



Service Manual

Generator Set

D1703M or V2203M Engine with PC1.1 Control

C10 D6 (Spec A)

C15 D6 (Spec A)

C20 D6 (Spec A)

CALIFORNIA
Proposition 65 Warning

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

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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.

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, coolant, or exhaust leaks. Do not step on the generator set when entering or leaving the generator set room.

1.3 Generator Set Safety Code

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

⚠ WARNING***Electrical Generating Equipment***

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

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

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.

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.

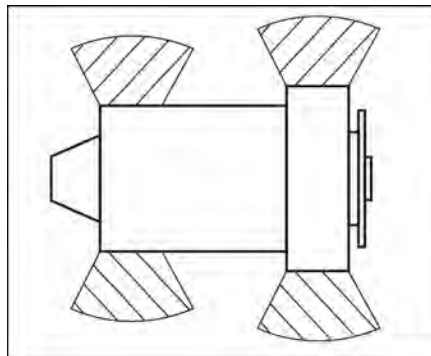


FIGURE 1. HATCHED AREAS

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

Energized Circuits

Any work with exposed energized circuits with potentials of 50 VAC or 75 VDC or higher poses a significant risk of electrical shock and electrical arc flash. These silent hazards can cause severe injuries or death.

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 lockout/tagout procedures 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.

- Do not tamper with or bypass interlocks unless you are authorized to do so.
- Make sure that an accompanying person who can undertake a rescue is nearby.

AC Supply and Isolation

NOTICE

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

NOTICE

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

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

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

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.

Spillage

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

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.

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.

What Is Carbon Monoxide Poisoning?

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.

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.

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.

2 Introduction

WARNING

Hazardous Voltage

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

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

WARNING

Electrical Generating Equipment

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

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

2.1 About This Manual

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 Icons

The following symbols may have been used in this manual to help communicate the intent of the instructions. They are defined below.

Icon	Description
	Clean the part or assembly.
	Indicates an electrical measurement.
	Indicates that an inspection is required.
	Indicates an installation or assembly procedure.
	Lubricate the part or assembly.
	Indicates a mechanical or time measurement.
	Refer to another publication for additional information.
	Indicates a removal or disassembly step.
	Tighten to a specific torque.
	Indicates parts or tools required.
	Indicates that the component is heavy (50 lb or 23 kg or more). To reduce the possibility of personal injury, use a hoist or get assistance to lift.

2.3 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)
- Jumper leads
- Tachometer or frequency meter
- Wheatstone bridge or digital ohmmeter
- 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)
- Engine display harness

2.4 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

Abbr.	Description	Abbr.	Description
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
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

Abbr.	Description	Abbr.	Description
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		

2.5 Related Literature



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 literature provided with the generator set is as follows:

- Health and Safety Manual (0908-0110-00)
- Warranty Statement (A028U870)
- Emissions Component Defect Warranty Statement (A048K395)
- Generator Set Installation Manual (A049J580)
- Generator Set Operator Manual (A049J586)
- Installation Quick Start Guide (A050N805)
- Operator Quick Start Guide (A050N807)

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

- Service Manual (A049J589)
- Kubota D1703M and V2203M Engine Service Manual (A049P923)
- Parts Manual (A048W980)
- RA Series Transfer Switch Owner's Manual (A046S594) - if applicable
- PowerCommand® 1302 Controller Owner's Manual (900-0661)
- Standard Repair Times (SRT) Manual - GF Family (A049M410)

- Application Manual T-030 - for application information (A040S369)
- Service Tool Manual (A043D529)
- Universal Annunciator Operator Manual (900-0301)

2.6 After Sales Services

Cummins offers a full range of maintenance and warranty services.

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 Inc. 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 Inc. service provider.

Warranty

For details of the warranty coverage for your generator set, refer to the *Global 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.

Warranty Limitations

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

3 Manufacturing Facilities

U.S. and CANADA	EMEA, CIS	EMEA, CIS
Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Inc. Columbus Avenue Manston Park Manston, Ramsgate Kent CT12 5BF United Kingdom	Cummins Inc. Royal Oak Way South Daventry Northamptonshire NN11 8NU United Kingdom
Toll Free 1-800-CUMMINS™ (1-800-286-6467) Phone +1 763-574-5000 Fax +1 763-574-5298	Phone +44 1843 255000 Fax +44 1843 255902	Phone +44 1327 88-6453 Fax +44 1327 88-6125
BRAZIL	CHINA	INDIA
Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 CNPJ: 43.2201.151/0001-10 Brazil	Cummins Inc. No.118 South Quanli Road , Wuhan Economic& Technological Development Zone , Hubei, P.R.China 430058	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka- Phaltan Dist- Satara, Maharashtra 415523 India
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3.1 How to Obtain Service

For parts, service, and product information, contact the nearest authorized Cummins Inc. dealer. To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-CUMMINS™ (1-800-286-6467) or visit <http://www.cummins.com/support>.

Locating a Distributor

In the U.S. and Canada

To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-CUMMINS™ (1-800-286-6467) or visit www.cummins.com/support.

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

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

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

Outside the U.S. and Canada

Refer to www.cummins.com/support and select Distributor Locator, or send an email to ask.powergen@cummins.com.

Fuel Information Needed for Service Issue

When servicing is needed on a failed fuel tank, the following questions must be answered and conveyed via the submission of the Technical Support Request form (TSR).

1. Is there an actual confirmed leak?
 - Has the rupture basin alarm gone off?
 - What Fault Code(s) are present?
 - Is the sensor functioning properly?
 - Is there visible fuel in the basin or outside the tank (i.e. is there an EPA concern)?
 - If so, what is the leak rate?
 - Is the fluid fuel and NOT water?
 - What is the level of the fuel, in inches, in the tank and basin? A dipstick may be required to obtain an accurate reading.
 - Can the leak locale be identified?

CAUTION

High Pressure

Excessive pressurization can rupture tanks or basins which can result in severe personal injury or death.

Remove all liquids before pressure testing. Do not exceed 2 psig when testing a tank or basin.

- Has the tank been previously repaired?
- Is there evidence of physical damage that may be contributing to the leak?

- Pictures may convey a great deal of information and should be considered.
2. What are the CPG and manufacturer's details associated with the tank? Include the following in the Issue:
 - CPG part number.
 - Manufacturer's part number, model, serial number and date of manufacture.
 3. What time frame is required for the needed repair or replacement (i.e. how sensitive of an issue is this with the client and do they have any flexibility in the repair timing)?
 - If replacement, has there been an order placed for a new tank?
 - If ordered, is it categorized as machine down?
 - If not, then please update the order accordingly.
 - If an order has been placed, the Issue is to reflect this data (order number) as well.

Obtaining Information Needed for Fuel Tank Service Issues

CAUTION

High Pressure

Excessive pressurization can rupture tanks or basins which can result in severe personal injury or death.

Remove all liquids before pressure testing. Do not exceed 2 psig when testing a tank or basin.

To aid in identifying/isolating the leak or obtaining some of the information needed for Fuel Tank Service Issues:

1. Seal all penetrations/fittings with plugs except for one.
2. For the remaining penetration, fit up a regulated pressure source with a calibrated pressure gauge and a pressure relief valve (set to no more than 2.5 psig).
3. Pressurize the tank or basin to 2 psig and observe for the following:
 - For secondary tank (basin) work, spray all exterior weld seams with a soap water solution. Observe the pressure gauge for no change in a 30 minute period and visually observe the exterior seams for bubbling. Results are to be conveyed in the Issue details.
 - For the primary fuel tank, spray all exterior weld seams with a soap water solution. Observe the pressure gauge for no change in a 30 minute period and visually inspect the interior of the basin to the maximum extent possible. Results are to be conveyed in the Issue details.

NOTICE

For further questions or concerns regarding the information stated above, please contact (in the following order):

1. Your local Service Manager
2. DFSE-Counterpart
3. The Cummins Distributor Technical Support Line (1-812-377-6517)

3.2 Service Technician Support

For technical support for service technicians, call 1-855-TECH711 (1-855-832-4711) to reach the Channel One Technical Support Hotline in the United States or Canada. Distributors should contact their Cummins Inc. service contact.

4 Specifications

4.1 Model Specifications

TABLE 1. MODEL VARIATIONS

Model	Engine	Cylinder	Hz	RPM
C10 D6, C15 D6	D1703M	3	60	1800
C20 D6	V2203M	4	60	1800

TABLE 2. COLD WEATHER SPECIFICATIONS

All Models	
For NFPA 110 applications, a coolant heater is required. Factory option is available.	
Above 40 °F (4 °C)	No starting aids required. Standard battery (group 26)
0 to 40 °F (-17 to 4 °C)	Coolant heater and battery charger recommended for starting. Factory options available. Standard battery (group 26)
Below 0 °F (-17 °C)	All starting aides (battery heater, coolant heater, battery charger) recommended. Factory options available. Larger battery (group 34)

TABLE 3. FUEL CONSUMPTION

	C10 D6	C15 D6	C20 D6
Full Load (Standby Rating) US	1.12 gal/hr (4.24 L/hr)	1.38 gal/hr (5.22 L/hr)	1.81 gal/hr (6.85 L/hr)
Full Load (Prime Rating) US	1.02 gal/hr (3.86 L/hr)	1.26 gal/hr (4.77 L/hr)	1.65 gal/hr (6.24 L/hr)

TABLE 4. ENGINE SPECIFICATIONS

	C10 D6	C15 D6	C20 D6
Engine	Kubota -D1703M - 3 Cylinder-in-line, liquid-cooled, 4-stroke	Kubota -D1703M - 3 Cylinder-in-line, liquid-cooled, 4-stroke	Kubota -V2203M - 4 Cylinder-in-line, liquid-cooled, 4-stroke
Aspiration	Naturally Aspirated		
Displacement	100.5 in ³ (1650 cc)		134.1 in ³ (2200 cc)
Compression Ratio	22:1		22:1
Lube Oil Capacity, qt (L)	7.4 qt (7.0 L)		10.0 qt (9.5 L)
Oil Recommendation	• SAE30 or SAE10W30: Above 75 °F (25 °C) • SAE20 or SAE10W30: 32 °F (0 °C) to 75 °F (25 °C) • SAE10W or SAE10W30: Below 32 °F (0 °C) • Oil Grade - API CF or better		
Fuel	Diesel fuel: Meeting European Norm (EN) 590 or American Society of Testing and Materials (ASTM) D975 recommended. Cetane Rating: Minimum recommended is 45. A rating greater than 50 is preferred, especially in low ambient temperature below –20 °F (–4 °C) and elevation above 5000 ft (1500 m). Note: The diesel fuel specification type and sulfur content percentage (ppm) used must be compliant with all applicable emission regulations. When operated in United States environmental protection agency (US EPA) required areas, No.2-D, S500, or S15 or No.1-D S500 or S15 is mandatory. Use No.1-D for ambient temperature below –14 °F (10 °C). • No.1–D or No.2-DS500: Low sulfur diesel (LSD) less than 500 ppm or 0.05% by weight. • No.1–D or No.2-D S15: Ultra low sulfur diesel (ULSD) 15 ppm or 0.0015% by weight. Sulfur Content: 0.10% (1000 ppm) or less is recommended. Note: If high sulfur fuel (0.5-1%) is used, change the engine oil and oil filter more frequently (approx. 125 hours). Do not use fuels that have sulfur content greater than 1% (10000 ppm).		
Cooling System	2.4 gal (9.1 L)		2.7 gal (10.2 L)
Coolant	50/50 coolant solution (50% pure water and 50% ethylene glycol)		

	C10 D6	C15 D6	C20 D6
Exhaust	Maximum Allowable Back Pressure: 42 H ₂ O (10.47 kPa)		
	Exhaust Flow at Rated Load: 99 cfm (2.8 m ³ /min)	Exhaust Flow at Rated Load: 126 cfm (3.6 m ³ /min)	Exhaust Flow at Rated Load: 174 cfm (4.9 m ³ /min)
	Temperature: 644 °F (340 °C)	Temperature: 970 °F (521 °C)	Temperature: 970 °F (521 °C)
Fuel Pump	Fuel Supply: 0.375 in. (9.5 mm) Hose Barb		
	Fuel Return: 0.312 in. (7.9 mm) Hose Barb		
	Maximum Fuel Lift Restriction (with Clean Filter): 2 in. HG (51 mm Hg) Maximum Fuel Lift Restriction: 6 in. Hg (152 mm Hg)		

TABLE 5. GENERATOR SET SIZE SPECIFICATIONS

	10-20 kW 1800 RPM
Size (with Sound Level 1 Enclosure without Fuel Tank)	(L x W x H) 72 x 34 x 45.5 in (1830 x 864 x 1156 mm)

TABLE 6. GENERATOR SET WEIGHT (POUNDS) 60 HZ, 1800 RPM

	C10D6	C15D6	C20D6
Sound Level 1 (Wet) without Fuel Tank	962	1064	1127

TABLE 7. ALTERNATOR SPECIFICATIONS 60 HZ, 1800 RPM

	C10D6	C15D6	C20D6
Generator	Brushless, 4-pole rotating field, single bearing		
Power (kVA) 1-Phase/3-Phase - Standby	10/12.5	15/18.75	20/25
Power (kVA) 1-Phase/3-Phase - Prime	9.1/11.4	13.5/16.9	18.2/22.7

	C10D6	C15D6	C20D6
Rated Voltages (V)	120/240, 1-Ph		
	277/480, 3-Ph		
	120/208, 3-Ph		
	120/240, 3-Ph		
	347/600, 3-Ph		

NOTICE**Maximum I_2 = 8%.****TABLE 8. GENERATOR SET DERATING GUIDELINES**

	C10D6	C15D6, C20D6
Standby, Prime	Engine power available up to 2500 m (8200 ft) and ambient temperatures up to 40 °C (104 °F). Above these conditions, derate at 3% per 300 m (985 ft) and 3.5% per 10 °C (18 °F).	Engine power available up to 150 m (490 ft) and ambient temperatures up to 25 °C (77 °F). Above these conditions, derate at 4% per 300 m (985 ft) and 4% per 10 °C (18 °F).

TABLE 9. DC SYSTEM SPECIFICATIONS

All Models	
Nominal Battery Voltage	12 VDC
Battery Group	26 standard, 34 high capacity (high capacity battery requires an accessory battery tray)
Battery Type	Maintenance free
Minimum Cold Crank Amps	545 standard, 850 high capacity (high capacity battery requires an accessory battery tray)

4.2 CA115 Winding Resistances

TABLE 10. CA115 WINDING RESISTANCES

Alternator Type	Resistance of Windings at 22 °C (Measured Values Should Be within 10%)							
	Main Stator Windings, L-N (leads) (Ohms)				Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	EBG (Ohms)
	311	41	17	06				
CA115-M12	0.156	0.207	-	0.078	18.81	0.268	1.536	12.9
CA115-T12	0.112	0.124	-	0.048	19.31	0.210	1.767	12.9
CA115-P12	0.112	0.156	-	-	19.31	0.210	1.531	12.9
CA115-J12	0.204	0.270	-	-	17.68	0.256	1.248	12.9
CA115-R12	-	-	-	0.060	19.31	0.210	1.548	12.9
CA115-D14	0.961	1.227	1.910	0.539	17.68	0.256	0.412	12.9
CA115-H14	0.374	0.466	0.736	-	18.81	0.268	0.543	12.9
CA115-J14	-	-	-	0.128	18.81	0.268	0.606	12.9
CA115-L14	0.199	0.276	0.437	0.092	19.31	0.210	0.668	12.9
CA115-P14	0.194	0.244	0.384	-	20.61	0.216	0.779	12.9
CA115-R14	-	-	-	0.070	20.61	0.216	0.806	12.9
CA115-S14	0.142	0.191	0.304	-	20.61	0.216	0.869	12.9
CA115-V14	0.119	0.175	0.259	0.048	21.27	0.224	0.944	12.9

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5 Maintenance

5.1 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.

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."

5.2 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 Inc. 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 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.

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.

NOTICE

Perform maintenance tasks as specified using the period of operation that occurs first.

TABLE 11. PERIODIC MAINTENANCE SCHEDULE

Maintenan ce Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Month s or After 200 Hours¹	2 Years¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check air cleaner restriction indicator (where fitted): If the service indicator shows red, replace air cleaner elements and reset the air cleaner service indicator.	■								
Check operation of operator panel: Check display (the system will perform a control panel test on initial activation).	■								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check coolant level of radiator(s): 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.	■								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check drive belt condition and tension: Visually check belt for evidence of wear or slippage. To replace, contact your authorized distributor.	■								
Check coolant lines and radiator hoses for leaks, wear and cracks: Visually check the hoses. Replace worn or damaged components.	■								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
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.	■								
Verify that the coolant heater has power and is running (where fitted). Check for evidence of leaks. Remove any corrosion from fittings.	■								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check engine oil level: If low, top up to engine specifications level, with recommended oil.	■								
Check fuel level in fuel tank. Refill as required.	■								
Check fuel lines and hoses: Visually check for leaks, worn or damaged hoses. To replace, contact your authorized distributor.	■								
Check charge alternator: Check visually and audibly when the generator set is running. To replace, contact your authorized distributor.	■ ²								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
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.	■								

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check generator set enclosure: Visually check enclosure, walk around inspection of generator set. Make sure no inlets/outlets are covered/restricted, service access doors are operational and safety systems are in place and operational. To replace damaged parts, contact your authorized distributor.	■								
Replace engine oil and filters. Refer to the Engine Oil section for the procedure.		■ ²		■ ²					

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check battery: Check connections to verify that they are secure.		■			■				
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.			■						

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Month s or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
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.			■						
Clean radiator core.				■ ³					
Check water pump for leaks. Check weep holes for evidence of leaks. Replace if leaking.				■					
Replace cooling system coolant.					■				
Replace coolant hoses and clamps.					■				

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Months or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check engine ground. Clean as necessary.					■				
Check engine mounts general condition and for signs of excessive wear.					■				
Check starting motor for general condition, wiring connections.					■				
Replace fuel hoses and clamps.					■				
Check battery general condition. Remove any corrosion on terminals with wire brush.					■				

Maintenance Item	Daily or After 24 Hours	Weekly or After 50 Hours	100 Hours	12 Month s or After 200 Hours ¹	2 Years ¹	400 Hours	500 Hours	800 Hours	4000 Hours
Check electrical connections (battery, starter motor, alternator connections). Check for tight connections, general condition and remove any corrosion.					■				
Replace fuel filter and water separator.						■			
Replace fan belt.							■		
Check valve clearance.								■	
Inspect all sealed bearings every 4000 to 4500 hours									■
¹ – To be performed by a qualified Service Technician. ² – Cleaning schedule may be reduced depending on operating conditions/environment. ³ – After the initial 50 hour interval and every 200 hours thereafter. ⁴ – Replace all bearings every 30000 hours or 5 years (or if necessary after 10000 hours or 2 years).									

