanced within 1%.	Reconnect all leads, and return to test 2.
6	Disconnect the flexible lead ends of each diode on the rotating rectifier. Use a multimeter to test each diode.	One or more diodes do not function properly.	Replace all diodes, as well as the varistor. Return to test 4.
		All diodes function properly.	Proceed to test 7.
7	Inspect the varistor for signs of damage or overheating. Disconnect the positive output lead from the rotating rectifier. Measure resistance across the varistor.	The varistor shows signs of a thermal event or measures no resistance in one or both directions.	Replace all diodes and the varistor. Return to test 4.
		The varistor shows no signs of a thermal event and has near infinite resistance in both directions.	Proceed to test 8.
8	Disconnect the 6 exciter rotor leads from the rotating rectifier. Use a μΩ meter to measure the resistance across all of the leads connected to the same polarity diodes.	Resistance is within 10% of the relevant value in **Section 2.5 on page 14**.	Replace the exciter rotor/alternator assembly.
		Resistance is not within 10% of the relevant value in **Section 2.5 on page 14**.	Proceed to test 9.
9	Disconnect one of the main rotor leads from the rotating rectifier. Use a multimeter to measure the resistance of the main rotor.	Resistance value is more than 10% different than the relevant value from **Section 2.5 on page 14**.	Replace the main rotor/alternator assembly.
		Resistance value is less than 10% different than the relevant value from **Section 2.5 on page 14**.	Proceed to test 10.
10	Use a multimeter to check the continuity of the sense leads.	One or more sense leads measure "open".	Replace the sensing leads.
		All sense leads measure continuous.	Proceed to test 11.
11	Use a multimeter to measure the voltage across the leads of the PMG.	All voltages are 170-220V phase to phase and are balanced within 1%.	Replace the control board.
		Voltages are not 170-220V phase to phase and/or not balanced within 1%.	Proceed to test 12.
12	Use a multimeter to measure the resistance of the PMG stator.	Resistance is not within 10% of the relevant value in **Section 2.5 on page 14**.	Replace the PMG stator.
		Resistance is within 10% of the relevant value in **Section 2.5 on page 14**.	Replace the PMG rotor.

5.14 Engine Performance Troubleshooting

5.14.1 Engine Is Difficult to Start or Does Not Start

Possible Causes:

1. Battery voltage is low, interrupted, or open
2. Fuel system issues.
3. Air intake or exhaust issues
4. Sensor issues
5. Base engine problem

Diagnosis and Repair:

1. Battery voltage is low, interrupted, or open
    a. Check the battery connections, unswitched battery supply circuit, and fuses.
    b. Correct or replace if necessary.
2. Fuel system issues
    a. Verify fuel pressure at the generator set.
    b. Inspect fuel lines and connections for leaks. Spray soapy water along the lines and at connection. Bubbling indicates a likely leak location.
        i. Repair the leaks. Refer to the Fuel System section.
    c. The manual fuel shutoff (FSO) valve is closed.
        i. Open the valve.
    d. FSO valve solenoids or circuit are malfunctioning.
        i. Check the FSO valve solenoids and circuit for proper operation. Check for continuity, and proper operation.
        ii. Correct or replace if necessary. Refer to the Fuel System section.
    e. The wiring to the throttle body has failed (shorted or open).
        i. Examine the wiring for damage.
        ii. Check for DTC fault codes. If any are present, troubleshoot as specified in the E-Controls manual.
        iii. Repair if necessary
    f. The throttle plate and shaft are binding.
        i. Check for fault codes using the E-Controls tool. Troubleshoot those as specified in the E-Controls manual.
        ii. Inspect the bore of the throttle body.
        iii. Clean if necessary, or replace if worn.
    g. Inspect the pressure regulator and EPR assembly for damage.
        i. The valve located inside the assembly should move freely.
        ii. Clean or replace if necessary.

3. Air intake or exhaust issues
    a. The air intake system restriction is above specification.
        i. Check the air intake system restriction.
        ii. Clean or replace the air filter and inlet piping if necessary. Refer to the Air Intake section.
    b. The exhaust system restriction is above specification.
        i. Check the exhaust system restrictions.
        ii. Correct or replace if necessary. Refer to the Exhaust section.
4. Sensor issues
    a. The intake manifold pressure sensor is malfunctioning.
        i. Check the intake manifold pressure sensor.
        ii. Correct or replace if necessary.
    b. The temperature manifold absolute pressure (TMAP) sensor is malfunctioning.
        i. Refer to the Sensors section.
    c. The crankshaft and/or camshaft speed/position sensors are reading incorrectly.
        i. Refer to the Control System section and/or the Sensors section.
5. Base engine problem
    a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
    b. Correct or replace if necessary.

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

Possible Cause:

1. Excessive load
2. Fuel system issues
3. Air intake or exhaust issues
4. Engine speed governor issue
5. Other issues

Diagnosis and Repair:

1. Excessive loads
    - 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.
2. Fuel system issues
    - Inspect fuel lines, fuel connections, and fuel filters for leaks.
        - Repair if leaks are found.
    - Fuel shutoff valve solenoid or circuit is malfunctioning.
        - Check the fuel shutoff valve solenoid and circuit.

3. 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.
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
4. Engine speed governor issue
    - Refer to the engine service manual.
5. Other issues
    - The generator set is operating above recommended altitude.
        - Generator set power decreases above recommended altitude.
            - Refer to the Generator Set Data Sheet for the specific generator set for specifications.
    - Base engine problem
        - Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
            - Refer to the engine service manual.
    - Engine calibration values set in control are not correct.
        - Verify governor settings in control. If needed, contact your service support representative.

5.14.3 Engine Runs Rough or Misfires

Possible Cause:

1. O_2 Sensor issues
2. Ignition system issues
3. Fuel system issues
4. Engine air intake system or engine exhaust system issues
5. Sensor issues
6. Other issues

Diagnosis and Repair:

1. O_2 Sensor issues
    a. On 4G units, use Econtrols 4G Display software to compare UEGO Phi uncorrected on the HD Service page against a lambda meter measurement at the end of the exhaust.
        - Lambda is the inverse of Phi. 1/UEGO Phi = Lambda.

          Example: UEGO Phi is 0.7: 1/.07=1.4 lambda
        - If the calculated lambda is more than a .04 difference than the lambda measurement, replace the O_2 sensor.

2. Ignition system issues
    a. Replace the spark plugs.
        i. Spark plug defects on gaseous engines are very hard to detect. Microscopic carbon tracing can be very hard to see. Replace the spark plugs with Cummins approved spark plugs to ensure this is not an issue.
    b. Check the spark plug wires.
        i. Inspect connection points and wires for breaks or damage.
    c. Test the ignition coils.

NOTICE
This type of ignition coil cannot be tested using resistance checks.

        i. Use a coil on a plug tester (or in-line spark tester) to isolate the faulty coil.
        ii. Replace the faulty coil if necessary.
3. Fuel system issues
    a. Inspect fuel lines and fuel connections for leaks.
        i. Repair if leaks are found.
    b. Check for excessive distance from the regulator to the generator set. This is more likely to be an issue at light loads (> 150 ft).
        i. Use Econtrols software to check the command fuel pressure against the actual fuel pressure: MJ_P_cmd vs. MJ_P_act.
        ii. If there is a variation in the command versus the actual, add a regulator right at the generator set

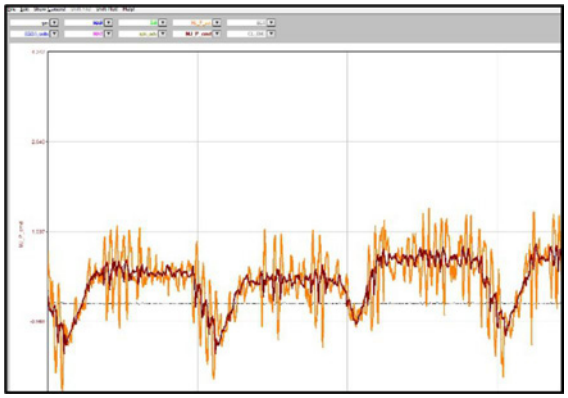


FIGURE 77. POOR FUEL CONTROL EXAMPLE

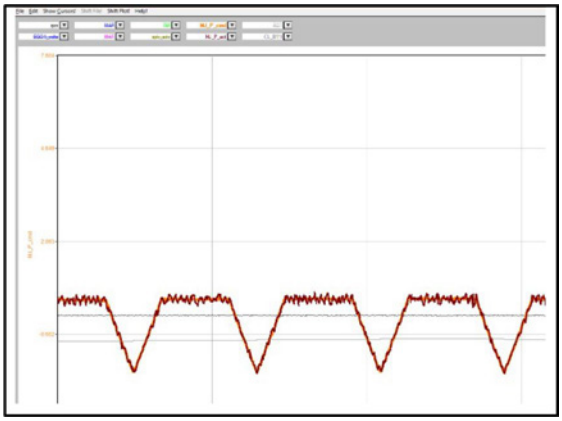


FIGURE 78. GOOD FUEL CONTROL EXAMPLE

4. Engine air intake system or engine exhaust system issues
    a. Engine air intake system restriction is above specification.
        i. Check the air intake system for restriction.
        ii. Clean or replace the air filter and inlet piping as necessary.
    b. There are air intake system or exhaust system leaks.
        i. Repair if necessary.
    c. Exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Replace the exhaust system if necessary.
5. Sensor issues
    a. Crankshaft and/or camshaft speed/position sensors reading incorrectly.
        i. Check for fault codes at the PCC.
        ii. Check for fault codes at the Engine Control Module (ECM).
        iii. Correct or replace if necessary.
6. Other issues
    - Verify that the proper fuel type is selected.
    - There is a base engine problem.
        a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
        b. Correct or replace if necessary.

5.14.4 Engine Shuts Off Unexpectedly or Dies during Deceleration

Possible Causes:

1. Emergency Stop (if used)
2. Fuel system issues
3. Wiring to the throttle body has failed (shorted or open)
4. Engine Control Module (ECM) related issues

5. Base engine problem

Diagnosis and Repair:

1. Emergency Stop (if used)
    a. The Emergency Stop circuit is energized.
        i. Make sure that the Emergency Stop circuit is not energized.
2. Fuel system issues
    a. Check the fuel supply for appropriate pressure and flow.
    b. The manual fuel shutoff (FSO) valve is closed.
        i. Open the valves.
    c. The FSO valve solenoids or circuit are malfunctioning.
        i. Check the FSO valve solenoids and circuit.
        ii. Repair if necessary.
3. Wiring to the throttle body has failed (shorted or open)
    a. Verify that the wiring is intact.
    b. Repair if necessary.
4. Engine Control Module (ECM) related issues
    a. The battery voltage supply to the ECM has been lost.
        i. Check the battery connections.
        ii. Check all components in the un-switched battery supply circuit to the ECM.
    b. The ECM is not grounded correctly.
        i. Check the grounding and verify the correct placement of the star washer on the engine block ground cable.
    c. There is a problem between the ECM and the PCC.
        i. Check connections, wiring and components (i.e., relays).
    d. The ECM is malfunctioning.
        i. Correct or replace if necessary.
5. Base engine problem
    a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
    b. Correct or replace if necessary.

5.14.5 Engine Speed Surges Under Load or in Operating Range

Possible Causes:

1. O_2 Sensor issues
2. Ignition system issues
3. Fuel system issues
4. Engine air intake system or engine exhaust system issues
5. Sensor issues
6. Other issues

Diagnosis and Repair:

1. O_2 Sensor issues
    a. On 4G units, use Econtrols 4G Display software to compare UEGO Phi uncorrected on the HD Service page against a lambda meter measurement at the end of the exhaust.
        - Lambda is the inverse of Phi. 1/UEGO Phi = Lambda.

          Example: UEGO Phi is 0.7: 1/.07=1.4 lambda
        - If the calculated lambda is more than a .04 difference than the lambda measurement, replace the O_2 sensor.
2. Ignition system issues
    a. Replace the spark plugs.
        i. Spark plug defects on gaseous engines are very hard to detect. Microscopic carbon tracing can be very hard to see. Replace the spark plugs with Cummins approved spark plugs to ensure this is not an issue.
    b. Check the spark plug wires.
        i. Inspect connection points and wires for breaks or damage.
    c. Test the ignition coils.

NOTICE
This type of ignition coil cannot be tested using resistance checks.

        i. Use a coil on a plug tester (or in-line spark tester) to isolate the faulty coil.
        ii. Replace the faulty coil if necessary.
3. Fuel system issues
    a. Inspect fuel lines and fuel connections for leaks.
        i. Repair if leaks are found.
    b. Check for excessive distance from the regulator to the generator set. This is more likely to be an issue at light loads (> 150 ft).
        i. Use Econtrols software to check the command fuel pressure against the actual fuel pressure: MJ_P_cmd vs. MJ_P_act.
        ii. If there is a variation in the command versus the actual, add a regulator right at the generator set

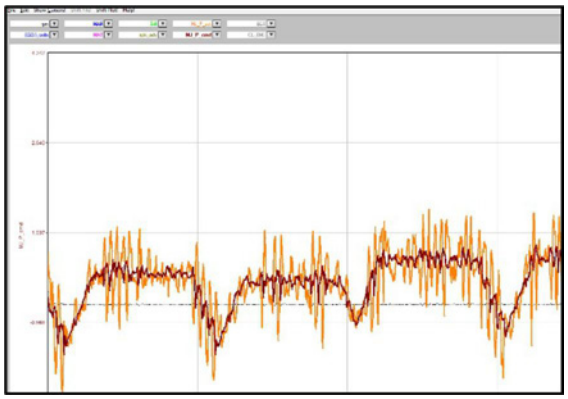


FIGURE 79. POOR FUEL CONTROL EXAMPLE

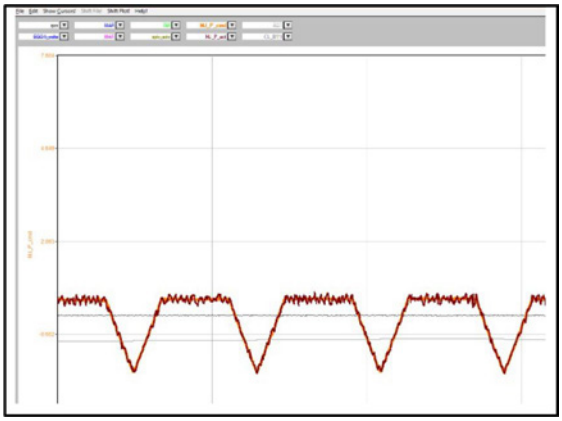


FIGURE 80. GOOD FUEL CONTROL EXAMPLE

4. Engine air intake system or engine exhaust system issues
    a. Engine air intake system restriction is above specification.
        i. Check the air intake system for restriction.
        ii. Clean or replace the air filter and inlet piping as necessary.
    b. There are air intake system or exhaust system leaks.
        i. Repair if necessary.
    c. Exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Replace the exhaust system if necessary.
5. Sensor issues
    a. Crankshaft and/or camshaft speed/position sensors reading incorrectly.
        i. Check for fault codes at the PCC.
        ii. Check for fault codes at the Engine Control Module (ECM).
        iii. Correct or replace if necessary.
6. Other issues
    a. There is moisture in the wiring harness connectors.
        i. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
    b. There is a base engine problem.
        i. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
        ii. Correct or replace if necessary.
    c. The alternator is malfunctioning.
        i. Temporarily disconnect the alternator and test-run the engine.
        ii. Replace the alternator if necessary.

5.14.6 Poor Engine Transient Response

Possible Cause:

1. Excessive loads

2. Fuel system leaks
3. Air intake or exhaust issues
4. Other issues

Diagnosis and Repair:

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
        i. Re-visit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
2. Fuel system leaks
    a. Inspect fuel lines, fuel connections, and fuel filters for leaks.
        i. Repair if leaks found.
        ii. Refer to the procedures in the troubleshooting and repair manual for the specific engine.
3. Air intake or exhaust issues
    a. There are air intake or exhaust leaks.
        i. Inspect the air intake and exhaust systems for air leaks.
    b. The air intake system restriction is above specification.
        i. Check the air intake system for restriction.
        ii. Clean or replace the air filter and inlet piping as necessary.
    c. The exhaust system restriction is above specification.
        i. Check the exhaust system for restrictions.
4. Other issues
    a. The generator set is operating above the recommended altitude.
        i. Generator set power decreases above the recommended altitude.
            A. Refer to the Generator Set Data Sheet for the specific generator set for specifications.
    b. Base engine problem
        i. Check the engine for high crankcase pressure, low compression, damaged pistons, damaged camshaft, and other damaged parts.
            A. Refer to the engine service manual.
    c. The engine calibration values set in the control are not correct.
        • Verify the governor settings in the control. If needed, contact your service support representative.

5.14.7 Engine Will Not Reach Rated Speed (RPM)

Possible Causes:

1. Excessive loads
2. Air intake or exhaust issues
3. Other issues

Diagnosis and Repair:

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set KW rating.
        i. 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 issues
    a. The air intake system restriction is above specification.
        i. Check the air intake system restriction.
        ii. Clean or replace the air filter and inlet piping if necessary.
    b. The exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Clean or replace if necessary.
3. Other issues
    a. The engine is operating above the recommended altitude.
        i. Verify the product capability at altitude against the installed load.
        ii. Refer to altitude and temperature derates to calculate expected power.
    b. There is a base engine problem.
        i. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
        ii. Correct or replace if necessary.

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

Logic: The PCC has not received or recognized a manual start signal.

Possible Causes:

1. No power supplied to the control (green "Heartbeat" LED on the baseboard not flashing)
2. Baseboard not properly calibrated or corrupt calibration (green "Heartbeat" LED on baseboard flashes every 0.5 seconds)
3. Active Emergency Stop switch or defective wiring
4. Defective Manual Run/Stop button, harness, or baseboard
5. Bad starter relay, wiring issue, bad starter or key switch relay

Diagnosis and Repair:

1. No power supplied to the control (green "Heartbeat" LED on the baseboard not flashing)
    a. There are poor battery cable connections.
        i. Clean the battery cable terminals and tighten all connections.
    b. There is a continuity problem.
        i. Remove Fuse F3 and check continuity. If open, replace the fuse with one of the same type and amp rating (20 Amps).

ii. If Fuse F3 is OK, remove connector PCC-P20 and check for B+ at pins 9, 10, 20, and 21; and ground at pins 2, 4, 7, and 12.

iii. If B+ and ground are OK, the baseboard may be defective. Cycle power to the baseboard by reconnecting PCC-P20.

iv. Replace the baseboard if necessary.

2. Baseboard not properly calibrated or corrupt calibration (green "Heartbeat" LED on baseboard flashes every 0.5 seconds)
   a. Confirm that the installed calibration part number matches the serial plate information.
   b. Re-enter a calibration file if necessary.

NOTICE
When properly installed, the green "Heartbeat" LED flashes once every second.

3. Active Emergency Stop switch or defective wiring
   a. With the Emergency Stop push button not activated, remove connectors JE and PE.
   b. Bypass the Emergency Stop switch by connecting the JE and PE connectors.
   c. Attempt to start the generator set in manual mode. If it starts, the Emergency Stop Switch is faulty.
   d. Correct or replace if necessary.
4. Defective Manual Run/Stop button, harness, or baseboard
   a. Remove connector PCC-P25 from the baseboard and check for continuity from pin PCC-P25-10 to Display P1-6.
   b. If there is no continuity when pressing the Manual Run/Stop button, replace the front membrane panel.
5. Bad starter relay, wiring issue, bad starter or key switch relay
   a. Inspect and test these components.
   b. Correct and replace components if necessary.

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

Logic:

The PCC has not received or recognized a remote start signal.

Possible Causes:

1. Faulty remote start customer wiring
2. Bad starter relay, wiring issue, bad starter, or key switch relay

Diagnosis and Repair:

1. Faulty remote start customer wiring
   a. Reset the control. Attempt to start and check for wiring connections.
   b. If ground is not present, isolate to the remote switch or customer wiring. Repair if necessary.
2. Bad starter relay, wiring issue, bad starter, or key switch relay
   a. Inspect and test these components.

b. Correct and replace components if necessary.

5.14.10 Engine Starts but Will Not Keep Running

Possible Causes:

1. Battery voltage is low, interrupted, or open
2. Run/Stop circuit issues
3. Fuel system issues
4. Base engine problem

Diagnosis and Repair:

1. Battery voltage is low, interrupted, or open.
    a. Check the battery connections, unswitched battery supply circuit, and fuses.
    b. Correct or replace if necessary.
2. Run/Stop circuit issues
    a. The alternator Run/Stop circuit is malfunctioning.
        i. Check the alternator Run/Stop circuit.
        ii. Correct or replace if necessary.
3. Fuel system issues
    a. Verify fuel pressure at the generator set.
    b. Inspect fuel lines and connections for leaks. Spray soapy water along the lines and at connection. Bubbling indicates a likely leak location.
        i. Repair leaks, if found
    c. The fuel shutoff (FSO) valve is closed.
        i. Open the valve.
    d. FSO valve solenoid or circuit are malfunctioning.
        i. Check the FSO valve solenoids and circuit for proper operation. Check for continuity, and proper operation.
        ii. Correct or replace if necessary.
    e. The wiring to the throttle body has failed (shorted, or open).
        i. Examine the wiring for damage.
        ii. Check for DTC fault codes. If any are present, troubleshoot as specified in the E-Controls manual.
        iii. Repair if necessary
    f. The throttle plate and shaft are binding.
        i. Check for fault codes using the E-Controls tool. Troubleshoot those as specified in the E-Controls manual.
        ii. Inspect the bore of the throttle body.
        iii. Clean if necessary. Replace if worn.
    g. Inspect the pressure regulator and EPR assembly for damage.
        i. The valve located inside the assembly should move freely.

ii. Clean or replace if necessary.

4. Base engine problem
    a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
    b. Correct or replace if necessary.

5.14.11 Engine Will Not Shut Off

Possible Cause:

1. Run/Stop circuit issue

Diagnosis and Repair:

1. Run/Stop circuit issue
    a. Run/stop circuit is malfunctioning.
        i. Check the alternator Run/Stop circuit.
        ii. Correct or replace if necessary.

5.14.12 Fuel Consumption Is Excessive

Possible Causes:

1. Excessive loads
2. Maintenance, repair or environmental effects
3. Air intake or exhaust issues
4. Fuel system issues
5. Crankshaft and/or camshaft speed/position sensors are reading incorrectly
6. Other issues

Diagnosis and Repair:

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
        i. Re-visit the generator set sizing process to make sure 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 environmental effects
    a. Fuel consumption has increased after an engine repair.
        i. Evaluate the engine repair to determine its effect on fuel consumption.
            A. Correct if necessary.
        ii. Check part numbers to make sure the correct parts were used.
            A. Replace incorrect parts.
    b. Lubricating oil level is above specification.
        i. Check the oil level.
        ii. Verify the dipstick calibration and oil pan capacity.
        iii. Fill the system to the specified level.

c. Environmental factors are affecting fuel consumption.

i. 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 issues

a. There are air intake or exhaust leaks.

i. Inspect the air intake and exhaust systems for air leaks. Refer to the Air Intake System section.

b. The air intake system restriction is above specification.

i. Check the air intake system for a restriction.

ii. Clean or replace the air filter and inlet piping if necessary. Refer to the Air Intake System section.

4. Fuel system issues

a. There are leaks in fuel lines and/or fuel connections.

i. Repair the leaks. Refer to the Fuel System section.

b. The fuel system pressure sensors (fueling/timing) are malfunctioning.

i. Check the fuel system pressure sensors (fueling/timing), including: the camshaft sensor, fuel pressure sensors, throttle positions sensors, crankshaft sensor, O2 sensor, and TMAP sensors for proper operation. Refer to the E-Controls manual for test methods for each device.

5. Crankshaft and/or camshaft speed/position sensors are reading incorrectly

a. Check the sensors.

b. Check for ECM fault codes related to these sensors. Refer to the Engine Control Module (ECM) section.

c. Correct or replace if necessary.

6. Other issues

a. Engine parasitics are excessive.

i. Check engine-driven units for correct operation. Refer to the operator manual.

ii. Check the cooling fan for correct operation. With fan belt removed, the fan should spin freely by hand in both directions.

A. Correct or replace if necessary.

b. There is a base engine problem.

i. Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts. Listen for unusual noises, and inspect possible causes. Analyze the oil and inspect the filters to locate an area of probable damage.

ii. Correct or replace if necessary.

5.14.13 Engine Noise Is Excessive

Possible Cause:

1. Air intake or exhaust leaks
2. Turbocharger noise
3. Mechanical or internal component wear or damage

Diagnosis and Repair:

1. Air intake or exhaust leaks
    a. There are air intake or exhaust leaks.
        i. Inspect the air intake and exhaust systems for air leaks. Refer to the Air Intake System section and/or Exhaust System section.
    b. There is a faulty muffler.
        i. Replace the muffler if necessary. Refer to the Exhaust System section.
2. Turbocharger noise
    a. Inspect the turbochargers for excessive mechanical noise.
        i. Replace them if necessary.
3. Mechanical or internal component wear or damage
    a. There is internal engine damage.
        i. Analyze the oil and inspect the filters to locate an area of probable damage.
        ii. Inspect and further investigate area of probable damage.
    b. Valvetrain components are damaged.
        i. Replace damaged components.
    c. The vibration damper is damaged.
        i. Replace the vibration damper.
    d. There is main bearing or connecting rod bearing noise.
        i. The engine is damaged, and needs repair or replacement.
    e. Flywheel or flexplate cap screws are loose or broken.
        i. Check the flywheel or flexplate and the mounting cap screws.
        ii. Tighten any loose screws; replace any broken screws.
    f. Piston, piston rings, or cylinder liner is/are worn or damaged.
        i. Replace worn or damaged components.

5.14.14 DC (Battery-Charging) Alternator Troubleshooting

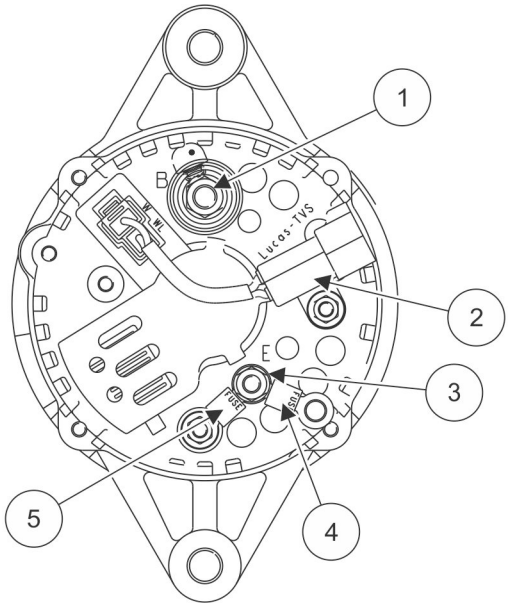
⚠ WARNING

Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a tank of strong soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to reduce the possibility of serious personal injury.

⚠ WARNING

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

ALTERNATOR WIRING SYSTEMS



Key	Terminal	Connected To
1	BAT	Battery
2	I	Flash signal
3	GRD	Ground
4	Spare Fuse	--
5	Fuse	--

FIGURE 81. ALTERNATOR (LUCAS)

TEST

1. Check for open circuits.

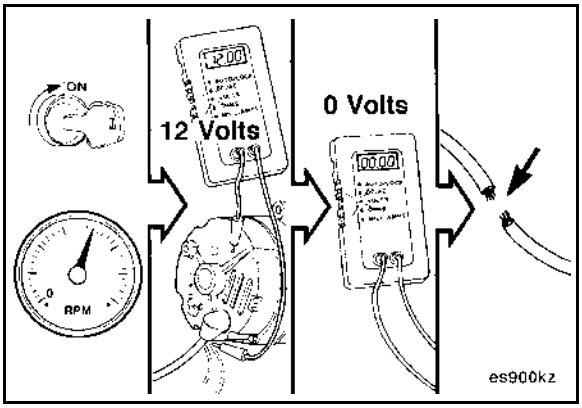


FIGURE 82. CHECK FOR OPEN CIRCUITS

2. Connect a multimeter to alternator “BAT” terminal to ground.
3. Run the generator and check for battery voltage on the meter.
4. Stop the generator set.

5. Connect a carbon-pile load (battery/alternator tester) across the batteries in one of the battery boxes.

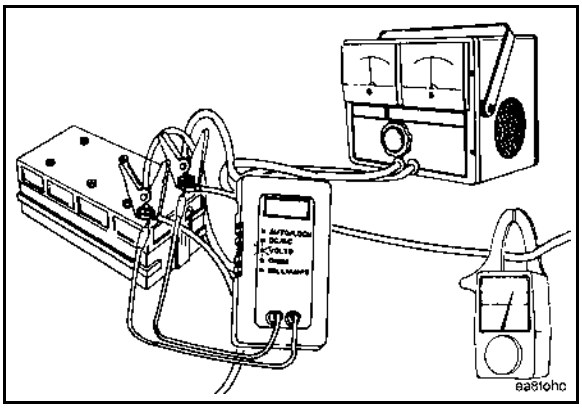


FIGURE 83. CONNECT A CARBON PILE LOAD

6. Clamp an induction pickup-type ampere-hour meter around the battery cable.
7. Disconnect the 120V battery charger (if present).

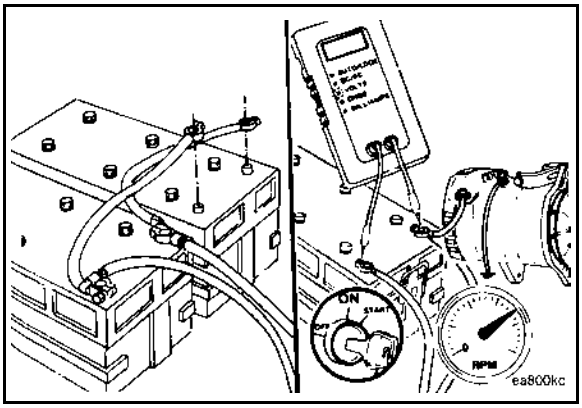


FIGURE 84. DISCONNECT BATTERY CABLES; MEASURE THE ALTERNATOR VOLTAGE OUTPUT

8. Operate the engine.
9. Measure the alternator voltage output to the batteries with a digital multimeter as shown in the image above. Refer to the alternator manufacturer's specifications.

NOTICE
Any multimeter reading of zero voltage indicates an open circuit.

10. Operate the engine.
11. Adjust the carbon-pile load-testing equipment to apply the maximum rated amperage load to the alternator. Refer to the alternator manufacturer's specifications.

NOTICE
The alternator maximum rated amperage output is normally stamped or labeled on the alternator.

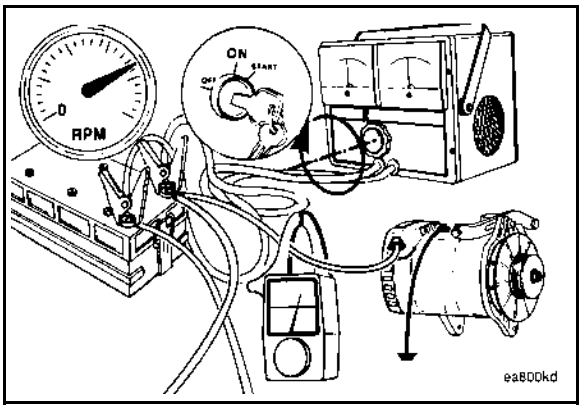


FIGURE 85. APPLY THE MAXIMUM RATED AMPERAGE LOAD

12. Measure the alternator amperage output. Refer to the alternator manufacturer's specifications.
13. If the alternator output (amps) is not within 10% of rated output, repair or replace the alternator. Refer to the alternator manufacturer's instructions for repair procedures.
14. Shut off the engine, and remove the test equipment.

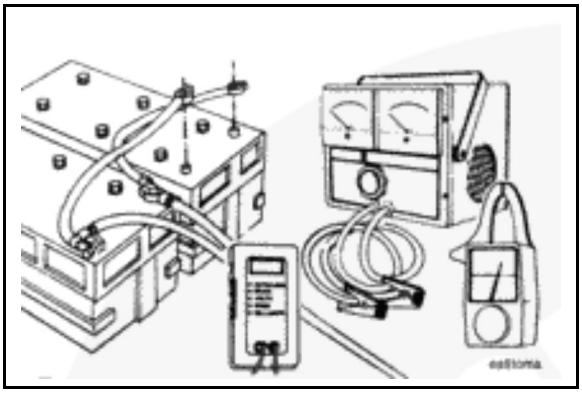


FIGURE 86. REMOVE TEST EQUIPMENT

15. Connect all battery cables, negative (-) cables last.

5.14.15 Cylinder Head Gasket Troubleshooting

Low compression on a single cylinder can be caused by an external leak or a leak to a coolant passage.

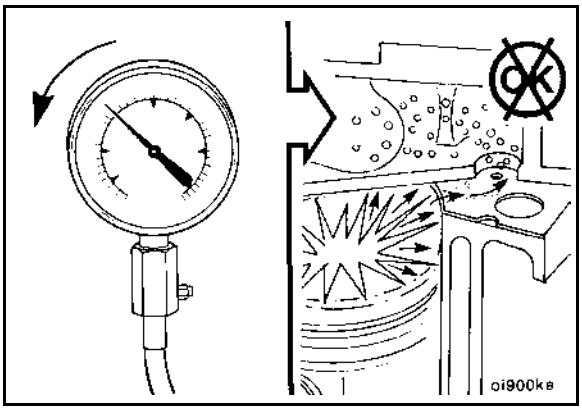


FIGURE 87. LOW COMPRESSION

1. Perform the following tests:
   a. Perform a dry compression test.
      - If low compression is indicated in any cylinder(s), perform a wet compression test.
   b. Perform a wet compression test with liquid soap to determine if there is an external cylinder head gasket leak.
      - If so, replace the gasket with a new one. Refer to the Cylinder Head Maintenance section.