5.3 Engine Oil

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. Refer to the [Section 4.1 on page 21](#) for oil specification.

Checking Engine Oil Level

NOTICE

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

⚠ WARNING

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

⚠ CAUTION

Overfilling can cause foaming or aeration of the oil while 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.

⚠ WARNING

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. Accidental or remote starting of the generator set can cause severe personal injury or death. Disconnect the negative (-) battery cable and place the control switch in its OFF position before starting work.

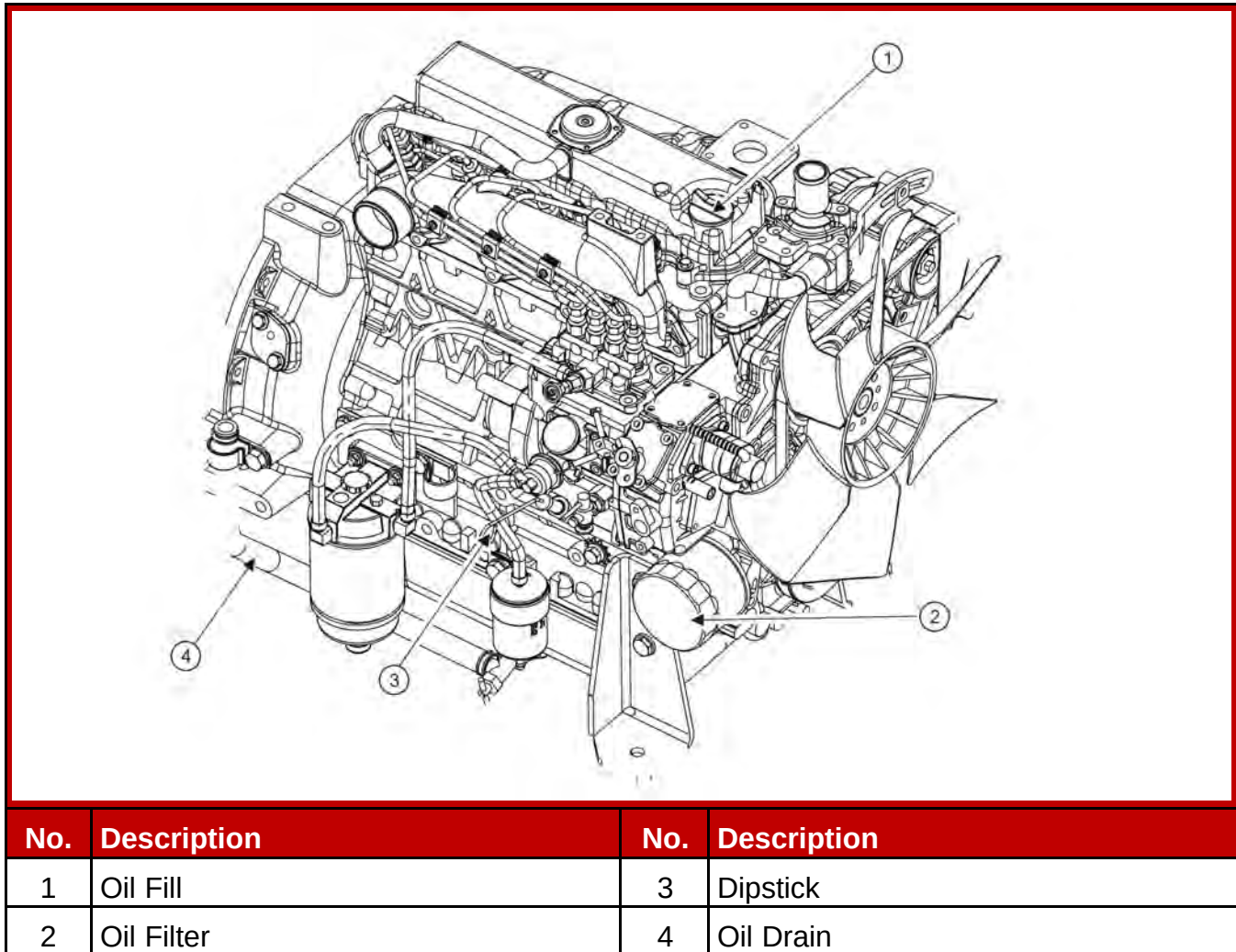


FIGURE 2. ENGINE OIL COMPONENTS

To check the engine oil level:

1. Make sure that the engine has not been running for approximately five minutes.
2. Clean off the area surrounding the dipstick port to prevent entry of debris into the oil pan.
3. Pull out the dipstick and wipe it clean.
4. Reinsert and fully seat the dipstick.
5. Remove the dipstick and check the oil level.
6. Reinsert and fully seat the dipstick.

If the engine oil level check shows excessive or insufficient levels of oil (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.

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.

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.

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.

Changing Engine Oil and Oil Filter

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

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 engine is not running and is out of Auto 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. Before changing the oil, the generator set should be operated until the water temperature is approximately 60 °C (140 °F).
2. 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. If applicable, 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.
3. Drain the oil. Place the end of the drain hose into an appropriate container.

NOTICE

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

4. Remove the oil filter, and clean the filter mounting surface on the engine block. Remove the old gasket if it remains.
5. Make sure the gasket is in place on the new filter and apply a thin film of clean oil to the gasket.
6. 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.
7. Remove the container used to collect oil when removing the oil filter.
8. Close the oil drain valve.
9. 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.

10. Operate the engine at idle to inspect for leaks at the lubricating oil filter and the drain plug.
11. Confirm that the correct oil level is in the pan:
 - a. Shut the generator set off and wait 5 minutes.
 - b. Check the engine oil level.
12. Check and repair any leaks identified.
13. Dispose of the used oil and oil filter according to local environmental regulations.

5.4 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.***

Replace the battery charger if the battery keeps running down.

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.

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6 Troubleshooting

6.1 GATRR Troubleshooting Approach

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

TABLE 12. 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.
	T - Test: Perform tests in order of likelihood based on troubleshooting trees 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.

6.2 Service Repair Levels

The following table lists the differences in Repair Level (dealers) versus Full Service Level (distributors). Dealers are authorized to perform service on the items at their level *only*. However, distributors are authorized to perform service on all of the items shown in the table.

TABLE 13. SERVICE BILL OF MATERIAL GUIDE

Level	Description
Both Full Service (Distributor) and Repair (Dealer)	• Alternator and bracket • Belt tensioner • Belts • Exhaust manifold • Fan hub • Filters and filter heads • Front cover and front cover gasket • Gaskets associated with major components on this list (e.g. water pump gaskets, exhaust manifold gaskets, etc.) • Glow plugs • Maintenance items • Starter • Thermostat • Valve cover and gasket • Vibration damper • Water pumps
Full Service (Distributor) ONLY	• Component rebuild parts, such as fuel system sub-components and if equipped, turbocharger sub-components • Maintenance items • Repair items plus internal engine components (internal wear/failure items plus head gaskets, rod/main bearings, rings, and lube pumps)

6.3 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.

Display Setup and Software Information

The Display Setup Menu is used to modify the display and user preferences.

- *Connection*: A display can be set up to be Local or Remote (default = Local).
- *Access Code*: A display can be set up to require or not require an access code when entering the mode (Auto, Manual Run, or Off).
- *Symbols*: A display can be set up to display international symbols on the Operator Menus (default = Yes).

To access the Display Setup Menu:

1. From any Information Menu, hold down the up and down arrows simultaneously for two seconds. The Service Menu appears.
2. Select **Setup Menus**.
3. Enter the password **574** on the Password screen. The Setup Menu appears.
4. Select **Genset Setup**.
5. Advance through the screens until the Display Setup Menu appears.

To update the Connection, Access Code, or Symbols on the Display Setup Menu:

1. Access the Display Setup Menu.
2. Select **Adjust**.
3. Adjust settings, and press **Save** to save any changes.

When updating these settings, the functions of the keys are as follows:

- The horizontal right arrow key is used to select successive blocks for editing settings on the screen.
- Adjust values by using the + or - keys on the Adjust Menu of the Display Setup Menu.
- Press **Save** to save any changes. After savings, the Save button changes to the Adjust button.

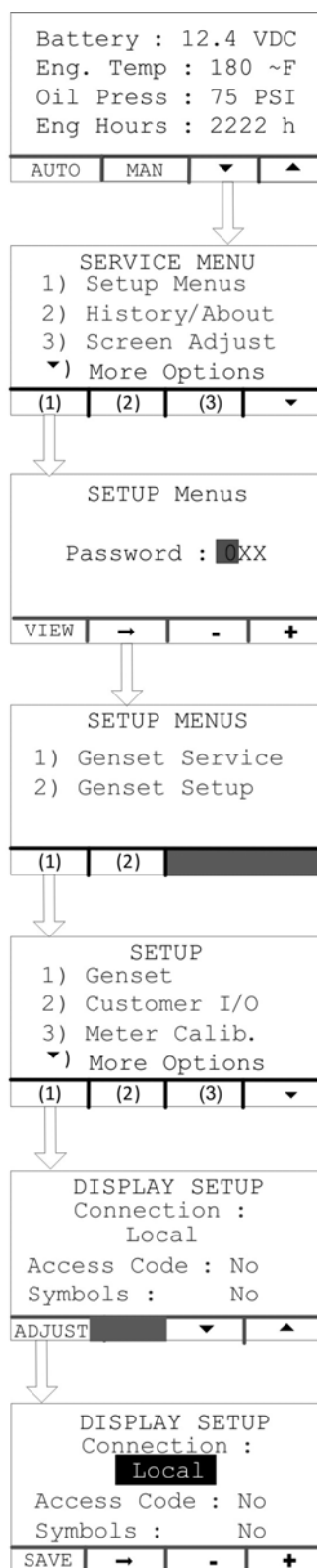


FIGURE 3. DISPLAY SETUP MENU NAVIGATION

6.4 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.

6.5 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.

Disabling the AMF Feature

NOTICE

This procedure must be performed by a qualified technician.

On single-phase units, the control is shipped with the Automatic Mains Failure (AMF) feature enabled. This feature has logic to control the RA Automatic Transfer Switch (ATS), including a 5-minute retransfer to utility delay. If you are not using an RA ATS, you can eliminate the 5-minute retransfer to utility delay by disabling the AMF feature using the instructions below.

NOTICE

This procedure is optional. If you do not disable the AMF feature, the generator set will just run for an additional 5 minutes after the utility has been restored.

NOTICE

These steps cannot be performed with the HMI211; they can only be performed with the InPower service tool.

1. Connect to the PCC1302 via InPower.
2. Navigate to the Adjustments->Features->Automatic Transfer Switch folder.
3. Select the Auto Mains Failure Enable parameter.
4. Double-click on Enabled in the Value field.
5. A pop-up will appear with available choices. Select Disabled.
6. Select Device->Save Adjustments from the top menu bar.
7. A pop-up will appear asking if the change is to be saved. Click the Save button.
8. After a pop-up appears confirming that the change has been saved, disconnect InPower from the PCC1302.

6.6 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.

6.7 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 14. SYMBOLS

Symbol	Text
	Generator Warning Fault
	Generator Shutdown Fault
	Coolant Temperature
	Oil Pressure
	Voltage Alternating Current (VAC)
	Voltage Direct Current (VDC)
	AC Current
Hz	Frequency
	Battery
	Out of Range
	High or Pre-High
	Low or Pre-Low
	Annunciator
	Over Speed

Symbol	Text
	Crank Fail
	Emergency Stop

6.8 Alternator Performance Troubleshooting

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 12 VDC battery with a diode in the positive lead as shown below.

NOTICE

The PCC will be destroyed if connected with the wrong polarity and no diode.

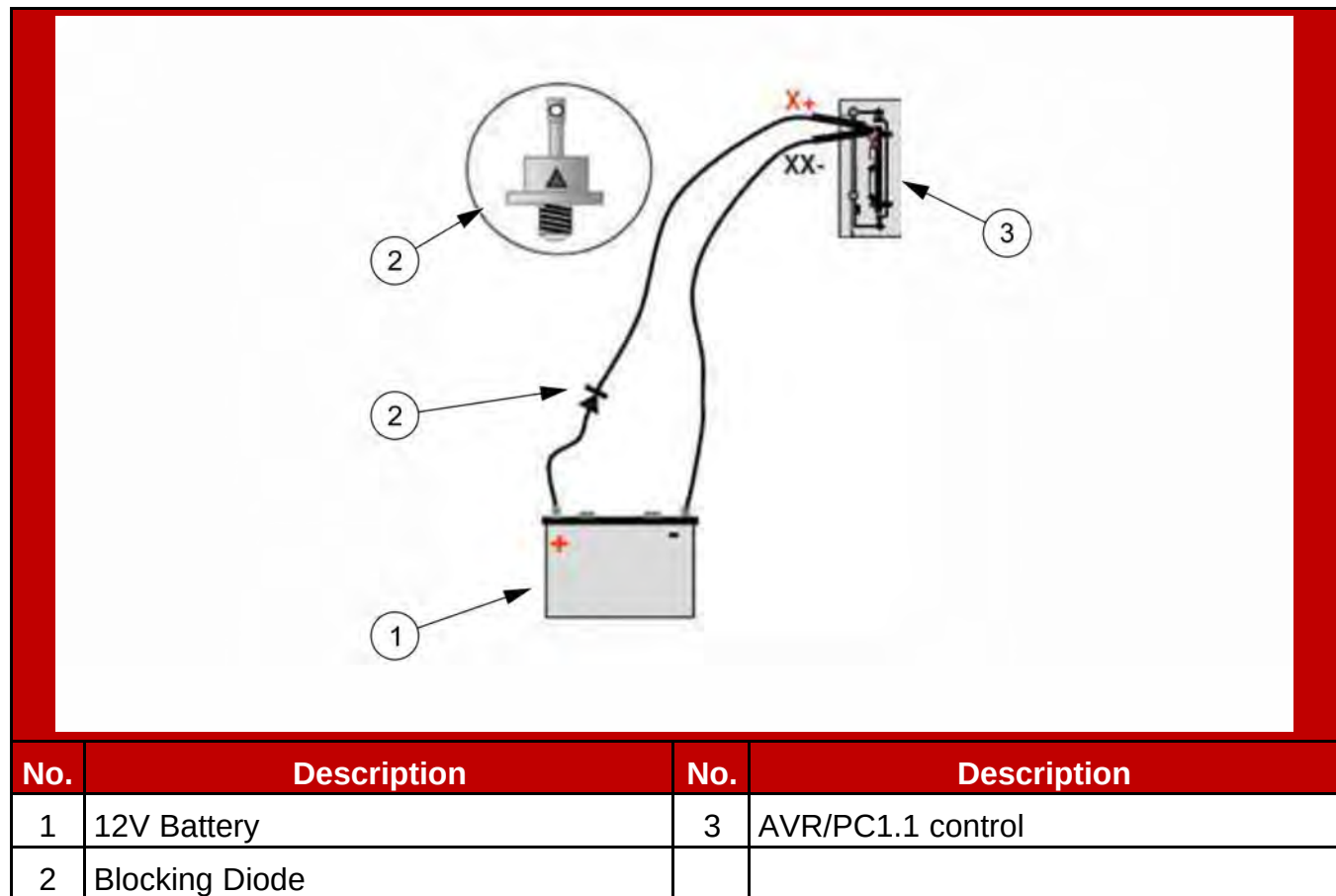


FIGURE 4. RESTORE MAGNETISM

- ii. Run the generator at rated speed, no load.
- iii. Briefly (maximum one second) connect the positive lead to PCC terminal X+ (F1: P17-1) and the negative lead to PCC terminal XX- (F2: P17-2).

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.

Unbalanced Voltage (With Load)

Possible Causes:

1. Engine governing unstable

Diagnosis and Repair:

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

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

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.

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.

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).

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.).

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. Compare measurements with the test report supplied with the alternator.

The following list is to aid in troubleshooting and is not exhaustive. If in doubt, consult Cummins service department.

Without AVR

NOTICE

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

NOTICE

Disconnect the exciter stator leads X+ (F1) and XX- (F2) from the PCC 1302 control board, then do the tests in the table below.

TABLE 15. FAULT FINDING: WITHOUT AVR

Test		Result	Action
1	Disconnect the sensing leads from the AVR (6, 7, and 8), the ground cable, and customer connection from the terminal block. Use a $\mu\Omega$ meter to measure resistance from the leads to ground.	Resistance is less than 1 M Ω .	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 M Ω .	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 within 10% of the relevant value in the Windings section.	Stator windings are damaged. Replace the exciter stator.
		Resistance is within 10% of the relevant value in the Windings section.	Proceed to Test 3.
3	Use an insulation tester to megger from the XX- (F2) to ground.	Resistance value is less than 1 M Ω .	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 M Ω .	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 $\mu\Omega$ meter/kelvin bridge to measure each winding resistance.	Resistances are not within 10% of the relevant value from the Windings section, or are not balanced within 1%.	Replace the alternator.
		Resistances are within 10% of the relevant value from the Windings section, and are balanced within 1%.	Reconnect all leads, and then 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 $\mu\Omega$ 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 the Windings section.	Replace the exciter rotor/alternator assembly.
		Resistance is not within 10% of the relevant value in the Windings section.	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 the Windings section.	Replace the main rotor/alternator assembly.
		Resistance value is less than 10% different than the relevant value from the Windings section.	Proceed to Test 10.

Test		Result	Action
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 if equipped with EBS. Proceed to Test 13 if equipped with PMG. If not equipped with either, replace control board.
11	Disconnect EBS. Run the generator set at nominal speed. Use a multimeter to measure AC output voltage.	Output voltage is within 10% of nominal.	Proceed to Test 12 if the EBS service tool is available. If not, replace the EBS.
		Output voltage is not within 10% of nominal.	Replace the control board. Proceed to Test 12 if the EBS/EBC service tool is available. If not, replace the EBS.
12	Use the EBS service tool to check for proper function of the EBS and EBC.	EBS or EBC does not operate properly.	Replace the faulty component.
		EBS and EBC operate properly.	Replace the control board.
13	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 14.
14	Use a multimeter to measure the resistance of the PMG stator.	Resistance is not within 10% of the relevant value in the Windings section.	Replace the PMG stator.
		Resistance is within 10% of the relevant value in the Windings section.	Replace the PMG rotor.

6.9 Engine Performance Troubleshooting

Engine Is Difficult to Start or Does Not Start

Possible Cause:

1. Battery voltage is low, interrupted, or open
2. Fuel system issues
3. Air intake or exhaust issues

4. Starting procedure/aid
5. Engine speed governor issue
6. Base engine problem

Diagnosis and Repair:

1. Battery voltage is low, interrupted, or open
 - Check the battery connections, unswitched battery supply circuit, and fuses.
2. Fuel system issues
 - Inspect fuel lines and fuel connections for leaks.
 - Repair if leaks are found.
 - Manual fuel shutoff valve is closed.
 - Open manual fuel valves.
 - 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.
 - Exhaust system restriction is above specification.
 - Check the exhaust system for restrictions.
4. Starting procedure/aid
 - Starting aid is necessary for cold weather or starting aid is malfunctioning.
 - Check for the correct operation of the starting aid.
5. Engine speed governor issue
 - Refer to the engine service manual.
6. Base engine problem
 - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

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.

Parameter	3 Cylinder	4 Cylinder
G1 (60 Hz)	2200	1700
G2 (60 Hz)	240	600
G3 (60 Hz)	30000	28800
Governor Damping Effect (60 Hz)	0.94	0.93
Initial Crank Fuel Duty Cycle	35	
Initial Crank Fueling Period	0	
Crank Fueling Ramp Rate	50	
Max Crank Fuel Duty Cycle	100	
Crank Exit Fuel Duty Cycle	60	
Governor Enable Engine Speed	1100	
Governor Preload Offset	250	
Governor Ramp Time	0.1	
Dither Factor	15	
Maximum Duty Cycle	95	
Minimum Duty Cycle	20	
Electronic Governor Enable	Enable	

Engine Runs Rough or Misfires

Possible Cause:

1. Air intake or exhaust issues
2. Fuel system leaks
3. Engine speed governor issue
4. Base engine problem

Diagnosis and Repair:

1. 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.
 - Exhaust system restriction is above specification.
 - Check the exhaust system for restrictions.
2. Fuel system leaks
 - Inspect fuel lines, fuel connections, and fuel filters for leaks.
 - Repair if leaks found.

-
3. Engine speed governor issue
 - Refer to the engine service manual.
 4. Base engine problem
 - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

Engine Shuts Off Unexpectedly or Dies During Deceleration

Possible Cause:

1. Emergency Stop/Remote Emergency Stop energized
2. Fuel system issues
3. Engine speed governor issue
4. Base engine problem

Diagnosis and Repair:

1. Emergency Stop/Remote Emergency Stop energized
 - Verify that either the Emergency Stop or the Remote Emergency Stop circuit is not energized.
2. Fuel system issues
 - Check the fuel supply for appropriate pressure and flow.
 - Manual fuel shutoff valve is closed.
 - Verify that the fuel system valves are open.
3. Engine speed governor issue
 - Refer to the engine service manual.
4. Base engine problem
 - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

Engine Speed Surges Under Load or in Operating Range

Possible Cause:

1. Fuel system issues
2. Engine speed governor issue
3. Other issues

Diagnosis and Repair:

1. Fuel system issues
 - Inspect fuel lines and fuel connections for leaks.
 - Repair if leaks found.
 - Manual fuel shutoff valve is closed.
 - Verify that the fuel system valves are open.
 - Engine governor actuator or circuit is malfunctioning.
 - Check the engine governor actuator and circuit.
2. Engine speed governor issue
 - Refer to the engine service manual.
3. Other issues
 - Moisture in the wiring harness connectors
 - Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
 - Base engine problem
 - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

Poor Engine Transient Response***Possible Cause:***

1. Excessive loads
2. Fuel system leaks
3. Air intake or exhaust issues
4. Engine speed governor issue
5. 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. Engine speed governor issue
 - a. Refer to the engine service manual.
5. 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.

Parameter	3 Cylinder	4 Cylinder
G1 (60 Hz)	2200	1700
G2 (60 Hz)	240	600
G3 (60 Hz)	30000	28800
Governor Damping Effect (60 Hz)	0.94	0.93
Initial Crank Fuel Duty Cycle	35	
Initial Crank Fueling Period	0	
Crank Fueling Ramp Rate	50	
Max Crank Fuel Duty Cycle	100	
Crank Exit Fuel Duty Cycle	60	
Governor Enable Engine Speed	1100	

Parameter	3 Cylinder	4 Cylinder
Governor Preload Offset	250	
Governor Ramp Time	0.1	
Dither Factor	15	
Maximum Duty Cycle	95	
Minimum Duty Cycle	20	
Electronic Governor Enable	Enable	

Engine Will Not Reach Rated Speed (RPM)

Possible Cause:

1. Excessive loads
2. Air intake or exhaust issues
3. Engine speed governor issue
4. Other issues

Diagnosis and Repair:

1. Excessive loads.
 - Ensure that the load on the generator set does not exceed the generator set KW rating.
 - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
2. 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.
 - Exhaust system restriction is above specification.
 - Check the exhaust system for restrictions.
3. Engine speed governor issue
 - Refer to the engine service manual.
4. Other issues
 - The generator set is operating above the recommended altitude.
 - Generator set power decreases above the 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, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

Engine Noise Is Excessive

Possible Cause:

1. Lubrication issues
2. Cooling issues
3. Air intake or exhaust leaks
4. Base engine problem

Diagnosis and Repair:

1. Lubrication issues
 - Lubricating oil level is below specification.
 - Check the oil level.
 - Fill the system to the specified level.
 - Lubricating oil pressure is below specification.
 - Check the oil pressure.
 - Lubricating oil is thin or diluted.
 - Analyze the oil.
2. Cooling issues
 - Coolant temperature is above specification.
 - Check the coolant level.
 - Fan drive belt is loose, tight, or not in alignment.
 - Check the fan drive belt.
3. Air intake or exhaust leaks
 - Inspect the air intake and exhaust systems for air leaks.
4. Base engine problem
 - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
 - Refer to the engine service manual.

6.10 Code 121 - Loss of Speed Sense (Shutdown)

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

Possible Causes:

1. Faulty Magnetic Pickup (MPU) sensor connections and wiring
2. Improper installation of the MPU sensor
3. Faulty MPU sensor
4. Incorrect calibrations in PowerCommand controls
5. Faulty control board
6. Damaged flywheel ring gear

Diagnosis and Repair:

1. Faulty Magnetic Pickup (MPU) sensor connections and wiring
 - a. Inspect the MPU sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the MPU sensor.
 - ii. Inspect for:
 - A. Corroded, bent, broken, pushed back, expanded, or loose pins
 - B. Evidence of moisture in or on the connector; dry the connectors with Cummins electronic cleaner, Part Number 3824510
 - C. Missing or damaged connector seals
 - D. Dirt or debris in or on the connector pins
 - E. Damaged or shorted wiring
 2. Improper installation of the MPU sensor
 - a. Inspect the installation of the MPU sensor.
 - i. Check if the clearance between the MPU sensor tip and the flywheel teeth is correct.
 - ii. Adjust the clearance if it is not as specified.
 - A. Set the clearance from the MPU tip to the ring gear teeth to 0.5 - 0.6 mm, using one of the following methods:
 - The preferred method of setting the MPU tip clearance is to use a feeler gauge.
 - An alternate method is to rotate the flywheel until the ring gear tooth is directly over the center of the MPU hole; then gently rotate the MPU until it touches the tooth. Back off $\frac{1}{4}$ turn and tighten the jam nut.
-  **CAUTION**

Prevent the MPU from rotating when tightening the lock nut. Failure to do so may cause damage to the sensor tip.
- iii. Verify that the orientation of the MPU sensor mounting is correct. Verify linear alignment of the MPU sensor with the flywheel ring gear.

3. Faulty MPU sensor

- a. Check the MPU sensor output voltage.
 - i. Disconnect the main harness connector from the MPU sensor.
 - ii. Remove the MPU sensor connectors and check for 3.5 to 15 VAC at the MPU while cranking. If no output, check for damage or debris on the end of the MPU, and for proper installation of MPU (see above). If there is still no output, replace the MPU sensor.

4. Incorrect calibrations in the 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.
 - ii. Verify that the MPU sensor feature is enabled in calibration.

5. Faulty control board

- a. Check the MPU sensor output voltage at the base board.
 - i. If the MPU output is OK, check for MPU voltage at J11-9 (MAG PICK+) to J11-10 (MAG PICK-) while cranking.
 - ii. If the MPU voltage is OK, replace the control board. If not OK, use continuity checks to isolate connectors and/or harness.

6. Damaged flywheel ring gear

- a. Inspect the flywheel for:
 - i. Damaged, malformed, missing or broken flywheel ring gear teeth
 - ii. Evidence of corrosion or other materials on or around the flywheel ring gear teeth
 - iii. Dirt or debris on the flywheel ring gear teeth

6.11 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 connections and wiring
2. Faulty oil pressure sensor
3. Incorrect calibrations in PowerCommand controls
4. Faulty control board

Diagnosis and Repair:

1. Faulty oil pressure sensor connections and wiring
 - a. Inspect the oil pressure sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the oil pressure sensor.
 - ii. Inspect for corroded pins, bent or broken pins, and 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 pins.
 - vi. Inspect the wiring for any damage or shorting.
2. Faulty oil pressure sensor
 - a. Check the oil pressure sensor supply voltage.
 - i. Disconnect the main harness connector from the oil pressure sensor.
 - ii. Measure the supply voltage using multimeter with the control powered and awake. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
 - b. Check the oil pressure sensor signal (sense) voltage.
 - i. Disconnect the main harness connector from the oil pressure sensor; supply power and ground must be supplied to the sender.
 - ii. Measure the signal voltage using multimeter with the control powered and awake. If the reading is between 0.5 and 4.5 V, then the signal voltage is correct. If not, the sensor is faulty.
3. Incorrect calibrations in the 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.
 - ii. Verify that the feature is defined properly as a 3 wire sensor in the calibration.
4. Faulty control board
 - a. Check the oil pressure sensor output voltage at control board.
 - b. If the sensor output is OK, check for oil pressure sensor voltage at J11-3 to J11-2 while cranking.
 - c. If the oil pressure sensor voltage is OK, replace the base board. If not OK, use continuity checks to isolate the connectors and/or harness.

6.12 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 connections and wiring
2. Faulty oil pressure sensor
3. Incorrect calibrations in PowerCommand controls
4. Faulty control board

Diagnosis and Repair:

1. Faulty oil pressure sensor connections and wiring
 - a. Inspect the oil pressure sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the oil pressure sensor.
 - ii. Inspect for corroded pins, bent or broken pins, and 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 pins.
 - vi. Inspect the wiring for any damage or shorting.
2. Faulty oil pressure sensor
 - a. Check the oil pressure sensor supply voltage.
 - i. Disconnect the main harness connector from the oil pressure sensor.
 - ii. Measure the supply voltage using a multimeter with the control powered and awake. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
 - b. Check the oil pressure sensor signal (sense) voltage.
 - i. Disconnect the main harness connector from the oil pressure sensor; supply power and ground must be supplied to the sender.
 - ii. Measure the signal voltage using a multimeter with the control powered and awake. If the reading is between 0.5 and 4.5 V, then the signal voltage is correct. If not, the sensor is faulty.
3. 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.
 - ii. Verify that the feature is defined as a 3 wire sensor in the calibration.

4. Faulty control board
 - a. Check the oil pressure sensor output voltage at control board.
 - b. If the sensor output is OK, check for oil pressure sensor voltage at J11-3 to J11-2 while cranking.
 - c. If the oil pressure sensor voltage is OK, replace the base board. If not OK, use continuity checks to isolate the connectors and/or harness.

6.13 Code 143 - Engine Oil Pressure Low (Warning)

Logic: Engine oil pressure is below the low oil pressure warning threshold (40 psig for 5 seconds).

Possible Cause:

1. Low lubricating oil level
2. External leak
3. Fault simulation enabled or threshold set too high
4. Incorrect calibrations in PowerCommand controls
5. Plugged lubricating oil cooler
6. Inaccurate or blocked oil pressure sensor
7. Faulty main oil pressure regulator
8. Faulty lubricating oil pump

Diagnosis and Repair:

1. Low lubricating oil level
 - 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 cap screws, pipe plugs, and fittings.
 - c. Replace gaskets, if necessary.
3. Fault simulation enabled or threshold set too high
 - a. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
 - b. Verify that the fault threshold is not within the normal operating range for the oil pressure sensor.
4. Incorrect calibrations in the 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.

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- ii. Verify that the feature is defined as 3 wires in calibration.
5. Plugged lubricating oil cooler
 - a. Refer to the engine service manual.
 6. Inaccurate or blocked oil pressure sensor
 - a. Verify oil pressure is near zero with the engine off and the control powered and awake. If the pressure is not near zero, the sensor is faulty or the PCC calibration is not correct.
 - b. Connect a mechanical oil pressure gauge of known quality and calibration to the engine.
 - c. Only proceed if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
 - d. Start the generator set.
 - e. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
 - If readings are substantially different, the oil pressure sender is obstructed or faulty.
 - If the oil pressure reading is below specification, refer to the engine service manual.
 7. Faulty main oil pressure regulator
 - a. Refer to the engine service manual.
 8. Faulty lubricating oil pump
 - a. Refer to the engine service manual.

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

Logic:

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

Possible Causes:

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

Diagnosis and Repair:

1. Faulty coolant temperature sensor connections
 - a. Inspect the coolant temperature sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the coolant 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 coolant temperature sensor
 - a. Check the resistance of the sensor.
 - 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. Sensor resistance is approximately linear over two segments: 540 Ohms at -40 °F to 1100 ohms at 100 °F, and 1100 ohms at 100 °F to 1800 ohms at 230 °F. If calculated temperature differs from unit display by more than 8 °F, replace the sensor.
- 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.

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

Logic:

Engine coolant temperature signal voltage is out of range – shorted high.

Possible Causes:

- 1. Faulty coolant temperature sensor connections
- 2. Faulty coolant temperature sensor
- 3. Incorrect controller calibrations

Diagnosis and Repair:

- 1. Faulty coolant temperature sensor connections
 - a. Inspect the coolant temperature sensor and the harness connector pins.
 - b. Disconnect the engine harness connector from the coolant temperature sensor.

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- 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.
 - i. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
 - e. Inspect for missing or damaged connector seals.
 - f. Inspect for dirt or debris in or on the connector pins.
2. Faulty coolant temperature sensor
- a. Check the resistance of the sensor.
 - i. Disconnect the engine harness connector from the coolant temperature sensor.
 - ii. Measure the resistance between the coolant temperature signal pin and the coolant temperature sensor return pin. Sensor resistance is approximately linear over two segments: 540 Ohms at -40 °F to 1100 Ohms at 100 °F, and 1100 Ohms at 100 °F to 1800 Ohms at 230 °F. If calculated temperature differs from unit display by more than 8 °F, replace the sensor.
3. Incorrect controller calibrations
- a. Using the display or the InPower Service tool, verify the calibration in the PCC control
 - i. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

6.16 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 Cause:

1. High ambient temperature
2. Coolant level is below specification
3. Cooling system components are damaged or obstructed
4. Inaccurate coolant temperature sensor
5. Fault simulation feature is enabled
6. Thermostat is faulty
7. Water pump is malfunctioning
8. Air or combustion gases are 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 is 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. Cooling system components are damaged or obstructed
 - 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 contaminants (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.

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- 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. Sensor resistance is approximately linear over two segments:
 - 540 Ohms at -40 °F (-40 °C) to 1100 Ohms at 100 °F (38 °C)
 - 1100 Ohms at 100 °F (38 °C) to 1800 Ohms at 230 °F (110 °C)If the calculated 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 is 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. Thermostat is faulty
 - a. Refer to the engine service manual.
 7. Water pump is malfunctioning
 - a. Refer to the engine service manual.
 8. Air or combustion gases are entering the cooling system
 - a. Refer to the engine service manual.