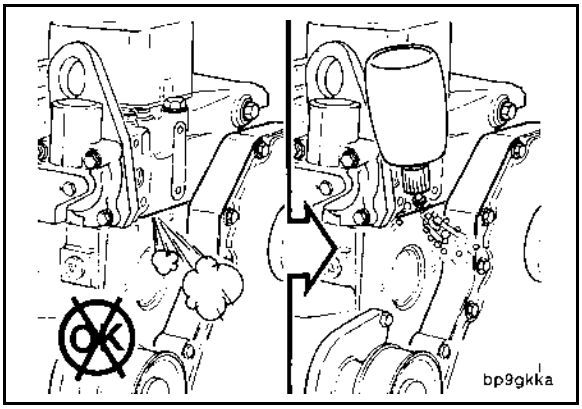


FIGURE 88. USE LIQUID SOAP TO DETERMINE IF THERE IS A LEAK

   c. If there is no external cylinder head gasket leak, but compression was found to be low on adjacent cylinders:
      i. Oil the rings to increase the pressure.
      ii. Re-check the pressure.
      iii. If the pressure has still not increased, the head gasket is probably leaking between the cylinders. Replace the gasket with a new one. Refer to the Cylinder Head Maintenance section.

NOTICE
Never reuse the old head gasket. Always use a new head gasket to prevent leakage.

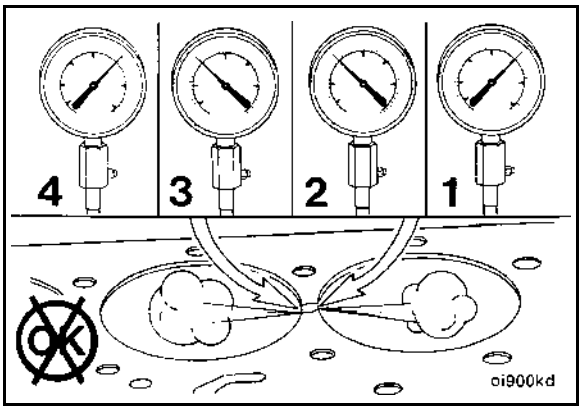


FIGURE 89. LEAKS BETWEEN THE CYLINDERS

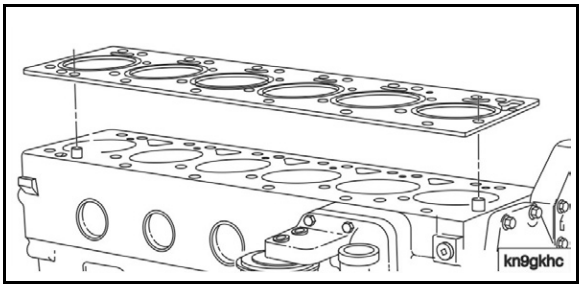


FIGURE 90. REPLACE THE HEAD GASKET

5.15 Code 135 - Oil Pressure Sensor OOR - High

Logic:

Engine oil pressure sensor signal is out of range – shorted high.

Possible Causes:

1. Faulty oil pressure sensor and/or circuit
2. Faulty ECM
3. Faulty ECM connection or harness

Diagnosis and Repair:

1. Faulty oil pressure sensor and/or circuit
    a. Connect the 4G service tool.
    b. Start the generator set.
    c. Check the oil pressure voltage. If the value is *greater than* that the limit defined in calibration, stop the engine and disconnect the oil pressure sensor from the wire harness.
    d. Re-check the oil pressure voltage. If the value *is greater than or equal to* 4.9 VDC, jumper the oil pressure sensor circuit to 5V Analog Return.

e. Re-check the oil pressure voltage.

i. If the value is *less than* 0.1 VDC, then at least one of the following conditions apply:

- There is a faulty connection to the sensor. Inspect the oil pressure sensor and harness connectors and pins. Repair as needed.
- The oil pressure sensor is faulty. Repair or replace it.

ii. If the value displayed is *greater than* 0.1 VDC, jumper the oil pressure sensor circuit to ground.

iii. Re-check the oil pressure voltage. If the service tool displays a value that is *less than* 0.1 VDC, then at least one of the following conditions apply:

- There is a faulty connection to the sensor. Inspect the oil pressure sensor and harness connectors and pins. Repair as needed.
- The oil pressure sensor is faulty. Repair or replace it.
- There is an open oil pressure ground (5Vrtn1) circuit. Repair it.

2. Faulty ECM connection or harness

a. Connect the 4G service tool.

b. Start the generator set.

c. Check the oil pressure voltage. If the value is greater than the limit defined in calibration, stop the engine, disconnect the oil pressure sensor from the wire harness.

d. Re-check the oil pressure voltage. If the value displayed is *less than* 4.9 VDC, the ECM is faulty. Repair or replace as necessary.

3. Faulty ECM

a. Check the ECM, and wiring harness for bent, broken, or missing pins. Repair as necessary.

b. If none of the previous steps fix the problem, replace the ECM.

5.16 Code 141 - Oil Pressure Sensor OOR Low

Logic:

Engine oil pressure sensor signal is out of range – shorted low.

Possible Causes:

1. Faulty oil pressure sensor
2. External wiring problem
3. Faulty ECM

Diagnosis and Repair:

1. Faulty oil pressure sensor

a. Connect the 4G service tool.

b. Start the generator set.

c. Check the oil pressure voltage. If the value displayed is *less than* the limit defined in calibration, stop the engine and disconnect the oil pressure sensor from the wire harness.

d. Re-check the oil pressure voltage. If the value displayed is *greater than or equal to* 4.9 VDC, the oil pressure sensor is faulty. Repair or replace it.

2. External wiring problem
    a. Connect the 4G service tool.
    b. Start the generator set.
    c. Check the oil pressure voltage. If the value displayed is *less than* the limit defined in calibration, stop the engine and disconnect the oil pressure sensor from the wire harness.
    d. Re-check the oil pressure voltage. If the value displayed is *not greater than* 4.9 VDC, the oil pressure sensor signal circuit oil is faulty. Check the wire harness for a short to ground. Repair or replace the harness.
3. Faulty ECM
    a. If none of the previous steps fixes the problem, refer to the Engine Control Module (ECM) section. If the ECM is faulty, replace it.

5.17 Code 143 - Engine Oil Pressure Low (Warning)

Logic:

Engine oil pressure is below the low oil pressure warning threshold.

NOTICE
Although this is an ECM-driven fault, it does not have a corresponding DTC in the E-Controls Manual.

Possible Causes:

1. Low lubricating oil level
2. External leak
3. Lubricating oil does not meet specifications
4. Lubricating oil contaminated with coolant or fuel
5. Engine angularity during operation exceeds specification
6. Coolant temperature above specification
7. Faulty main oil pressure regulator
8. Loose or broken lubricating oil suction or transfer tube
9. Faulty lubricating oil pump
10. Incorrect lubricating oil cooler installed
11. Plugged lubricating oil cooler
12. Lubricating oil temperature above specification
13. Damaged or incorrectly installed piston cooling nozzles
14. Inaccurate or blocked oil pressure sensor
15. Fault simulation enabled or the threshold set too high

Diagnosis and Repair:

1. Low lubricating oil level
    a. Check the oil level. Add or drain oil, if necessary. Refer to the Periodic Maintenance section.

2. External leak
    a. Inspect the engine and surrounding area for external oil leaks.
    b. Tighten the capscrews, pipe plugs, and fittings.
    c. Replace gaskets, if necessary.
3. Lubricating oil does not meet specifications
    a. Verify lubricating oil meets the specifications. Refer to the Periodic Maintenance section.
    b. Verify alternative oil and additives were not added during the oil life.
    c. Verify the age of the lubricating oil.
    d. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.
4. Lubricating oil contaminated with coolant or fuel
    a. Refer to the Engine Oil section.
5. Engine angularity during operation exceeds specification
    a. Verify container is level or near level. Refer to the engine specification to determine suitable amount of angularity.
6. Coolant temperature above specification
    a. On the display or using the InPower service tool, read the engine coolant temperature.
    b. Compare the coolant temperature against the expected coolant temperature for that engine model.
    c. If the coolant temperature is outside of the expected range, refer to FC 145 to troubleshoot an above-normal coolant temperature.
7. Faulty main oil pressure regulator
    a. Inspect the plunger and plunger bore for nicks or scratches.
    b. Verify the plunger moves freely in the bore.
    c. If the regulator meets the above specifications, the regulator is not faulty.
8. Loose or broken lubricating oil suction or transfer tube
    a. Inspect lubricating oil suction tube or transfer tube for leaks. Visually inspect for cracks, kinks, or tears.
    b. Inspect the capscrews for signs of leaks.
    c. Inspect the gaskets and o-rings for signs of damage, excessive wear or pinching.
9. Faulty lubricating oil pump
    a. Check the amount of oil added versus the mileage to verify the correct oil consumption rate.
    b. Verify the correct lubricating oil drain interval. Refer to the oil recommendations in the Model Specifications section.
    c. 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 oil recommendations in the Model Specifications section.
    d. Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary. Refer to the Torque Specifications section.
    e. Verify that the lubricating oil meets the specifications for operating conditions. If not, change the oil and filters. Refer to the oil recommendations in the Model Specifications section.

f. If none of the previous steps fixes the problem, contact a Cummins Authorized Repair Facility.

10. Incorrect lubricating oil cooler installed
    a. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.
11. Plugged lubricating oil cooler
    a. Visually inspect the oil cooler for cleanliness.
    b. Clean the oil cooler housing.
12. Lubricating oil temperature above specification
    a. On the display or using the InPower service tool, read the engine oil temperature.
    b. Compare the oil temperature against the expected oil temperature. Refer to the coolant or block heater specification for a non-running engine.
    c. If the oil temperature is outside of the expected range, refer to FC 145 to troubleshoot an above-normal coolant temperature.
13. Damaged or incorrectly installed piston cooling nozzles
    a. Inspect capscrew and piston cooling nozzle for damage.
    b. Check for leaks and improper seating.
14. Inaccurate or blocked oil pressure sensor
    a. Connect a properly calibrated mechanical oil pressure gauge to the engine at the plug on top of the oil filter head.
    b. Connect InPower.
    c. While engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
    d. Only proceed if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
    e. Start the generator set.
    f. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
15. Fault simulation enabled or the threshold set too high
    a. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
    b. Using the electronic service tool, verify that the fault threshold is **not** within the normal operating range for the oil pressure sensor.

5.18 Code 144 - Engine Coolant Temperature OOR Low (Warning)

Logic:

Engine coolant temperature signal voltage is out of range - shorted low.

NOTICE
The E-controls manual applies to several applications. See the wiring diagrams provided with the generator set or in APPENDIX for appropriate pin numbers.

Diagnosis and Repair:

For the troubleshooting procedure, refer to DTC 118 in the E-Controls Service Manual.

5.19 Code 145 - Engine Coolant Temperature OOR High (Warning)

Logic: Engine coolant temperature signal voltage is out of range - shorted high.

Diagnosis and Repair:

For the troubleshooting procedure, refer to DTC 117 in the E-Controls Manual, which applies to several applications. See the drawings provided with the generator set or the wiring diagrams appendix for the appropriate pin numbers.

5.20 Code 146 - Engine Coolant Temperature Above Normal (Warning)

Logic: Engine coolant temperature has exceeded the warning threshold (220 °F [105 °C]) for high coolant temperature

Possible Causes:

1. High ambient temperature
2. Coolant level below specification
3. Damaged or obstructed cooling system components
4. Inaccurate coolant temperature sensor
5. Fault simulation feature enabled
6. Faulty thermostat
7. Malfunctioning water pump
8. Air or combustion gases entering the cooling system

Diagnosis and Repair

1. High ambient temperature
    a. Measure the air temperature entering the air intake louver of the generator set enclosure if enclosed, or cooling air to the radiator if not enclosed.
    b. Verify the expected cooling system ambient temperature capability.
    c. Inspect for recirculation of cooling discharge air into the generator set enclosure air inlet or the area surrounding the radiator cooling air inlet.
2. Coolant level below specification
    a. Inspect the engine, cooling system, and surrounding area for external coolant leaks.
        i. Repair as required.
    b. Verify the coolant level is correct.
        i. Add coolant as necessary.

3. Damaged or obstructed cooling system components
    a. Inspect the radiator, charge air cooler (if used), and other cores (if used).
        i. Inspect for damaged fins.
        ii. Inspect for dirt, debris or obstructions.
        iii. Remove the blockage.
    b. Inspect the fan shroud for damage and clearance.
        i. Repair or replace the shroud if damaged.
    c. Inspect the fan belt(s) for damage, wear, and proper tension. Inspect the pulleys and belt tensioner for damage or wear.
        i. Repair or replace the parts that are damaged or worn.
    d. Inspect the radiator cap and gasket for damage and proper pressure operation.
        i. Replace the radiator cap if it is not operating correctly.
    e. Inspect the upper and lower radiator hoses for collapse, distortion, or fluid leaks.
        i. Replace the hose(s) if damaged or worn.
    f. Inspect the cooling system components for internal contaminates (dirt, scale, or sludge) and clean as required.
        i. Open the radiator cap and inspect for contaminated coolant and scale.
        ii. Flush the cooling system per the engine service manual.
4. Inaccurate coolant temperature sensor
    a. Measure the coolant temperature near the sender and compare it to the coolant temperature displayed on the control panel.
    b. Verify the temperature sender resistance and compare it to the specification.
        i. Disconnect the main harness connector from the coolant temperature sensor.
        ii. Measure the resistance between the coolant temperature signal pin and the coolant temperature sensor return pin.

TABLE 35. ENGINE COOLANT TEMP (ECT) CALIBRATION

Degrees Fahrenheit	Degrees Celsius	Ohms
266	130	278
248	120	375
230	110	494
221	105	568
212	100	657
203	95	764
194	90	892
185	85	1,045
176	80	1,229
158	70	1,720

Degrees Fahrenheit	Degrees Celsius	Ohms
140	60	2,450
122	50	3,560
77	25	10,000
32	0	33,650
-13	-25	138,100
-40	-40	361,100

If the temperature differs from the unit display by more than 8 °F (13 °C), replace the sensor.

c. Verify the continuity of temperature sender leads. Harness lead resistance should be less than 0.5 Ohm for each lead from the connection to the PCC control board connector.

d. Repair or replace faulty components or wiring.

5. Fault simulation feature enabled
   a. Connect InPower.
   b. Verify that the fault simulation is disabled for the engine coolant temperature sensor by connecting to the PCC via InPower.
6. Faulty thermostat
   a. Refer to the Coolant Thermostat Troubleshooting section.
7. Malfunctioning water pump
   a. replace the water pump. Refer to the Water Pump Removal and Installation section.
8. Air or combustion gases entering the cooling system
   a. Refer to the engine service manual.

5.21 Code 151 - Engine Coolant Temperature High (Shutdown)

Logic: The engine coolant temperature has exceeded the alarm (shutdown) threshold for high coolant temperature.

Diagnosis and Repair

For the troubleshooting procedure, refer to DTC 217 in the E-Controls Manual, which applies to several applications. See the drawings provided with the generator set or the wiring diagrams appendix for the appropriate pin numbers.

5.22 Code 153 - Intake Manifold Temperature OOR High (Warning)

Logic:

Engine intake manifold temperature sensor signal is out of range – shorted high.

NOTICE

The E-controls manual applies to several applications. See the wiring diagrams provided with the generator set or in APPENDIX for appropriate pin numbers.

Diagnosis and Repair:

For the troubleshooting procedure, refer to DTC 113 in the E-Controls Manual.

5.23 Code 154 - Intake Manifold Temperature OOR Low (Warning)

Logic:

Engine intake manifold temperature sensor signal is out of range – shorted low.

NOTICE

The E-controls manual applies to several applications. See the wiring diagrams provided with the generator set or in APPENDIX for appropriate pin numbers.

Diagnosis and Repair:

For the troubleshooting procedure, refer to DTC 112 in the E-Controls Manual.

5.24 Code 155 - Intake Manifold Temperature High (Shutdown)

Logic: The engine intake manifold temperature has exceeded 95 °C (203 °F) for greater than 10 seconds.

Diagnosis and Repair:

For the troubleshooting procedure, refer to DTC 127 in the E-Controls Manual, which applies to several applications. See the drawings provided with the generator set or the wiring diagrams appendix for the appropriate pin numbers.

5.25 Code 234 - Engine Speed High (Shutdown)

Logic:

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

Possible Causes:

1. Faulty Hall Effect (HE) sensor connections and wiring
2. Faulty HE sensor
3. Fault simulation feature is enabled
4. Incorrect threshold setting
5. Incorrect settings on the ECM
6. Incorrect calibrations in the PowerCommand control (PCC)
7. Flywheel teeth number is incorrectly set in the PCC or E-Controls
8. Engine speed is higher than shutdown threshold

Diagnosis and Repair:

1. Faulty HE sensor connections and wiring
    a. Inspect the HE sensor and the main harness connector pins.
        i. Disconnect the main harness connector from the HE sensor.
        ii. Inspect for corroded, bent, broken, pushed back, expanded, or loose pins.
        iii. Inspect for evidence of moisture in or on the connector.
            A. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
        iv. Inspect for missing or damaged connector seals.
        v. Inspect for dirt or debris in or on the connector pins.
        vi. Inspect the wiring for any damage or shorting.
    b. Check for 5V at the 5V supply pin of the harness, and ground at the ground pin.
        i. If one or both are not present, repair or replace the harness.
    c. Check continuity from the signal lead of the sensor to the ECM (see wiring diagrams for ECM pin-outs).
        i. If there is not continuity, repair or replace the harness.
2. Faulty HE sensor
    a. Disconnect the main harness connector from the HE sensor.
    b. Remove the sensor from the flywheel housing, clean and inspect it for damage. If damaged, replace the HE sensor, as well as inspect the flywheel and starter.
    c. Check for continuity across all three of the pins. If one or more pins are open, replace the HE Sensor.
    d. If an oscilloscope is available, with sensor connected to the wiring harness, measure the voltage across the ground and output lead (ground and signal) while cranking the engine. A clean square wave should appear. If not, replace the HE sensor.
3. Fault simulation feature is enabled
    a. Connect the InPower service tool.
    b. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC.
4. Incorrect threshold setting
    a. Use the service tool to connect to the PCC and verify fault threshold settings; then compare them to the specifications. The threshold setting values are:
        - Overspeed Trip Level (60 Hz) = 2250
        - Secondary Overspeed Trip Speed (60 Hz) = 2250
    b. Recalibrate the PCC to reset the threshold settings.
5. Incorrect settings on the ECM
    a. Check that the max allowed governed speed is consistent with the PCC.
    b. Verify that the HE sensor is communicating with the ECM with the E-Controls service tool.

6. Incorrect calibrations in the PowerCommand control (PCC)
    a. Using the display or the InPower service tool, verify the calibration in the PCC.
        i. 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.
        ii. Verify that the HE sensor feature is enabled in calibration.
7. Flywheel teeth number is incorrectly set in the PCC or E-Controls
    a. Make sure that the correct number of flywheel teeth is set in the PCC and E-Controls.
        i. Use InPower and the E-controls 4G to ensure that both the PCC and E-controls have the correct number of teeth. These generator sets have 60 evenly spaced teeth, with 2 removed.
8. Engine speed is higher than shutdown threshold
    a. The engine speed governor is not operating correctly. Verify that the throttle plate can move freely. Clean or repair as required.

5.26 Code 256 - Ambient Temperature OOR Low (Warning)

Logic:

Ambient temperature signal voltage is out of range – shorted low.

Possible Causes:

1. Faulty ambient temperature sensor connections
2. Faulty ambient temperature sensor
3. Incorrect controller calibrations

Diagnosis and Repair:

1. Faulty ambient temperature sensor connections
    a. Inspect the ambient temperature sensor and the main harness connector pins.
        i. Disconnect the main harness connector from the ambient temperature sensor.
        ii. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
        iii. Inspect for evidence of moisture in or on the connector.
            A. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
        iv. Inspect for missing or damaged connector seals.
        v. Inspect for dirt or debris in or on the connector pins.
2. Faulty ambient temperature sensor
    a. Check the resistance of the sensor.
        i. Disconnect the main harness connector from the ambient temperature sensor.
        ii. Measure the resistance between the ambient temperature sensor signal pin and the ambient temperature sensor return pin. Sensor resistance varies linearly with temperature: 700 Ohms at 0 °F, and 1100 Ohms at 100 °F (+/- 3%).

3. Incorrect controller calibrations
    a. Using the display or the InPower service tool, verify the calibration in the PCC.
        i. 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.

5.27 Code 286 - CAN Address Conflict Failure (Warning)

Logic: There are two or more devices on the network use the same source address.

NOTICE
The E-controls manual applies to several applications. See the wiring diagrams provided with the generator set or in APPENDIX for appropriate pin numbers.

Diagnosis and Repair:

1. For the troubleshooting procedure, refer to DTC 1628 in the E-Controls Manual.
    a. If another Cummins device is found to have the same slave address, refer to that service manual for that device to change the slave address.

5.28 Code 359 - Fail to Start

This indicates that the engine failed to start after the expiration of crank time.

Possible Causes:

1. Fuel system issues
2. Incorrect starter disconnect speed

Diagnosis and Repair:

1. Fuel system issues
    a. Inspect fuel lines and fuel connections for leaks.
        i. Repair if leaks are found. Refer to the Fuel System section.
    b. The manual fuel shutoff (FSO) valve is closed.
        i. Open the valve.
    c. The FSO valve solenoids or circuit are malfunctioning.
        i. Check the FSO valve solenoids and circuit.
        ii. Correct or replace as necessary.
2. Incorrect starter disconnect speed
    a. Connect to the control via the InPower service tool. Make sure Starter Disconnect Speed is set to 450 RPM.

5.29 Code 415 - Engine Oil Pressure Low (Shutdown)

Logic: Engine oil pressure is below the low oil pressure shutdown threshold (less than 10 psig for more than 2 seconds).

NOTICE

This is an ECM driven fault. The corresponding DTC is 524.

NOTICE

The generator set uses either a normally open switch type (two wire) or a sensor type (three wire) pressure sensor. See the Wiring Diagrams appendix for pressure sensor connections.

Possible Causes:

1. Lubricating oil level is low
2. External leak
3. Fault simulation is enabled or the threshold is set too high
4. Coolant temperature is above specification
5. Lubricating oil does not meet specifications
6. Lubricating oil is contaminated with coolant or fuel
7. Oil pressure sensor is inaccurate or blocked
8. Engine angularity during operation exceeds specification
9. Incorrect lubricating oil cooler is installed
10. Lubricating oil pump is faulty
11. Main oil pressure regulator is faulty
12. Lubricating oil suction or transfer tube is loose or broken
13. Piston cooling nozzles are damaged or are not installed correctly
14. Lubricating oil filter plumbing is not routed correctly

Diagnosis and Repair:

1. Lubricating oil level is low
    a. Check the oil level. Add or drain oil, if necessary.
2. External leak
    a. Inspect the engine and surrounding area for external oil leaks.
    b. Tighten the capscrews, pipe plugs, and fittings.
    c. Replace gaskets that show signs of oil leaks.
3. Fault simulation is enabled or the threshold is set too high
    a. Connect to the control with InPower and ensure that the fault simulation for LOP (Low Oil Pressure) is not enabled.
    b. Using the electronic service tool, verify that the fault threshold is not within the normal operating range for the oil pressure sensor (greater than 20 - 65 psig).
4. Coolant temperature is above specification
    a. On the display or using the InPower service tool, read the engine coolant temperature.
    b. Compare the coolant temperature against the expected coolant temperature for that engine model (less than 221 °F [105 °C]).
    c. If the coolant temperature is outside of the expected range, refer to DTC 217 in the E-Controls manual.

5. Lubricating oil does not meet specifications
    a. Verify lubricating oil meets the specifications as described in the Model Specifications section.
    b. Verify alternative oil and additives were not added during the oil life.
    c. Verify the age of the lubricating oil.
    d. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.
6. Lubricating oil is contaminated with coolant or fuel
    a. Damaged head gasket
    b. Damaged intake gasket
7. Oil pressure sensor is inaccurate or blocked
    a. Connect a mechanical oil pressure gauge of known good quality and calibration to the engine at one of the plugs on top of the oil filter head.
    b. Connect InPower.
    c. While engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
    d. Only proceed if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
    e. Start the generator set.
    f. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge. Oil pressure should be greater than 15 psig (low oil pressure warning level).
8. Engine angularity during operation exceeds specification
    a. Verify container is level or near level.
9. Incorrect lubricating oil cooler is installed
    a. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.
10. Lubricating oil pump is faulty
    a. Ensure that oil pump turns freely.
        i. Mark the angle of the oil pump shaft.
        ii. Remove the front gear cover. The oil pump should spin freely. Repair or replace as necessary.
        iii. Re-align the oil pump shaft with the mark made earlier.
    b. Inspect the lubricating oil pump gears for chips, cracks, or excessive wear.
    c. Check side clearances on the oil pump gears. Refer to the Engine Operation & Maintenance Manual for QSJ5.9G.
    d. If debris is suspected of having gone through the pump, drain the oil, and inspect the pump. Replace as necessary.
    e. Inspect the rear cover plate for scoring and grooves.
    f. Inspect the pump housing for damage and excessive wear.
11. Main oil pressure regulator is faulty
    a. Inspect the plunger and plunger bore for nicks or scratches.
    b. Verify the plunger moves freely in the bore.

c. Repair or replace as necessary.

12. Lubricating oil suction or transfer tube is loose or broken
    a. Inspect lubricating oil suction tube or transfer tube for leaks. Visually inspect for cracks, kinks, or tears.
    b. Inspect the capscrews for signs of leaks.
    c. Inspect the gaskets and o-rings for signs of damage, excessive wear or pinching.
13. Piston cooling nozzles are damaged or are not installed correctly
    a. Inspect capscrew and piston cooling nozzle for damage.
    b. Check for leaks and improper seating.
14. Lubricating oil filter plumbing is not routed correctly
    a. Inspect the lubricating oil filter plumbing.
    b. Compare plumbing to appropriate parts manual, repair or replace as necessary.

5.30 Code 427 - CAN Data Link Degraded

Logic:

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

Possible Causes:

1. The engine ECM has lost power or failed
2. The CAN datalink has failed

Diagnosis and Repair:

1. The engine ECM has lost power or failed
    a. The Emergency (E-Stop) button, if installed, is a closed relay when it is pulled out (inactive), and is an open relay when pressed (active). The E-Stop button disables power to the keyswitch input on the engine ECM when it is pressed (active); and CAN-LINK communication will stop.

       Make sure that the E-Stop is not active on the control:

       i. Pull out (inactivate) the E-Stop button.
       ii. Reset the E-Stop button.
       iii. Press the Off button on the Operator Panel.
       iv. Press the Reset button.
       v. Select Manual or Auto as required.

    b. Make sure that the E-Stop button is functioning correctly:
       i. Measure the outputs of the E-Stop (Normally Open and Normally Closed contacts).
       ii. Make sure that the outputs switch state correctly when engaged and disengaged.
       iii. Replace the switch if faulty.
    c. Check the wiring from the baseboard.

d. The keyswitch control relay is a normally open relay. Make sure 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.

e. Connect to the engine ECM with 4G Display to verify that the ECM is functioning properly and is communicating with the CAN-LINK network.
   i. Refer to the Engine Control Module (ECM) section. If the ECM is faulty, replace it.

2. The CAN datalink has failed
   a. There is a defective datalink harness connection, or open circuit.
      i. Inspect the datalink harness and connector pins from J11-20 to J1939+ and from J11-19 to J1939-.
      ii. Check the shield ground connection at J11-17.
   b. Check the terminating resistors.
      i. With connector J11 disconnected from the baseboard and the engine datalink connection disconnected from the ECM control, measure resistance between pins J11-19 and J11-20 (60 Ohms is satisfactory).
      ii. If resistance is not 60 Ohms, check the terminating resistors. Each of the two terminating resistors should be 120 Ohms; replace them if they are not 120 Ohms.

5.31 Code 441 - Low Battery Voltage

Logic:

Battery voltage is low.

Possible Causes:

1. Damaged battery cable connections
2. Low battery voltage
3. Discharged or defective battery
4. Bad battery ground connection
5. Damaged accessory wiring at B+
6. Faulty engine DC alternator
7. Battery voltage (12 VDC) does not match calibration
8. Battery charger (if equipped) is not adjusted and/or is not functioning properly

Diagnosis and Repair:

1. Damaged battery cable connections
   a. Inspect the battery cable connections for loose connections and/or corrosion, and repair if necessary.
2. Low battery voltage
   a. Using DVM, measure the battery voltage from the positive (+) terminal to the negative (-) terminal.
   b. If it is not within 11.0 to 14.2 V recharge the battery.

3. Discharged or defective battery
    a. Check the electrolyte level (if possible).
    b. Replenish the electrolyte level if low and recharge the battery (if possible). The specific gravity of a fully charged lead acid battery is approximately 1.26 at 80 °F (27 °C).
    c. If the battery is not able to hold adequate voltage, replace the battery.
4. Bad battery ground connection
    a. Inspect the battery ground connection.
        i. Disconnect the engine harness.
        ii. Measure the resistance from the negative (-) battery terminal to the engine block ground.
        iii. If the resistance is more than 1 Ohm, repair the battery ground connection.
5. Damaged accessory wiring at B+
    a. Check for add-on or accessory wiring at the positive (+) terminal of the battery.
        i. Starting at the positive (+) terminal, follow any add-on or accessory wiring and examine the wire(s) for damaged insulation or an installation error that can cause supply wire to be shorted to the engine block.
6. Faulty engine DC alternator
    a. Check the engine DC alternator.
    b. If the normal charging voltage is not 12-14 VDC then troubleshoot the DC alternator.
        i. Inspect alternator for signs of damage or excessive heat. If damaged, replace the DC alternator.
        ii. Check belt tension, and adjust the position of the DC alternator to ensure that the belt is properly tensioned and not slipping on the pulley.
        iii. If belt is properly tensioned, but still slips on the DC alternator pulley, remove the fan belt from the pulley, and spin the DC alternator by hand. It should spin freely and easily. If not, replace the DC alternator.
        iv. If the alternator still does not produce 12-14 VDC, replace the alternator.
7. Battery voltage (12 VDC) does not match calibration
    a. Verify the battery voltage in the calibration.
    b. Verify the DC voltage selection in the control calibration matches the generator set system DC voltage (12 VDC).
8. Battery charger (if equipped) is not adjusted and/or is not functioning properly
    a. Verify that the battery charger is adjusted properly.
    b. Verify that the battery charger is functioning properly.

5.32 Code 442 - High Battery Voltage

Logic:

Battery voltage is high.

Possible Causes:

1. A 12 VDC battery is connected but the charger is set for 24 VDC
2. Faulty engine DC alternator

3. Fault threshold is incorrect

Diagnosis and Repair:

1. A 12 VDC battery is connected but the charger is set for 24 VDC
    a. Adjust the battery charger to 12 VDC.
    b. Verify the battery selection and charger voltage selection match the requirements.
2. Faulty engine DC alternator
    a. Check the engine DC alternator.
    b. If the normal charging voltage is not 12-14 VDC, then troubleshoot the DC alternator.
        i. Inspect alternator for signs of damage or excessive heat. If damaged, replace the DC alternator.
        ii. Check belt tension, and adjust the position of the DC alternator to ensure that the belt is properly tensioned and not slipping on the pulley.
        iii. If belt is properly tensioned, but still slips on the DC alternator pulley, remove the fan belt from the pulley, and spin the DC alternator by hand. It should spin freely and easily. If not, replace the DC alternator.
        iv. If the alternator still does not produce 12-14 VDC, replace the alternator.
3. Fault threshold is incorrect
    a. Check the fault threshold values 16 V, 60 seconds.

5.33 Code 781 - ECM CAN Datalink Has Failed

Logic:

Communication between the Engine Control Module (ECM) and the generator set control is cut off.

Possible Causes:

1. The ECM has lost power or failed
2. The CAN datalink has failed

Diagnosis and Repair:

1. The ECM has lost power or failed
    a. The Emergency Stop (E-Stop) button, if installed, is a closed relay when it is pulled out (not active), and open relay when pressed (active). The E-Stop button disables power to the keyswitch input on the ECM when it is pressed (active), and CAN-LINK communication will stop. Make sure that the E-Stop is not active on the control:
        i. Pull out (inactivate) the Emergency Stop button.
        ii. Reset the Emergency Stop button.
        iii. Press the Off button on the operator panel.
        iv. Press the Reset button.
        v. Select Manual or Auto as required.
    b. Make sure that the Emergency Stop button is functioning correctly.
        i. Measure the outputs of the E-Stop (Normally Open and Normally Closed contacts).
        ii. Make sure that the outputs switch state correctly when engaged and disengaged.
        iii. Replace the switch if faulty.

c. Check the wiring from the baseboard.

d. The keyswitch control relay is a normally open relay. Make sure 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.

e. Connect to the ECM with 4G, to verify that the ECM is functioning properly and is communicating with the CAN-LINK network.

i. If CAN-LINK communications is disabled, enable CAN-LINK.

ii. Inspect the ECM for bent or damaged pins. Repair as necessary.

iii. Ensure that connectors are securely connected.

iv. Inspect the CAN datalink, as specified in the next troubleshooting step.

v. If none of the previous steps resolve the issue, replace the ECM.

2. The CAN datalink has failed

a. There is a defective datalink harness connection, or open circuit.

i. Inspect the Datalink harness and connector pins from J11-20 to J1939+ and from J11-19 to J1939-.

ii. Check the shield ground connection at J11-17.

b. Check the terminating resistors.

i. With connector J11 disconnected from the baseboard and the engine datalink connection disconnected from the ECM control, measure resistance between pins J11-19 and J11-20 (60 Ohms is satisfactory).

ii. 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.

5.34 Code 1117 - ECM Power Lost

Logic:

This indicates that "keyswitch" to the Engine Control Module (ECM) was not removed for 30 seconds before removing battery power to the ECM (removing connectors or battery cable).