6.17 Code 151 - Engine Coolant Temperature High (Shutdown)

Logic:

Engine coolant temperature has exceeded the shutdown threshold (230 °F/110 °C) for high coolant temperature

Possible Cause:

1. High ambient temperature
2. Coolant level is below specification
3. Cooling system components are damaged or obstructed
4. Inaccurate coolant temperature sensor
5. Fault simulation feature is enabled

6. Thermostat is faulty
7. Water pump is malfunctioning
8. Air or combustion gases are entering the cooling system

Diagnosis and Repair

1. High ambient temperature
 - a. Measure air temperature entering the air intake louver of the generator set enclosure when equipped or cooling air to the radiator when not enclosed.
 - b. Verify the expected cooling system ambient temperature capability.
 - c. Inspect for recirculation of cooling discharge air into generator set enclosure air inlet or the area surrounding the radiator cooling air inlet.
2. Coolant level is 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. Cooling system components are damaged or obstructed
 - a. Inspect 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 blockage.
 - b. Inspect fan shroud for damage and clearance.
 - i. Repair or replace if damaged.
 - c. Inspect fan belt(s) for damage, wear, and proper tension. Inspect pulleys and belt tensioner for damage or wear.
 - i. Repair or replace if damaged or worn.
 - d. Inspect radiator cap and gasket for damage and proper pressure operation.
 - i. Replace if not operating correctly.
 - e. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
 - i. Replace if damaged or worn.
 - f. Inspect cooling system components for internal contaminants (dirt, scale, or sludge) and clean as required.
 - i. Open the radiator cap and inspect for contaminated coolant and scale.
 - ii. Flush cooling system per engine service manual.

4. Inaccurate coolant temperature sensor

- a. Measure the coolant temperature near the sender and compare 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. Sensor resistance is approximately linear over two segments: 540 Ohms at -40 °F to 1100 ohms at 100 °F, and 1100 ohms at 100 °F to 1800 ohms at 230 °F. If calculated temperature differs from unit display by more than 8 °F, 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 is 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. Thermostat is faulty

- a. Refer to the engine service manual.

7. Water pump is malfunctioning

- a. Refer to the engine service manual.

8. Air or combustion gases are entering the cooling system

- a. Refer to the engine service manual.

6.18 Code 234 - Engine Speed High (Shutdown)

Logic:

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

Possible Causes:

1. Faulty magnetic pickup (MPU) sensor connections and wiring
2. Faulty MPU sensor
3. Improper installation of MPU
4. Fault simulation feature is enabled
5. Incorrect threshold setting

6. Incorrect calibrations in the PowerCommand control (PCC)
7. Flywheel teeth number is incorrectly set in the PCC
8. Engine speed higher than shutdown threshold

Diagnosis and Repair:

1. Faulty magnetic pickup (MPU) sensor connections and wiring
 - a. Inspect the MPU sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the MPU 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
2. Faulty MPU sensor
 - a. Faulty MPU sensor
 - i. Disconnect the main harness connector from the MPU sensor.
 - ii. Remove the MPU connectors and check for 3.5 to 15 VAC at the MPU while cranking. If no output, check for damage or debris on the MPU. If there is still no output, replace the MPU sensor.
3. Improper installation of MPU
 - a. Inspect the installation of MPU sensor.
 - i. Inspect the installation to check if the gap is proper between MPU tip and flywheel teeth.
 - ii. Adjust if not as per specification. Refer to the procedure in the service manual.
 - A. Set the clearance from the MPU tip to the ring gear teeth to 0.5 - 0.6 mm.
 - The preferred method of setting the MPU tip clearance is to use a feeler gauge.
 - An alternate method is to rotate the flywheel until the ring gear tooth is directly over the center of the MPU hole; then gently rotate the MPU until it touches the tooth. Back off $\frac{1}{4}$ turn and tighten the jam nut.

⚠ CAUTION

Prevent the MPU from rotating when tightening the lock nut. Failure to do so may cause damage to the sensor tip.

- iii. Check for the correctness of orientation of the MPU mounting as applicable. Verify linear alignment of the MPU with the flywheel ring gear.
4. Fault simulation feature is enabled
 - a. Connect InPower.
 - b. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
5. 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.
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 MPU sensor feature is enabled in calibration.
7. Flywheel teeth number is incorrectly set in the PCC
 - a. Ensure that the correct number of flywheel teeth is set in the PCC control.
 - i. Access the Flywheel Teeth setup screen through the operator panel and ensure that the PCC is set up with the correct number of engine flywheel teeth (110).
8. Engine speed higher than shutdown threshold
 - The engine speed governor is not operating correctly.
 - Refer to the engine service manual.

6.19 Code 359 - Engine Fail to Start

Logic:

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

Possible Causes:

1. Low fuel level
2. Closed shutoff valve in the fuel supply line
3. The fuel solenoid fuse is open
4. Failed intake air heater relay
5. Failed fuel solenoid
6. There is air in the fuel system
7. Failed intake air heater
8. The fuel injectors are clogged

Diagnosis and Repair:

1. Low fuel level
 - a. Check fuel level.
 - i. Open fuel tank and inspect level of fuel.
 - ii. Add fuel if needed.
 - iii. Bleed air from fuel system.
2. Closed shutoff valve in the fuel supply line
 - a. Check supply fuel lines.
 - i. Trace fuel supply line for shut off valve.
 - ii. Open any shut off valves that are closed.
3. The fuel solenoid fuse is open
 - a. Check fuse.
 - i. Set multimeter to ohms.
 - ii. Remove the fuse (if installed) and check continuity.
 - iii. If fuse is open, replace the fuse with one of the same type and amp rating.
 - iv. If the fuse reopens, check wiring continuity of the fuel solenoid circuit/test fuel solenoid.
4. Failed intake air heater relay
 - a. Check relay.
 - i. Set multimeter to VDC.
 - ii. Check for B+ at the intake air heater relay, If not present, check for an open circuit.
 - iii. If there is B+ at the intake air heater relay, attempt to start and test for B+ at the other end of the intake air heater relay.
 - iv. If B+ is present, check for an open circuit between the intake air heater relay contact and the intake air heater.

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5. Failed fuel solenoid
 - a. Test solenoid.
 - i. Set multimeter to VDC.
 - ii. Attempt to start the engine and check for B+ at the fuel solenoid coil.
 - iii. If B+ is present, the fuel solenoid is defective and must be replaced.
 6. There is air in the fuel system
 - a. Bleed air from fuel system. Refer to the engine service manual.
 7. Failed intake air heater
 - a. Check intake air heater.
 - i. The intake air heater should be hot to the touch if the engine has just been cranking.
 - ii. Clean and tighten the terminals of the intake air heater.
 - iii. Replace if needed.
 8. The fuel injectors are clogged
 - a. Refer to the engine service manual.

6.20 Code 415 - Engine Oil Pressure Low (Shutdown)

Logic: Engine oil pressure is below the low oil pressure shutdown threshold (35 psig).

Possible Causes:

1. Lubricating oil level is low
2. External leak
3. Fault simulation is enabled or the threshold is set too high
4. Incorrect calibrations in PowerCommand controls
5. Lubricating oil cooler is plugged
6. Oil pressure sensor is inaccurate or blocked
7. Main oil pressure regulator is faulty
8. Lubricating oil pump is faulty

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, if necessary.
- 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 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.
- 4. 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.
 - ii. Verify that the feature is defined properly as a 3 wire sensor in the calibration.
- 5. Lubricating oil cooler is plugged
 - Refer to the engine service manual.
- 6. Oil pressure sensor is inaccurate or blocked
 - a. Verify oil pressure is near zero with the engine off and the control powered and awake. If the pressure is not near zero, the sensor is faulty or the PCC calibration is not correct.
 - b. Connect a mechanical oil pressure gauge of known quality and calibration to the engine at one of the plugs on top of the oil filter head.
 - c. Start the generator set only if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
 - d. Compare the oil pressure reading on the control to the reading on the mechanical oil pressure gauge.
 - If the readings are substantially different, the oil pressure sender is obstructed or faulty.
 - If the oil pressure reading is below specification, refer to the engine service manual.
- 7. Main oil pressure regulator is faulty
 - Refer to the engine service manual.
- 8. Lubricating oil pump is faulty
 - Refer to the engine service manual.

6.21 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 or 24 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 as 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 on a 12 VDC system and 22 to 28.4 V on a 24 VDC system, 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 the supply wire to be shorted to the engine block.

6. Faulty engine DC alternator
 - a. Check the engine DC alternator.
 - a. If normal charging voltage is not 12-14 VDC in a 12 VDC system or 24-26 VDC in a 24 VDC system, then troubleshoot the DC alternator. Refer to the engine service manual.
7. Battery voltage (12 VDC or 24 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's 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.

6.22 Code 442 - High Battery Voltage

Logic:

Battery voltage is above the high battery threshold voltage setting (16 V for 60 seconds)

Possible Causes:

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

Diagnosis and Repair:

1. A 12 VDC battery is connected but the charger is set for 24 VDC
 - a. Verify that the battery charger is set to 12 VDC.
2. Fault threshold is incorrect
 - a. Check the fault threshold values 16 V, 60 seconds.
3. 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 Refer to the engine service manual.

6.23 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.

6.24 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-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 Coolant).

Possible Cause:

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:
 - Corroded, bent, broken, pushed back, or expanded pins
 - Evidence of moisture in or on the connector
 - Missing or damaged connector seals
 - Dirt or debris in or on the connector pins
 - 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+ 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 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
 - a. Verify calibration setting for Configurable Input #3 as "Fault Active State Selection = Active Closed".
- 5. Faulty control board
 - a. If the sender, harness and control settings are acceptable, replace the base board.

6.25 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 Cause:

1. Low fuel level
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 level
 - a. Add the manufacturer's prescribed fuel.

2. Faulty or inoperable switch

- a. 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 because that activates the fault.

4. Incorrect fault function settings are programmed into the control calibration

- a. Verify that control values match the parameters necessary for fault detection.

6.26 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.

6.27 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.

6.28 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.

6.29 Code 1435 - Low Coolant Temperature (Warning)

Logic:

The engine coolant temperature is below the low coolant temperature warning threshold (50 °F [10 °C] for D1703M and V2203M engines).

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. Ensure that the power supply of the coolant heater is on, and has power at the connection.
 - ii. Check for open circuits in the coolant heater. If the coolant temperature is above the heater thermostat setting the coolant heater will not be active, and thus show an open circuit.
 - b. The temperature is close to the ambient temperature when the ambient air temperature is below the coolant heater thermostat setting, replace the coolant heater(s).

- c. If the ambient temperature is very low, do not replace the coolant heater; check that the coolant heater thermostat is operating properly.
- 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.

6.30 Code 1438 - Fail to Crank (Shutdown)

Logic:

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

Possible Cause:

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 terminal 87 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 terminal 86 on the starter relay and J20-13 control board terminal. Resistance should be less than 1 Ohm.
- b. Check wiring for continuity between terminal 85 on the starter relay and J20-15 control board terminal. Resistance should be less than 1 Ohm.
- c. Check for B+ at terminal 30 on the starter relay. If voltage is not present, verify the 20 Amp fuse is in place and functional.
- d. Attempt to start the generator set and test for B+ at terminal 86 of the starter relay.
- e. Check wiring for continuity between terminal 85 of the starter relay and ground. Resistance should be less than 1 Ohm.
- f. Attempt to start the generator and test for B+ at terminal 87 of 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 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.

6.31 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).

6.32 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
6. Faulty EBS (Excitation Boost System) or EBS installed incorrectly (if used)

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.
6. Faulty EBS (Excitation Boost System) or EBS installed incorrectly (if used)
 - a. Connect with the InPower service tool and change the Local Status Output Function to Default.
 - b. Disconnect the EBS field jack from the alternator field plug.

- c. Disconnect the EBS plug from the field jack (connected to P17-1, P17-2).
- d. Reconnect the alternator field plug to the field jack.
- e. The set is now connected in a Shunt configuration. Start the generator set and determine if the issue still exists.
- f. If the problem does not exist, the EBS is faulty; replace it.

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

Diagnosis and Repair:

1. Incorrect threshold setting or AVR settings
 - a. Check threshold settings.
 - b. Verify that the fault threshold matches the specification.
 - c. Verify AVR settings. Compare gains, settings, and calibration factors against default calibrations.

Parameter	15 OR 20 KW MODEL (NOMINAL VOLTAGE)		10 KW MODEL (NOMINAL VOLTAGE)	
	<600 V	≥600 V	<600 V	≥600 V
K1 (60 Hz)	1000	500	750	500
K2 (60 Hz)	650	600	600	650
K3 (60 Hz)	10000			
K4 (60 Hz)	36429			
AVR D Gain Adjust	100			
AVR Enable	Enable			
AVR Enable Speed Offset	100			

Parameter	15 OR 20 KW MODEL (NOMINAL VOLTAGE)		10 KW MODEL (NOMINAL VOLTAGE)	
	<600 V	≥600 V	<600 V	≥600 V
AVR Gain Adjust	100			
AVR K2 Gain Adjust	100			
AVR K3 Gain Adjust	100			
Damping Effect (60 Hz)	0.8			
Full Wave Enable Firing Angle	1			
V/Hz Knee Frequency	0.5			
V/Hz Rolloff Slope	2.2			
Voltage Adjust	0			

d. Adjust or recalibrate as necessary

2. Faulty rotating rectifier assembly (diodes CR1 through CR6)

a. Check each diode. Refer to the Alternator Performance Troubleshooting section.

3. Overload

a. Ensure 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 Imaging 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 ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.

4. Low residual magnetism in excitation coil

a. Excitation coil may need to be flashed:

i. Remove 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 Field Coil+ and Field Coil- leads to the alternator.

-
- iv. Reset the control, and restart the generator set.
 - 5. Improper connections at generator output terminals
 - a. Check connections.
 - i. Compare connections in the generator to the wiring schematic.
 - ii. Correct according to the appropriate schematic as needed.
 - 6. 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.
 - 7. Faulty PCC (AVR circuit)
 - a. Connect the InPower service tool.
 - b. Start the generator set.
 - c. Using InPower, verify that the AC voltage output is greater than the residual value (20 VAC L-N).
 - d. If the AC voltage output is residual, use InPower to verify that the AVR is enabled.
 - e. Turn off the generator set.
 - f. Inspect the generator control harness connector pins for voltage sense and field connections.
 - g. Inspect the harness for corroded pins, bent or broken pins, and/or pushed back or expanded pins.

6.34 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 InPower and ensure that the Alternator LX-N overrides are not enabled.
 - i. If required, disable 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. Ensure that the load on the generator set does not exceed the Genset 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 Imaging 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 ensure 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. Refer to the engine service manual.

6.35 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. Verify that the Overfrequency Threshold and Overfrequency Time Delay are set per specification.
2. Engine governor problem
 - a. For further information, refer to the engine service manual.

6.36 Code 1469 - Speed/Hz Mismatch

Logic:

The perceived engine speed and generator set output frequency do not match.

Possible Cause:

1. Flywheel teeth number is incorrectly set in the control
2. Faulty magnetic pickup (MPU) signal
3. Load induced frequency errors
4. Speed/frequency mismatch threshold is set incorrectly
5. Speed/frequency mismatch fault time is set incorrectly
6. Frequency-to-speed gain select is set incorrectly

Diagnosis and Repair:

1. Flywheel teeth number is incorrectly set in the control
 - a. Ensure that the correct number of flywheel teeth set in the PCC control.
 - i. Access the Flywheel Teeth setup screen through the operator panel and ensure that the PCC is set up with the correct number of engine flywheel teeth (110).
2. Faulty magnetic pickup (MPU) signal
 - a. Inspect the MPU sensor and the main harness connector pins.
 - i. Disconnect the main harness connector from the MPU 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. Inspect the installation of the MPU sensor.
 - i. Inspect the installation to check if the gap is proper between MPU tip and flywheel teeth.
 - ii. Adjust if not as set per specification.
 - A. Set the clearance from the MPU tip to the ring gear teeth to 0.5 - 0.6 mm.
 - The preferred method of setting the MPU tip clearance is to use a feeler gauge.
 - An alternate method is to rotate the flywheel until the ring gear tooth is directly over the center of the MPU hole; then gently rotate the MPU until it touches the tooth. Back off $\frac{1}{4}$ turn and tighten the jam nut.

⚠ CAUTION

Prevent the MPU from rotating when tightening the lock nut. Failure to do so may cause damage to the sensor tip.

- iii. Check for the correctness of orientation of the MPU mounting as applicable. Verify linear alignment of the MPU with the flywheel ring gear.
- c. Check the MPU sensor output voltage.
 - i. Disconnect the main harness connector from the MPU sensor.
 - ii. Remove the MPU connectors and check for 3.5 to 15 VAC at the MPU while cranking. If no output, check for damage or debris on end of the MPU. If there is still no output, replace the MPU sensor.
- 3. Load induced frequency errors
 - a. Non-linear loads like Uninterruptible Power Supply (UPS) and certain types of lighting can have a considerable influence on a generator which can cause significant frequency fluctuations that do not match measured engine speed; for example, a UPS causes 62 Hz at 1800 RPM. This is an application issue; correct the application issue and refer to the T030 manual.
- 4. Speed/frequency mismatch threshold is set incorrectly
 - a. Connect with InPower.
 - b. Make sure the speed/frequency mismatch threshold is set to 2.0 Hz.
- 5. Speed/frequency mismatch fault time is set incorrectly
 - a. Connect with InPower.
 - b. Make sure the speed/frequency mismatch threshold time is set to 1.5 seconds.
- 6. Frequency-to-speed gain select is set incorrectly
 - a. Connect with InPower.
 - b. Make sure the frequency-to-speed gain select is set properly (30 RPM/Hz).

6.37 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. Ensure 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 caused by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imaging Equipment, Fire Pumps, and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set.
 - c. 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.
3. Incorrect CTs, CT connections, or CT setup
 - a. Check CTs.
 - i. Use the relevant parts manual to check that correct CT(s) are been installed.
 - ii. Check that CT connections are secure.
 - iii. Check that CTs are installed correctly.
 - CTs are on the correct lead.
 - CTs are the proper polarity. (Dot facing the current source.)
 - iv. Connect InPower.
 - v. Verify the correct CT ratio has been used.
 - vi. Adjust the setting as necessary.
 - vii. 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 continuity between pins 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 as necessary.
5. Incorrect rating setup
 - a. Connect InPower.
 - b. Verify the generator set rating is set correctly.
 - c. Adjust settings as necessary.
6. Fault override enabled
 - a. Connect with InPower and ensure that the fault is not enabled.
 - b. If InPower is not available, cycle power to the control:
 - i. Press the Emergency 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.

6.38 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. Ensure 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 caused by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imaging Equipment, Fire Pumps, and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set.
 - c. 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.
3. Incorrect CTs, CT connections, or CT setup
 - a. Check CTs.
 - i. Use the relevant parts manual to check that correct CT(s) are been installed.
 - ii. Check that CT connections are secure.
 - iii. Check that CTs are installed correctly.
 - CTs are on the correct lead.
 - CTs are the proper polarity. (Dot facing the current source.)
 - iv. Connect InPower.
 - v. Verify the correct CT ratio has been used.
 - vi. Adjust the setting as necessary.
 - vii. 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 as necessary.
5. Incorrect rating setup
 - a. Connect InPower.
 - b. Verify the generator set rating is set correctly.
 - c. Verify CT ratings in the control are set correctly.
 - d. Adjust settings as necessary.
6. Fault override enabled
 - a. Connect with InPower and ensure that the fault is not enabled.
 - b. If InPower is not available, cycle power to the control:
 - i. Press the Emergency 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 the calibration.

6.39 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.

6.40 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.

6.41 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.

6.42 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.

6.43 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.

6.44 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:
$$\text{Alternator Line Frequency} * \text{Alternator Line Frequency Gain} = \text{Alternator Excitation Frequency}$$
- 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.

6.45 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 actuator in fuel pump
2. Failed governor module or governor module wiring

Diagnosis and Repair:

1. Stuck fuel actuator and fuel shutoff valve
 - a. Refer to the engine service manual.

2. Failed governor module or governor module wiring
 - a. Verify that the governor drive signal on the Aux104 governor module (J1-4) is high impedance to ground (greater than 10,000 Ohms) when the generator set is off.
 - If low impedance, inspect wiring for short to ground.
 - If no wiring issues are identified, replace the Aux104 board.

6.46 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 1302 is incorrect. Make sure there is proper wiring.
 - PCC 1302 TB1-1 – PCC Net A (+) to AUX 101 J1-3
 - PCC 1302 TB1-2 – PCC Net B (-) to AUX 101 J1-4
 - PCC 1302 TB1-3 – B+ Return to AUX 101 J14-2
 - PCC 1302 TB1-5 – Customer Fused B+ to AUX 101 J14-1
 - PCC 1302 TB15-5 – System Wake-up to AUX 101 J1-5
2. I/O settings misconfigured
 - a. If no AUX 101 is connected to PCC 1302, 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.

6.47 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 1302 is incorrect. Make sure there is proper wiring.
 - PCC 1302 TB1-1 – PCC Net A (+) to AUX 101 J1-3
 - PCC 1302 TB1-2 – PCC Net B (-) to AUX 101 J1-4
 - PCC 1302 TB1-3 – B+ Return to AUX 101 J14-2
 - PCC 1302 TB1-5 – Customer Fused B+ to AUX 101 J14-1
 - PCC 1302 TB15-5 – System Wake-up to AUX 101 J1-5
2. I/O settings misconfigured
 - a. If no AUX 101 is connected to PCC 1302, 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.

6.48 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.

6.49 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.

6.50 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.

6.51 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.

6.52 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.).

6.53 Code 5134 - Unknown Shutdown

Logic: PCC has detected that engine RPM has decreased to zero, while not in run at rated mode

Possible Causes:

1. Incorrect calibration in the PowerCommand control
2. Air intake or exhaust restriction
3. MPU signal loss
4. Improper start disconnect
5. Fuel supply issue
6. Faulty control board

Diagnosis and Repair:

1. Incorrect calibration in the PowerCommand control
2. Air intake or exhaust restriction
 - a. Intake restriction
 - Inspect air intake system and filter for debris.
 - b. Exhaust restriction
 - Inspect exhaust system for debris or leaks.
3. MPU signal loss
 - a. Faulty Magnetic Pickup (MPU) sensor connections and wiring.
 - i. Inspect the MPU sensor and the main harness connector pins.
 - A. Disconnect the main harness connector from the MPU sensor.
 - B. Inspect for corroded, bent, broken, pushed back, expanded, or loose pins.
 - C. Inspect for evidence of moisture in or on the connector. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
 - D. Inspect for missing or damaged connector seals.
 - E. Inspect for dirt or debris in or on the connector pins.
 - F. Inspect the wiring for any damage or shorting
 - b. Improper installation of the MPU sensor
 - i. Inspect the installation of the MPU sensor.
 - A. Check if the clearance between the MPU sensor tip and the flywheel teeth is correct.
 - B. Adjust if not as per specification.
 - A. Set the clearance from the MPU tip to the ring gear teeth to 0.5 - 0.6 mm.

- B. The preferred method of setting the MPU tip clearance is to use a feeler gauge.
- C. An alternate method is to rotate the flywheel until the ring gear tooth is directly over the center of the MPU hole; then gently rotate the MPU until it touches the tooth. Back off $\frac{1}{4}$ turn and tighten the jam nut.

NOTICE

Prevent the MPU from rotating when tightening the lock nut. Failure to do so may cause damage to the sensor tip.

- C. Check for the correctness of orientation of the MPU sensor mounting as applicable. Verify linear alignment of the MPU sensor with the flywheel ring gear.
- c. Faulty MPU sensor
 - i. Check the MPU sensor output voltage.
 - A. Disconnect the main harness connector from the MPU sensor.
 - B. Remove the MPU sensor connectors and check for 3.5 to 15 VAC at the MPU while cranking. If no output, check for damage or debris on the end of the MPU, and for proper installation of MPU (see above). If there is still no output, replace the MPU sensor.
 - d. Verify that the MPU sensor feature is enabled in calibration.
- 4. Improper start disconnect
 - a. One or more start disconnect signal is activating too soon after cranking, causing the starter to drop out, and the engine to stop.
 - i. Starter disconnect set incorrectly in InPower.
 - 12V Charging Alternator Disconnect Voltage: 9 VDC
 - Starter Disconnect Speed: 450 RPM
 - Flywheel Teeth: 110
 - ii. Connect with InPower, and monitor Battery Charging Alternator Voltage during cranking. If voltage exceeds 9 VDC, increase 12V Charging Alternator Disconnect Voltage to just above the peak seen during cranking.
- 5. Fuel supply issue
 - a. Restricted fuel supply
 - i. The fuel level is below the pickup tube in tank.
 - Add fuel if low. Prime the fuel system.
 - ii. The shutoff valve in the supply line is closed.
 - Open any closed shutoff valve in the fuel line supplying the engine.

- iii. The fuel filter or strainer is plugged.
 - Replace the fuel filter or strainer
 - b. The fuel solenoid fuse is open.
 - i. Check fuse.
 - Set multimeter to VDC.
 - Attempt to start the engine and check for B+ at the fuel solenoid coil.
 - If B+ is present, the fuel solenoid is defective and must be replaced.
 - c. There is air in the fuel system.
 - i. Bleed air from the fuel system.
 - d. Fuel injectors are clogged.
 - i. Refer to the engine service manual.
6. Faulty control board
- a. If none of the previous steps solved the issue, replace the PCC board.

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7 Fuses and Relays

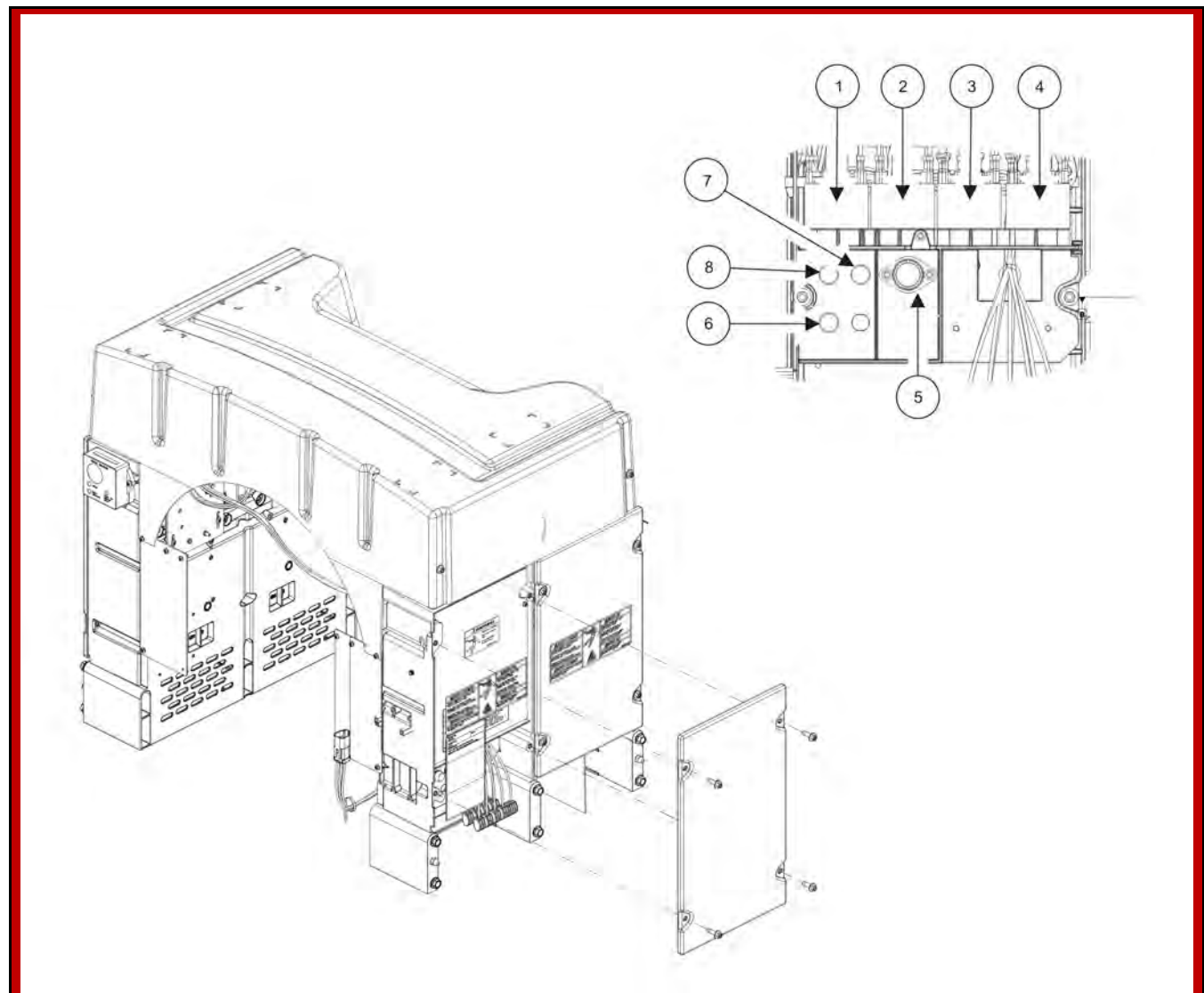
WARNING

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.

7.1 Fuse and Relay Locations



No	Description	No	Description
1	Power Relay (K2)	5	Fuse, 10A, 600 VAC (F5)
2	Power Relay (K4)	6	Fuse, 10A, 250 VAC (F3)
3	Power Relay (K8)	7	Fuse, 10A, 250 VAC (F2)
4	Power Relay (K5)	8	Fuse, 20A, 32 VAC (F1)

7.2 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.

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8 Sensors

The following figure shows the locations of the sensors and senders to which the PCC responds for the engine.

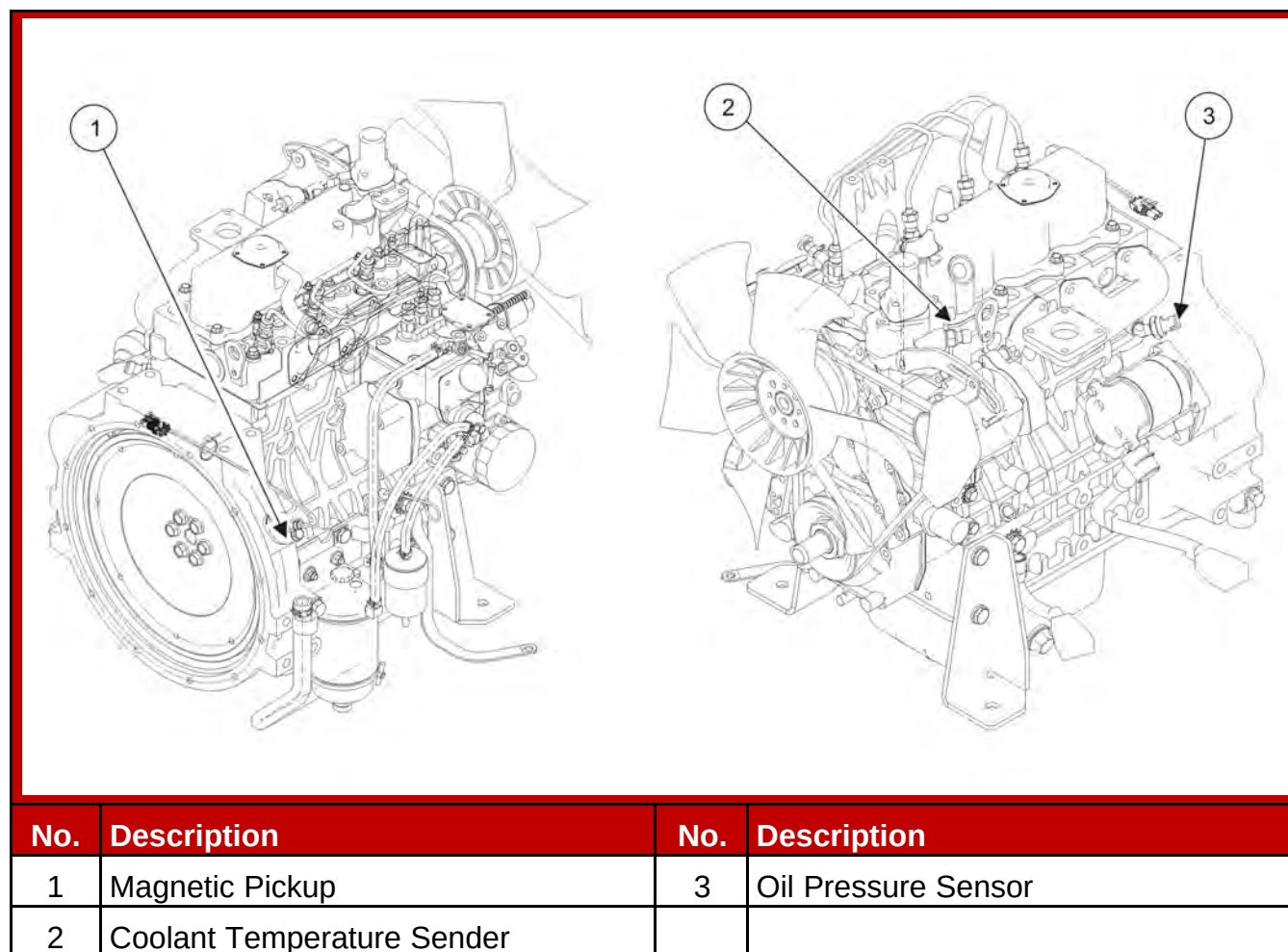


FIGURE 5. D1703M OR V2203M ENGINE SENSOR AND SENDER LOCATIONS

8.2 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.

8.3 Engine Coolant Temperature (ECT) Sensor

The PCC monitors the engine coolant temperature through the ECT (Engine Coolant Temperature) sensor mounted on the engine. The PCC uses this sensor input to protect the engine from overheating during normal operation.

8.4 Magnetic Pickup (MPU) Sensor

The Magnetic Pickup (MPU) sensor is used to determine engine RPM.

8.5 Additional Sensors

Refer to the specific engine manual for other engine-mounted sensors.

9 Fuel System Adjustments

NOTICE

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

9.1 Fuel System

WARNING

Fuel ignition.

Ignition of fuel can cause serious personal injury or death by fire or explosion.

DO NOT permit any flame, cigarette, or other igniter near the fuel system, or in areas sharing ventilation.

WARNING

Fuel mixtures.

Mixing gasoline or alcohol with diesel fuel, can cause an explosion which may result in severe personal injury or death.

Do not mix gasoline or alcohol with diesel fuels.

NOTICE

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

See the *Model Specifications* section for fuel requirements.