Possible Causes:

1. ECM power lost

Diagnosis and Repair:

1. ECM power lost

a. To reset, press the Off button, press the Emergency Stop button, and wait 30 seconds.

5.35 Code 1244 - Engine Normal Shutdown

Logic:

The engine has received a normal shutdown request.

Possible Causes:

1. The generator set is going through a normal shutdown.

Diagnosis and Repair:

1. The generator set is going through a normal shutdown.
    a. The generator set is going through a normal shutdown and there are no active shutdown fault(s) in the ECM for at least 2 seconds.

5.36 Code 1245 - Engine Shutdown Fault

Logic:

An engine shutdown fault has occurred in the Engine Control Module (ECM), and no other active shutdown faults exist on the PCC.

Possible Cause:

1. Event/fault code 1245 is activated by another active shutdown fault in the ECM

Diagnosis and Repair:

1. Event/fault code 1245 is activated by another active shutdown fault in the ECM
    a. Connect to the ECM with 4G Display to determine the actual shutdown fault that is generating event/fault code 1245.
    b. Troubleshoot the shutdown fault(s).

5.37 Code 1246 - CAN Unknown Engine Fault

Logic: The PCC received an unknown message from the ECM.

Possible Cause:

1. ECM/engine fault

Diagnosis and Repair:

1. ECM/engine fault
    a. Refer to the E-Controls service tool.

5.38 Code 1248 - Engine Warning

Logic:

An engine warning fault has occurred in the Engine Control Module (ECM), and there are no active warning faults on the PCC.

Possible Cause:

1. Another active warning fault in the ECM activates event/fault code 1248

Diagnosis and Repair:

1. Another active warning fault in the ECM activates event/fault code 1248
    a. Connect to the ECM with 4G Display to determine the actual warning fault that is generating event/fault code 1248.
    b. Troubleshoot the shutdown fault(s).

5.39 Codes 1311 and 1312 - Customer Input #1 and #2 (Warning or Shutdown)

Logic:

The nature of the fault is an optional customer selection. Examples of inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, Low Starting Hydraulic Pressure, Low Starting Air Pressure, etc.

Each of the fault functions can be programmed using the InPower service tool, as follows:

- Enable/disable input (default: enable)
- Status, Warning, or Shutdown (default: #1-None, #2-Warning 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).

Possible Cause:

1. Fault condition exists at customer inputs
2. External wiring problem
3. Incorrect fault function settings are programmed into the control calibration

Diagnosis and Repair:

1. Fault condition exists at customer inputs
2. External wiring problem
    a. Disconnect the signal lead from TB1 and reset the control.
        i. Configure input 1 - TB1-12
        ii. Configure input 2 - TB1-14
    b. Disconnect the signal wire from the relevant customer sensor. Check resistance to GND at TB1-12 (fault 1311) or TB1-14 (fault 1312). If there is a continuity, repair or replace the harness.
    c. If the message goes away, the external wiring has a short circuit. Check for any grounding of either input because that activates the fault.
3. Incorrect fault function settings are programmed into the control calibration
    a. Verify that control values match the parameters necessary for fault detection.

5.40 Code 1317 - Low Coolant Level (Warning or Shutdown)

Logic: This fault is used when an optional coolant level sensor 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).

Possible Causes:

1. Low coolant
2. Faulty coolant level sensor connections
3. Faulty coolant level sensor
4. Incorrect calibration settings for the Low Coolant fault in the control
5. Faulty control board

Diagnosis and Repair:

1. Low coolant
    a. Stop the engine and allow the engine to cool down.
    b. Visually inspect and verify that the engine coolant is at the appropriate level.
    c. If the coolant level is too low, add coolant per specifications.
2. Faulty coolant level sensor connections
    a. Inspect the coolant level sensor and the main harness connector pins.
        i. Disconnect the main harness connector from the coolant level sensor.
        ii. Inspect for:
            A. Corroded, bent, broken, pushed back, or expanded pins
            B. Evidence of moisture in or on the connector
            C. Missing or damaged connector seals
            D. Dirt or debris in or on the connector pins
            E. Wiring for any damage or shorting
3. Faulty coolant level sensor
    a. Check sender operation.
        i. Remove the connector from the sensor.
        ii. Verify battery power at pin C of the sensor harness plug (Sig P-9 lead into connector). If B+ is not present, check Fuse F1; repair or replace the harness.
        iii. Verify ground at pin B of the sensor harness plug (Sig P-11 lead into connector). If ground is not present, repair or replace the harness.
        iv. Verify continuity of pin D of sensor harness plug (Sig P-10 lead into connector) and the J20-17 connector. If continuity is not present, repair or replace the harness.
        v. With the sensor out of coolant:
            A. Provide power to sensor pin C, and ground at pin B.
            B. With a multimeter in diode/continuity test mode, connect the red meter lead to pin D and black to ground.
                - The meter indication should be "continuity". If this indication is not present, the sensor is defective.
        vi. With the sensor in coolant:
            A. Provide power to sensor pin C, and ground at pin B.

B. With a multimeter in diode/continuity test mode, connect the red meter lead to pin D and black to ground.

- The meter indication should *not* be "continuity". If this indication is present, the sensor is defective.

4. Incorrect calibration settings for the Low Coolant fault in the control
   - Verify calibration setting for Configurable Input #3 as "Fault Active State Selection = Active Closed".
5. Faulty control board
   - If the sender, harness and control settings are acceptable, replace the baseboard.

5.41 Code 1318 - Low Fuel (Warning or Shutdown)

Logic: This fault is used when an optional low fuel level 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:

Fault Function	Default
Enable/disable input	Enable
Status, Warning, or Shutdown	#1-None, #2-Warning and #3-Warning
Active closed or open	Closed (ground)

Change the display name using up to 19 characters (default: #1-Customer Fault 1, #2-Ground Fault, #3-Low Fuel).

Possible Causes:

1. Low fuel pressure
2. Faulty or inoperable switch
3. No actual fault; external wiring problem
4. Incorrect fault function settings are programmed into the control calibration

Diagnosis and Repair:

1. Low fuel pressure
   - Measure the fuel pressure at the fuel pump inlet.
2. Faulty or inoperable switch
   - Remove the switch and verify proper switch operation. If either of the following conditions is not demonstrated, the switch is defective:
     - When the float is at the bottom of the switch, the wires must show continuity.
     - When the float is raised, the wires must show an open circuit.
3. No actual fault; external wiring problem
   a. Disconnect the signal lead from TB1 and reset the control.
   b. Disconnect the signal wire from the fuel level switch. Check resistance to GND at the J20-18 harness wire or on the back of the annunciator (if equipped). If there is continuity, repair or replace the harness.
   c. If the message goes away, the external wiring has a short circuit. Check for any grounding of either input, which activates the fault.

4. Incorrect fault function settings are programmed into the control calibration
    - Verify that control values match the parameters necessary for fault detection.

5.42 Code 1417 - Power Down Failure

Logic:

The PCC has failed to go to sleep.

Possible Cause:

1. Incorrect calibrations in PowerCommand controls
2. Faulty baseboard

Diagnosis and Repair:

1. Incorrect calibrations in PowerCommand controls
    a. Using the display or the InPower Service tool, verify the calibration in the PCC.
        i. 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. Faulty baseboard
    a. Remove power (B+) from the PCC for 5 to 10 seconds and reconnect B+ to the PCC.
        i. 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 baseboard.

5.43 Code 1433 - Local E-Stop

Logic:

The state of the Local Emergency Stop (E-Stop) has been changed.

Possible Causes:

1. The local E-Stop button has been activated
2. Faulty connection or faulty E-Stop switch

Diagnosis and Repair:

1. The Local E-Stop button has been activated
    a. Reset the Local E-Stop:
        i. Pull the Local E-Stop button out.
        ii. Press the Off button.
        iii. Press the Reset button.
        iv. Select Manual or Auto as required.
2. Faulty connection or faulty E-Stop switch
    a. Verify that the E-Stop button is working properly. The E-Stop button is a closed contact when it is pulled out (not active), and an open contact when pressed (active).
        i. Check for an open circuit condition in the connection and/or wiring from the Local E-Stop switch to the PCC. A ground connection to the Local E-Stop control input (J25-2 Input; J25-6 Ground) disables the E-Stop alarm. An open circuit should activate the E-Stop alarm.

5.44 Code 1434 - Remote E-Stop

Logic:

The state of the Remote Emergency Stop has been changed.

Possible Causes:

1. The Remote Emergency Stop button has been activated
2. Jumper not installed in control
3. Faulty connection or faulty Emergency Stop switch

Diagnosis and Repair:

1. The Remote Emergency Stop button has been activated
    a. 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.
2. Jumper not installed in control
    a. Install the missing jumper between TB1-16 Input and TB1-15 Ground.
3. Faulty connection or faulty Emergency Stop switch
    a. 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 an open relay when pressed (active).
        i. Verify the connection and/or 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.

5.45 Code 1435 - Low Coolant Temperature (Warning)

Logic:

The engine coolant temperature is below the low coolant temperature warning threshold.

Possible Causes:

1. Threshold is set too high
2. Coolant heater(s) is/are not operating properly
3. Low ambient temperature

NOTICE
In applications where the ambient temperature falls below 40 °F (4 °C), the Low Coolant Temp may be indicated even though the coolant heaters are operating.

Diagnosis and Repair:

1. Threshold is set too high
    a. Verify that the LCT Warning Threshold is set to 50 °F (10 °C).

2. Coolant heater(s) is/are not operating properly
    a. Make sure that the coolant heater(s) is/are connected properly to a power supply.
        i. Check for open circuits in the wiring.
        ii. Make sure that the power supply of the coolant heater is working properly.
    b. Measure the temperature of the coolant. If the coolant temperature is close to the ambient temperature when the ambient air temperature is below the coolant heater thermostat setting, replace the coolant heater(s).
3. Low ambient temperature
    a. If the coolant heater(s) is/are working properly and the radiator has enough coolant, but the ambient temperature around the generator set is very cold (less than 40 °F [4 °C]), the coolant heaters might not have the capability to keep the coolant temperature above the low coolant temperature warning threshold. This could be an application issue and will need to be further investigated.

5.46 Code 1438 - Fail to Crank (Shutdown)

Logic:

The engine failed to crank after the generator control received a start signal.

Possible Causes:

1. Dead or weak battery
2. Failed starter
3. Failed starter solenoid
4. Failed starter relay
5. Engine or rotor is locked or binding

Diagnosis and Repair:

1. Dead or weak battery
    a. Verify battery voltage is at least 12 VDC (24 VDC where applicable).
    b. Charge or replace the battery as necessary.
2. Failed starter
    a. Press the Reset/Fault Acknowledge button on the display.
    b. Attempt to start the generator and test for B+ at the starter supply lug.
    c. If B+ is present at the starter supply lug, the starter could be defective.
3. Failed starter solenoid
    a. Press the Reset/Fault Acknowledge button on the display.
    b. Check wiring for continuity between the terminal on the starter relay and start solenoid SW terminal. Resistance should be less than 5 Ohms.
    c. Attempt to start the generator set and test for B+ at SW terminal of the starter solenoid.
    d. Check wiring for continuity between the solenoid COM terminal and B+ lug of the battery. Resistance should be less than 1 Ohm.
    e. Attempt to start the generator set and test for B+ at the solenoid output lug.
    f. If B+ is not present, the starter solenoid is defective.

4. Failed starter relay
    a. Check wiring for continuity between the terminal on the starter relay and J20-13 control board terminal. Resistance should be less than 1 Ohm.
    b. Check wiring for continuity between the terminal on the starter relay and J20-15 control board terminal. Resistance should be less than 1 Ohm.
    c. Check for B+ at the terminal on the starter relay.
    d. Attempt to start the generator set and test for B+ at the terminal on the starter relay.
    e. Check wiring for continuity between the terminal on the starter relay and ground. Resistance should be less than 1 Ohm.
    f. Attempt to start the generator and test for B+ at the terminal on the starter relay.
    g. If B+ is not present, the starter relay is defective.
5. Engine or rotor is locked or binding
    a. Verify that the generator can rotate freely by barring the engine over by hand. If the generator set cannot be turned over, identify the source of the bind, and repair as necessary.

NOTICE
Do not use the alternator fan to rotate the engine.

5.47 Code 1442 - Weak Battery

Logic:

This fault occurs when the engine is starting (cranking) and the voltage of the battery drops below the Weak Battery Voltage Threshold (8 V) for the time set in the Weak Battery Voltage Set Time (2 seconds).

Possible Causes:

1. Weak or discharged battery
2. Battery connections are loose or dirty
3. Insufficient battery charging voltage
4. Faulty engine DC alternator
5. Faulty harness
6. Weak Battery Voltage Threshold is set too high

Diagnosis and Repair:

1. Weak or discharged battery
    a. Measure the voltage of the battery with a voltmeter. Battery voltage should be 12 VDC or greater.
    b. If the battery voltage is low, check the electrolyte level in the battery (if possible). Replenish the electrolyte level if low and recharge the battery; the specific gravity for a fully charged lead acid battery is approximately 1.26 at 80 °F (27 °C).
    c. If the battery cannot hold adequate voltage, replace the battery.
2. Battery connections are loose or dirty
    a. Clean and tighten battery terminals and battery cable connectors. If the battery cable connectors are cracked or worn out, replace them.

3. Insufficient battery charging voltage
    a. Make sure that the battery charger (if applicable) is charging the battery at an acceptable rate. Adjust the charge rate if the rate is below the recommendation of the manufacturer.
    b. If the battery located far from the battery charger, make sure that a proper wire size is used to compensate for voltage drop.
4. Faulty engine DC alternator
    a. Check the engine DC alternator.
    b. If normal charging voltage is not 12-14 VDC, then troubleshoot the DC alternator.
        i. Inspect alternator for signs of damage or excessive heat. If damaged, replace the DC alternator.
        ii. Check belt tension, and adjust the position of the DC alternator to ensure that the belt is properly tensioned and not slipping on the pulley.
        iii. If belt is properly tensioned, but still slips on the DC alternator pulley, remove the fan belt from the pulley, and spin the DC alternator by hand. It should spin freely and easily. If not, replace the DC alternator
        iv. If the alternator still does not produce 12-14 VDC, replace the alternator.
5. Faulty harness
    a. Measure the battery voltage at the battery terminals.
    b. Measure the battery voltage at the baseboard input.
    c. Measure the voltage at:
        - B+ (J20-9, J20-10, J20-20, and J20-21) and
        - B- (negative) input (J20-1, J20-2, J20-4, J20-7, J20-12)
    d. If the voltage at the battery terminals and the control is not the same, check the harness and replace it if necessary.
6. Weak Battery Voltage Threshold is set too high
    a. Make sure that the Weak Battery Voltage Threshold is set to the specified values (8 V, 2 seconds).

5.48 Code 1446 - High AC Voltage

Logic:

One or more of the phase voltages has exceeded the High AC Voltage Threshold (110% of nominal voltage, 10 seconds).

Possible Causes:

1. High AC Voltage Threshold is set too low
2. Faulty PCC control board (AVR circuit)
3. Improper connections at generator output terminals
4. Faulty PMG (if used)
5. Engine speed/frequency surge

Diagnosis and Repair:

1. High AC Voltage threshold is set too low
    a. Verify parameter settings.
2. Faulty PCC control board (AVR circuit)
    a. Measure the output at J17-1 and J17-2 on the PCC board. The output should be at 3 - 30 VDC when the generator set is operating at “No Load".
        i. If the voltage output of J17-1 and J17-2 is constantly above 30 VDC at no load, then the AVR portion of the baseboard is faulty. Replace the baseboard.
3. Improper connections at generator output terminals
    a. Compare connections in the generator to the wiring schematic.
    b. Correct according to the appropriate schematic if necessary.
4. Faulty PMG (if used)
    a. Start the generator set and run at rated speed. Measure the voltages at the terminals P2 (J18-1) and P3 (J18-2). These should be balanced and within the range of 60 Hz generators 190 to 220 V.
5. Engine speed/frequency surge
    a. Refer to fault codes 234 and 1449 for diagnosis.

5.49 Code 1447 - Low AC Voltage (Shutdown)

Logic:

One or more of the phase voltages has dropped below the Low AC Voltage Threshold (85%) for more than the specified amount of time (10 seconds).

Possible Causes:

1. Incorrect threshold setting or AVR settings
2. Overload
3. Improper connections at generator output terminals
4. Incorrect voltage sense or setup wiring connection
5. Faulty PCC board (AVR circuit)
6. Faulty rotating rectifier assembly (diodes CR1 through CR6)
7. Low residual magnetism in excitation coil

Diagnosis and Repair:

1. Incorrect threshold setting or AVR settings
    a. Verify factory settings have not changed. Contact factory service support for original settings.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. If the generator set is producing correct voltage with no load, but shutting down on under voltage when the generator set picks up certain loads, the undervoltage shutdowns are being caused 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.

c. Revisit the generator set sizing process to make sure 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.

3. Improper connections at generator output terminals
   a. Check connections.
      i. Compare connections in generator to wiring schematic.
      ii. Correct according to the appropriate schematic as needed.
4. Incorrect voltage sense or setup wiring connection
   a. Verify that the voltage sensing inputs J22-1, J22-2, J22-3, and J22-4 are connected to L1, L2, L3, and L0 respectively.
   b. Verify that excitation inputs J18-1 and J18-2 are connected to the correct generator terminals.
5. Faulty PCC board (AVR circuit)
   a. Connect the InPower service tool.
   b. Start the generator set.
   c. Using the InPower service tool, verify that the AC voltage output is greater than residual.
   d. If the AC voltage output is residual, using the InPower service tool, verify that the AVR is enabled.
   e. Inspect the generator control harness connector pins for voltage sense and field connections.
   f. Turn off the generator set.
   g. Visually inspect harness for corroded pins, bent or broken pins, pushed back or expanded pins.
6. Faulty rotating rectifier assembly (diodes CR1 through CR6)
   a. Check each diode. Refer to the Alternator Performance Troubleshooting section.
7. Low residual magnetism in excitation coil
   a. The excitation coil may need to be flashed:
      i. Remove the Field Coil+ and Field Coil- leads from the alternator.
      ii. Using a 12 VDC supply:
         A. Touch the positive supply terminal to Field Coil+ and the negative supply terminal to Field Coil-.
         B. Remove after brief contact.
         C. Repeat three times.
      iii. Reconnect the Field Coil+ and Field Coil- leads to the alternator.
      iv. Reset the control.
      v. Restart the generator set.

5.50 Code 1448 - Underfrequency

Logic:

The frequency has dropped below the Underfrequency Threshold (6 Hz) for the time set in the Underfrequency Delay parameter (10 seconds).

Possible Causes:

1. Overrides are enabled
2. Underfrequency threshold is set too high
3. Overload
4. Engine governor problem

Diagnosis and Repair:

1. Overrides are enabled
    a. Connect with the InPower service tool.
    b. Make sure that the Alternator LX-N overrides are not enabled. If required, disable the Alternator LX-N overrides.
2. Underfrequency threshold is set too high
    a. Verify the Underfrequency Threshold and Underfrequency Time Delay set values.
3. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. If the generator set is producing correct voltage with no load, but is shutting down on under voltage when the generator set picks up certain loads, the under voltage shutdowns are being caused 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. Refer to the T-030 manual.
    c. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
4. Engine governor problem
    a. Verify that the wiring to the throttle body actuator works correctly. Correct if faulty.
    b. Verify that the throttle shaft and plate are free to move. Clean or repair if necessary.

5.51 Code 1449 - Overfrequency

Logic:

The frequency has gone above the Overfrequency Threshold (6 Hz) for the time that is registered in the Overfrequency Delay (10 seconds).

Possible Causes:

1. Overfrequency threshold is set too low
2. Engine governor problem

Diagnosis and Repair:

1. Overfrequency threshold is set too low
    a. To access the Overfrequency configuration menu on the operator panel, go to **Setup > Genset Setup > Volt Protection**.
    b. Verify that the Overfrequency Threshold and Overfrequency Time Delay are per specification. Refer to the list to see the default value for Overfrequency.
2. Engine governor problem
    a. Verify that the wiring to the throttle body actuator works correctly. Correct if faulty.

b. Verify that the throttle shaft and plate are free to move. Clean or repair if necessary.

5.52 Code 1471 - High AC Current (Warning)

Logic:

The generator output current has exceeded the warning limit threshold (110%) for greater than the set time limit (60 seconds).

Possible Causes:

1. Short
2. Overload
3. Incorrect CTs, CT connections, or CT setup
4. Incorrect CT harness connections
5. Incorrect rating setup
6. Fault override enabled
7. Parameter set incorrectly

Diagnosis and Repair:

1. Short
    a. Inspect the load cables and the AC harness connections.
    b. Disconnect the AC harness from the load cables.
    c. Inspect the AC harness and board connector pins.
    d. Visually inspect for corroded pins, bent or broken pins, and/or pushed back or expanded pins.
    e. Check for a short circuit of the harness to engine block ground.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. 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.
    c. Revisit the generator set sizing process to make sure 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.
3. Incorrect CTs, CT connections, or CT setup
    a. Check that the correct CT(s) has/have been installed.
    b. Check that CT connections are secure.
    c. Check that the CTs are installed correctly.
    d. Connect the InPower service tool.
    e. Verify that the correct CT ratio has been used. Adjust the setting if necessary.
    f. Check and correct connections for any bent pins, sockets, dirt, etc.

4. Incorrect CT harness connections
    a. Measure the resistance of the CT harness on each pin.
    b. Disconnect connector P12 from the control board and CTs.
    c. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
    d. Verify that the CT harness plug wiring is correct. Verify continuity between pin pairs as follows:
        - P12-1 (CT1) to P12-4 (CT1-COM)
        - P12-2 (CT2) to P12-5 (CT2-COM)
        - P12-3 (CT3) to P12-6 (CT3-COM)
    e. Re-terminate connections if necessary.
5. Incorrect rating setup
    a. Connect the InPower service tool.
    b. Verify the generator set rating is set correctly. Adjust settings if necessary.
6. Fault override enabled
    a. Connect the InPower service tool and make sure that the fault is not enabled.
    b. If InPower is not available, cycle power to the control:
        i. Press the Emergency Stop (E-Stop) button (if installed) and wait 30 seconds.
        ii. Disconnect and disable the stand alone battery charger (if installed).
        iii. Disconnect the battery (disconnect the negative first).
        iv. Leave the controller without power for 1 minute.
        v. In the following order: Reconnect the battery, enable the stand alone battery charger, pull out the E-Stop button, and reset the control.
7. Parameter set incorrectly
    a. Verify fault threshold values in calibration.

5.53 Code 1472 - High AC Current (Shutdown)

Logic:

The generator output current has exceeded the Shutdown set limit (150%) for greater than the set time limit (10 seconds).

Possible Causes:

1. Short
2. Overload
3. Incorrect CTs, CT connections, or CT setup
4. Incorrect CT harness connections
5. Incorrect rating setup
6. Fault override enabled
7. Parameter set incorrectly

Diagnosis and Repair:

1. Short or overload
    a. Inspect the load cables and the AC harness connections.
    b. Disconnect the AC harness from the load cables.
    c. Inspect the AC harness and board connector pins.
    d. Visually inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
    e. Check for a short circuit of the harness to engine block ground.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. 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.
    c. Revisit the generator set sizing process to make sure 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.
3. Incorrect CTs, CT connections, or CT setup
    a. Check that correct CTs have been installed.
    b. Check that CT connections are secure.
    c. Check that CTs are installed correctly.
    d. Connect the InPower service tools.
    e. Verify the correct CT ratio has been used. Adjust the setting if necessary.
    f. Check and correct connections for any bent pins, sockets, dirt, etc.
4. Incorrect CT harness connections
    a. Measure the resistance of the CT harness on each pin.
    b. Disconnect connector P12 from the control board and CTs.
    c. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
    d. Verify the CT harness plug wiring is correct**.** Verify that continuity between pins pairs is as follows:
        - P12-1 (CT1) to P12-4 (CT1-COM)
        - P12-2 (CT2) to P12-5 (CT2-COM)
        - P12-3 (CT3) to P12-6 (CT3-COM)
    e. Re-terminate connections if necessary.
5. Incorrect rating setup
    a. Connect the InPower service tool and make sure that the fault is not enabled.
    b. Verify the generator set rating is set correctly.
    c. Verify CT ratings in the control are set correctly. Adjust settings if necessary.

6. Fault override enabled
    a. Connect with the InPower service tool and make sure that the fault is not enabled.
    b. If InPower is not available, cycle power to the control:
        i. Press the Emergency Stop (E-Stop) button (if installed) and wait 30 seconds.
        ii. Disconnect and disable the stand alone battery charger (if installed).
        iii. Disconnect the battery (disconnect the negative first).
        iv. Leave the controller without power for 1 minute.
        v. In the following order: Reconnect the battery, enable the stand alone battery charger, pull out the E-Stop button, and reset the control.
7. Parameter set incorrectly
    a. Verify the fault threshold values in the calibration.

5.54 Code 1853 - Annunciator Input 1 Fault

Logic:

Customer fault 1 (input 1, LED 1) on the universal annunciator is active.

Possible Cause:

1. Condition for which "Annunciator Input #1" is configured for is active
2. Incorrectly configured or wiring issue
3. Faulty annunciator

Diagnosis and Repair:

1. Condition for which "Annunciator Input #1" is configured for is active
    a. Check the condition for which "Annunciator Input #1" has been configured for. For example, 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 the next step.

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	Do Not Invert	Invert

2. Incorrectly configured or wiring issue
    a. 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:
        - *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; the default is set to non-inverted.
    b. 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.

c. Make sure that the universal annunciator is correctly configured; for setup and configuration instructions, refer to the universal annunciator operator's manual.

d. Check the wiring at TB1-1 and make sure that customer input 1 is wired correctly. Depending on the configuration of the annunciator shown in step 1, make sure that there is not a short or open circuit at the TB1-1 connection.

e. Check the sender, relay, or device that is activating Input 1 on the universal annunciator. Replace if faulty.

3. Faulty annunciator

a. If the wiring and configuration is satisfactory, replace the universal annunciator.

5.55 Code 1854 - Annunciator Input 2 Fault

Logic:

Customer fault 2 (Input 2, LED 2) on the universal annunciator is active.

Possible Cause:

1. Condition for which "Annunciator Input #2" is configured for is active
2. Incorrectly configured or wiring issue
3. Faulty annunciator

Diagnosis and Repair:

1. Condition for which "Annunciator Input #2" is configured for is active

a. Check the condition for which "Annunciator Input #2" has been configured for. For example, 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 the next step.

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	Do Not Invert	Invert

2. Incorrectly configured or wiring issue

a. 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:

- *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; the default is set to non-inverted.

b. 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.

c. Make sure that the universal annunciator is correctly configured; for setup and configuration instructions, refer to the universal annunciator operator's manual.

d. Check the wiring at TB1-2 and make sure that customer input 2 is wired correctly. Depending on the configuration of the annunciator in step 1, make sure that there is not a short or open circuit at the TB1-2 connection.

e. Check the sender, relay, or device that is activating input 2 on the universal annunciator. Replace if faulty.

3. Faulty annunciator

a. If the wiring and configuration is satisfactory, replace the universal annunciator.

5.56 Code 1855 - Annunciator Input 3 Fault

Note: The nature of the annunciator fault is an optional configurable selection.

Logic:

Customer fault 3 (input 3, LED 3) on the universal annunciator is active.

Possible Cause:

1. Condition for which "Annunciator Input #3" is configured for is active
2. Incorrectly configured or wiring issue
3. Faulty annunciator

Diagnosis and Repair:

1. Condition for which "Annunciator Input #3" is configured for is active

a. Check the condition for which "Annunciator Input #3" has been configured for. For example, 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 the next step.

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	Do Not Invert	Invert

2. Incorrectly configured or wiring issue

a. 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.

- 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; the default is set to non-inverted.

b. 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.

c. Make sure that the universal annunciator is correctly configured; for setup and configuration instructions, refer to the universal annunciator operator's manual.

d. Check the wiring at TB1-3 and make sure that customer input 3 is wired correctly. Depending on the configuration of the annunciator, make sure that there is not a short or open circuit at the TB1-3 connection.

e. Check the sender, relay, or device that is activating Input 3 on the universal annunciator, replace if faulty.

3. Faulty Annunciator
    a. If the wiring and configuration is satisfactory, replace the universal annunciator.

5.57 Code 1944 - Annunciator Configuration Error (Warning)

Logic: More than one network device is configured to activate one of the annunciator output relays.

Possible Causes:

1. Bad network configuration
2. Bad device on network

Diagnosis and Repair

1. Bad network configuration
    a. Check the setup of devices on the network against duplicate use of the same annunciator relay output.
2. Bad device on network
    a. Troubleshoot the network for malfunctioning devices.

5.58 Code 2118 - Fuel Pressure Low

Logic:

This fault is used when an optional low fuel pressure switch is installed. The nature of the fault is an optional customer selection. The fault function is programmed (using the InPower service tool), as follows:

- *Function:* Low Fuel Pressure Switch (default: Disabled)
- *Fault Level Response:* Warning (default: #1-None, #2-Warning and #3-Warning)
- *Fault Active State Selection:* Active Closed (default: Active Closed)
- *Display Name:* LOW FUEL PRESSURE

Possible Causes:

1. Low fuel pressure
2. Faulty fuel pressure switch connections
3. Faulty fuel pressure switch
4. Incorrect fuel system selected in control
5. Faulty control board

Diagnosis and Repair:

1. Low fuel pressure
    a. Check fuel supply and change as required.
2. Faulty fuel pressure switch connections
    a. Inspect the fuel pressure switch and the harness connectors.
    b. Disconnect the harness connector from the fuel pressure switch.
    c. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
    d. Inspect for evidence of moisture in or on the connector.

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

f. Inspect the wiring for any damage or shorting.

3. Faulty fuel pressure switch

   a. Check switch operation.

   b. Turn off the fuel supply to the unit, and vent fuel in the line. Check for continuity across the two leads of the switch. The circuit should be open.

   c. Turn fuel supply to the unit on, and check for continuity across the two leads of the switch. The circuit should be closed

4. Incorrect fuel system selected in control

   a. Verify fuel system selection in control menu. Refer to the Converting the Fuel System Type section.

5. Faulty control board

   a. If the sender, harness and control settings are acceptable, the baseboard is defective. Replace it.

5.59 Code 2335 - Excitation Fault (Loss of AC Sense)

Logic:

The control has lost voltage sensing or has lost zero cross sensing.

Possible Causes:

1. Incorrect configuration
2. Bad fuse
3. Bad wire harness or wrong connections
4. Low residual magnetism in excitation coil
5. Excitation coil is defective
6. Incorrect generator set setup
7. Bad control board
8. Short circuit

Diagnosis and Repair:

1. Incorrect configuration

   a. Make sure that values for the Low of AC Voltage Threshold (85%) and Low of AC Voltage Time Delay (10 seconds) are correct in calibration.

2. Bad fuse

   a. Check the fuse F5 (10 Amp).

   b. Replace if necessary.

3. Bad wire harness or wrong connections

⚠ CAUTION

Excessive voltage is possible during testing. Make sure your meter can handle alternator full voltage.

a. Check electrical continuity between the following locations. If resistance is greater than 1 Ohm, repair or replace the harness:
   - J22 Pin 4 and the terminal marked N on the alternator terminal block (identified as Sense N on the generator wiring diagram)
   - J22 Pin 3 and the terminal marked W on the alternator terminal block (identified as Sense W on the generator wiring diagram)
   - J22 Pin 2 and the terminal marked V on the alternator terminal block (identified as Sense V on the generator wiring diagram)
   - J22 Pin 1 and the terminal marked U on the alternator terminal block (identified as Sense U on the generator wiring diagram)

b. Check continuity between the following leads. If resistance is greater than 1 Ohm, repair or replace the harness.
   - J17 Pin 1 and Field Coil + (F1)
   - J17 Pin 2 and Field Coil - (F2)

c. Check continuity between the following leads. If resistance is greater than 1 Ohm, repair or replace the harness:
   - J18 Pin 1 and the terminal marked Shunt 1 on the alternator terminal block or PMG terminal marked P2
   - J18 Pin 2 and the terminal marked Shunt 2 on the alternator terminal block or PMG terminal marked P3

d. Make sure that the inline connectors in the wiring harness are connected properly.

4. Low residual magnetism in excitation coil
   a. Flash the excitation coil:
      i. Remove Field Coil+ and Field Coil- leads from the alternator.
      ii. Using a 12 VDC supply, touch the positive supply terminal to Field Coil+ and the negative supply terminal to Field Coil-. Remove after brief contact. Repeat three times.
      iii. Reconnect Field Coil+ and Field Coil- leads to the alternator.
      iv. Reset the control, and restart the generator set.
5. Excitation coil is defective
   a. Refer to the Alternator Performance Troubleshooting section.
6. Incorrect generator set setup
   a. Verify that the generator set is capable of reaching the rated speed.
7. Bad control board
   a. Replace the control board module after performing all other steps.
8. Short circuit
   a. If none of the previous debugging steps solve the problem, then the shutdown may be due to a short circuit on the main output lines of the alternator. Inspect the main output lines from the alternator for mis-wire, faulty wire, or any other signs of short circuit.

5.60 Code 2676 - Alternator Frequency Conflict (Shutdown)

Logic: The Alternator Line Frequency and Alternator Excitation Frequency do not match.