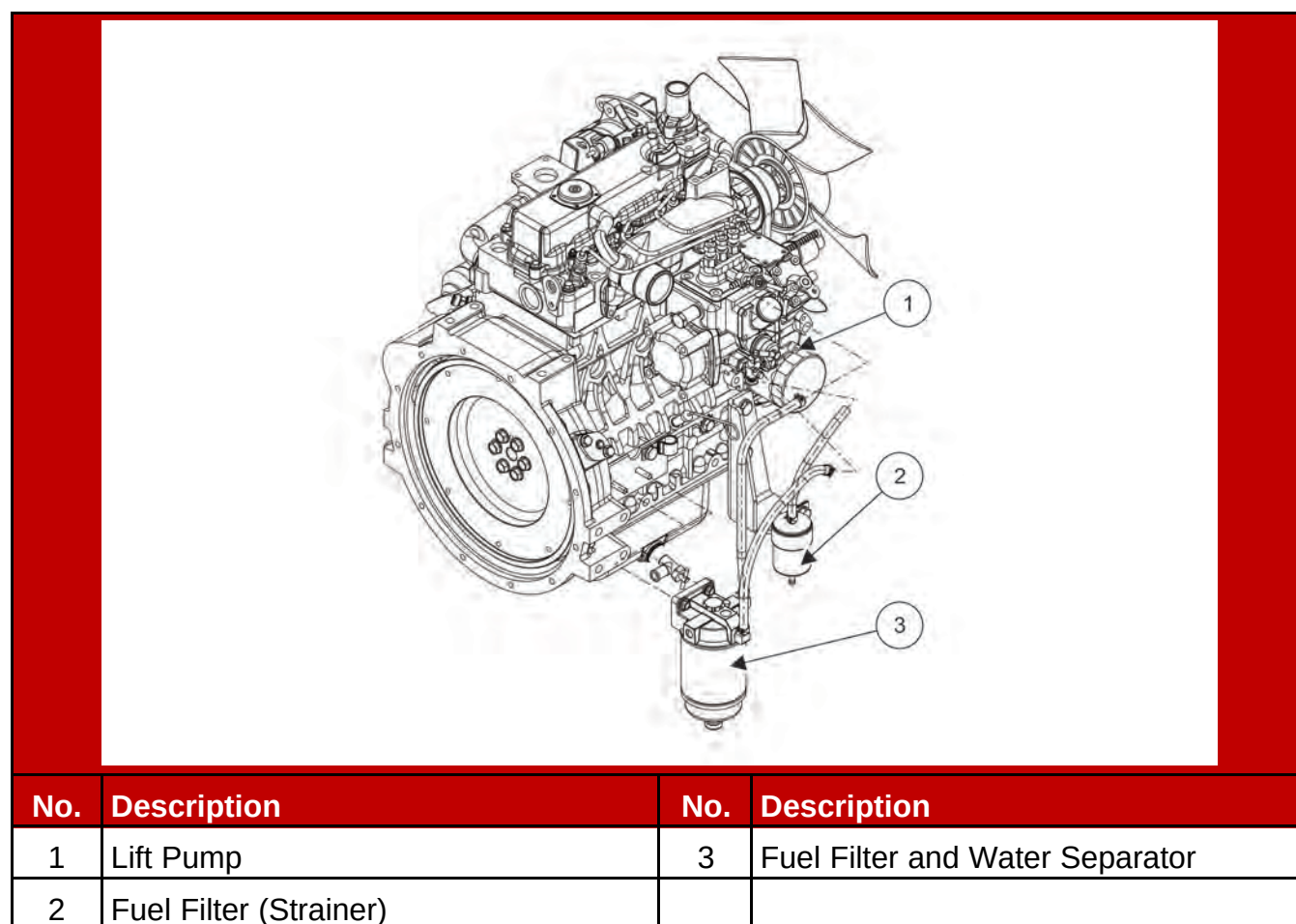


FIGURE 6. LOCATIONS OF LIFT PUMP, FUEL FILTER AND FUEL WATER SEPARATOR

9.2 Air Bleeding

The engine may not start or run properly when air is present in the engine fuel system. Air may be present in the fuel system for a variety of reasons, such as a new installation of the generator set, changing the fuel filter, running out of fuel, etc. Air must be removed (bled) from the engine fuel system for proper generator set operation.

There are two manual priming pumps on the generator set. The first is a manual priming pump (fuel filter priming pump). The pump plunger handle is screwed into the filter head. Turn the knob on the pump handle counterclockwise and pull up from the filter head. The pump is activated by moving the pump plunger up and down.

The second priming pump (fuel pump priming pump) is built into the engine's fuel pump. This pump is operated with a lever on the engine fuel pump that acts against the pump diaphragm that is used when the engine is running. To pump fuel, push the lever down full travel, let it return, and repeat. The pump diaphragm is driven off a cam in the engine when it is running. The engine can stop with the cam in a location that pushes against the diaphragm. Under this condition, the manual lever does not move the diaphragm and the pump does not work. To resolve this problem, rotate the cam to a new position by briefly engaging the starter motor, without starting the engine.

A noticeable increase in the resistance in operating the manual priming lever is an indication that the air has been purged from the fuel injection pump.

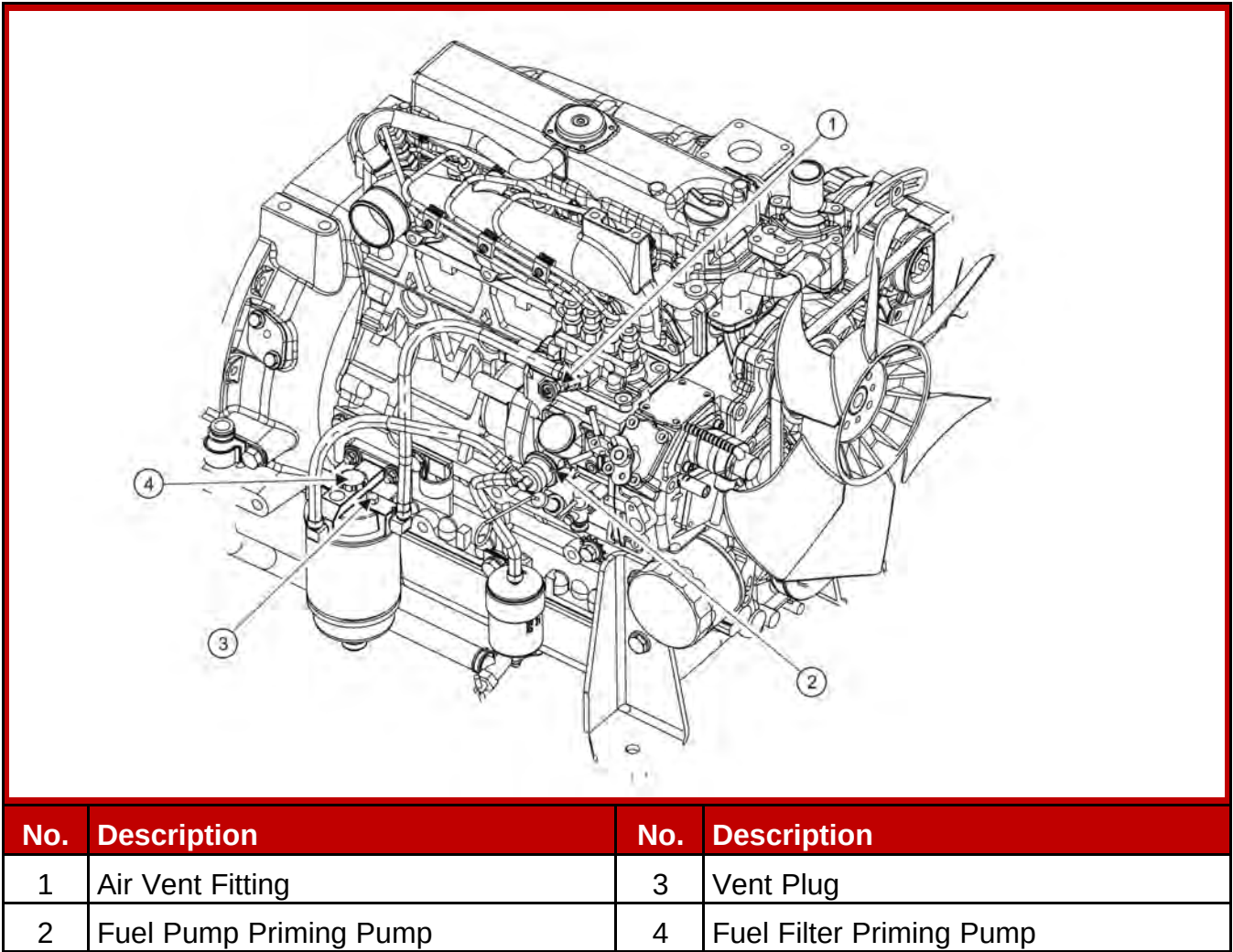


FIGURE 7. ENGINE COMPONENTS

NOTICE

If a new fuel filter has been installed or there is no fuel evident in the clear bowl on the filter, the filter needs to be filled with fuel before performing the air bleed process.

To fill the fuel filter:

1. Open the manual fuel filter priming pump.
2. Loosen the vent on the fuel filter head.
3. Operate the fuel filter head priming pump until fuel comes out of the vent fitting area.
4. Tighten the vent fitting.

To bleed (remove) the air the fuel system for proper generator set operation:

1. Prepare the manual fuel filter priming pump.
2. Using the manual priming pump lever on the engine, operate the lever several times to note its resistance to movement.
3. Using the priming pump on the fuel filter head, move the plunger handle up and down 10 to 15 times.
4. Return to the manual pump lever and note its resistance.
 - If there is a marked change in resistance, air has been bled from the injection pump.
 - If no difference is observed, open the air vent fitting by turning it counterclockwise to allow air to escape, immediately after the air is vented close the air vent fitting.
5. Repeat steps 3 and 4 as many times as necessary to bleed the injection pump.
6. Verify that the air vent fitting is closed.
7. Return the manual fuel filter priming pump to the original position screwed in the filter head.
8. Verify that the engine starts and runs acceptably. If the engine does not start or run acceptably, there may be air in the fuel injection lines. Repeat the air bleed procedure until all air is bled from the engine fuel system.

9.3 Fuel Level

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

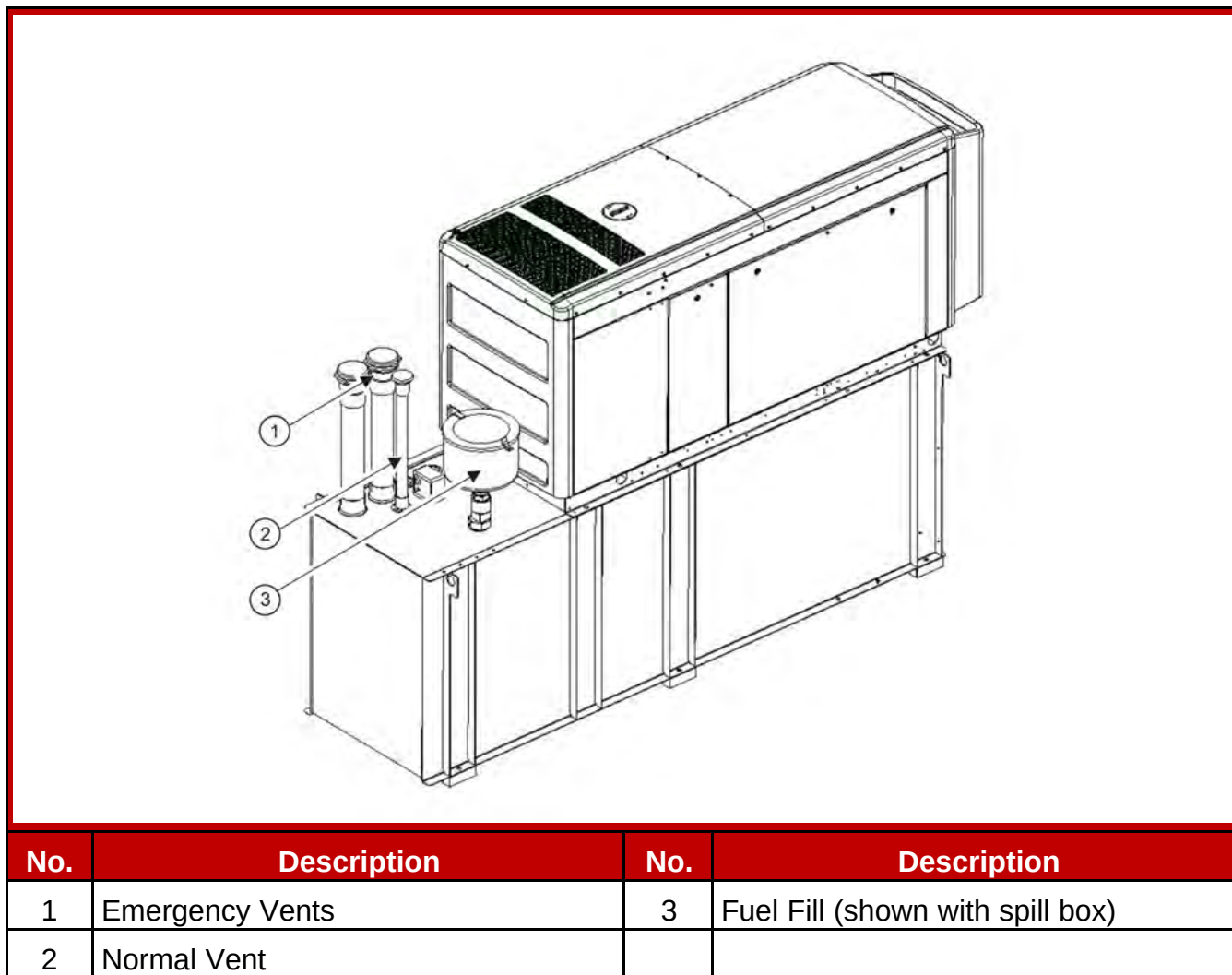
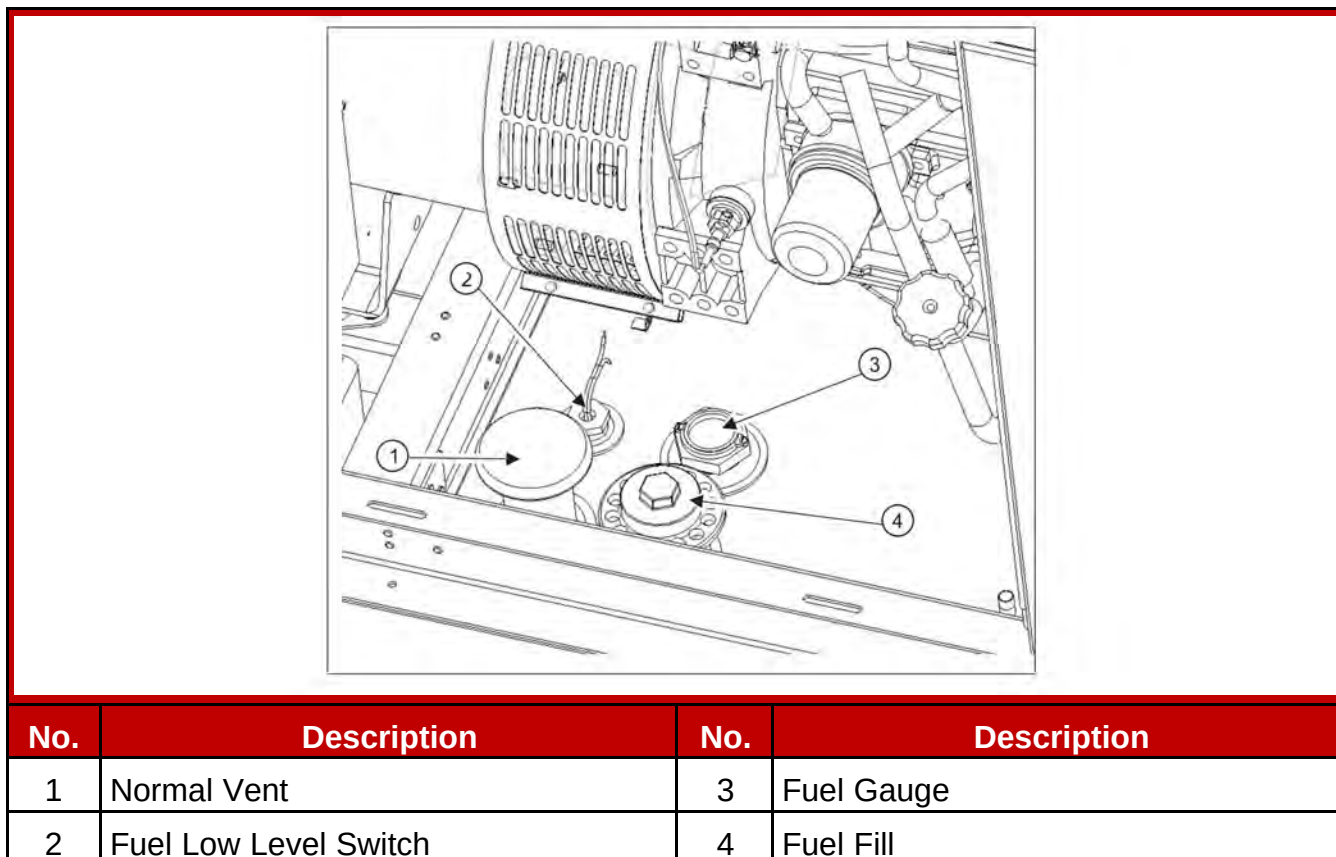


FIGURE 8. EXAMPLE OF REGIONAL FUEL TANK OPTION

**FIGURE 9. EXAMPLE OF BASIC FUEL TANK OPTION**

10 Air Intake System

10.1 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 25 in water column (6.2 kPa), at which point the filter elements should be changed.

10.2 Normal Duty Air Cleaner

Normal Duty Air Cleaner Element Removal

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 Inc. does not recommend cleaning paper-type air cleaner elements.

1. Loosen the strap clamp (2).
2. 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.
3. Remove the dirty cleaner (1).
4. Dispose of the dirty element in accordance with local environmental agency requirements.