Possible Causes:

1. Incorrect setting
2. Bad wire harness or wrong connections
3. Bad control board
4. Bad alternator

Diagnosis and Repair:

1. Incorrect setting
    a. Check the Alternator Line Frequency Gain trim using the operator panel or the InPower service tool.
        - When Shunt is selected, a gain of 1 is the default.
        - When PMG is selected, a gain of 2 is the default.
    b. Measure the Alternator Line Frequency (J22-1 to J22-4).
    c. Measure the Alternator Excitation Frequency (J18-1 to J18-2).
    d. Calculate the Alternator Excitation Frequency value using the following equation:

    *Alternator Line Frequency * Alternator Line Frequency Gain = Alternator Excitation Frequency*

    e. Compare the Alternator Excitation Frequency that was *measured* to the Alternator Excitation Frequency that was *calculated*.
    f. Check the voltage sense leads and exciter power lead for open circuits or short circuits.
2. Bad wire harness or wrong connections

⚠ CAUTION
Excessive voltage is possible during testing. Make sure your meter can handle alternator full voltage.

    a. Check continuity between the following leads; if resistance is greater than 1 Ohm, repair or replace the harness:
        - J17 Pin 1 and Field Coil + (F1)
        - J17 Pin 2 and Field Coil **-** (F2)
    b. Make sure that the inline connectors in the wiring harness are connected properly.
3. Bad control board
    - Replace the control board.
4. Bad alternator
    - Replace the alternator.

5.61 Code 2677 - Fail to Stop (Shutdown)

Logic:

The generator set continues to run after receiving shutdown command from the controller.

Possible Causes:

1. Stuck fuel shutoff (FSO) valve

Diagnosis and Repair:

1. Stuck fuel shutoff (FSO) valve
    a. Check keyswitch operation and make sure it is not stuck closed. Use a multimeter and check continuity across the relay (K3-1 and K3-4). With the Emergency stop pressed, the relay should be open.
    b. Check for a stuck FSO valve. Check the FSO relay and related wiring. Check that the FSO is not mechanically stuck. (The controller shuts off the fuel supply valves only or the spark plug supply.)
    c. If issue persists, consult DTC 1181 in the E-Controls manual.

5.62 Code 2729 - IO Module Lost (Warning)

Logic: There is an intermittent data link between the I/O module and the PCC control (Aux 101 I/O Module option) and no input fault levels were set to Shutdown.

Possible Causes:

1. Incorrect wiring
2. I/O settings misconfigured

Diagnosis and Repair:

1. Incorrect wiring
    a. The connection between AUX 101 and PCC 2300 is incorrect. Make sure there is proper wiring.
        - PCC 2300 TB1-1 – PCC Net A (+) to AUX 101 J1-3
        - PCC 2300 TB1-2 – PCC Net B (-) to AUX 101 J1-4
        - PCC 2300 TB1-3 – B+ Return to AUX 101 J14-2
        - PCC 2300 TB1-5 – Customer Fused B+ to AUX 101 J14-1
        - PCC 2300 TB15-5 – System Wake-up to AUX 101 J1-5
2. I/O settings misconfigured
    a. If no AUX 101 is connected to PCC 2300, connect to the InPower service tool.
        - Go to **Adjustments > System I/O Adjustment > Output Relays**. Make sure System IO Board Enable is disabled.
        - Go to **Adjustments > System I/O Adjustment**. Make sure no inputs or outputs are configured as enabled.

5.63 Code 2731 - IO Module Lost (Shutdown)

Logic: Indicates an intermittent data link between the I/O module and the PCC control (Aux 101 I/O Module option) and at least one input fault level was set to Shutdown.

Possible Causes:

1. Incorrect wiring

2. I/O settings misconfigured

Diagnosis and Repair:

1. Incorrect wiring
    a. The connection between AUX 101 and PCC 2300 is incorrect. Make sure there is proper wiring.
        - PCC 2300 TB1-1 – PCC Net A (+) to AUX 101 J1-3
        - PCC 2300 TB1-2 – PCC Net B (-) to AUX 101 J1-4
        - PCC 2300 TB1-3 – B+ Return to AUX 101 J14-2
        - PCC 2300 TB1-5 – Customer Fused B+ to AUX 101 J14-1
        - PCC 2300 TB15-5 – System Wake-up to AUX 101 J1-5
2. I/O settings misconfigured
    a. If no AUX 101 is connected to PCC 2300, connect to InPower.
        i. Go to **Adjustments > System I/O Adjustment > Output Relays**. Make sure System IO Board Enable is disabled.
        ii. Go to **Adjustments > System I/O Adjustment**. Make sure no inputs or outputs are configured as enabled.

5.64 Code 2897 - Factory Memory Block Corrupt

Logic: The control has detected a corrupted memory block.

Possible Cause:

1. Defective memory block

Diagnosis and Repair:

1. Defective memory block
    a. Connect to device using InPower version 10.0 or greater.
    b. In InPower, right click on the device, and select Initial Calibration (Recover Device) from the menu that appears.
    c. If the capture file for the device is available, select "overlay capture file". If not, select feature codes.
        - Feature codes can be found on the nameplate of the device, located on the alternator housing.
    d. If the problem persists, contact the factory for support.

5.65 Code 2898 - Periodic or Fault Memory Block Corrupt

Logic: The control has detected a corrupted memory block.

Possible Cause:

1. Defective memory block

Diagnosis and Repair:

1. Defective memory block
    a. Connect to the device using InPower version 10.0 or greater.
    b. In InPower, right click on the device, and select Initial Calibration (Recover Device) from the menu that appears.
    c. If the capture file for the device is available, select "overlay capture file". If not, select feature codes.
        • Feature codes can be found on the nameplate of the device, located on the alternator housing.
    d. If the problem persists, contact the factory for support.

5.66 Code 2899 - User Memory Block Corrupt

Logic: The control has detected a corrupted memory block.

Possible Cause:

1. Defective memory block

Diagnosis and Repair:

1. Defective memory block
    a. Connect to the device using InPower version 10.0 or greater.
    b. In InPower, right click on the device, and select Initial Calibration (Recover Device) from the menu that appears.
    c. If the capture file for the device is available, select "overlay capture file". If not, select feature codes.
        • Feature codes can be found on the nameplate of the device, located on the alternator housing.
    d. If the problem persists, contact the factory for support.

5.67 Code 2911 - Trim Memory Block Corrupt

Logic: The control has detected a corrupted memory block.

Possible Cause:

1. Defective memory block

Diagnosis and Repair:

1. Defective memory block
    a. Connect to the device using InPower version 10.0 or greater.
    b. In InPower, right click on the device, and select Initial Calibration (Recover Device) from the menu that appears.
    c. If the capture file for the device is available, select "overlay capture file". If not, select feature codes.
        • Feature codes can be found on the nameplate of the device, located on the alternator housing.
    d. If the problem persists, contact the factory for support.

5.68 Code 2964 - Intake Air Temperature Higher than Expected

Logic: The manifold air temperature exceeds 94 °C (200 °F) for more than 60 seconds, while the engine is running (DTC 111 active).

Possible Causes:

1. Exhaust air entering intake
2. TMAP sensor failure

Diagnosis and Repair:

1. Exhaust air entering intake
    a. Inspect the exhaust system for leaks. Check the exhaust manifold gaskets, turbo gasket (if equipped), and exhaust tubing for holes or escaping exhaust. Replace the faulty component(s) if necessary.
    b. The unit is not properly ventilated. Make sure that the unit is greater than 5 feet from any obstruction.
        - For units located inside of a structure, make sure that exhaust gases do not exit within 5 feet of the intake for the structure or generator set.
        - For enclosed sets, make sure that there are no objects blocking the exhaust opening on the top of the enclosure, or objects that may redirect exiting airflow towards the intake end of the unit.
2. TMAP sensor failure
    a. Remove TMAP sensor from the intake manifold, and expose it to ambient air.
    b. Make sure that the tip is well away from the engine or other heat/cold sources.
    c. Connect using the E-controls service tool, and monitor the manifold air temperature. Compare that to the known ambient air temperature.
    d. Check for continuity across leads 1 and 2 of the TMAP sensor. If the circuit is open, replace the TMAP sensor.

5.69 Code 2972 - Field Overload (Shutdown)

Logic:

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.

Possible Causes:

⚠ CAUTION
Excessive voltage is possible during testing. Make sure your meter can handle alternator full voltage.

1. Voltage sensing into the baseboard is too low, or there is an open/short circuit
2. Application issue

Diagnosis and Repair:

1. Voltage sensing into the baseboard is too low, or there is an open/short circuit
    a. Measure the voltage going into the baseboard 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.
        i. If the voltage going into the control board is zero, or less than the Nominal Voltage calibration, then the wiring from the alternator to the baseboard for an open circuit or short circuit.
    b. 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.
        i. 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 baseboard if the AVR is faulty.
2. Application issue
    a. 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.).

5.70 Code 5134 - Unknown Shutdown at Idle

Logic:

Engine is not getting a proper fuel supply.

Possible Causes:

1. Fuel supply issue

Diagnosis and Repair:

1. Fuel supply issue
    a. Check that there is a proper supply of fuel to the engine.

5.71 Code 5365 - Fault Code on Secondary Source (Information that the Fueling Has Been Shifted to Secondary Source)

Logic:

This fault is used when an optional low fuel pressure switch is installed and the generator set is set up for dual fuel operation. The nature of the fault is an optional customer selection. The fault function is programmed (using the InPower service tool), as follows:

- *Low Fuel Pressure Switch Active State Selection:* Active Closed
- *Function:* Low Fuel Pressure Switch (default: Disabled)
- *Fault Level Response:* Warning (default: #1-None, #2-Warning and #3-Warning)
- *Fault Active State Selection:* Active Closed (default: Active Closed)
- *Gas Fuel Type:* Dual

Possible Causes:

1. Low primary fuel pressure
2. Faulty fuel pressure switch connections
3. Faulty fuel pressure switch
4. Incorrect calibration settings for the Low Fuel Pressure fault in the control
5. Faulty control board

Diagnosis and Repair:

1. Low primary fuel pressure
    a. Check fuel supply. Diagnose and fix as required.
    b. Check fuel valve connections and operation. Diagnose and fix as required.
2. Faulty fuel pressure switch connections
    a. Inspect the fuel pressure switch and the harness connectors.
        i. Disconnect the harness connector from the fuel pressure switch.
        ii. Inspect for corroded, bent or broken tabs on the fuel pressure switch.
        iii. Inspect for evidence of moisture in or on the harness connectors.
        iv. Inspect for dirt or debris in or on the harness connectors.
        v. Inspect the wiring for any damage or shorting.
3. Faulty fuel pressure switch
    a. Check switch operation.
        i. Remove the connector from the fuel pressure switch.
        ii. Verify battery power on the sensor harness connector that plugs into tab NO on the fuel pressure switch. If B+ not present, repair or replace the harness.
        iii. Verify ground on the sensor harness connector that plugs into tab C on the fuel pressure switch. If ground is not present, repair or replace the harness.
4. Incorrect calibration settings for the Low Fuel Pressure fault in the control
    a. Verify calibration setting for Low Fuel Pressure Switch Active State Selection = Active Closed.
    b. Verify calibration setting for Configurable Input #3 Function = Low Fuel Pressure Switch.
    c. Verify calibration setting for Configurable Input #3 Fault Active State Selection = Active Closed.
5. Faulty control board
    a. If the sender, harness and control settings are acceptable, the baseboard is defective. Swap the control board.

5.72 Code 5669 - Engine Combustion (Shutdown)

Logic:

Rapid rate of increase of intake manifold temperature detected.

Possible Causes:

1. Intake manifold over-pressurization event
2. Faulty TMAP sensor

3. Faulty engine harness

Diagnosis and Repair:

1. Intake manifold overpressurization event
    a. Inspect the hose couplings between the compressor outlet and intake manifold.
        i. Inspect the hose couplings for damage.
        ii. Inspect the clamps for damage.
    b. Inspect the turbocharger (if used).
        i. Externally inspect the turbocharger for damage.
        ii. Inspect for loose or missing bolts on the compressor housing.
    c. Inspect the mixer.
        i. Remove the air cleaner and confirm there are no loose pieces within the mixer.
2. Faulty TMAP sensor
    a. For the troubleshooting procedure, refer to DTC 127 in the E-Controls manual.
3. Faulty engine harness
    a. Inspect the engine harness and the connector pins.
        i. Disconnect the engine harness connector from the extension harness.
        ii. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
        iii. Inspect for evidence of moisture in or on the connector.
        iv. Inspect for missing or damaged connector seals.
        v. Inspect for dirt or debris in or on the connector pin.
        vi. Disconnect the harness from the ECM and sensor.
        vii. Measure the resistance in each pin from ECM to sensor. Resistance should be 5 Ohms or less.
        viii. Repair or replace the harness as necessary.

5.73 Code 6518 - Cold Start Idle Active (Event)

Logic:

Cold Start Idle is required to avoid turbo failures at cold temperatures due to a lack of lube oil circulation. Cold Start Idle runs the generator set at idle speed to allow oil pressure to reach the turbo before the generator set reaches rated speed. When Cold Start Idle is active, an event is generated. This condition exists for up to 2 minutes after start when the ambient temperature is below 20 °F (-6.7 °C), and up to 40 Seconds for ambient temperatures below -5 °F (-21 °C) with feature code A059D281.

(See the Cold Start Idle Time Table below.) When the generator set reaches rated speed, Cold Start Idle will be deactivated.

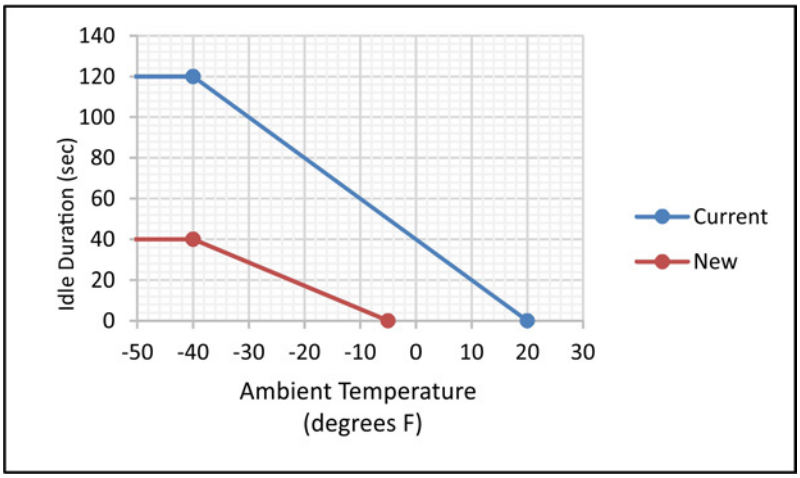


FIGURE 91. COLD START IDLE TIME TABLE

TABLE 36. COLD START IDLE

Name	Units	Range	Current	New
Cold Start Idle Transition to Rated Temperature	Deg F	0-50	20	-5
Cold Start Idle Knee Point	Deg F	-50-50	-40	-40

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Appendix A. Wiring Diagrams

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A.0 Wiring Diagrams

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

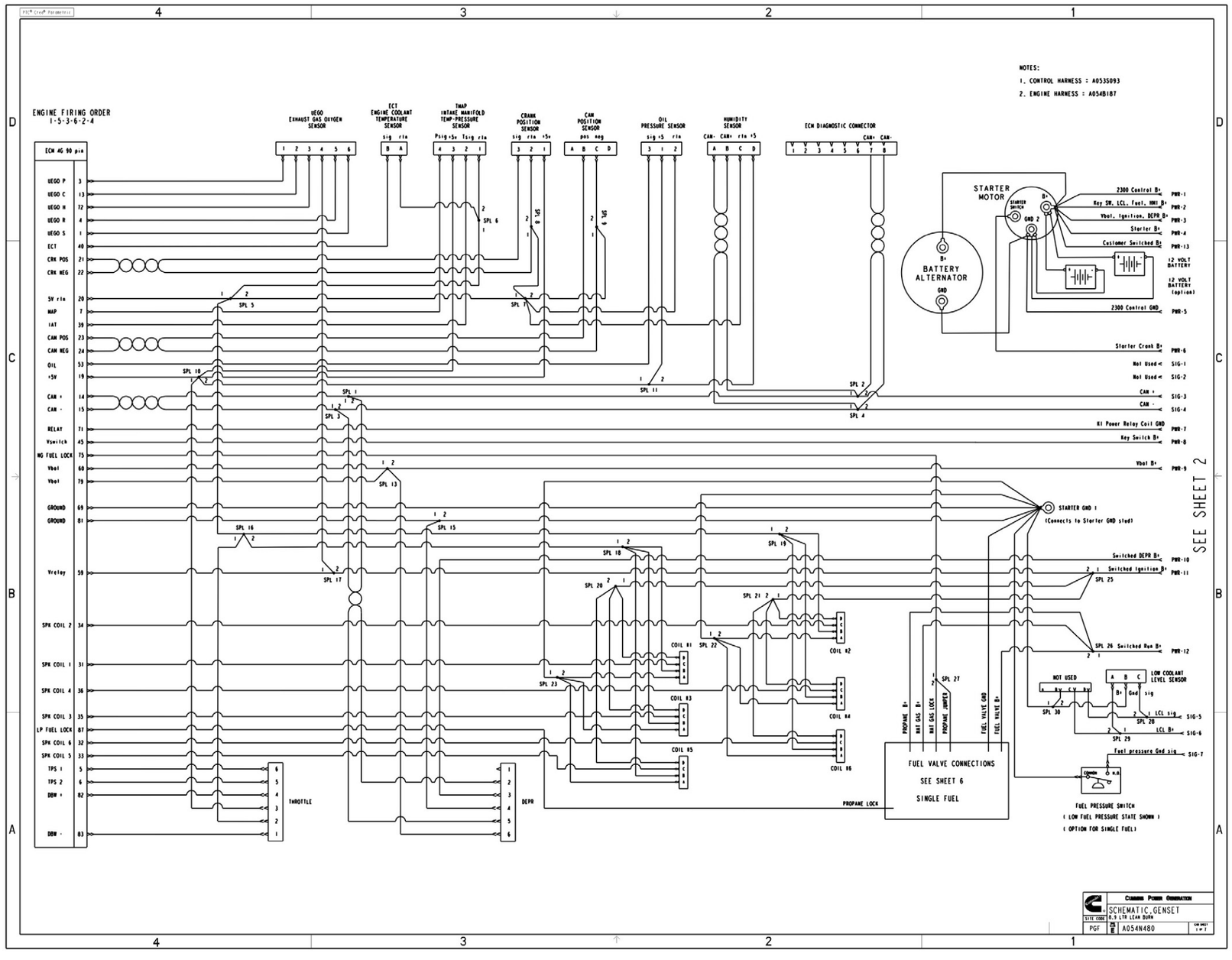


FIGURE 92. WIRING DIAGRAM PC 2.3 (SHEET 1 OF 7)

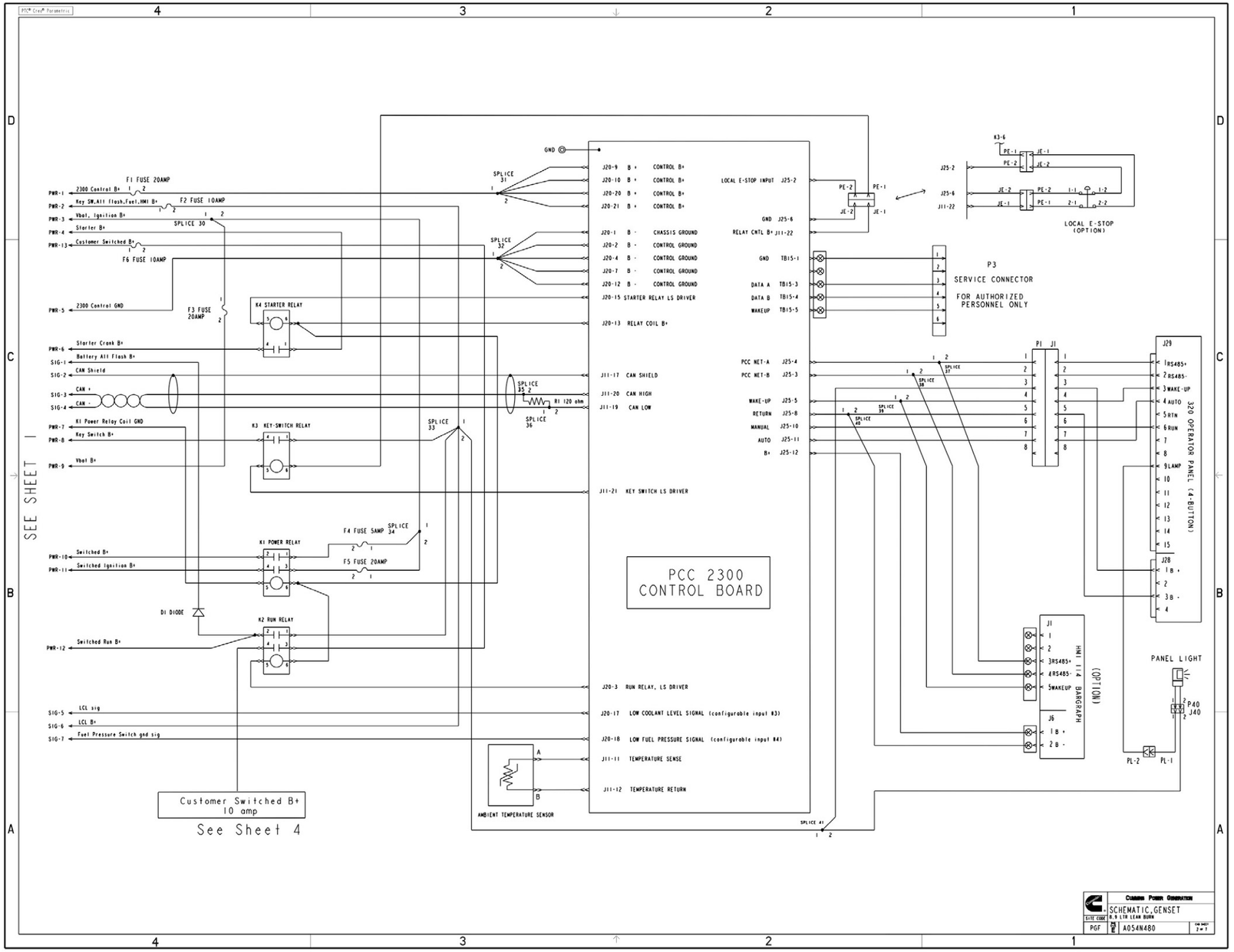


FIGURE 93. WIRING DIAGRAM PC 2.3 (SHEET 2 OF 7)

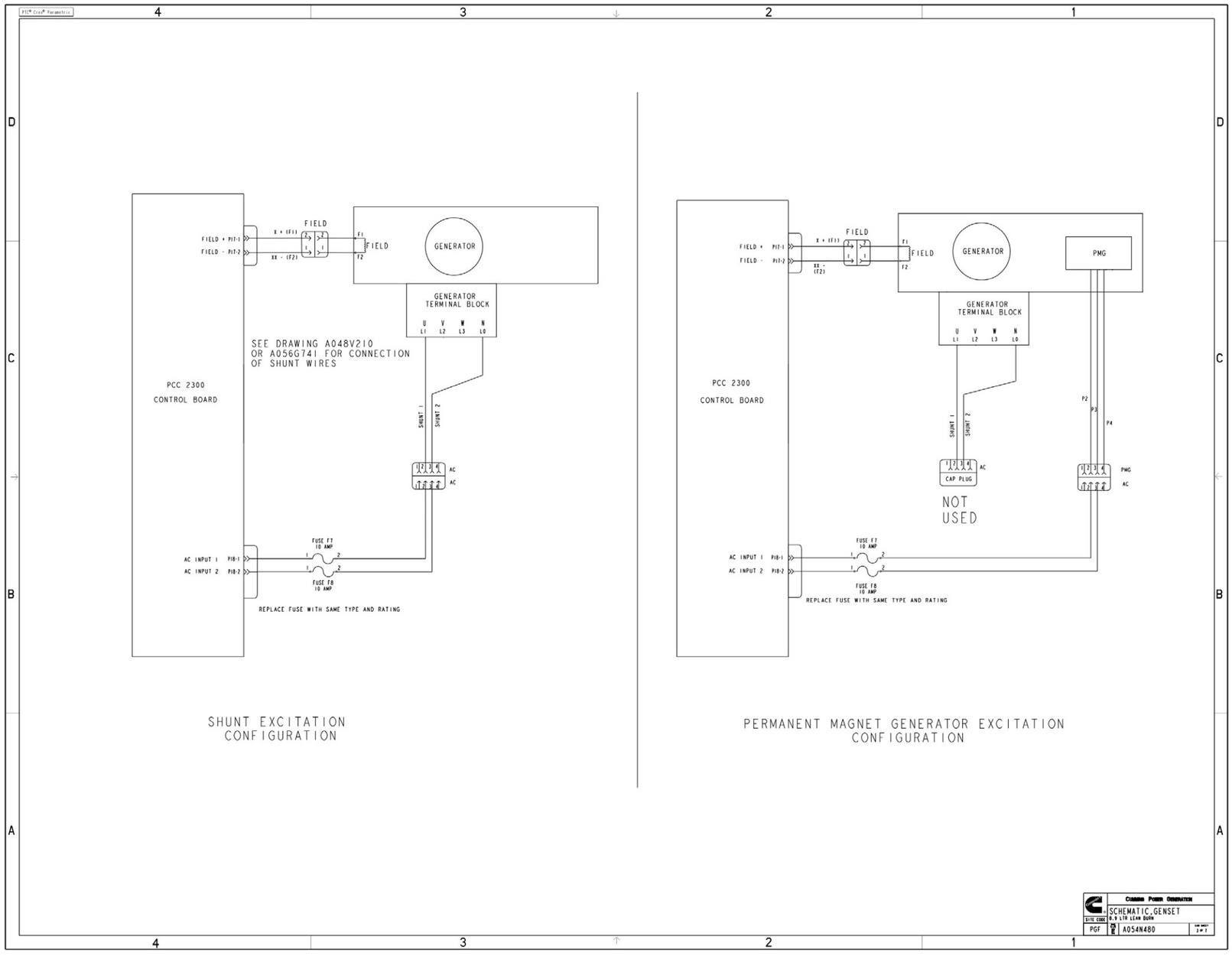
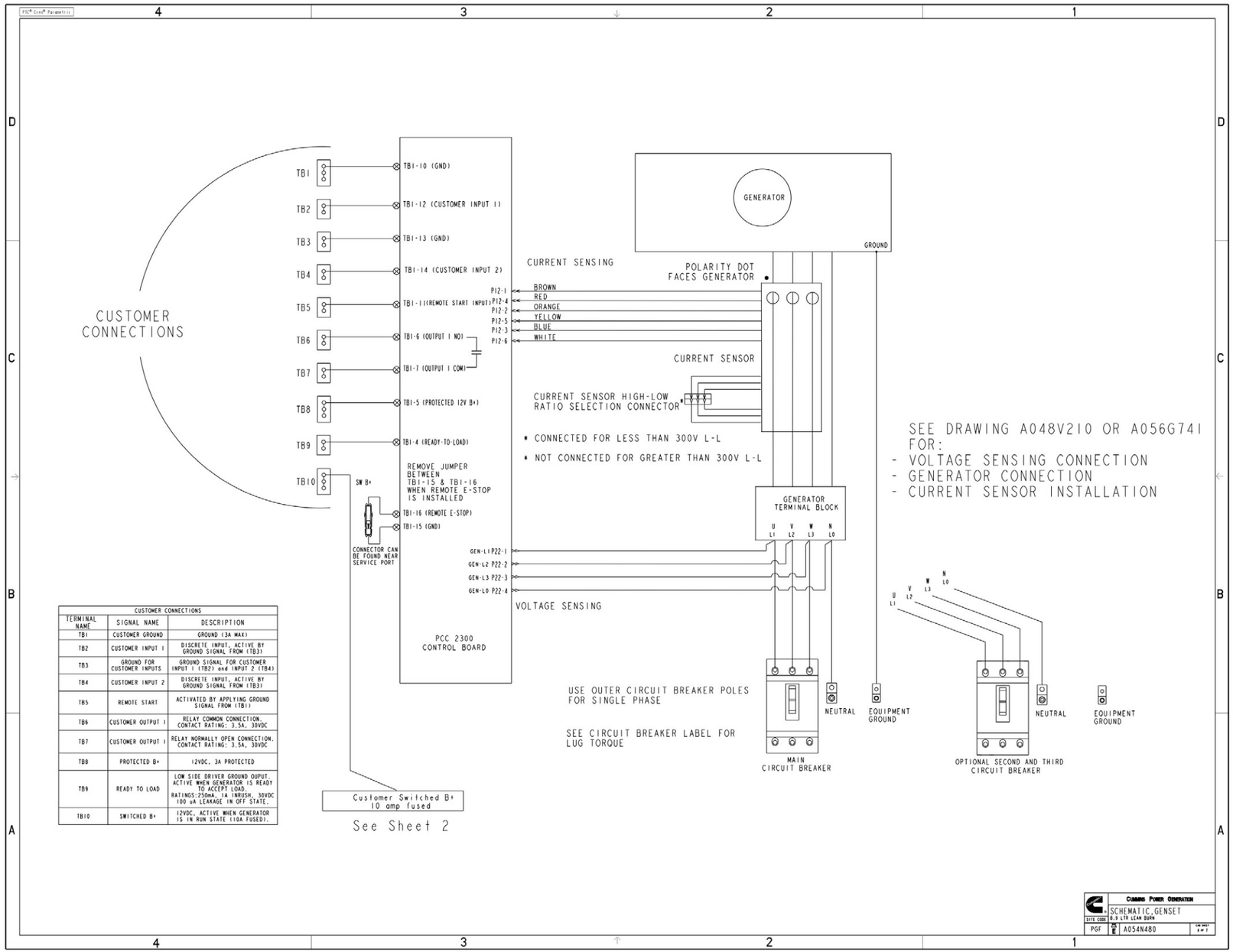


FIGURE 94. WIRING DIAGRAM PC 2.3 (SHEET 3 OF 7)



CUSTOMER CONNECTIONS		
TERMINAL NAME	SIGNAL NAME	DESCRIPTION
TB1	CUSTOMER GROUND	GROUND (3A MAX)
TB2	CUSTOMER INPUT 1	DISCRETE INPUT, ACTIVE BY GROUND SIGNAL FROM (TB3)
TB3	GROUND FOR CUSTOMER INPUTS	GROUND SIGNAL FOR CUSTOMER INPUT 1 (TB2) and INPUT 2 (TB4)
TB4	CUSTOMER INPUT 2	DISCRETE INPUT, ACTIVE BY GROUND SIGNAL FROM (TB3)
TB5	REMOTE START	ACTIVATED BY APPLYING GROUND SIGNAL FROM (TB1)
TB6	CUSTOMER OUTPUT 1	RELAY COMMON CONNECTION. CONTACT RATING: 3.5A, 30VDC
TB7	CUSTOMER OUTPUT 1	RELAY NORMALLY OPEN CONNECTION. CONTACT RATING: 3.5A, 30VDC
TB8	PROTECTED B+	12VDC, 3A PROTECTED
TB9	READY TO LOAD	LOW SIDE DRIVER GROUND OUPUT. ACTIVE WHEN GENERATOR IS READY TO ACCEPT LOAD. RATINGS:250mA, 1A INRUSH, 30VDC 100 uA LEAKAGE IN OFF STATE.
TB10	SWITCHED B+	12VDC, ACTIVE WHEN GENERATOR IS IN RUN STATE (10A FUSED).

FIGURE 95. WIRING DIAGRAM PC 2.3 (SHEET 4 OF 7)

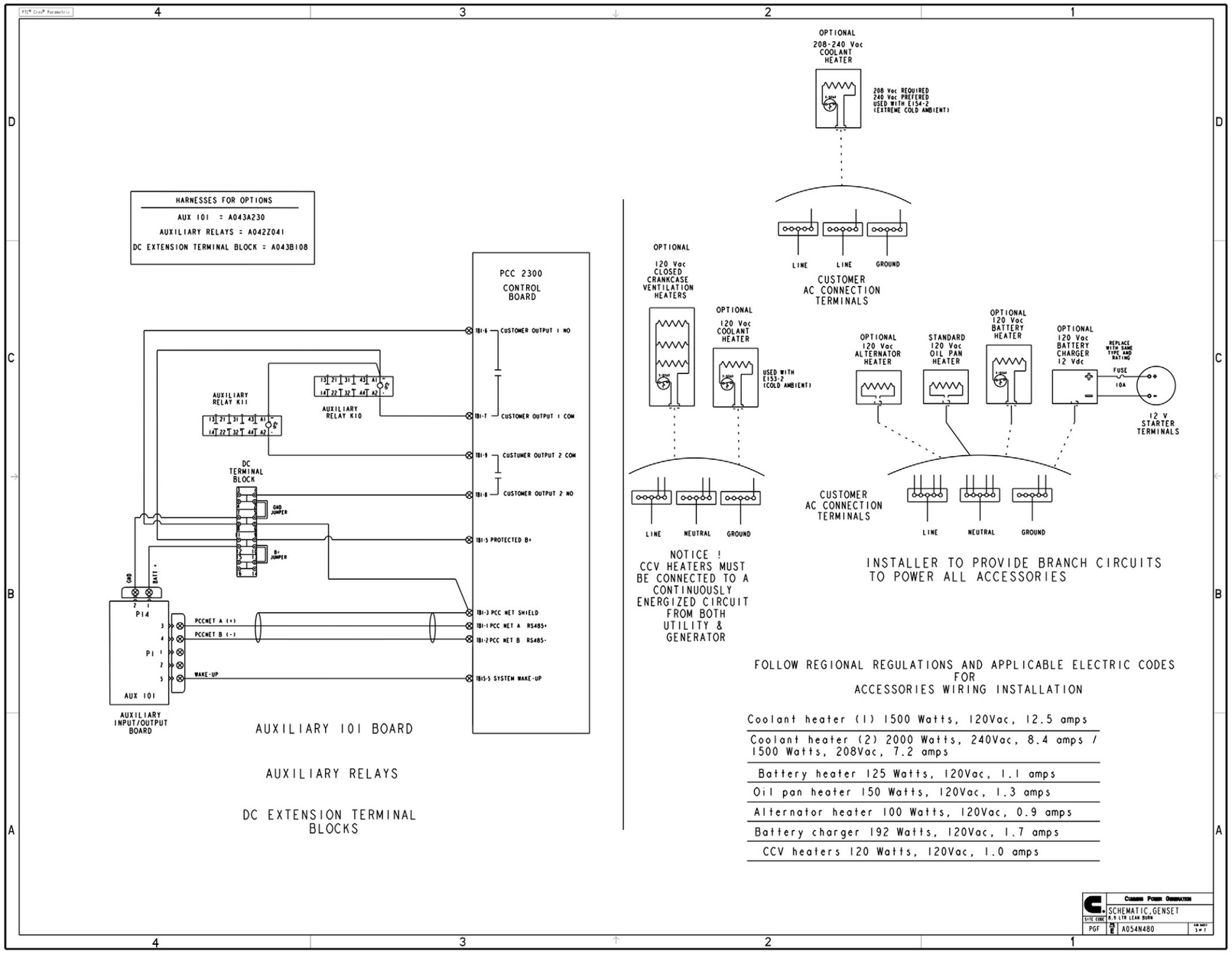


FIGURE 96. WIRING DIAGRAM PC 2.3 (SHEET 5 OF 7)

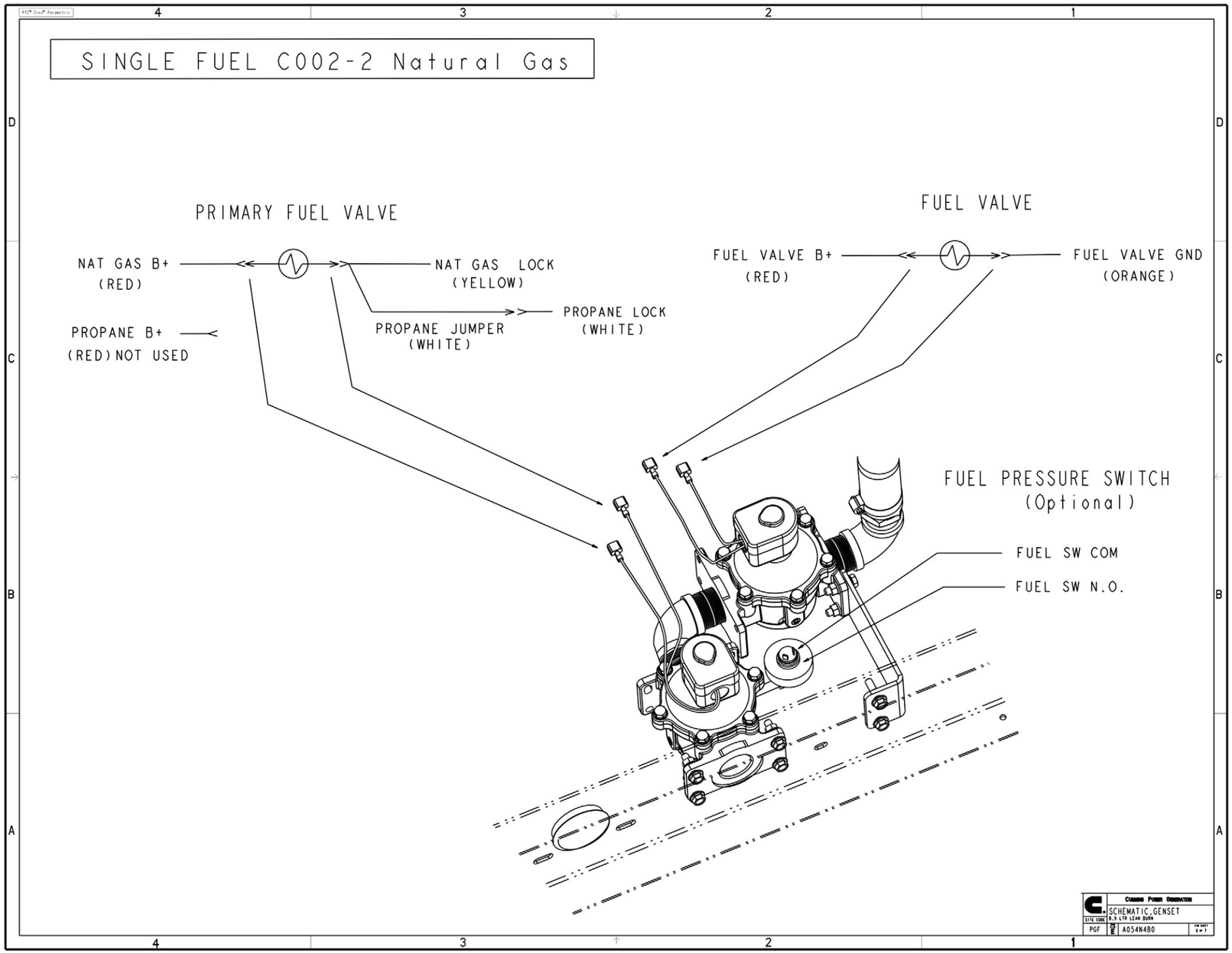


FIGURE 97. WIRING DIAGRAM PC 2.3 (SHEET 6 OF 7)

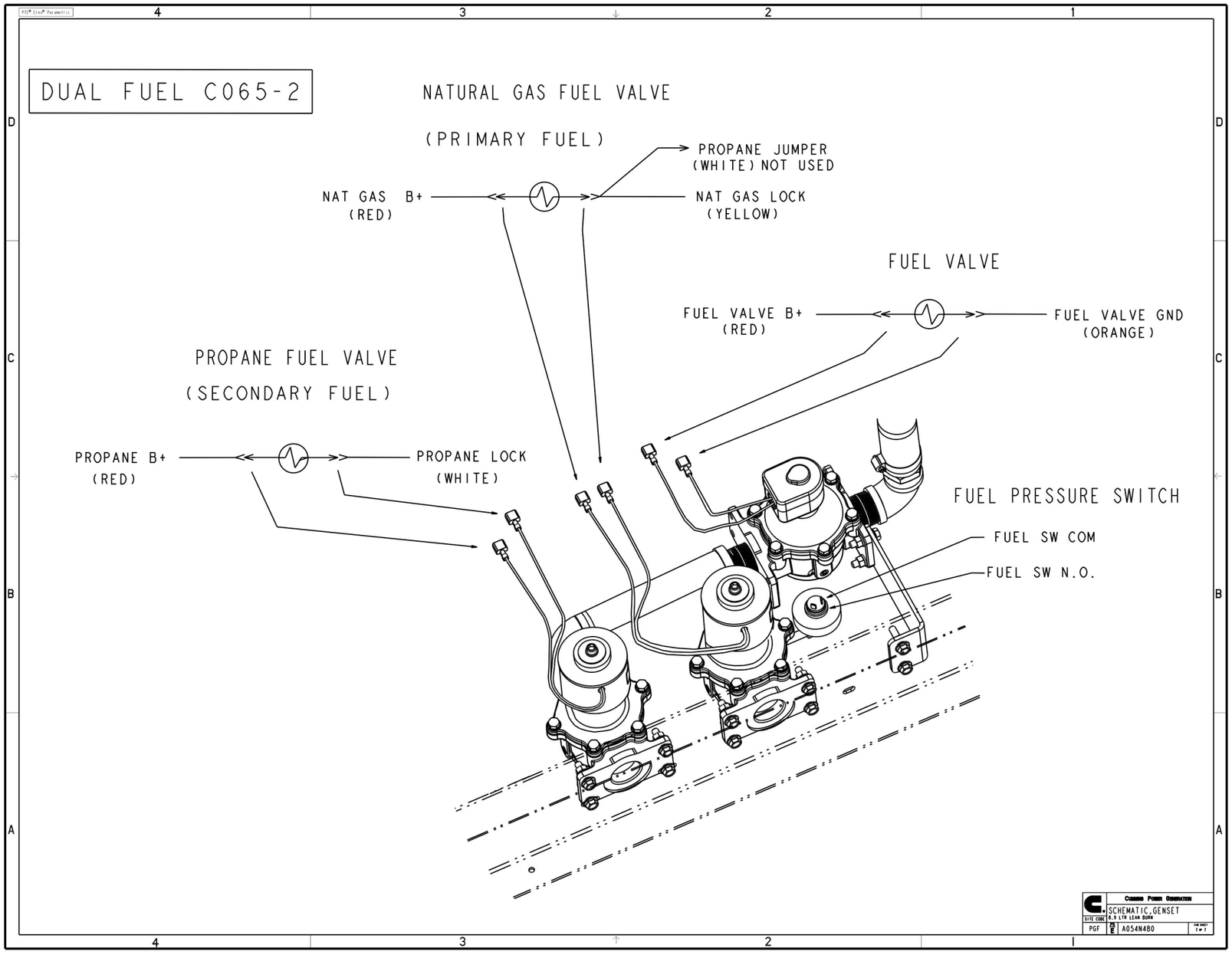
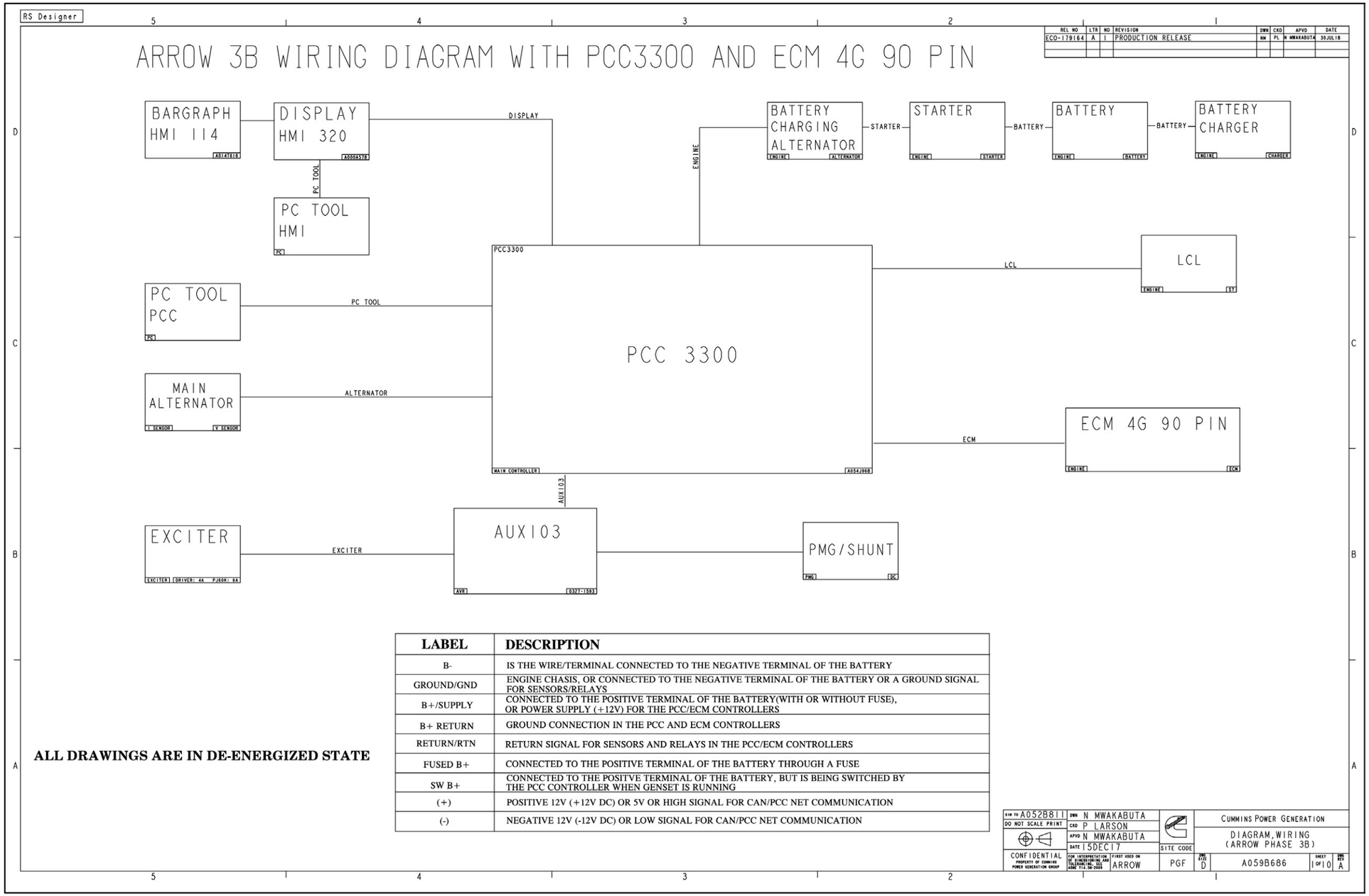


FIGURE 98. WIRING DIAGRAM PC 2.3 (SHEET 7 OF 7)



LABEL	DESCRIPTION
B-	IS THE WIRE/TERMINAL CONNECTED TO THE NEGATIVE TERMINAL OF THE BATTERY
GROUND/GND	ENGINE CHASIS, OR CONNECTED TO THE NEGATIVE TERMINAL OF THE BATTERY OR A GROUND SIGNAL FOR SENSORS/RELAYS
B+/SUPPLY	CONNECTED TO THE POSITIVE TERMINAL OF THE BATTERY(WITH OR WITHOUT FUSE), OR POWER SUPPLY (+12V) FOR THE PCC/ECM CONTROLLERS
B+ RETURN	GROUND CONNECTION IN THE PCC AND ECM CONTROLLERS
RETURN/RTN	RETURN SIGNAL FOR SENSORS AND RELAYS IN THE PCC/ECM CONTROLLERS
FUSED B+	CONNECTED TO THE POSITIVE TERMINAL OF THE BATTERY THROUGH A FUSE
SW B+	CONNECTED TO THE POSITVE TERMINAL OF THE BATTERY, BUT IS BEING SWITCHED BY THE PCC CONTROLLER WHEN GENSET IS RUNNING
(+)	POSITIVE 12V (+12V DC) OR 5V OR HIGH SIGNAL FOR CAN/PCC NET COMMUNICATION
(-)	NEGATIVE 12V (-12V DC) OR LOW SIGNAL FOR CAN/PCC NET COMMUNICATION

FIGURE 99. WIRING DIAGRAM PC 3.3 (SHEET 1 OF 10)

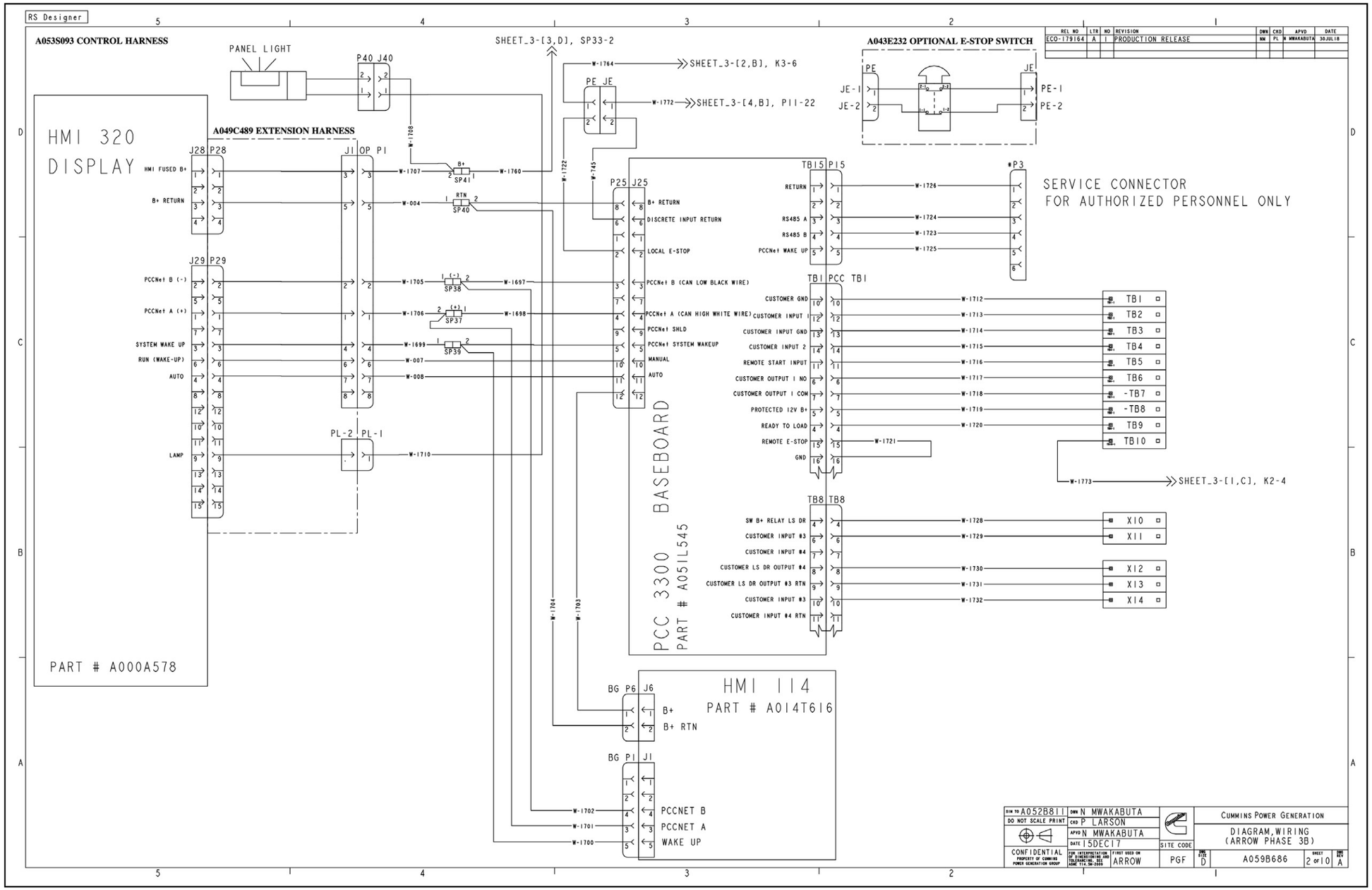


FIGURE 100. WIRING DIAGRAM PC 3.3 (SHEET 2 OF 10)

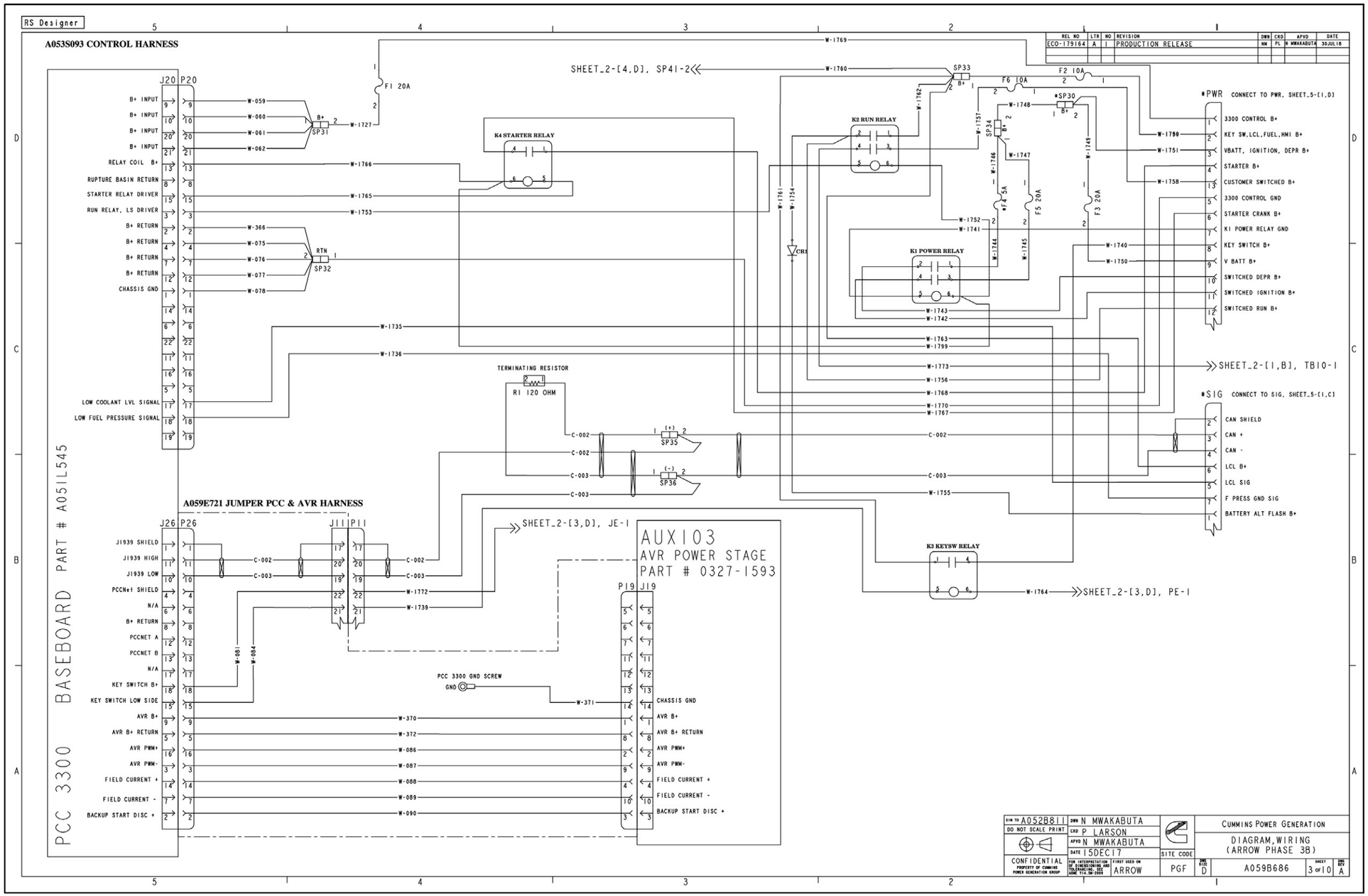


FIGURE 101. WIRING DIAGRAM PC 3.3 (SHEET 3 OF 10)

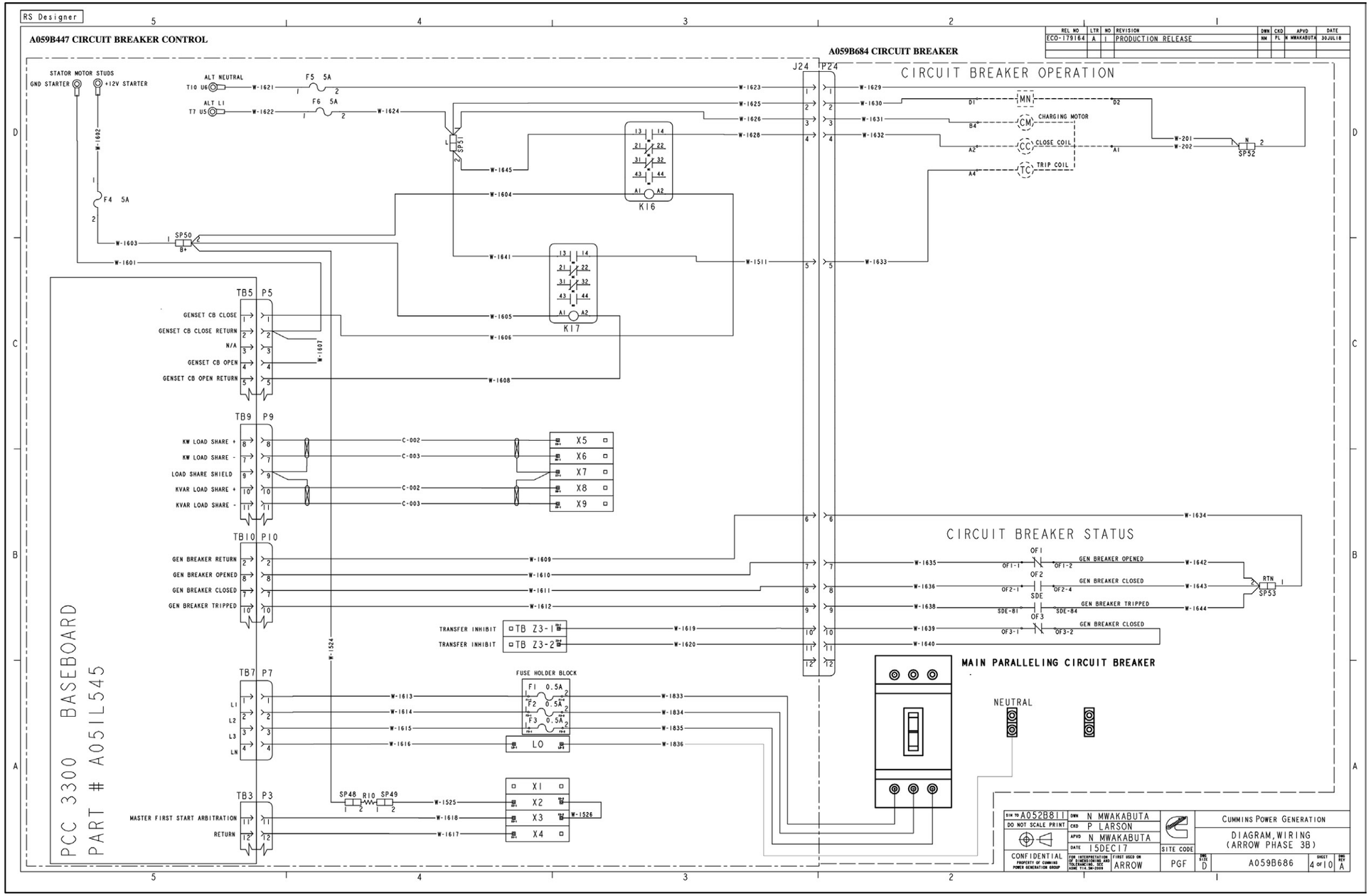


FIGURE 102. WIRING DIAGRAM PC 3.3 (SHEET 4 OF 10)

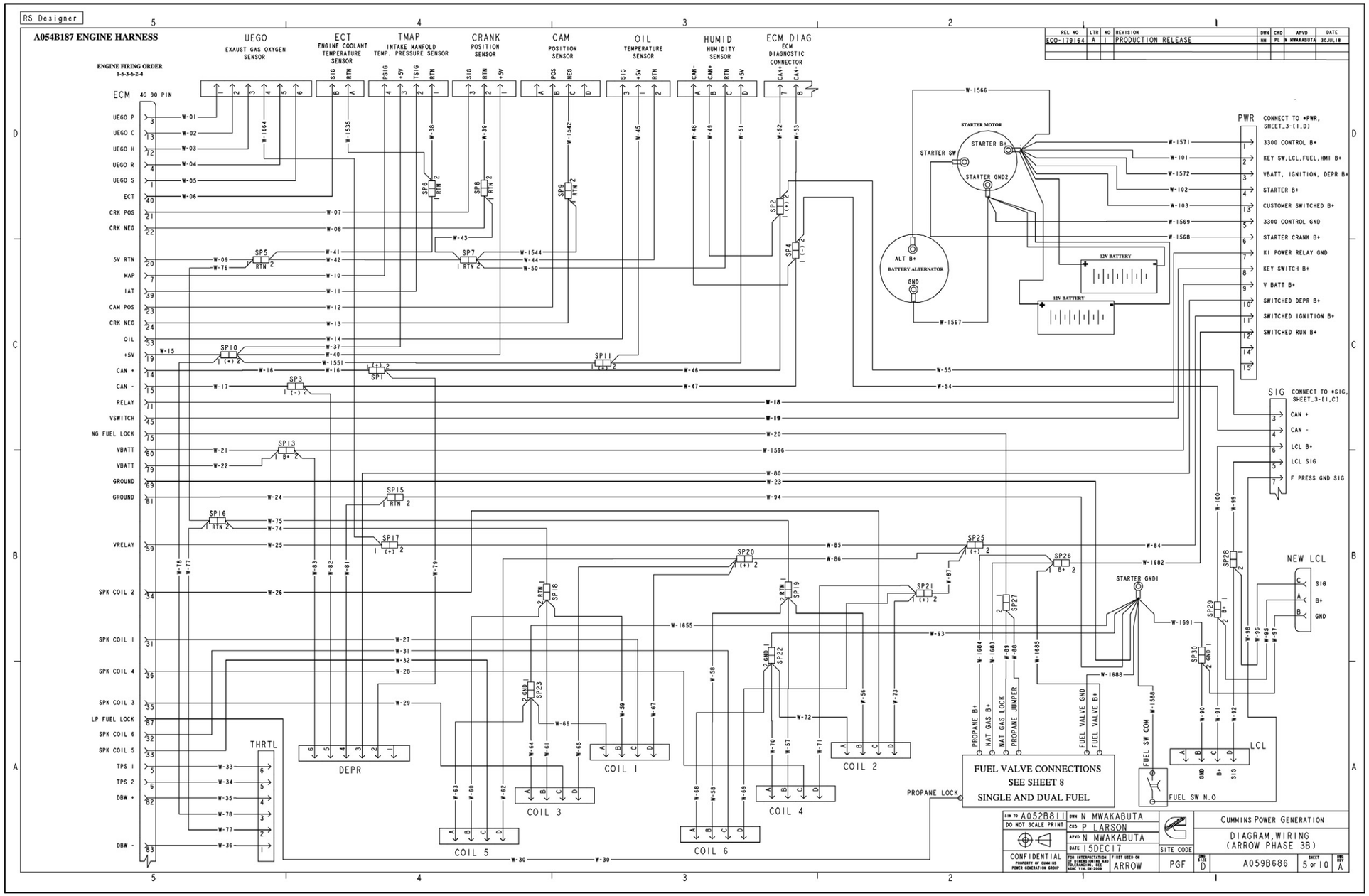


FIGURE 103. WIRING DIAGRAM PC 3.3 (SHEET 5 OF 10)

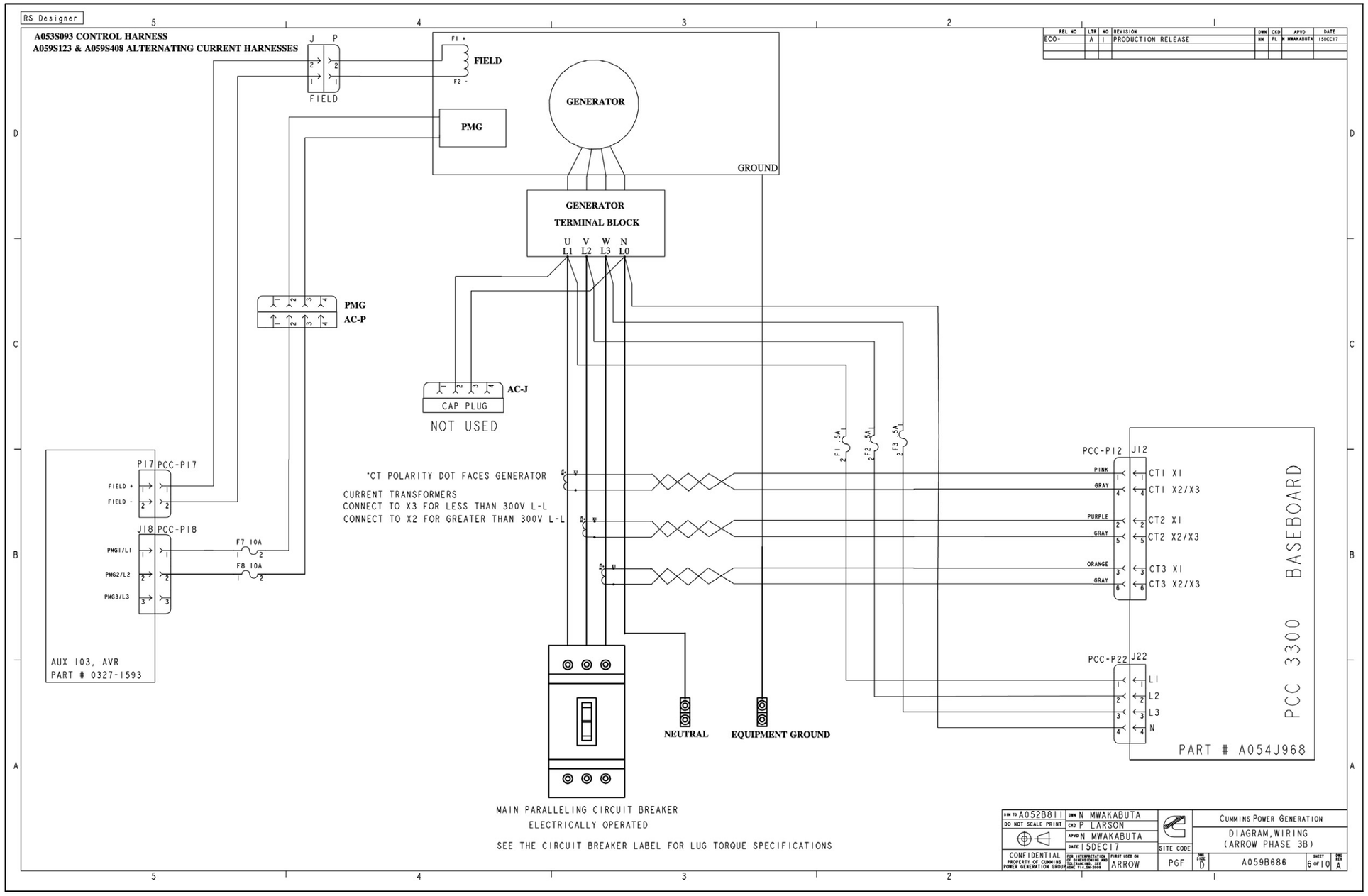


FIGURE 104. WIRING DIAGRAM PC 3.3 (SHEET 6 OF 10)