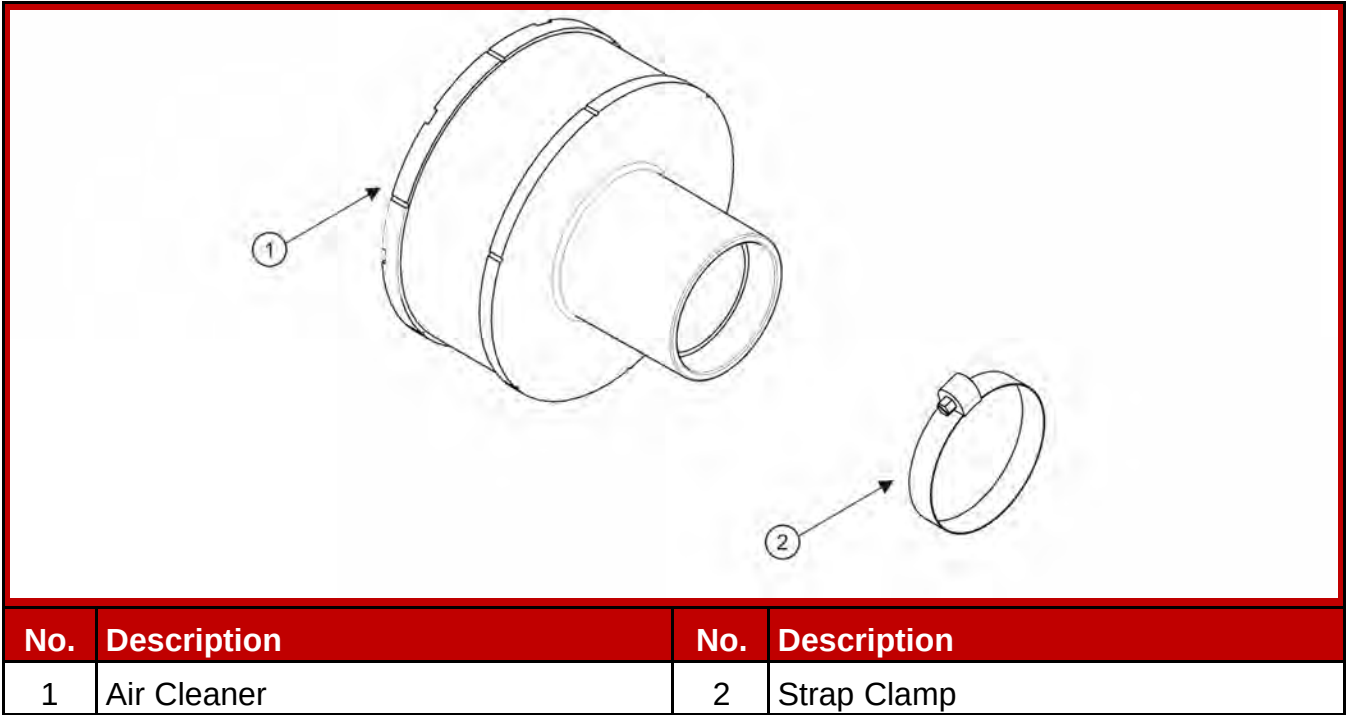


FIGURE 10. NORMAL DUTY AIR CLEANER

Normal Duty Air Cleaner Element Installation

Install the air cleaner as follows:

1. Install the air cleaner (1).
2. Tighten strap clamp (2) to 3.4 to 4.5 Nm.

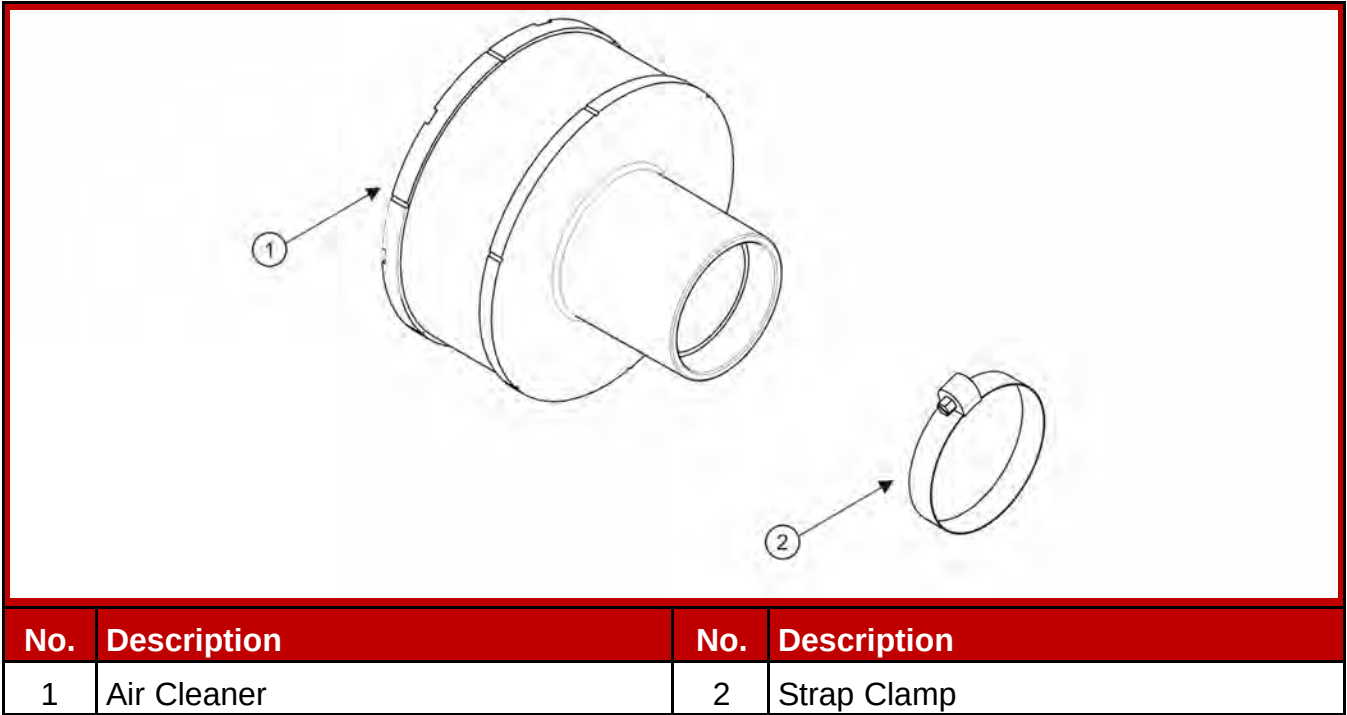


FIGURE 11. NORMAL DUTY AIR CLEANER

10.3 Heavy Duty Air Cleaner

Heavy Duty Air Cleaner Element Removal

⚠ 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 Inc. does not recommend cleaning paper-type air cleaner elements.

1. Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner.
2. Lift tab (3) and turn end cover (4) counterclockwise. See the figure below.

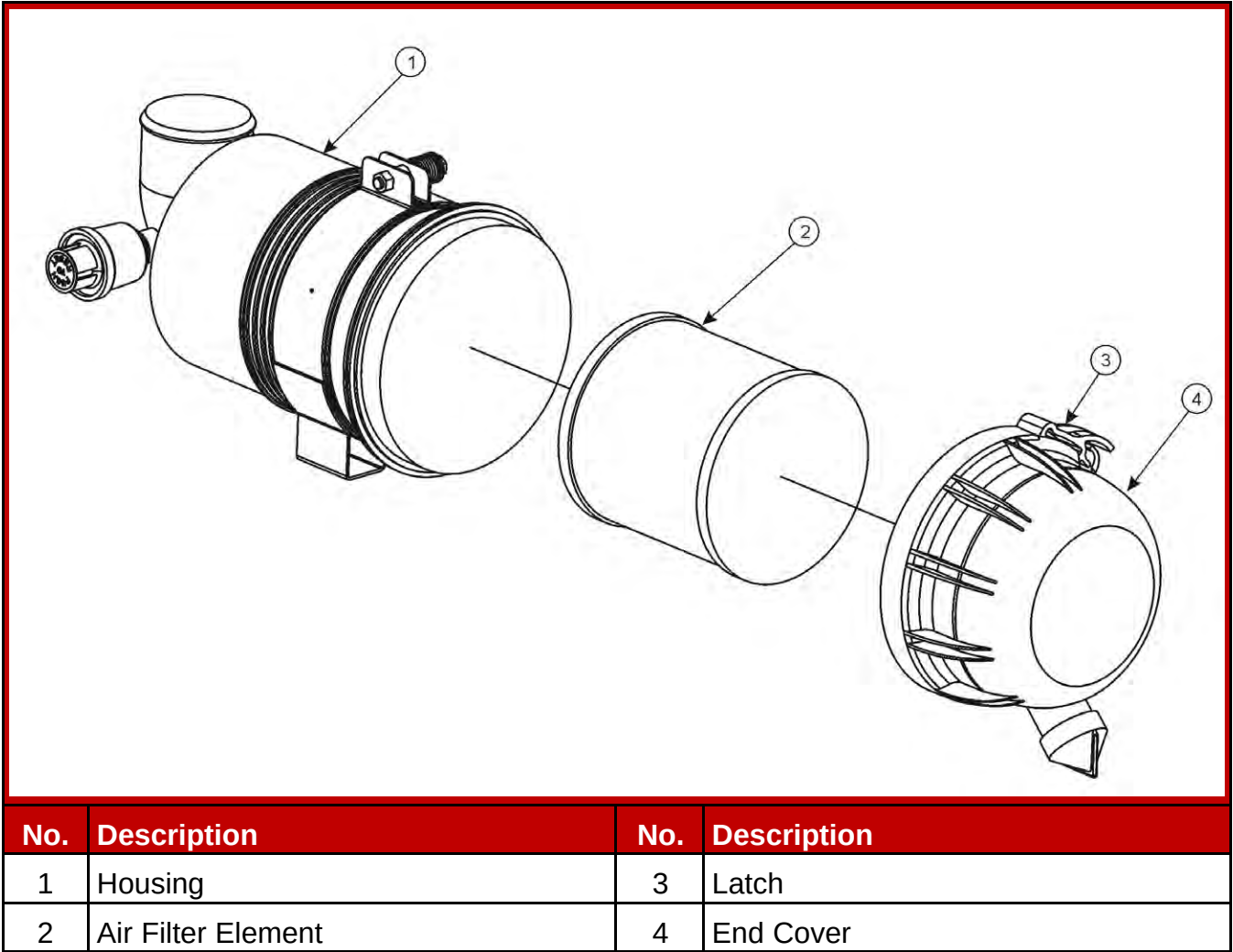


FIGURE 12. HEAVY DUTY AIR CLEANER

- 3. Pull the end cover (4) away from the housing (1).
- 4. Remove the air filter element (2) from the housing (1).
- 5. Dispose of the dirty element in accordance with local environmental agency requirements.

Heavy Duty Air Cleaner Element Installation

- 1. Ensure that no debris enters the filter element or connection point on the air cleaner housing.
- 2. Insert the air filter element (2) into the housing (1). See the figure below.

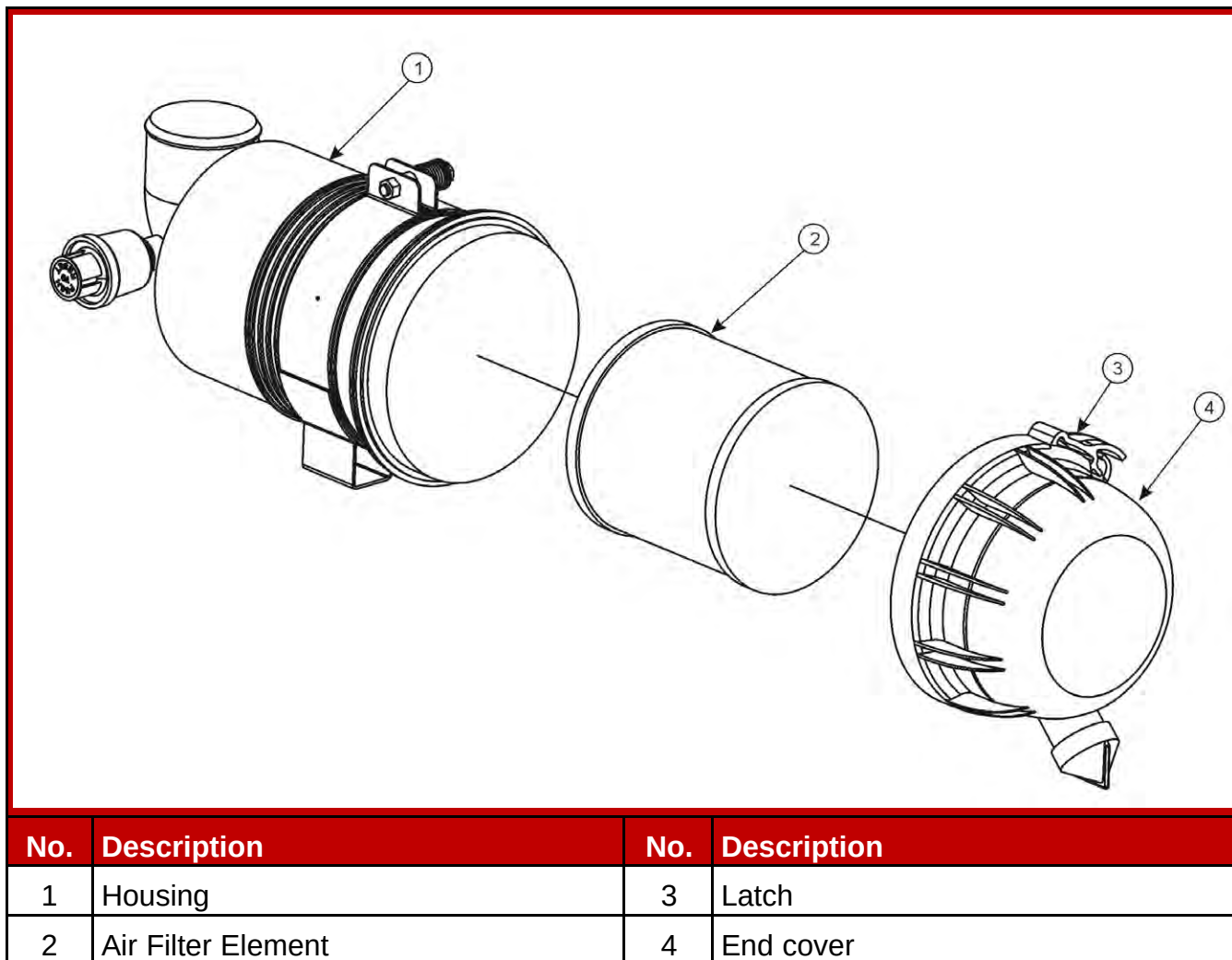


FIGURE 13. HEAVY DUTY AIR CLEANER

3. Install the end cover (4) onto the housing (1).
4. Turn the end cover (4) clockwise until latch (3) snaps into place.

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11 Exhaust System

11.1 Exhaust System Components 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 includes the following components:

- Turbocharger (if equipped)
- Muffler/catalytic converter (if equipped)
- Manifold(s)
- Piping connecting the other components

11.2 Exhaust System Graphic

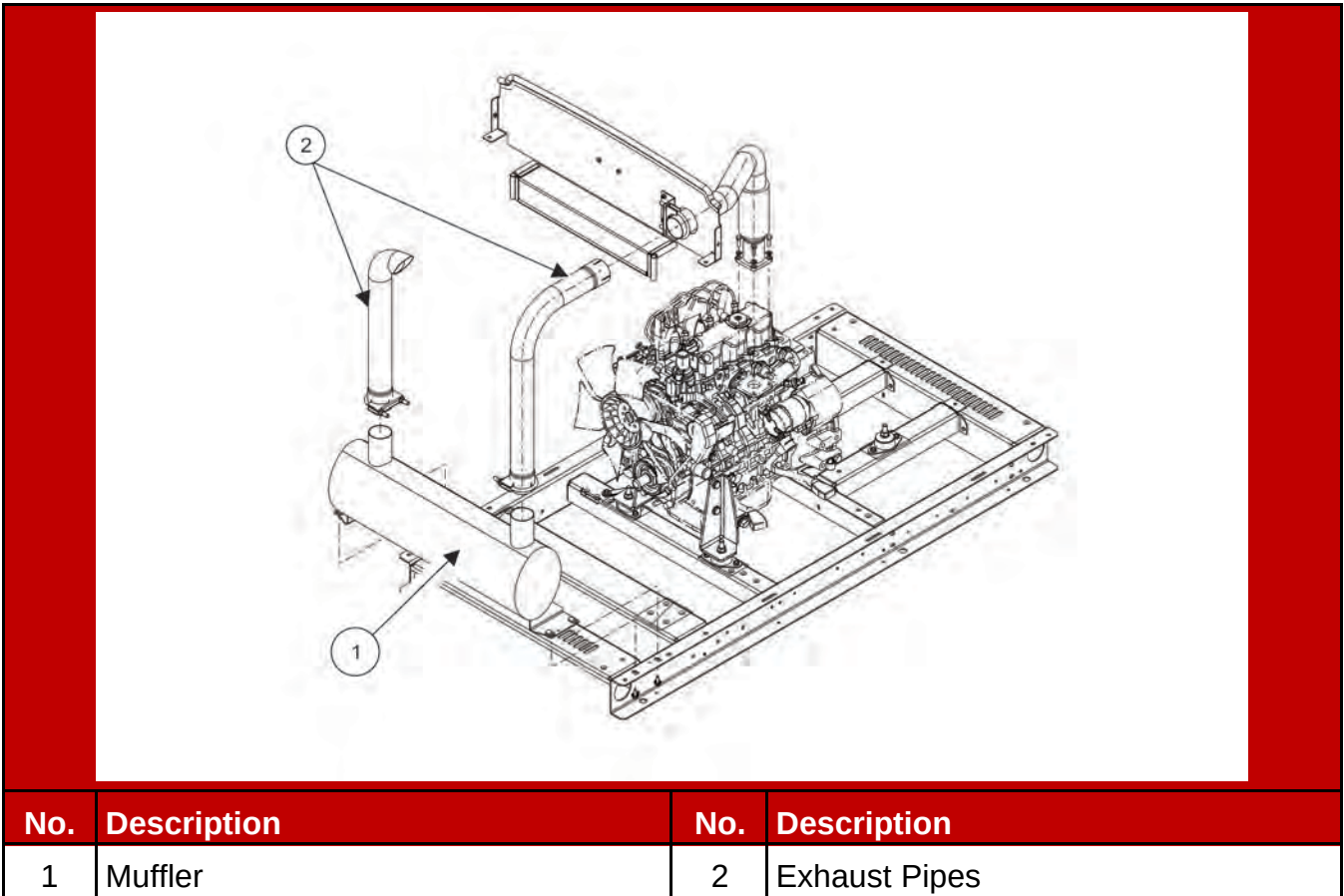


FIGURE 14. EXHAUST SYSTEM

11.3 Muffler Removal

 **WARNING**

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.