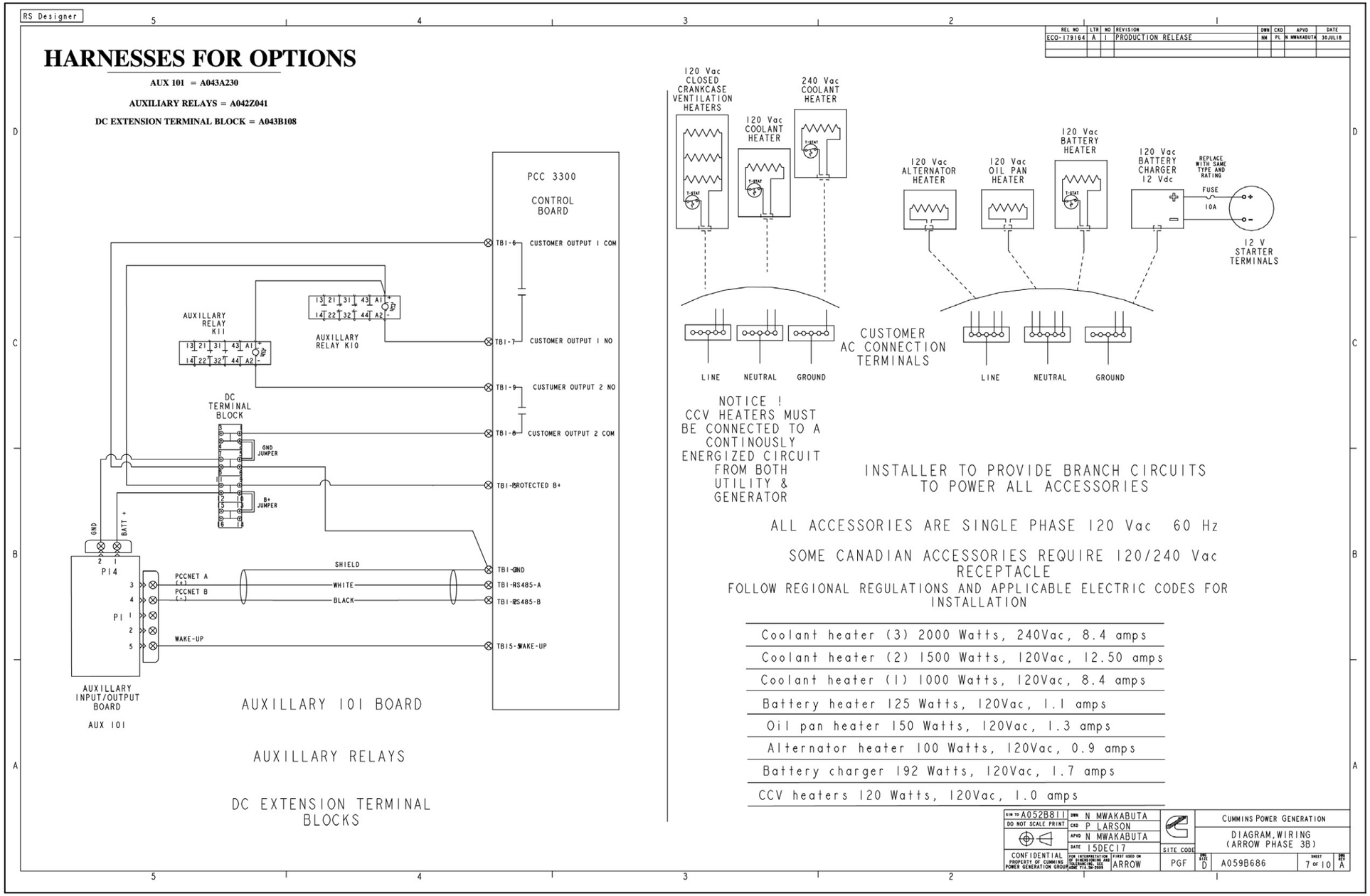


FIGURE 105. WIRING DIAGRAM PC 3.3 (SHEET 7 OF 10)

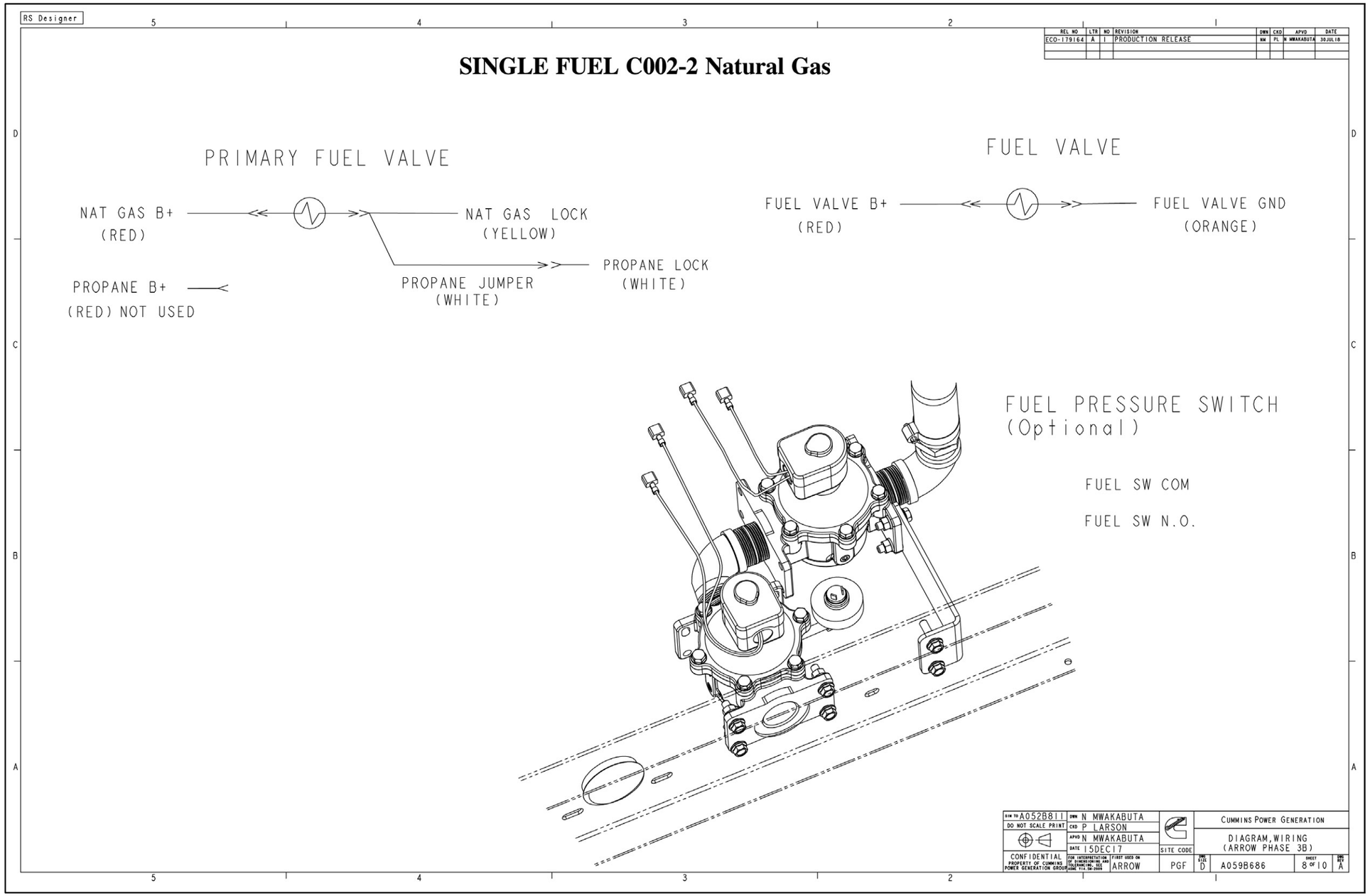


FIGURE 106. WIRING DIAGRAM PC 3.3 (SHEET 8 OF 10)

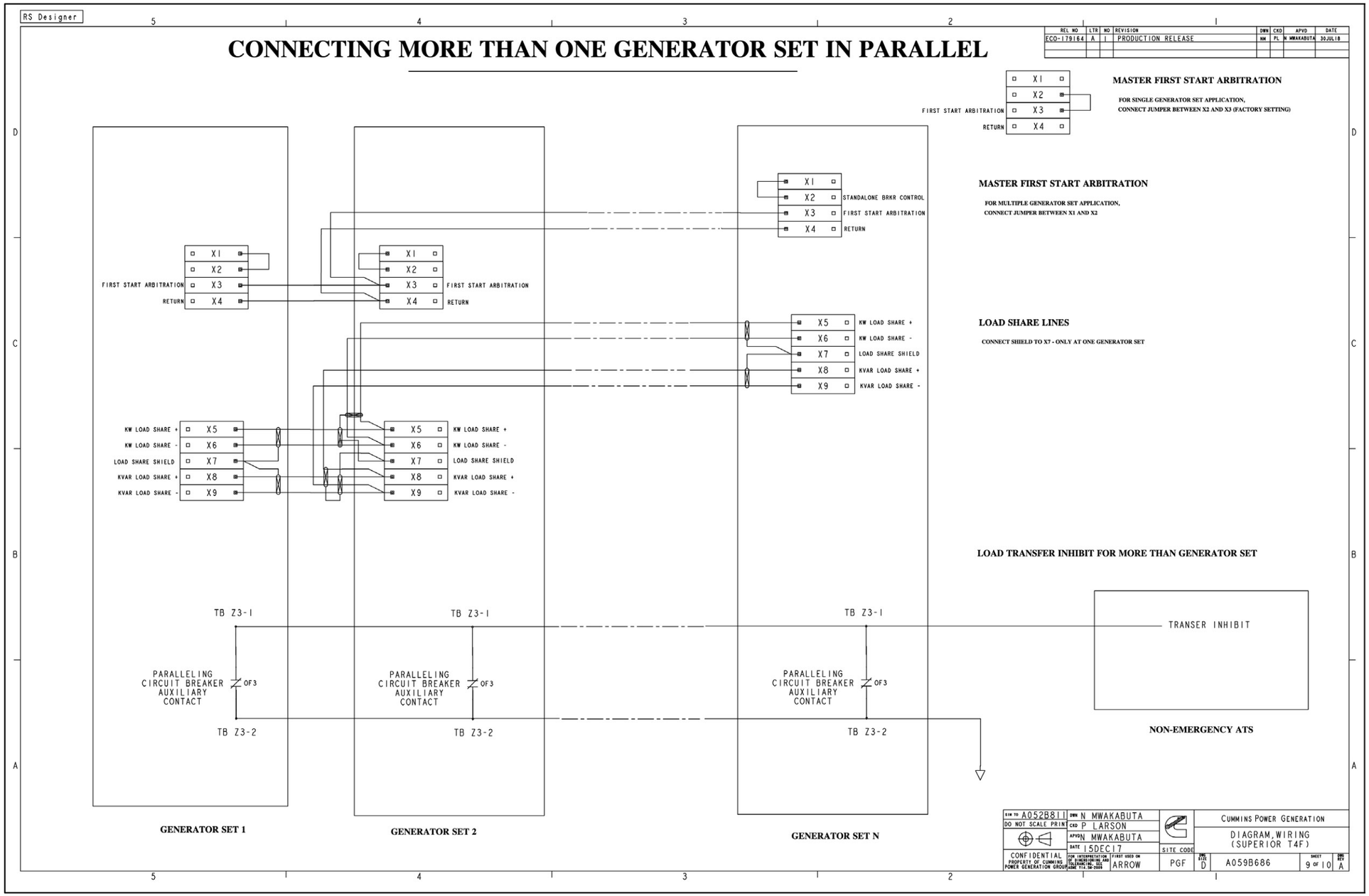


FIGURE 107. WIRING DIAGRAM PC 3.3 (SHEET 9 OF 10)

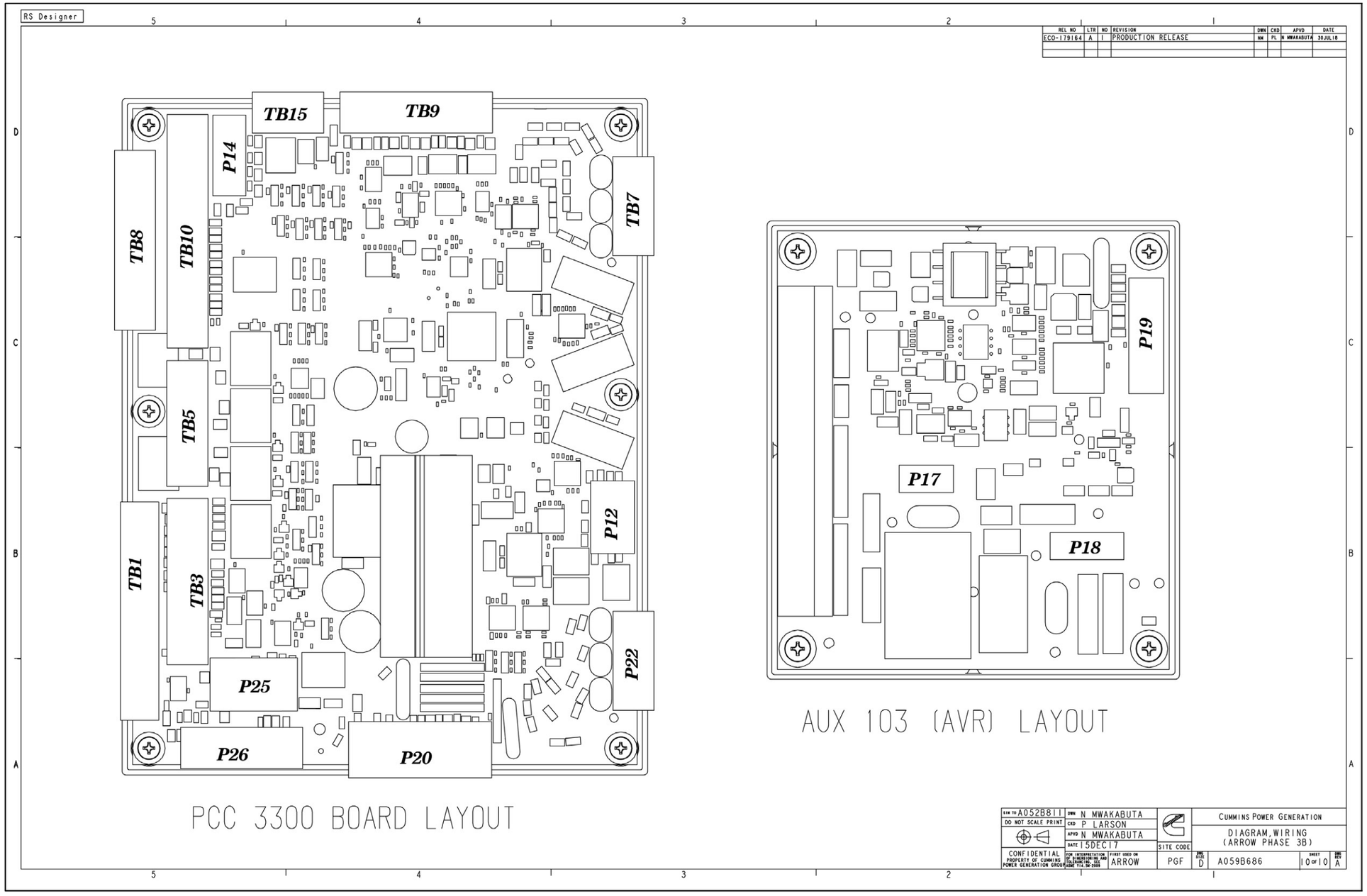


FIGURE 108. WIRING DIAGRAM PC 3.3 (SHEET 10 OF 10)

IO/TROW WIRE LIST

	FROM					TO					WIRE		
INDEX	CONNECTOR NAME	CONNECTOR PART NUMBER	LOCATION	TERMINAL	SEAL/PLUG	CONNECTOR NAME	CONNECTOR PART NUMBER	LOCATION	TERMINAL	SEAL / PLUG	WIRE	WIRE SIZE (AWG)	COLOR
1	ECM	A047W205	ECM-3	A047J914	N.A.	UEGO	A047V884	UEGO-1	A047X560	A048C236	0334-2251-04	18	WHITE
2	ECM	A047W205	ECM-13	A047J914	N.A.	UEGO	A047V884	UEGO-2	A047X560	A048C236	0334-2251-04	18	WHITE
3	ECM	A047W205	ECM-T2	A047J914	N.A.	UEGO	A047V884	UEGO-3	A047X560	A048C236	0334-2251-04	18	WHITE
4	ECM	A047W205	ECM-4	A047J914	N.A.	UEGO	A047V884	UEGO-5	A047X560	A048C236	0334-2251-04	18	WHITE
5	ECM	A047W205	ECM-1	A047J914	N.A.	UEGO	A047V884	UEGO-6	A047X560	A048C236	0334-2251-04	18	WHITE
6	SPL 17	A047J670	SPL 17-1	N.A.	N.A.	UEGO	A047V884	UEGO-4	A047X560	A048C236	0334-2251-04	18	WHITE
7	SPL 17	A047J670	SPL 17-1	N.A.	N.A.	ECM	A047W205	ECM-59	A048C184	N.A.	0334-2251-05	16	WHITE
8	ECM	A047W205	ECM-7	A047J914	N.A.	TMAP	A043M553	TMAP-4	A030P836	A030P835	0334-2251-04	18	WHITE
9	SPL 10	A047J585	SPL 10-2	N.A.	N.A.	TMAP	A043M553	TMAP-3	A030P836	A030P835	0334-2251-04	18	WHITE
10	ECM	A047W205	ECM-39	A047J914	N.A.	TMAP	A043M553	TMAP-2	A030P836	A030P835	0334-2251-04	18	WHITE
11	SPL 6	A047J670	SPL 6-2	N.A.	N.A.	TMAP	A043M553	TMAP-1	A030P836	A030P835	0334-2251-04	18	WHITE
12	SPL 6	A047J670	SPL 6-2	N.A.	N.A.	ECT	A001M809	ECT-A	0323-1818	N.A.	0334-2251-04	18	WHITE
13	ECM	A047W205	ECM-40	A047J914	N.A.	ECT	A001M809	ECT-B	0323-1818	N.A.	0334-2251-04	18	WHITE
14	CRANK	A053R777	CRANK-3	A047J447	N.A.	ECM	A047W205	ECM-21	A047J914	N.A.	0334-2251-04	18	WHITE
15	CRANK	A053R777	CRANK-2	A047J447	N.A.	SPL 8	A047J670	SPL 8-2	N.A.	N.A.	0334-2251-04	18	WHITE
16	CRANK	A053R777	CRANK-1	A047J447	N.A.	SPL 10	A047J585	SPL 10-2	N.A.	N.A.	0334-2251-04	18	WHITE
17	ECM	A047W205	ECM-22	A047J914	N.A.	SPL 8	A047J670	SPL 8-1	N.A.	N.A.	0334-2251-04	18	WHITE
18	ECM	A047W205	ECM-20	A048C184	N.A.	SPL 5	A047J585	SPL 5-1	N.A.	N.A.	0334-2251-05	16	WHITE
19	SPL 6	A047J670	SPL 6-1	N.A.	N.A.	SPL 5	A047J585	SPL 5-2	N.A.	N.A.	0334-2251-04	18	WHITE
20	SPL 7	A047J670	SPL 7-1	N.A.	N.A.	SPL 5	A047J585	SPL 5-2	N.A.	N.A.	0334-2251-05	16	WHITE
21	SPL 7	A047J670	SPL 7-1	N.A.	N.A.	SPL 8	A047J670	SPL 8-1	N.A.	N.A.	0334-2251-04	18	WHITE
22	ECM	A047W205	ECM-23	A047J914	N.A.	CAM	323-1451	CAM-B	0323-1444	323-1445	0334-2251-04	18	WHITE
23	SPL 9	A047J670	SPL 9-2	N.A.	N.A.	CAM	323-1451	CAM-C	0323-1444	323-1445	0334-2251-04	18	WHITE
24	SPL 9	A047J670	SPL 9-1	N.A.	N.A.	ECM	A047W205	ECM-24	A047J914	N.A.	0334-2251-04	18	WHITE
25	SPL 9	A047J670	SPL 9-1	N.A.	N.A.	SPL 7	A047J670	SPL 7-2	N.A.	N.A.	0334-2251-04	18	WHITE
26	SPL 10	A047J585	SPL 10-2	N.A.	N.A.	SPL 11	A047J670	SPL 11-1	N.A.	N.A.	0334-2251-04	18	WHITE
27	ECM	A047W205	ECM-53	A047J914	N.A.	OIL	A047W035	OIL-3	A047J447		0334-2251-04	18	WHITE
28	SPL 11	A047J670	SPL 11-2	N.A.	N.A.	OIL	A047W035	OIL-1	A047J447		0334-2251-04	18	WHITE
29	SPL 7	A047J670	SPL 7-2	N.A.	N.A.	OIL	A047W035	OIL-2	A047J447		0334-2251-04	18	WHITE
30	ECM	A047W205	ECM-14	A047J914	N.A.	SPL 1	A047J670	SPL 1-1	N.A.	N.A.	0334-2251-04	18	WHITE
31	ECM	A047W205	ECM-15	A047J914	N.A.	SPL 3	A047J670	SPL 3-1	N.A.	N.A.	0334-2251-04	18	WHITE
32	SPL 1	A047J670	SPL 1-2	N.A.	N.A.	SPL 2	A047J670	SPL 2-1	N.A.	N.A.	0334-2251-04	18	WHITE
33	SPL 3	A047J670	SPL 3-2	N.A.	N.A.	SPL 4	A047J670	SPL 4-1	N.A.	N.A.	0334-2251-04	18	WHITE
34	HUMID	A000A089	HUMID-A	0323-1818	N.A.	SPL 4	A047J670	SPL 4-1	N.A.	N.A.	0334-2251-04	18	WHITE
35	HUMID	A000A089	HUMID-B	0323-1818	N.A.	SPL 2	A047J670	SPL 2-1	N.A.	N.A.	0334-2251-04	18	WHITE
36	HUMID	A000A089	HUMID-C	0323-1818	N.A.	SPL 7	A047J670	SPL 7-2	N.A.	N.A.	0334-2251-04	18	WHITE
37	HUMID	A000A089	HUMID-D	0323-1818	N.A.	SPL 11	A047J670	SPL 11-2	N.A.	N.A.	0334-2251-04	18	WHITE
38	ECM DIAG	A043M775	ECM DIAG-B	A043M777	N.A.	SPL 4	A047J670	SPL 4-2	N.A.	N.A.	0334-2251-04	18	WHITE
39	ECM DIAG	A043M775	ECM DIAG-T	A043M777	N.A.	SPL 2	A047J670	SPL 2-2	N.A.	N.A.	0334-2251-04	18	WHITE
40	ECM	A047W205	ECM-71	A047J914	N.A.	PWR	A043G960	PWR-7	A043U712	N.A.	0334-2251-04	18	WHITE
41	ECM	A047W205	ECM-45	A047J914	N.A.	PWR	A043G960	PWR-8	A043U712	N.A.	0334-2251-04	18	WHITE
42	SPL 4	A047J670	SPL 4-2	N.A.	N.A.	SIG	A043M727	SIG-4	A043U707	N.A.	0334-2251-04	18	WHITE
43	SPL 2	A047J670	SPL 2-2	N.A.	N.A.	SIG	A043M727	SIG-3	A043U707	N.A.	0334-2251-04	18	WHITE
44	ECM	A047W205	ECM-31	A047J914	N.A.	COIL 1	A047W019	COIL 1-C	0323-1818	N.A.	0334-2251-04	18	WHITE
45	ECM	A047W205	ECM-34	A047J914	N.A.	COIL 2	A047W019	COIL 2-C	0323-1818	N.A.	0334-2251-04	18	WHITE
46	ECM	A047W205	ECM-35	A047J914	N.A.	COIL 3	A047W019	COIL 3-C	0323-1818	N.A.	0334-2251-04	18	WHITE
47	ECM	A047W205	ECM-36	A047J914	N.A.	COIL 4	A047W019	COIL 4-C	0323-1818	N.A.	0334-2251-04	18	WHITE
48	ECM	A047W205	ECM-33	A047J914	N.A.	COIL 5	A047W019	COIL 5-C	0323-1818	N.A.	0334-2251-04	18	WHITE
49	ECM	A047W205	ECM-32	A047J914	N.A.	COIL 6	A047W019	COIL 6-C	0323-1818	N.A.	0334-2251-04	18	WHITE
50	ECM	A047W205	ECM-87	A048C184	N.A.	PROPANE LOCK	0332-1993	PROPANE LOCK	N.A.	N.A.	0334-2251-05	16	WHITE
51	SPL 16	A047J585	SPL 16-2	N.A.	N.A.	SPL 18	A047J670	SPL 18-1	N.A.	N.A.	0334-2251-05	16	WHITE
52	SPL 16	A047J585	SPL 16-2	N.A.	N.A.	SPL 19	A047J585	SPL 19-1	N.A.	N.A.	0334-2251-05	16	WHITE
53	SPL 16	A047J585	SPL 16-1	N.A.	N.A.	SPL 5	A047J585	SPL 5-1	N.A.	N.A.	0334-2251-05	16	WHITE
54	SPL 16	A047J585	SPL 16-1	N.A.	N.A.	THRTL	A043M532	THRTL-2	A043M535	0323-2330	0334-2251-04	18	WHITE
55	ECM	A047W205	ECM-83	A047J914	N.A.	THRTL	A043M532	THRTL-1	A043M535	0323-2330	0334-2251-04	18	WHITE
56	ECM	A047W205	ECM-82	A047J914	N.A.	THRTL	A043M532	THRTL-4	A043M535	0323-2330	0334-2251-04	18	WHITE
57	ECM	A047W205	ECM-6	A047J914	N.A.	THRTL	A043M532	THRTL-5	A043M535	0323-2330	0334-2251-04	18	WHITE
58	ECM	A047W205	ECM-5	A047J914	N.A.	THRTL	A043M532	THRTL-6	A043M535	0323-2330	0334-2251-04	18	WHITE
59	SPL 10	A047J585	SPL 10-1	N.A.	N.A.	THRTL	A043M532	THRTL-3	A043M535	0323-2330	0334-2251-04	18	WHITE
60	SPL 10	A047J585	SPL 10-1	N.A.	N.A.	ECM	A047W205	ECM-19	A048C184	N.A.	0334-2251-05	16	WHITE
61	SPL 15	A047J670	SPL 15-1	N.A.	N.A.	ECM	A047W205	ECM-81	A048C184	N.A.	0334-2251-05	16	WHITE
62	SPL 15	A047J670	SPL 15-1	N.A.	N.A.	DEPR	A026D787	DEPR-4	0332-4416	0323-2653	0334-2251-04	18	WHITE
63	SPL 1	A047J670	SPL 1-2	N.A.	N.A.	DEPR	A026D787	DEPR-2	0332-4416	0323-2653	0334-2251-04	18	WHITE
64	PWR	A043G960	PWR-10	A043U712	N.A.	DEPR	A026D787	DEPR-3	0332-4416	0323-2653	0334-2251-04	18	WHITE
65	SPL 3	A047J670	SPL 3-2	N.A.	N.A.	DEPR	A026D787	DEPR-5	0332-4416	0323-2653	0334-2251-04	18	WHITE
66	SPL 13	A047J585	SPL 13-2	N.A.	N.A.	DEPR	A026D787	DEPR-6	0332-4416	0323-2653	0334-2251-04	18	WHITE
67	SPL 13	A047J585	SPL 13-2	N.A.	N.A.	PWR	A043G960	PWR-9	A043U712	N.A.	0334-2251-06	14	WHITE
68	ECM	A047W205	ECM-60	A048C184	N.A.	SPL 13	A047J585	SPL 13-1	N.A.	N.A.	0334-2251-04	18	WHITE
69	ECM	A047W205	ECM-79	A048C184	N.A.	SPL 13	A047J585	SPL 13-1	N.A.	N.A.	0334-2251-05	16	WHITE
70	SPL 18	A047J670	SPL 18-2	N.A.	N.A.	COIL 1	A047W019	COIL 1-B	0323-1818	N.A.	0334-2251-04	18	WHITE
71	SPL 18	A047J670	SPL 18-2	N.A.	N.A.	COIL 3	A047W019	COIL 3-B	0323-1818	N.A.	0334-2251-04	18	WHITE
72	SPL 18	A047J670	SPL 18-2	N.A.	N.A.	COIL 5	A047W019	COIL 5-B	0323-1818	N.A.	0334-2251-04	18	WHITE
73	SPL 19	A047J585	SPL 19-2	N.A.	N.A.	COIL 2	A047W019	COIL 2-B	0323-1818	N.A.	0334-2251-04	18	WHITE
74	SPL 19	A047J585	SPL 19-2	N.A.	N.A.	COIL 4	A047W019	COIL 4-B	0323-1818	N.A.	0334-2251-04	18	WHITE
75	SPL 19	A047J585	SPL 19-2	N.A.	N.A.	COIL 6	A047W019	COIL 6-B	0323-1818	N.A.	0334-2251-04	18	WHITE
76	SPL 23	A047J585	SPL 23-2	N.A.	N.A.	COIL 1	A047W019	COIL 1-A	0323-1818	N.A.	0334-2251-05	16	WHITE
77	SPL 23	A047J585	SPL 23-2	N.A.	N.A.	COIL 3	A047W019	COIL 3-A	0323-1818	N.A.	0334-2251-05	16	WHITE
78	SPL 23	A047J585	SPL 23-2	N.A.	N.A.	COIL 5	A047W019	COIL 5-A	0323-1818	N.A.	0334-2251-05	16	WHITE
79	SPL 22	A047J585	SPL 22-2	N.A.	N.A.	COIL 2	A047W019	COIL 2-A	0323-1818	N.A.	0334-2251-05	16	WHITE
80	SPL 22	A047J585	SPL 22-2	N.A.	N.A.	COIL 4	A047W019	COIL 4-A	0323-1818	N.A.	0334-2251-05	16	WHITE
81	SPL 22	A047J585	SPL 22-2	N.A.	N.A.	COIL 6	A047W019	COIL 6-A	0323-1818	N.A.	0334-2251-05	16	WHITE
82	PWR	A043G960	PWR-11	A043U712	N.A.	SPL 25	A047J585	SPL 25-1	N.A.	N.A.	0334-2251-06	14	WHITE
83	SPL 20	A047J585	SPL 20-1	N.A.	N.A.	SPL 25	A047J585	SPL 25-2	N.A.	N.A.	0334-2251-05	16	WHITE
84	SPL 21	A047J585	SPL 21-1	N.A.	N.A.	SPL 25	A047J585	SPL 25-2	N.A.	N.A.	0334-2251-05	16	WHITE
85	SPL 17	A047J670	SPL 17-2	N.A.	N.A.	SPL 25	A047J585	SPL 25-2	N.A.	N.A.	0334-2251-05	16	WHITE
86	SPL 20	A047J585	SPL 20-2	N.A.	N.A.	COIL 1	A047W019	COIL 1-D	0323-1818	N.A.	0334-2251-05	16	WHITE
87	SPL 20	A047J585	SPL 20-2	N.A.	N.A.	COIL 3	A047W019	COIL 3-D	0323-1818	N.A.	0334-2251-05	16	WHITE
88	SPL 20	A047J585	SPL 20-2	N.A.	N.A.	COIL 5	A047W019	COIL 5-D	0323-1818	N.A.	0334-2251-05	16	WHITE
89	SPL 21	A047J585	SPL 21-2	N.A.	N.A.	COIL 2	A047W019	COIL 2-D	0323-1818	N.A.	0334-2251-05	16	WHITE
90	SPL 21	A047J585	SPL 21-2	N.A.	N.A.	COIL 4	A047W019	COIL 4-D	0323-1818	N.A.	0334-2251-05	16	WHITE
91	SPL 21	A047J585	SPL 21-2	N.A.	N.A.	COIL 6	A047W019	COIL 6-D	0323-1818	N.A.	0334-2251-05	16	WHITE
92	SPL 27	A047J670	SPL 27-1	N.A.	N.A.	ECM	A047W205	ECM-75	A047J914	N.A.	0334-2251-05	16	WHITE
93	SPL 27	A047J670	SPL 27-2	N.A.	N.A.	NAT GAS LOCK	0332-1993	NAT GAS LOCK	N.A.	N.A.	0334-2228-05	16	YELLOW
94	SPL 27	A047J670	SPL 27-2	N.A.	N.A.	PROPANE JUMPER	0332-2431	PROPANE JUMPER	N.A.	N.A.	0334-2251-05	16	WHITE
95	PWR	A043G960	PWR-12	A043U712	N.A.	SPL 26	A047J585	SPL 26-1	N.A.	N.A.	0334-2251-05	16	WHITE
96	NAT GAS B+	0332-1993	NAT GAS B+	N.A.	N.A.	SPL 26	A047J585	SPL 26-2	N.A.	N.A.	0334-2228-01	16	RED
97	PROPANE B+	0332-1993	PROPANE B+	N.A.	N.A.	SPL 26	A047J585	SPL 26-2	N.A.	N.A.	0334-2228-01	16	RED
98	FUEL VALVE B+	0332-1993	FUEL VALVE B+	N.A.	N.A.	SPL 26	A047J585	SPL 26-2	N.A.	N.A.	0334-2228-01	16	RED
99	SPL 28	A047J585	SPL 28-2	N.A.	N.A.	LCL	0323-1765	LCL-D	0323-1709	N.A.	0334-2251-04	18	WHITE
100	SPL 29	A047J585	SPL 29-2	N.A.	N.A.	LCL	0323-1765	LCL-C	0323-1709	N.A.	0334-2251-04	18	WHITE
101	SPL 30	A047J585	SPL 30-2	N.A.	N.A.	LCL	0323-1765	LCL-B	0323-1709	N.A.	0334-2251-04	18	WHITE
102	SPL 23	A047J585	SPL 23-1	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-06	14	WHITE
103	SPL 22	A047J585	SPL 22-1	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-05	16	WHITE
104	ECM	A047W205	ECM-69	A048C184	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-05	16	WHITE
105	SPL 15	A047J670	SPL 15-2	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-05	16	WHITE
106	FUEL SW	0332-1992	FUEL SW COM	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-04	18	WHITE
107	FUEL SW	0332-1992	FUEL SW N.O.	N.A.	N.A.	SIG	A043M727	SIG-7	A043U707	N.A.	0334-2251-04	18	WHITE
108	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	PWR	A043G960	PWR-1	A050F507	N.A.	0334-2251-07	12	WHITE
109	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	PWR	A043G960	PWR-2	A043U712	N.A.	0334-2251-05	16	WHITE
110	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	PWR	A043G960	PWR-3	A050F507	N.A.	0334-2251-07	12	WHITE
111	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	PWR	A043G960	PWR-4	A043U712	N.A.	0334-2251-05	16	WHITE
112	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	PWR	A043G960	PWR-13	A043U712	N.A.	0334-2251-05	16	WHITE
113	STARTER B+	0332-0401	STARTER B+	N.A.	N.A.	ALT B+	0332-1302	ALT B+	N.A.	N.A.	0334-0762	8	WHITE
114	STARTER SW	0332-0807	STARTER SW	N.A.	N.A.	PWR	A043G960	PWR-6	A043U712	N.A.	0334-2251-06	14	WHITE
115	BATT ALT GND	0332-2748	BATT ALT GND	N.A.	N.A.	STARTER GND 2	A047T063	STARTER GND 2	N.A.	N.A.	0334-0762	8	WHITE
116	PWR	A043G960	PWR-5	A050F507	N.A.	STARTER GND 2	A047T063	STARTER GND 2	N.A.	N.A.	0334-2251-07	12	WHITE
117	FUEL VALVE	0332-1993	FUEL VALVE GND	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2228-02	16	ORANGE
118	SPL 28	A047J585	SPL 28-1	N.A.	N.A.	SIG	A043M727	SIG-5	A043U707	N.A.	0334-2251-04	18	WHITE
119	SPL 29	A047J585	SPL 29-1	N.A.	N.A.	SIG	A043M727	SIG-6	A043U707	N.A.	0334-2251-04	18	WHITE
120	SPL 30	A047J585	SPL 30-1	N.A.	N.A.	STARTER GND 1	0332-0791	STARTER GND 1	N.A.	N.A.	0334-2251-04	18	WHITE
121	SPL 28	A047J585	SPL 28-2	N.A.	N.A.	NEW LCL	0323-1493	NEW LCL-C	0323-1492	N.A.	0334-2251-04	18	WHITE
122	SPL 29	A047J585	SPL 29-2	N.A.	N.A.	NEW LCL	0323-1493	NEW LCL-A	0323-1492	N.A.	0334-2251-04	18	WHITE
123	SPL 30	A047J585	SPL 30-2	N.A.	N.A.	NEW LCL	0323-1493	NEW LCL-B	0323-1492	N.A.	0334-2251-04	18	WHITE

NOTES:

1. TOLERANCES: UP TO 500 ±15
   500 TO 1000 ±30
   1000 TO LONGER ±40

2. ALL LEADS/WIRES SHALL BE MARKED AT MAXIMUM OF 76 mm BEHIND THE CONNECTOR AND EVERY 30 MM. WITH BOTH STATION NUMBERS LISTED IN THE "FROM-TO" TABULATION. MARKING SHALL BE PERMANENT AND LEGIBLE. WIRE MARKINGS NEED TO HAVE FULL VISUAL ACCESS, END MARKINGS ARE NOT TO BE VISUALLY OBSCURED AND MUST BE FULLY DISPLAYED. TO/FROM DESIGNATIONS ARE NOT TO BE FRAGMENTED. DESIGNATOR SHALL APPEAR IN FULL TEXT AND NOT IN BROKEN SEGMENTS.

3. USE CABLE TIES (0332-3388) AS REQUIRED TO SECURE WIRES.

4. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER CATEGORY (ZPFW2). PACKAGING OF PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.

5. COVER ALL UNINSULATED FASTOMS, SPLICES, RING TERMINALS & RESISTORS WITH HEAT SHRINK (0898-1337-03)

6. IF THE VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.

7. USE TESA 51026 CLOTH WIRE HARNESS TAPE OR EQUIVALENT CLOTH TAPE TO COVER THE HARNESS.

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 IN THE FORMAT OF MONTH, DATE, LAST 2 YEAR DIGITS. LABEL MUST BE MADE FROM UL RECOGNIZED VINYL SELF LAMINATION LABEL SYSTEM.

1 TWISTED WIRE PAIRS SHOULD HAVE MINIMUM OF 5 TWIST PER 300 MM.

10 COIL UP & TIE WRAP THE SLEEVING TO THE MAIN BRANCH TO ALLOW SLEEVING TO BE REPOSITIONED DURING GENSET INSTALLATION.

11. INK FOR HARNESS MARKING, MUST RESIST ERASER ABRASION TEST, ANTIFREEZE, MOTOR OIL, TRANSMISSION FLUID, GASOLINE, DIESEL FUEL & BRAKE FLUID.

12. MANUFACTURE TO IPC/WHMA-A-620B WORKMANSHIP STANDARD FOR A CLASS 2 DEVICE.

13. POINT TO POINT CONTINUITY TEST MUST BE PERFORMED ON THIS HARNESS ASSEMBLY.

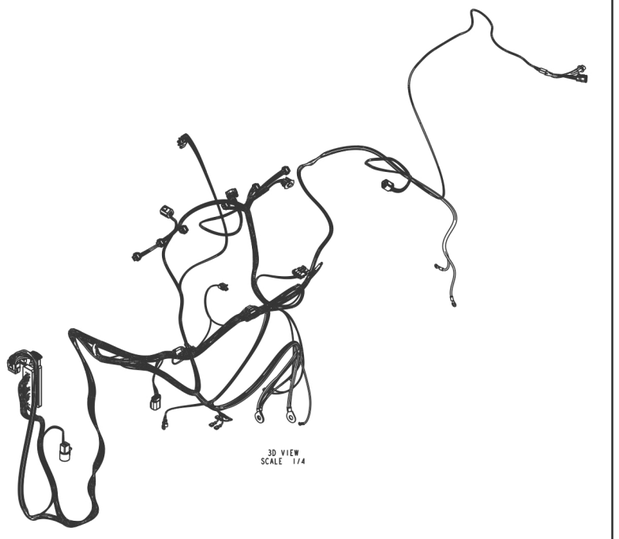
4 CONNECT "PROPANE LOCK" RECEPTACLE ONTO THE OPEN "PROPANE JUMPER" FASTON.

15. NOTE REMOVED.

8 ATTACH A LABEL WITH UL MARK (UL SYMBOL AND OTHER UL REQUIRED INFORMATION) IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY THE SUPPLIER'S UL PROGRAM.

1 ACCEPTABLE TO USE LABEL FOR WIRE MARKING IN PLACE OF NOTE 2.

9 LOCATION OF SPLICES ARE FOR REFERENCES ONLY. STAGGER THE SPLICES TO PREVENT BULGES IN THE HARNESS AND TO PREVENT ELECTRICAL SHORTING.



CUMMINS POWER GENERATION
SIZE CODE
PGF
HARNESS,ENGINE
A054B187
SHEET 1 OF 3

FIGURE 109. HARNESS, GENERATOR SET ELECTRICAL (SHEET 1 OF 3)

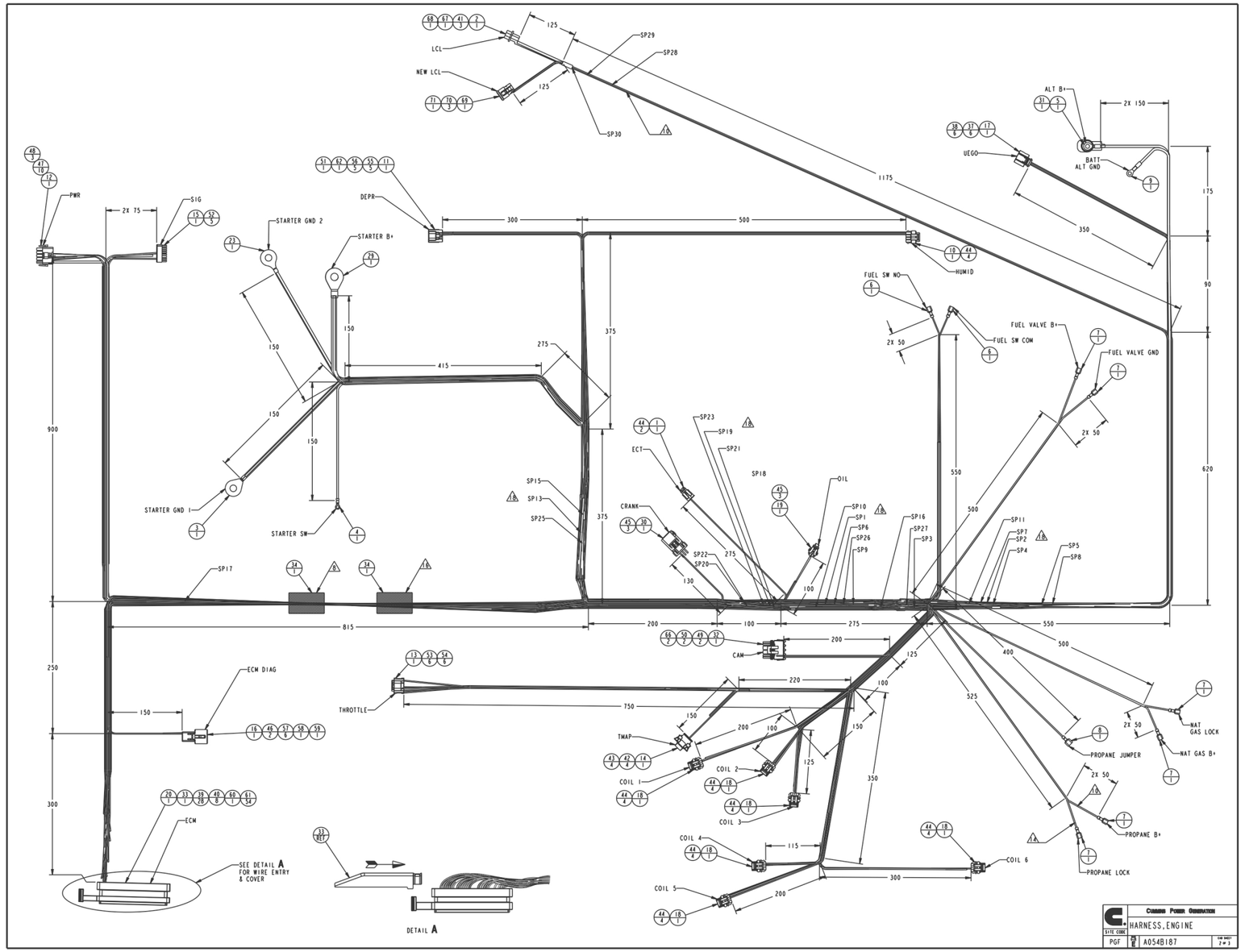


FIGURE 110. HARNESS, GENERATOR SET ELECTRICAL (SHEET 2 OF 3)

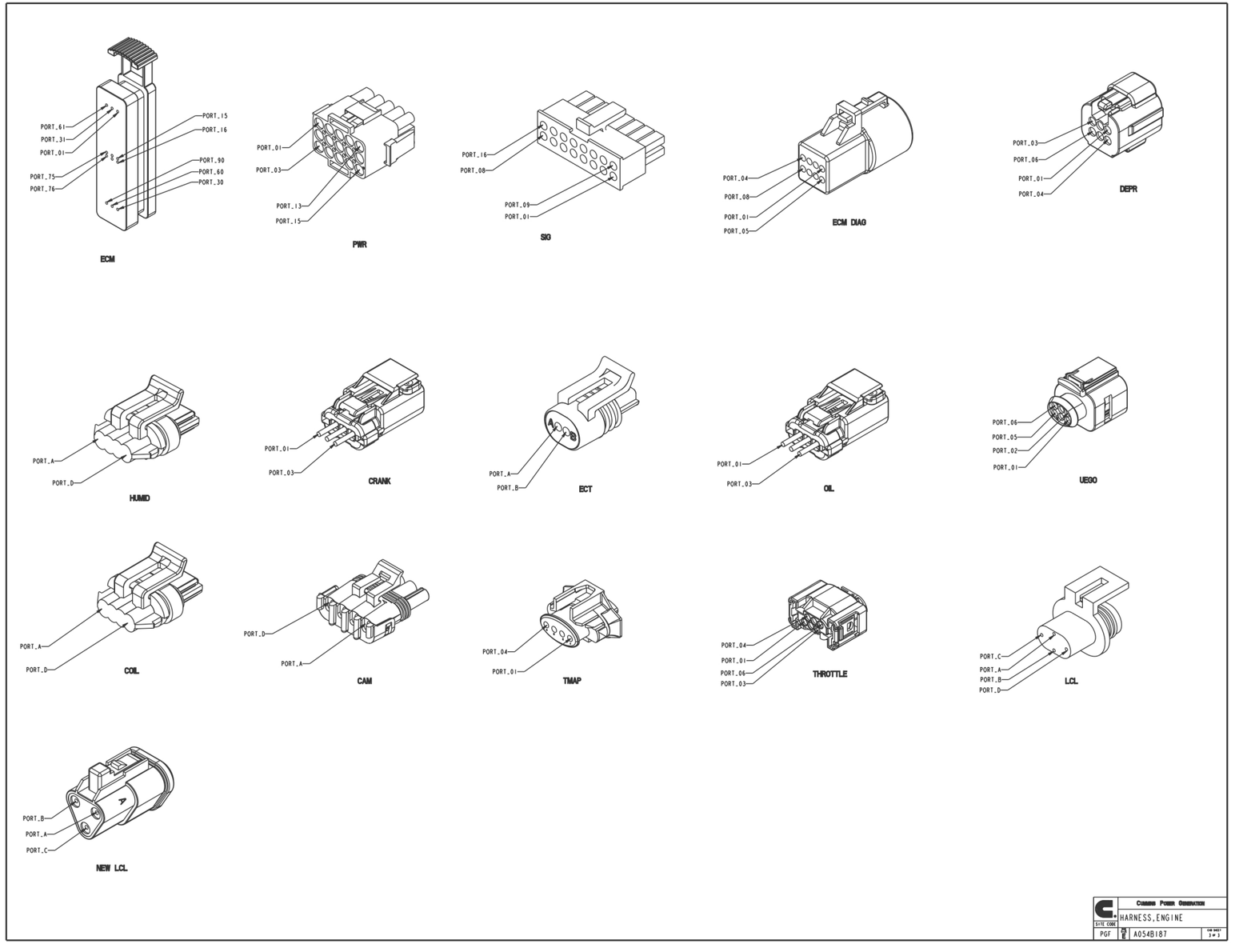


FIGURE 111. HARNESS, GENERATOR SET ELECTRICAL (SHEET 3 OF 3)

WIRE FROM / TO TABLE

LEAD NO	FROM STATION	FROM CPG P/N	TO STATION	TO CPG P/N	WIRE WIRE SIZE	WIRE COLOR	CPG P/N
101	PWR 1	A050S773	FUSE F1-1	0332-1995	12	WHITE	0334-0760
102	SPLICE 31-1	0332-3638	FUSE F1-2	0332-1995	12	WHITE	0334-0760
103			P20-9	0323-2466	18	WHITE	0334-0757
104	SPLICE 31-2	0332-3638	P20-10	0323-2466	18	WHITE	0334-0757
105			P20-20	0323-2466	18	WHITE	0334-0757
106			P20-21	0323-2466	18	WHITE	0334-0757
107	PWR 2	A043U187	FUSE F2-1	0332-1993	16	WHITE	0334-0758
108	SPLICE 33-1	0332-3638	FUSE F2-2	0332-1993	16	WHITE	0334-0758
109			K3-1	0332-1993	16	WHITE	0334-0758
110	SPLICE 33-2	0332-3638	SIG 6	A043H311	18	WHITE	0334-0757
111			SPLICE 41-1	0332-3638	18	WHITE	0334-0757
113			K2-1	0332-1993	16	WHITE	0334-0758
114	PWR 3	A050S773	SPLICE 30-1	0332-3638	12	WHITE	0334-0760
115	FUSE F3-1	0332-1995	SPLICE 30-2	0332-3638	12	WHITE	0334-0760
116	SPLICE 34-1	0332-3638				WHITE	0334-0760
117	SPLICE 34-2	0332-3638	FUSE F4-1	0332-1993	16	WHITE	0334-0758
118			FUSE F5-1	0332-1995	12	WHITE	0334-0760
119	FUSE F3-2	0332-1995	PWR 9	A043U187	14	WHITE	0334-0759
120	FUSE F4-2	0332-1993	K1-1	0332-1993	16	WHITE	0334-0758
121	FUSE F5-2	0332-1995	K1-3	0332-1995	12	WHITE	0334-0760
122	PWR 5	A043U187	SPLICE 32-1	0332-3638	16	WHITE	0334-0758
123	P20-1	0323-2466			18	WHITE	0334-0757
124	P20-2	0323-2466			18	WHITE	0334-0757
125	P20-4	0323-2466	SPLICE 32-2	0332-3638	18	WHITE	0334-0757
126	P20-7	0323-2466			18	WHITE	0334-0757
127	P20-12	0323-2466			18	WHITE	0334-0757
128	PWR 6	A050S773	K4-4	0332-1995	12	WHITE	0334-0760
129	PWR 10	A043U187	K1-2	0332-1993	16	WHITE	0334-0758
130	PWR 11	A050S773	K1-4	0332-1995	12	WHITE	0334-0760
131	PWR 12	A043U187	K2-2	0332-4041	16	WHITE	0334-0758
132	PWR 7	A043U187	K1-5	0332-1993	16	WHITE	0334-0758
133	PWR 8	A043U187	K3-4	0332-1993	16	WHITE	0334-0758
134	SIG 5	A043H311	P20-17	0323-2466	18	WHITE	0334-0757
135	SIG 7	A043H311	P20-18	0323-2466	18	WHITE	0334-0757
136	K2-5	0332-1992	P20-3	0323-2466	18	WHITE	0334-0757
137	K4-5	0332-1992	P20-15	0323-2466	18	WHITE	0334-0757
138	PWR 4	A043U187	K4-1	0332-1993	16	WHITE	0334-0758
139	K3-5	0332-1992	P11-21	0323-2466	18	WHITE	0334-0757
140	K4-6	0332-4041	P20-13	0323-2466	18	WHITE	0334-0757
141			K1-6	0332-4041	18	WHITE	0334-0757
142	K2-6	0332-1992			18	WHITE	0334-0757
143	SIG 1	A043H311	CR1-C	0332-1993	16	WHITE	0334-0758
144	CR1-A	0332-1993	K2-2	0332-4041	16	WHITE	0334-0758
145	SIG 2	A043H311	CAN SHIELD	-	18	-	0334-1354
146	CAN SHIELD	-	P11-17	0323-2466	18	-	0334-1354
147	SIG 3	A043H311	SPLICE 35-1	0332-3638	18	WHITE	0334-1354
148	R1-1	0351-1596-59			--	--	-
149	SIG 4	A043H311	SPLICE 36-1	0332-3638	18	BLACK	0334-1354
150	R1-2	0351-1596-59			-		
151	SPLICE 35-2	0332-3638	P11-20	0323-2466	18	WHITE	0334-1354
152	SPLICE 36-2	0332-3638	P11-19	0323-2466	18	BLACK	0334-1354
153	K3-6	0332-1992	PE-1	0323-2332	18	WHITE	0334-0757
154	P11-22	0323-2466	JE-1	A040M659	18	WHITE	0334-0757
155	P25-2	0323-2466	PE-2	0323-2332	18	WHITE	0334-0757
156	P25-6	0323-2466	JE-2	A040M659	18	WHITE	0334-0757
157	TB15-1	0332-3491-01	P3-1	A040B973	18	WHITE	0334-0757
158	TB15-3	0332-3491-01	P3-3	A040B973	18	WHITE	0334-0757
159	TB15-4	0332-3491-01	P3-4	A040B973	18	WHITE	0334-0757
160	TB15-5	0332-3491-01	P3-5	A040B973	18	WHITE	0334-0757
161	P25-4	0323-2466	SPLICE 37-1	0332-3638	20	WHITE	0334-0756
162	OP P1-1	0323-2466	SPLICE 37-2	0332-3638	20	WHITE	0334-0756
163	BG P1-3	0332-3491-01			20	WHITE	0334-0756
164	P25-3	0323-2466	SPLICE 38-1	0332-3638	20	WHITE	0334-0756
165	OP P1-2	0323-2466	SPLICE 38-2	0332-3638	20	WHITE	0334-0756
166	BG P1-4	0332-3491-01			20	WHITE	0334-0756
167	P25-5	0323-2466	SPLICE 39-1	0332-3638	20	WHITE	0334-0756
168	OP P1-4	0323-2466	SPLICE 39-2	0332-3638	20	WHITE	0334-0756
169	BG P1-5	0332-3491-01			20	WHITE	0334-0756
170	P25-8	0323-2466	SPLICE 40-1	0332-3638	20	WHITE	0334-0756
171	OP P1-5	0323-2466	SPLICE 40-2	0332-3638	20	WHITE	0334-0756
172	BG P6-2	0332-3491-01			20	WHITE	0334-0756
173	P25-10	0323-2466	OP P1-6	0323-2466	20	WHITE	0334-0756
174	P25-11	0323-2466	OP P1-7	0323-2466	20	WHITE	0334-0756
175	P25-12	0323-2466	BG P6-1	0332-3491-01	20	WHITE	0334-0756
176	P18-1	0323-2332	F7-1	0332-1993	16	WHITE	0334-0758
177	F7-2	0332-1993	AC-P-2	A043L492	16	WHITE	0334-0758
178	P18-2	0323-2332	F8-1	0332-1993	16	WHITE	0334-0758
179	F8-2	0332-1993	AC-P-3	A043L492	16	WHITE	0334-0758
180	TB1-1	0332-3491-01	PCC-TB1-10	0332-3491-01	18	WHITE	0334-0757
181	TB5-1	0332-3491-01	PCC-TB1-11	0332-3491-01	18	WHITE	0334-0757
182	TB2-1	0332-3491-01	PCC-TB1-12	0332-3491-01	18	WHITE	0334-0757
183	TB7-1	0332-3491-01	PCC-TB1-7	0332-3491-01	18	WHITE	0334-0757
184	PCC-TB1-15	0332-3491-01	PCC-TB1-16	0332-3491-01	18	WHITE	0334-0757
185	TB6-1	0332-3491-01	PCC-TB1-6	0332-3491-01	18	WHITE	0334-0757
186	TB8-1	0332-3491-01	PCC-TB1-5	0332-3491-01	18	WHITE	0334-0757
187	TB4-1	0332-3491-01	PCC-TB1-14	0332-3491-01	18	WHITE	0334-0757
188	TB3-1	0332-3491-01	PCC-TB1-13	0332-3491-01	18	WHITE	0334-0757
189	TB9-1	0332-3491-01	PCC-TB1-4	0332-3491-01	18	WHITE	0334-0757
190	PWR 13	A043U187	FUSE F6-1	0332-1993	16	WHITE	0334-0758
191	FUSE F6-2	0332-1993	K2-3	0332-1993	16	WHITE	0334-0758
192	TB10-1	0332-3491-01	K2-4	0332-1993	16	WHITE	0334-0758
193	P11-11	0323-2466	TEMP-A	0323-1818	18	WHITE	0334-0757
194	P11-12	0323-2466	TEMP-B	0323-1818	18	WHITE	0334-0757
195	SPLICE 41-2	0332-3638	OP P1-3	0323-2466	20	WHITE	0334-0756
196			J40-2	0323-1859	18	WHITE	0334-0757
197	PL-1	0332-2430	J40-1	0323-1859	18	WHITE	0334-0757
198	P18-3	0323-2332	AC-P-4	A043L492	16	WHITE	0334-0758

NOTES:

1. TOLERANCES: UP TO 500 +15/-5.
   500 TO 1000 +30/-10.
   1000 TO LONGER +40/-20.

2. ALL LEADS/WIRES SHALL BE MARKED AT MAXIMUM OF 76 mm BEHIND THE CONNECTOR AND AT EVERY 30 mm INTERVAL WITH BOTH STATION NUMBERS LISTED IN THE "FROM-TO" TABULATION.
   MARKING SHALL BE PERMANENT AND LEGIBLE. WIRE MARKINGS NEED TO HAVE FULL VISUAL ACCESS.END MARKINGS ARE NOT TO BE VISUALLY OBSCURED AND MUST BE FULLY DISPLAYED.
   TO/FROM DESIGNATIONS ARE NOT TO BE FRAGMENTED. DESIGNATOR SHALL APPEAR IN FULL TEXT AND NOT IN BROKEN SEGMENTS.

3. USE CABLE TIES (0332-3388) AT EVERY 200 mm AS NECESSARY TO SECURE WIRES.EXCEPT IN THOSE CABLE TIES EXPLICITLY DIMENSIONED IN THE DRAWING.

4 FOLD BACK SHIELD WIRE (0334-1354) AND SECURE TO CABLE WITH ELECTRICAL TAPE (0895-0030).

5. HARNESS MUST BE PROCURED FROM A SUPPLIER QUALIFIED AS A UL RECOGNIZED HARNESS MANUFACTURER CATEGORY (ZPFW2). PACKAGING OF PARTS TO BE MARKED IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY SUPPLIERS UL PROGRAM.

6 STAGGER THE SPLICES, RESISTORS & DIODE, COVER WITH HEAT SHRINK (0898-1337-03). PLACE THE SPLICES INLINE WITH BUNDLE.

⚠ LABEL MUST BE MADE FROM UL RECOGNIZED VINYL SELF LAMINATION LABEL SYSTEM.
MARK FUSES ABOVE THE FUSE HOLDERS ON THE BRACKET F1:20A, F2:10A, F3:20A ,F4:5A, F5:20A, F6:10A, F7:10A, F8:10A
MARK RELAYS TOP-CENTER K1,K2,K3 & K4 (DO NOT COVER TECHNICAL INFORMATION OF THE RELAY)

8. IF THE VALUE OF 0 (ZERO) IS USED IN THE BILL OF MATERIAL, THE QUANITY OF THE AFFECTED ITEMS SHALL BE DERIVED FROM THE DRAWING REQUIREMENTS.

9. SLEEVING MATERIAL SHOULD BE UL 94-V2 RATED & WITHSTAND UP TO -40°C TO 125°C OPERATING TEMPERATURE, CONTINUOUS USE 105°C.
   COLOR BLACK.

⚠ PLUG PE CONNECTOR IN TO JE CONNECTOR .

11 SHIPPING METHOD: BUNDLE THE WIRE WITH WIRE TIE (0332-3388).

12. INK FOR HARNESS MARKING,MUST RESIST ERASER ABRASION TEST,ANTIFREEZE,MOTOR OIL, TRANSMISSION FLUID,GASOLINE,DIESEL FUEL & BRAKE FLUID

⚠ SCREW TORQUE: 0.6-0.8 Nm.

14. CABLE AND HARNESS WORKMANSHIP SHALL COMPLY WITH IPC/WHMA-A-620 CLASS II REQUIREMENTS AND ACCEPTANCE FOR CABLE AND WIRE HARNESS ASSEMBLIES MOST CURRENT REVISION.

15. POINT TO POINT CONTINUITY TEST MUST BE PERFORMED ON THIS HARNESS ASSEMBLY.

⚠ 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 IN THE FORMAT OF MONTH, DATE, LAST 2 YEAR DIGITS.

⚠ PLACE INDIVIDUAL LABEL WITH FOLLOWING DETAIL

TB1 : "GROUND".

TB2 : "INPUT 1".

TB3 : "INPUTS RETURN".

TB4 : "INPUT 2".

TB5 : "REMOTE START".

TB6 : "OUTPUT 1 COM".

TB7 : "OUTPUT 1 N.O.".

TB8 : "FUSE B+ (3A)".

TB9 : "READY TO LOAD".

TB10: "SW B+ (10A)"

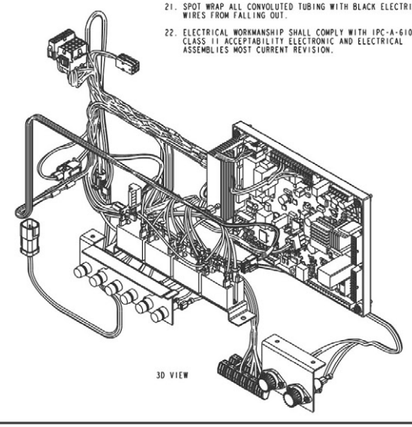
⚠ ATTACH A LABEL WITH UL MARK (UL SYMBOL AND OTHER UL REQUIRED INFORMATION) IN ACCORDANCE WITH REQUIREMENTS SPECIFIED BY THE SUPPLIER'S UL PROGRAM.

⚠ TORQUE TO 2.5-3.3 Nm.

20. CONVOLUTED TUBING ENDS SHALL BE WRAPPED WITH A MINIMUM OF 2 LAYERS OF BLACK ELECTRICAL TAPE, 0895-0030.

21. SPOT WRAP ALL CONVOLUTED TUBING WITH BLACK ELECTRICAL TAPE, 0895-0030 TO PREVENT WIRES FROM FALLING OUT.

22. ELECTRICAL WORKMANSHIP SHALL COMPLY WITH IPC-A-610A CLASS II ACCEPTABILITY ELECTRONIC AND ELECTRICAL ASSEMBLIES MOST CURRENT REVISION.



3D VIEW

QTY	ITEM NO	PLN_NOUN_NAME	
1	63	0332-2430	TERMINAL-RECEPTICAL
2	62	0323-1859	SOCKET-CONTACT
1	61	A049L078	HOUSING,RECEPTACLE
2	60	A040C612	SEAL,CONNECTOR
2	59	0323-1818	TERMINAL,SOCKET
1	58	0323-1755	CONNECTOR,SOCKET
2	57	0321_0372_05	FUSE,CARTRIDGE
12	56	0823_0002_04	SCREW,PAN HEAD TORX
4	55	A050S773	CONTACT,SOCKET
1	54	0257.0030	RECTIFIER,SILICON
1	53	A047U782	PLATE,MOUNTING
1	52	A047W483	PLATE,MOUNTING
1	51	A047G561	PANEL,RELAY
1	50	0323_1670_15	CONNECTOR,PLUG
7	49	A034P713	CONNECTOR,TERMINAL BLOCK
3	48	A034P436	CONNECTOR,TERMINAL BLOCK
1	47	0323_1626	WEDGE,RECEPTACLE
0	46	0334_0759	WIRE
0	45	0334_0756	WIRE
0	44	0334_0757	WIRE
0	43	0334_0758	WIRE
0	42	0334_0760	WIRE
2	41	A042Z472	FUSE,CARTRIDGE
2	40	A042Z462	HOLDER,FUSE
2	39	0307_2960_01	RELAY,POWER
2	38	0307_2960_03	RELAY,POWER
3	37	0321_0372_07	FUSE,CARTRIDGE
1	36	0321_0372_03	FUSE,CARTRIDGE
6	35	0321_0175	HOLDER,FUSE
11	34	A029W642	LABEL
1	33	A046S942	CAP
0	32	0898_1193_02	SLEEVING-CONVOLUTED
0	31	0898_1337_03	HEATSHRINK (SLEEVING W/ADHESIVE)
0	30	0895_0030	TAPE,FRICTION
0	29	0334_1354	CABLE,SHIELDED
0	28	0332_3388	TIE,CABLE
4	27	0323_2332	CONTACT,SOCKET
2	26	A040M659	CONTACT,PIN
9	25	A043U187	CONTACT,SOCKET
7	24	A043H311	TERMINAL,CRIMP
30	23	A0062863	TERMINAL,PIN
33	22	A001K345	TERMINAL,PIN
4	21	A040B973	TERMINAL,ELECTRICAL
2	20	A043L492	PIN,CONTACT
1	19	0323_2058	CONNECTOR,PLUG
1	18	0323_2237	CONNECTOR (2 PINS)
1	17	0323_1670_01	CONNECTOR-PLUG (3
1	16	0323_2011	CIRCUIT_BREAKER (15-AMPS-BLACK)
1	15	A044R291	CONNECTOR,RECEPTACLE (6 POSITION)
1	14	A042R319	HOUSING,RECEPTACLE
1	13	A043K864	CONNECTOR,HEADER
1	12	A043T411	CONNECTOR,HEADER
1	11	0323_2444	CONNECTOR,PLUG
1	10	0351_1596_59	RESISTOR-METAL OXIDE
12	9	0332_3638	SPLICE-BUTT (810-12_AWG)
5	8	0332_1992	TERMINAL-RECEPTICAL (.25)
9	7	0332_1995	TERMINAL-RECEPTICAL (.25)
21	6	0332_1993	TERMINAL-RECEPTICAL (.25)
2	5	0323_2197_04	CIRCUIT_BREAKER (15-AMPS-BLACK)
1	4	0323_2161	
1	3	0323_2445	CONNECTOR,PLUG
1	2	0323_2446	CONNECTOR,PLUG
3	1	0332_4041	TERMINAL,RECEPTACLE (.250 FEMALE FASTON)

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HARNESS,GENERATOR ELECTRICAL

PGF A053S093 SHT 1 of 4 REV C

FIGURE 112. CONTROL BOX HARNESS DIAGRAM (SHEET 1 OF 4)

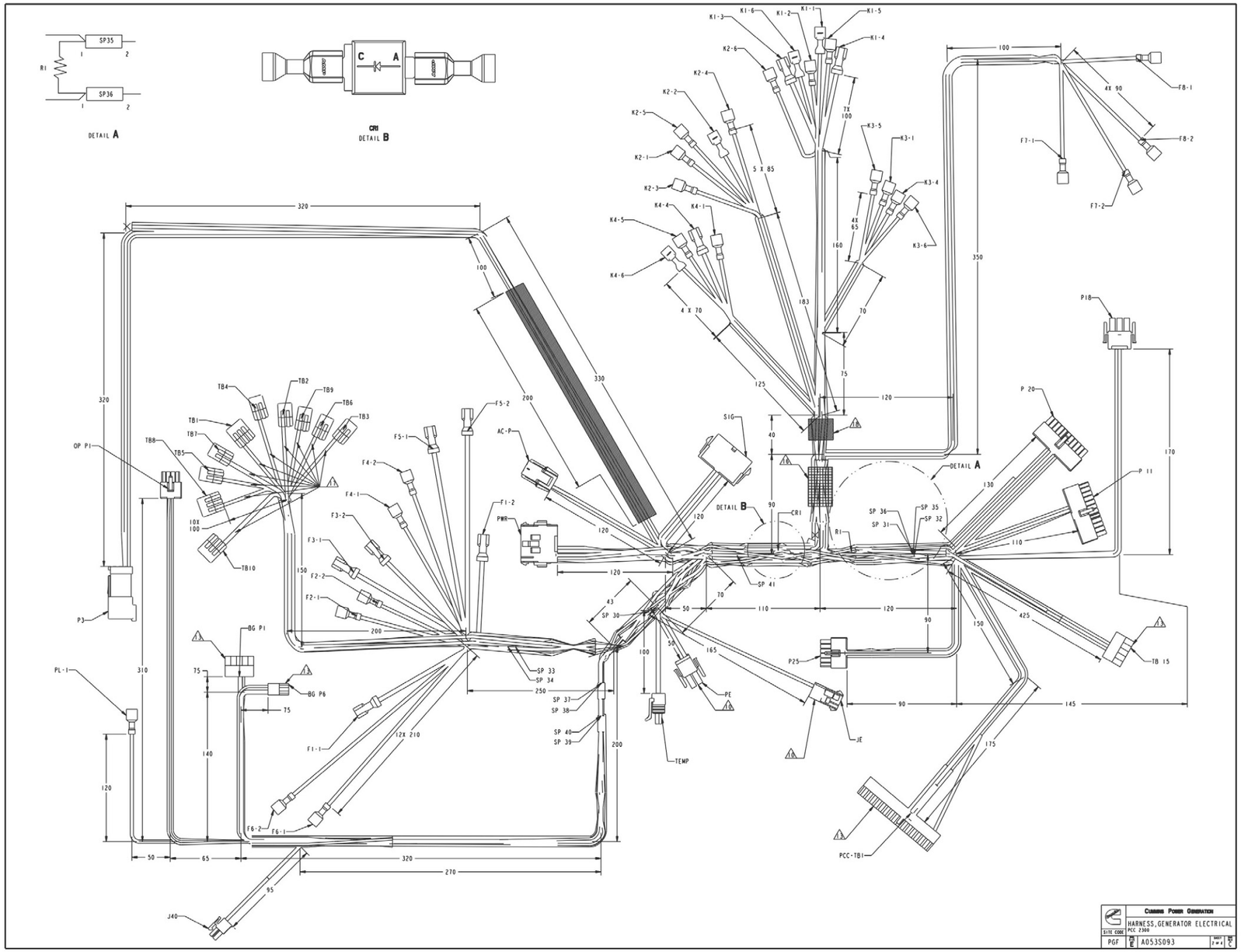

FIGURE 113. CONTROL BOX HARNESS DIAGRAM (SHEET 2 OF 4)

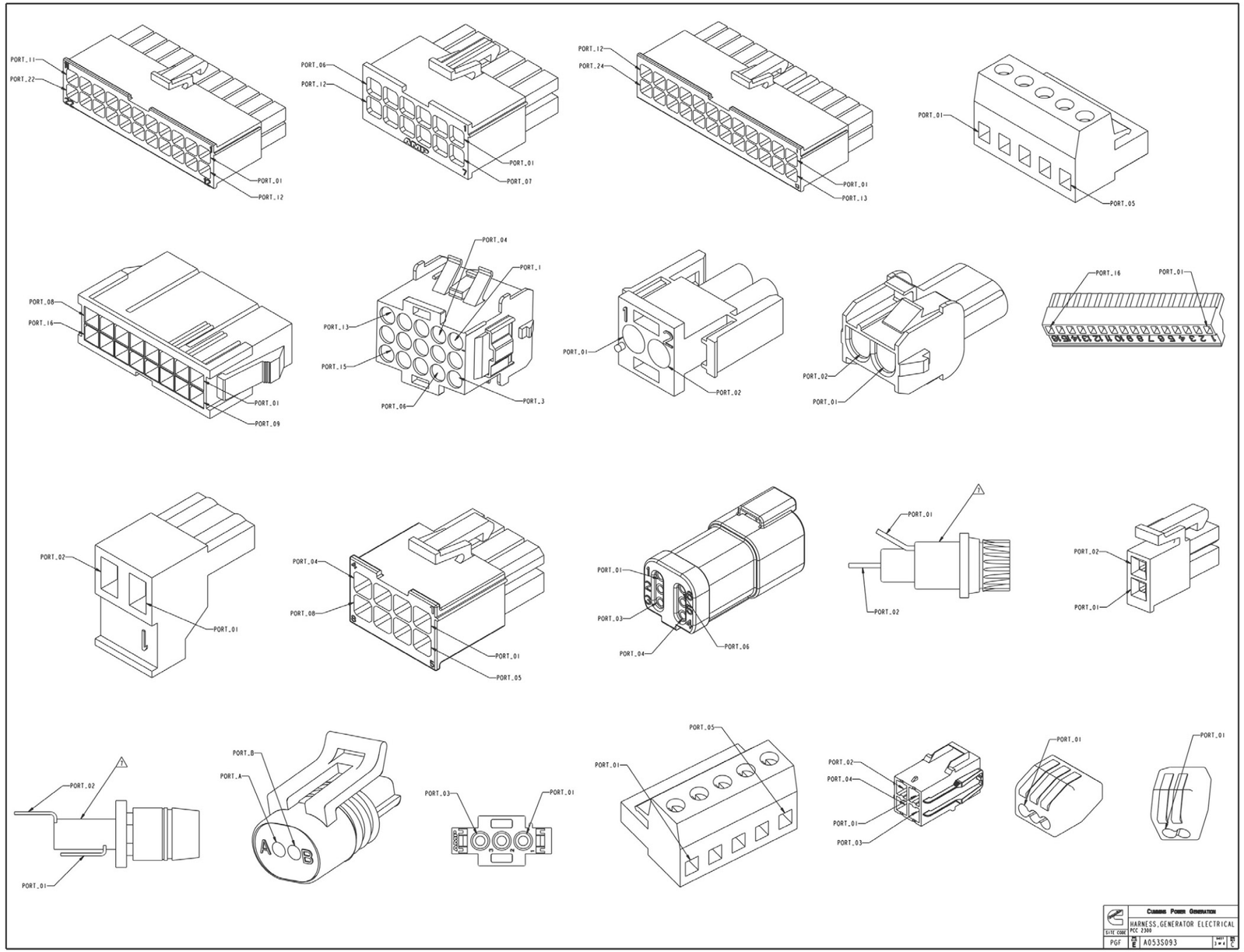

FIGURE 114. CONTROL BOX HARNESS DIAGRAM (SHEET 3 OF 4)

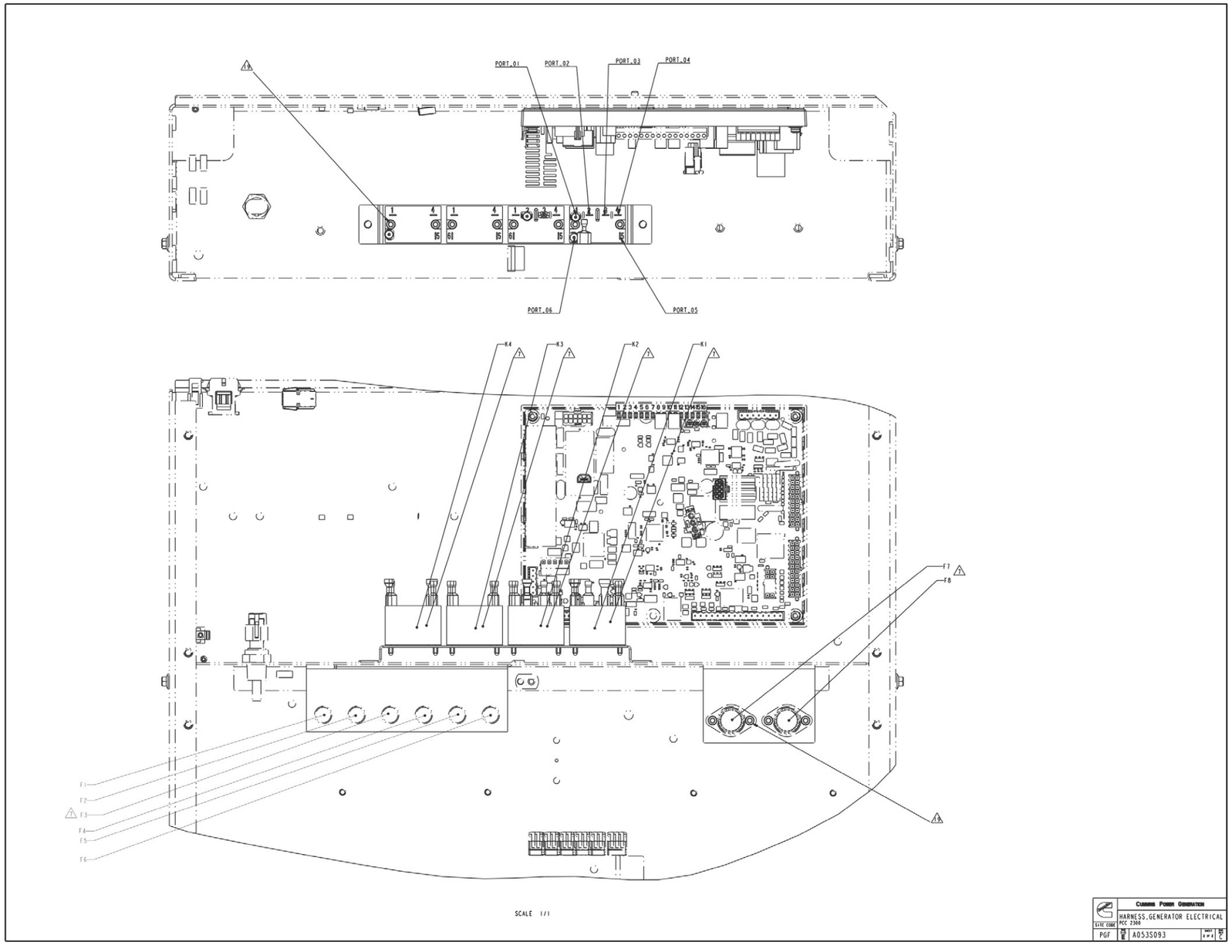

FIGURE 115. CONTROL BOX HARNESS DIAGRAM (SHEET 4 OF 4)

Appendix B. Alternator Reconnect Drawing

Table of Contents

B.0 A048V210 Reconnect Drawing for UC Alternator (One Circuit Breaker)

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

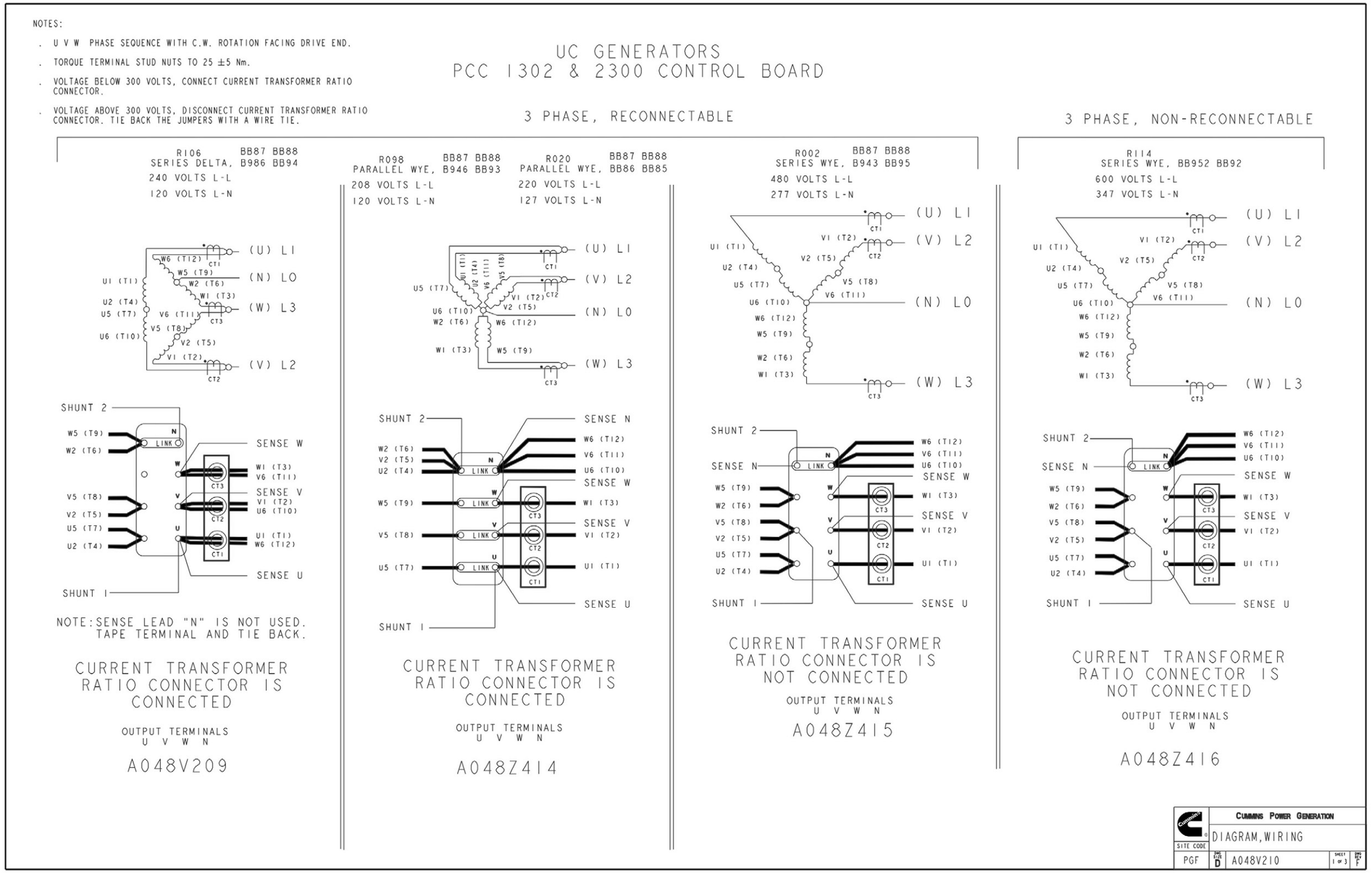

FIGURE 116. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 1 OF 3)

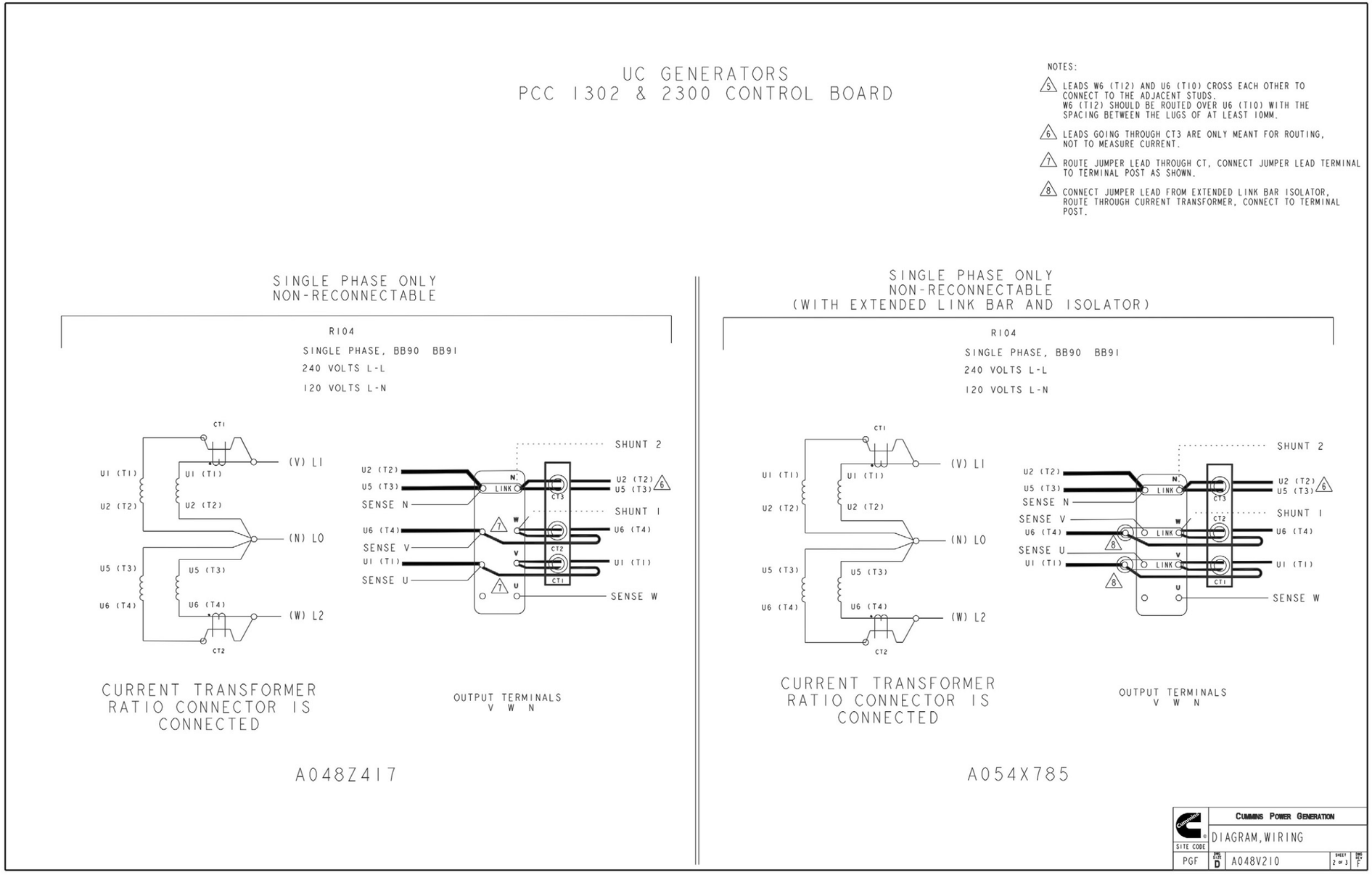

FIGURE 117. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 2 OF 3)

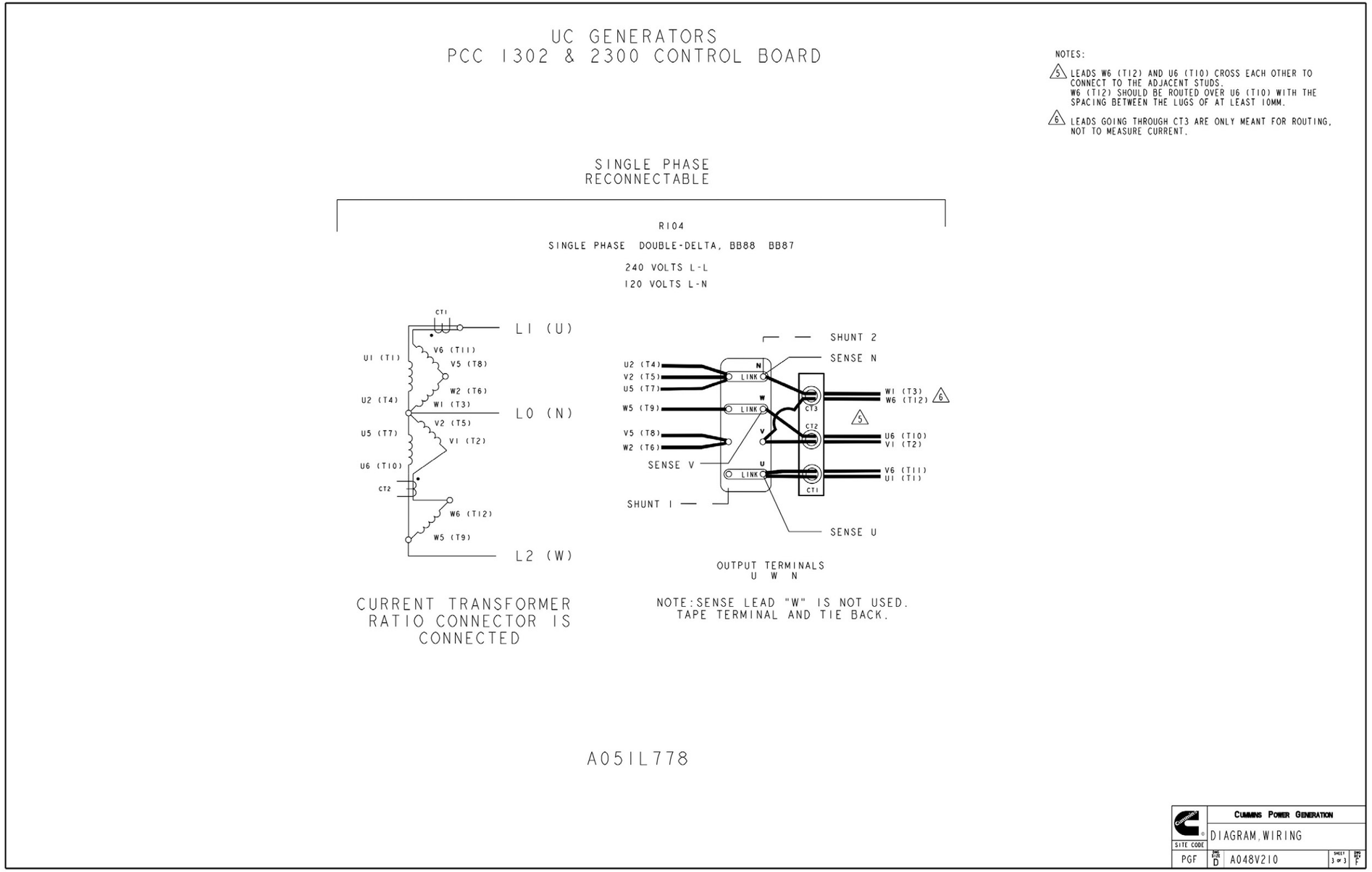

FIGURE 118. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 3 OF 3)

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B.1 A056G740 Reconnect Drawing for UC Alternator (Three Circuit Breakers)

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

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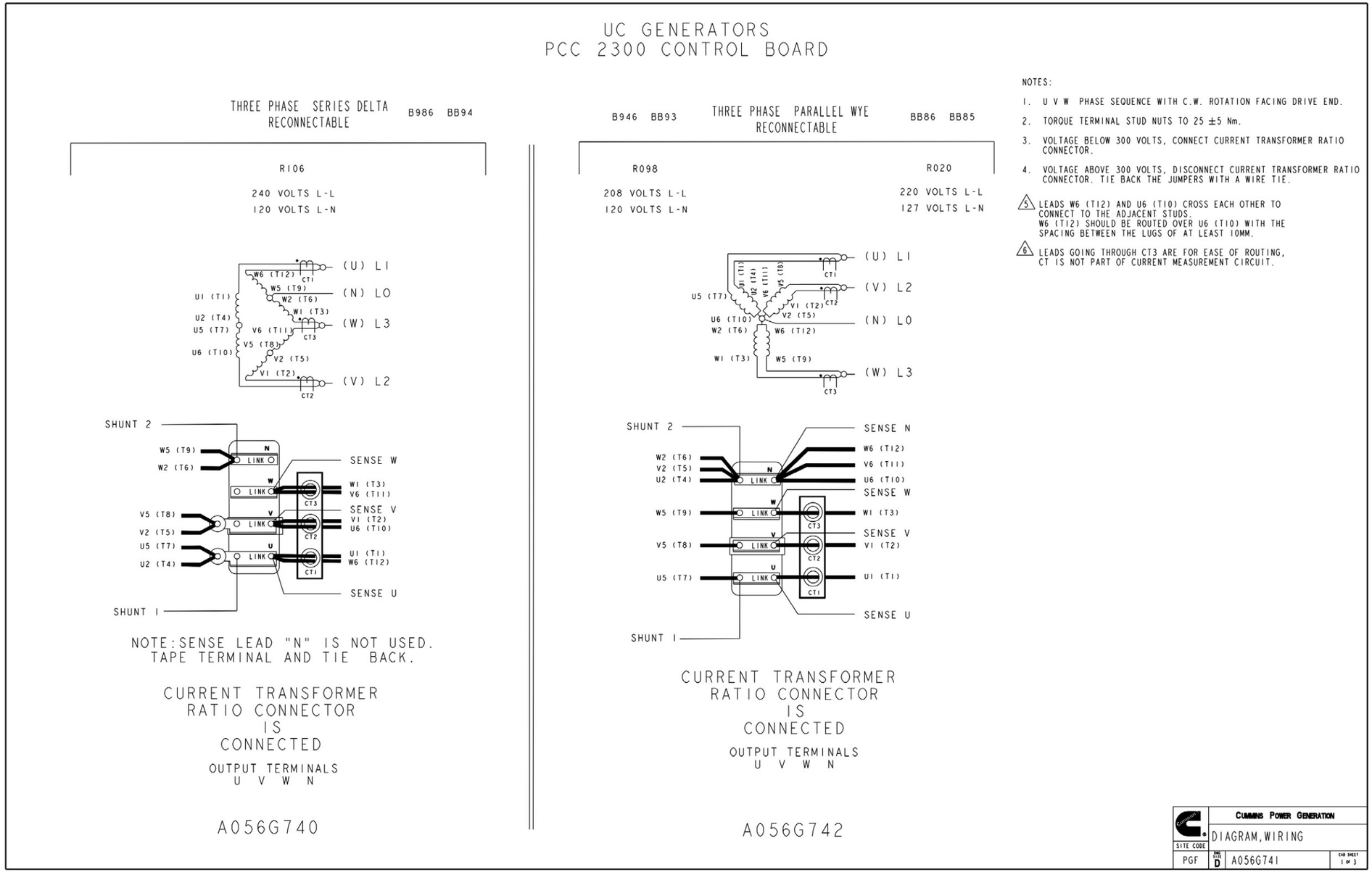

FIGURE 119. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 1 OF 3)

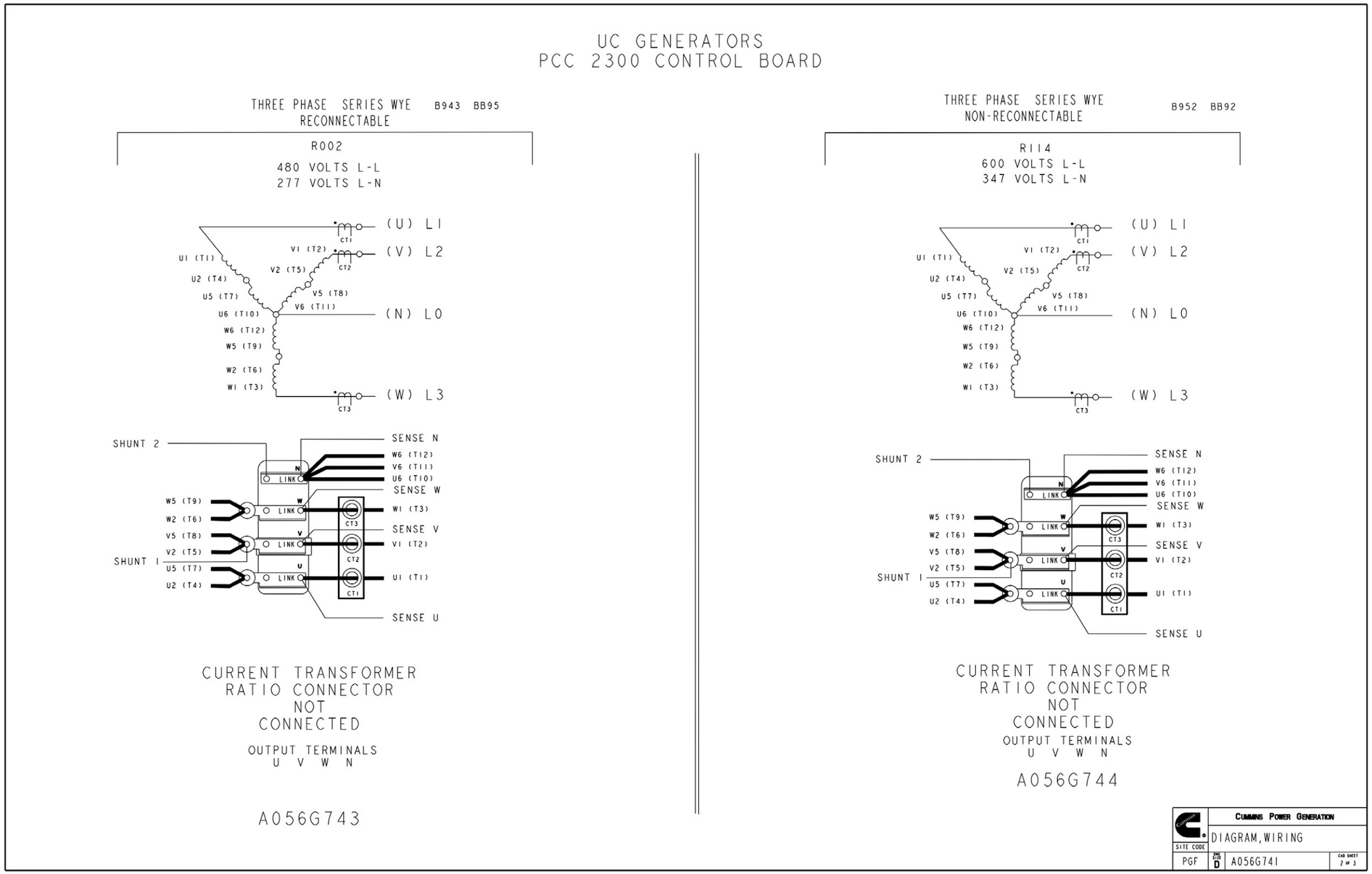

FIGURE 120. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 2 OF 3)

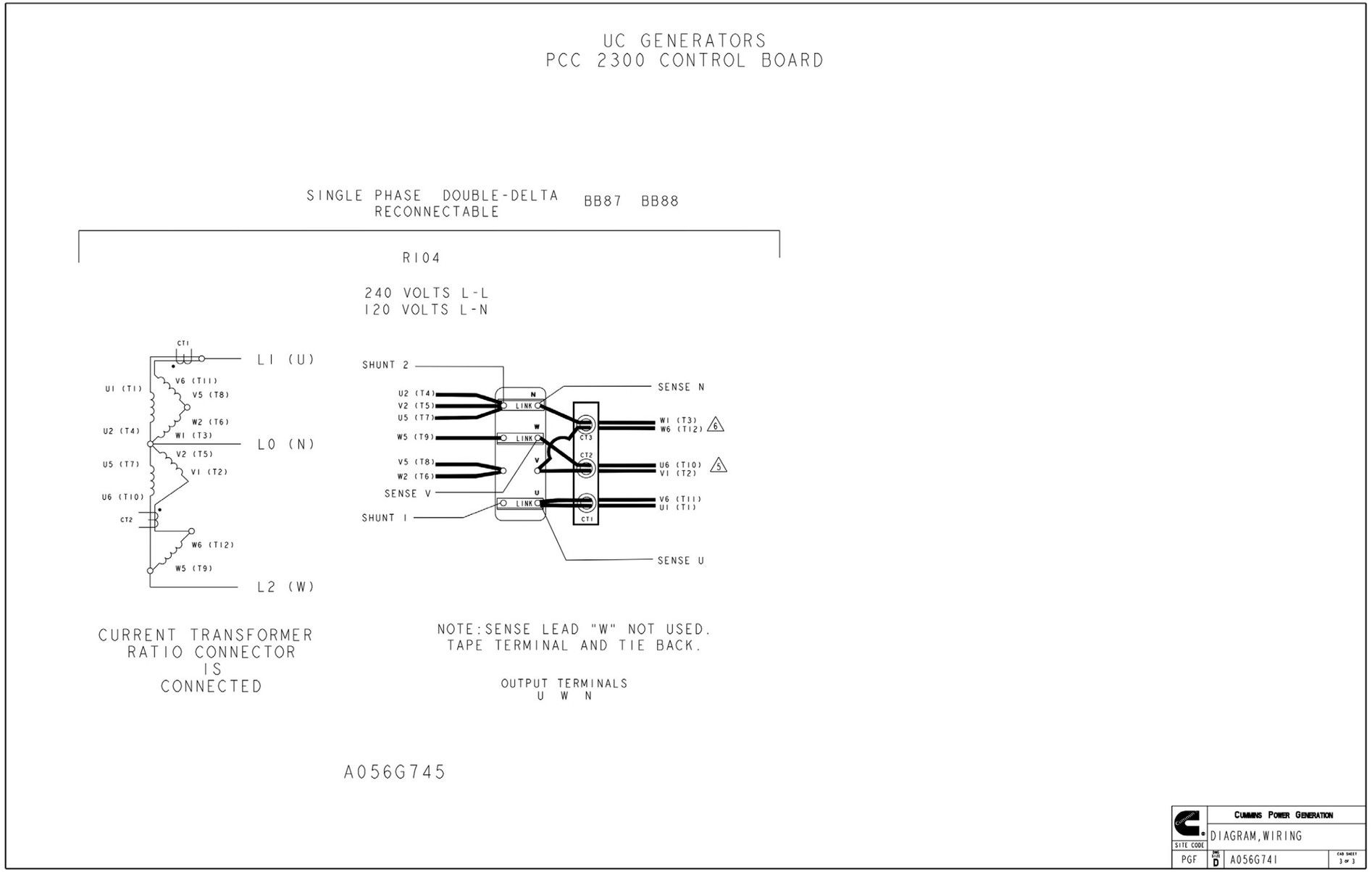

FIGURE 121. RECONNECT DRAWING FOR UC ALTERNATOR (SHEET 3 OF 3)

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