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).

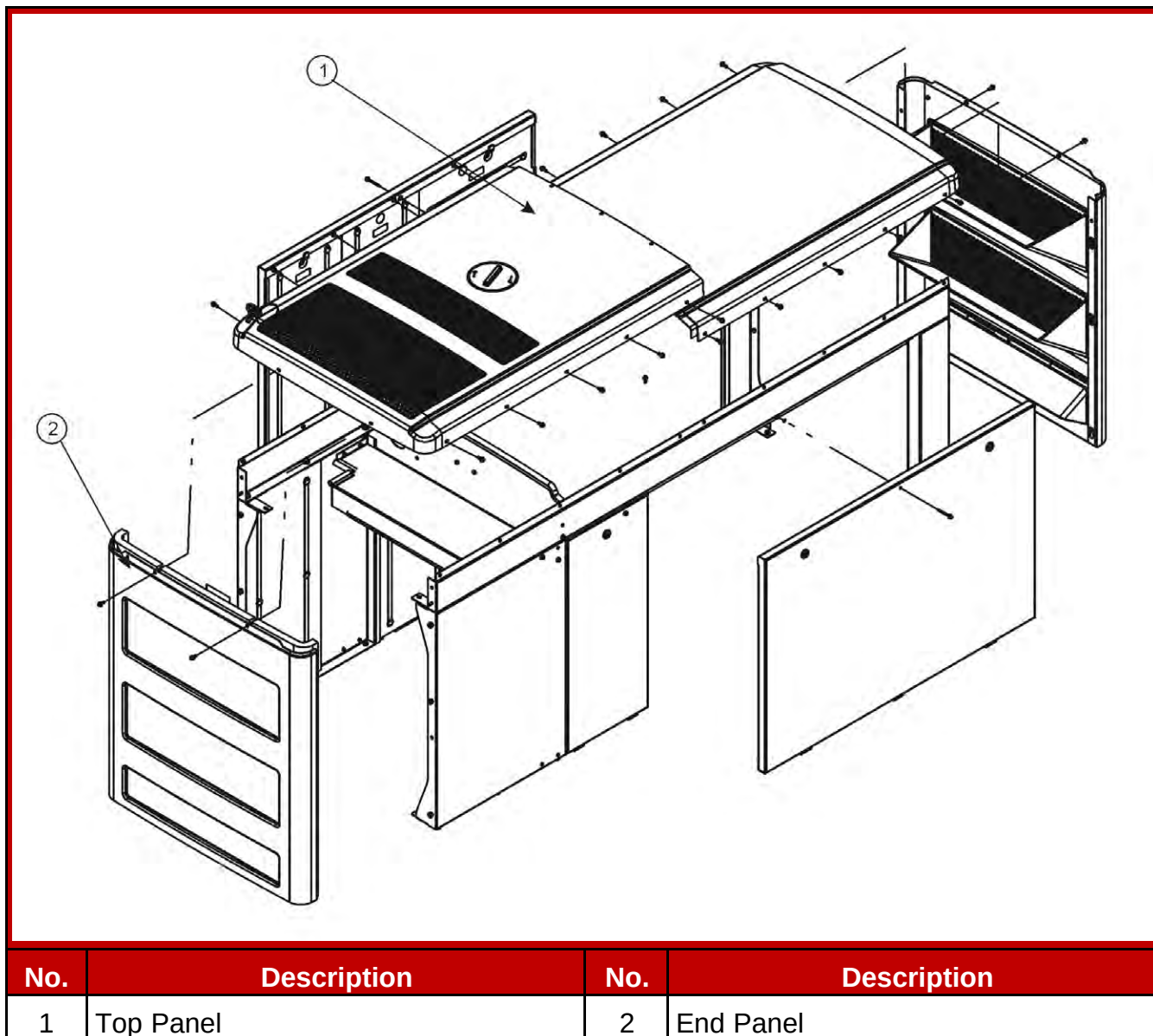


FIGURE 15. ENCLOSURE END PANEL REMOVAL

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

Remove Muffler

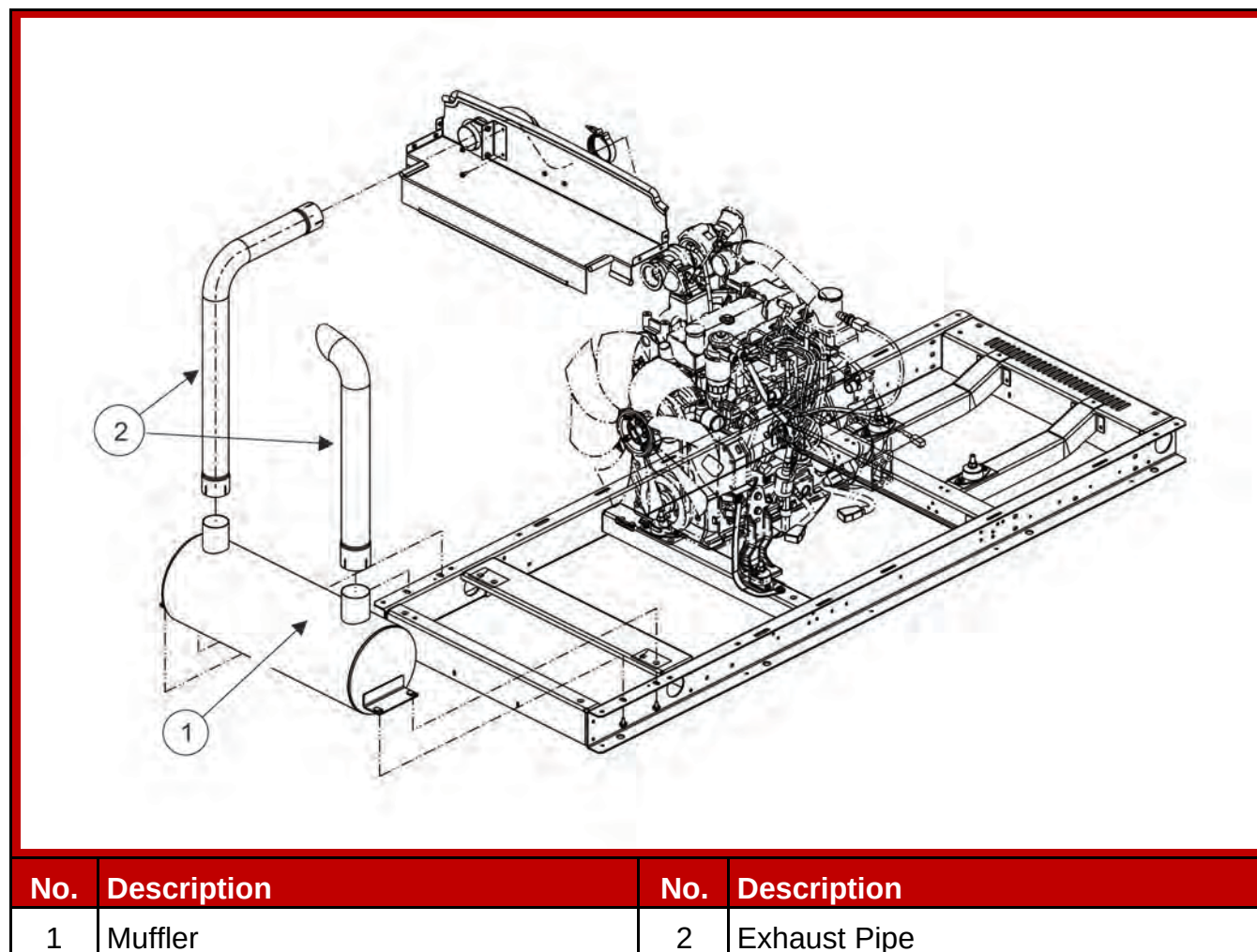


FIGURE 16. MUFFLER REMOVAL

⚠ WARNING

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 three clamps. Torque 24 to 29 Nm.
2. Remove the two bolts from each end of the muffler. Torque 24 to 29 Nm.
3. Remove the exhaust pipes from the muffler.
4. Remove the muffler from the enclosure.

11.4 Muffler Installation

Install Muffler

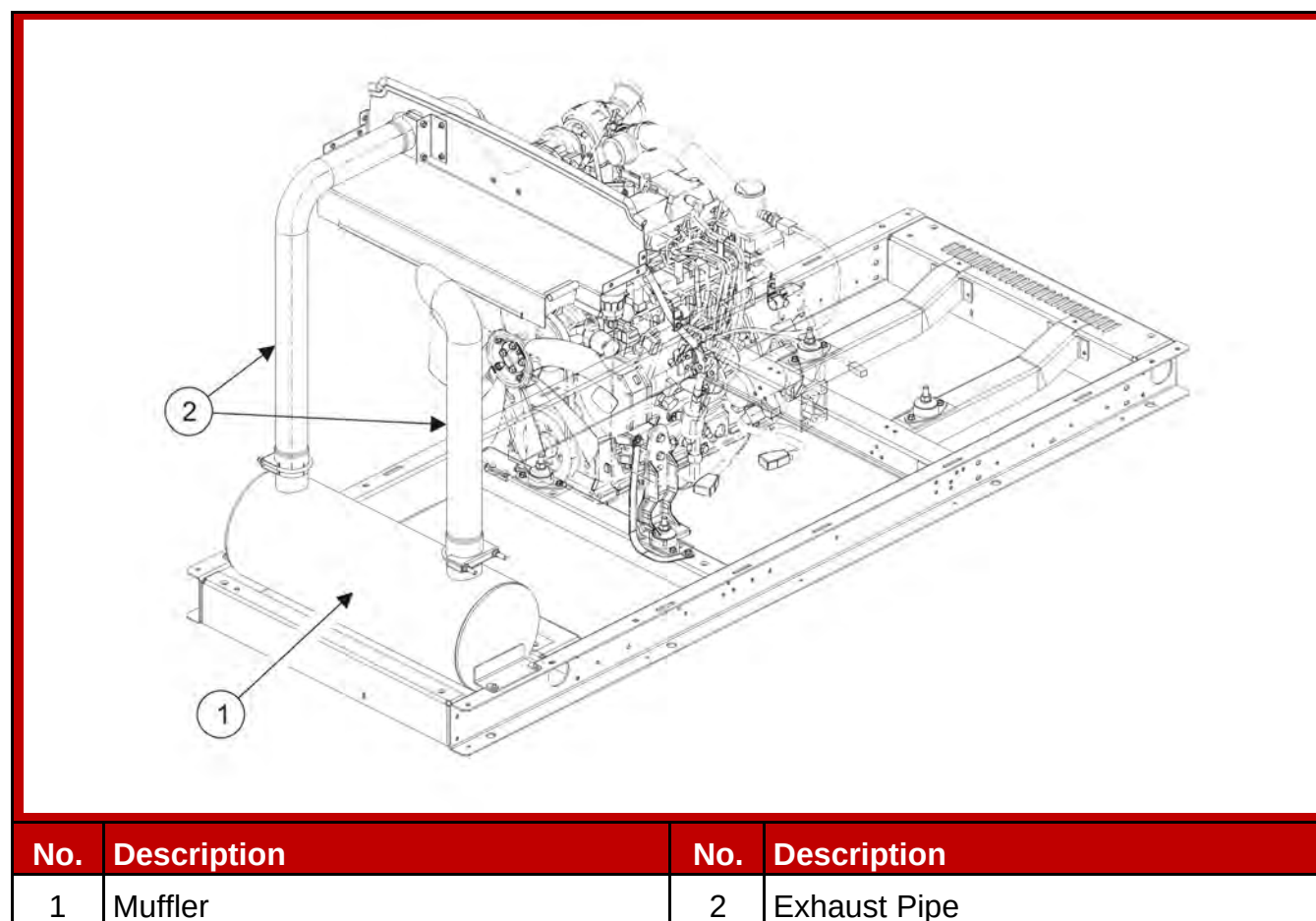


FIGURE 17. MUFFLER INSTALLATION

1. Place the muffler over the four bolt holes in the skid.
2. Attach the muffler with two bolts on each end of muffler.
3. Install exhaust pipes on the muffler.
4. Install three clamps.

Install Enclosure End Panel

1. Place the end panel (2) on each side panel locating pin. Refer to [Figure 20](#).
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.

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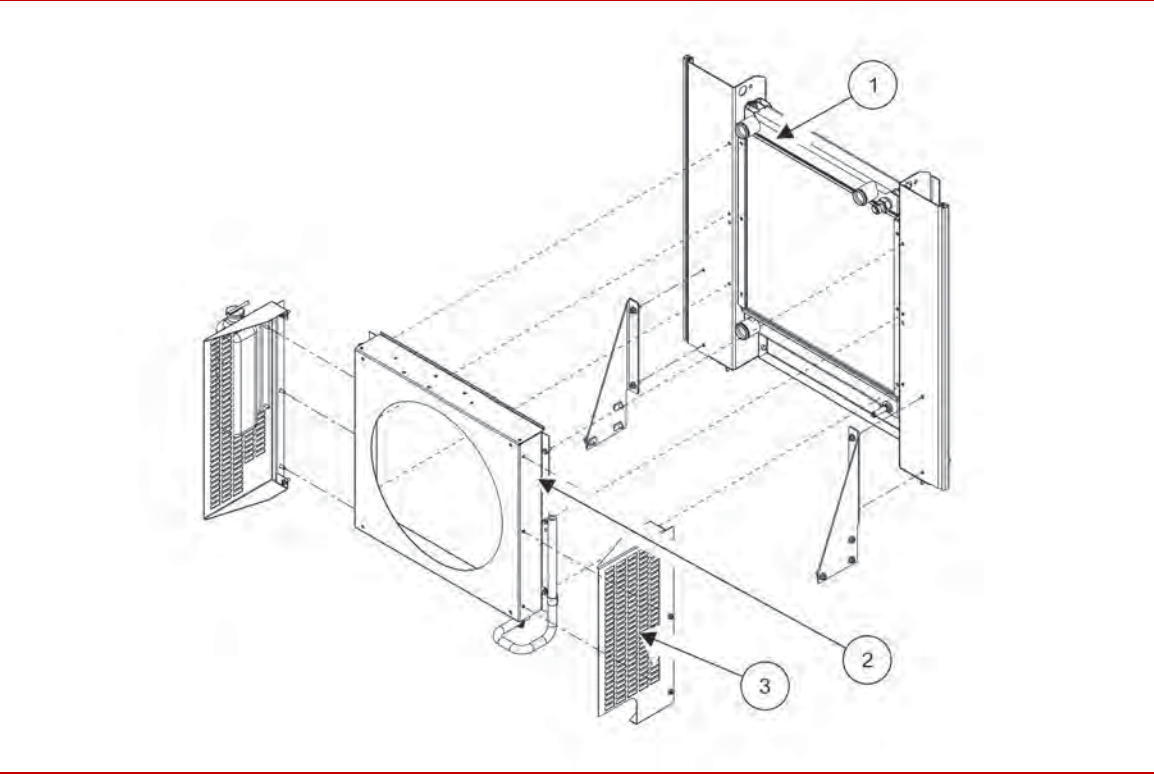
12 Cooling System

12.1 Cooling System Components



Cooling system components are shown below:

TABLE 16. COOLING SYSTEM COMPONENTS

			
No.	Description	No.	Description
1	Radiator	3	Fan Guard
2	Shroud		

12.2 Cooling System Maintenance

This section provides information on cleaning the radiator and updated information regarding bearings that has been provided by our supplier to enable efficient and prolonged life of the equipment.

NOTICE

The following information regarding the correct choice and fitting of hose clamps has also been provided by our supplier to assist and guide the user.

Cleaning

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.

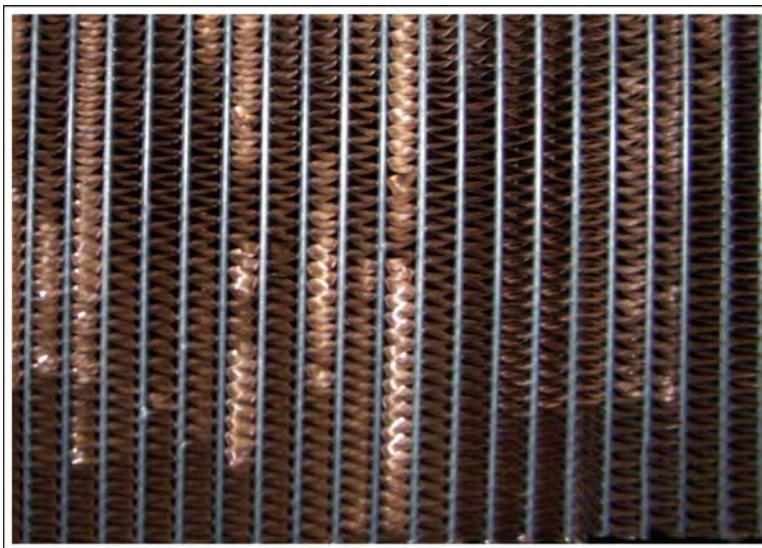


FIGURE 18. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE

⚠ 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.

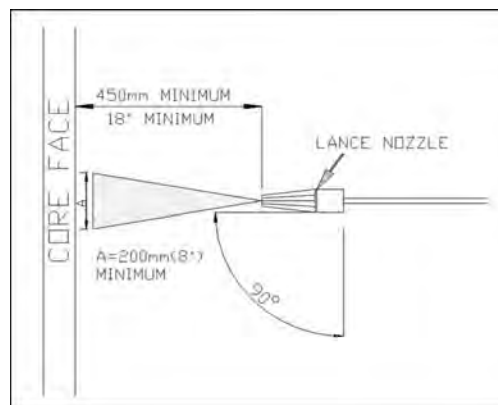


FIGURE 19. PRESSURE WASHER NOZZLE POSITIONING

⚠ 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.

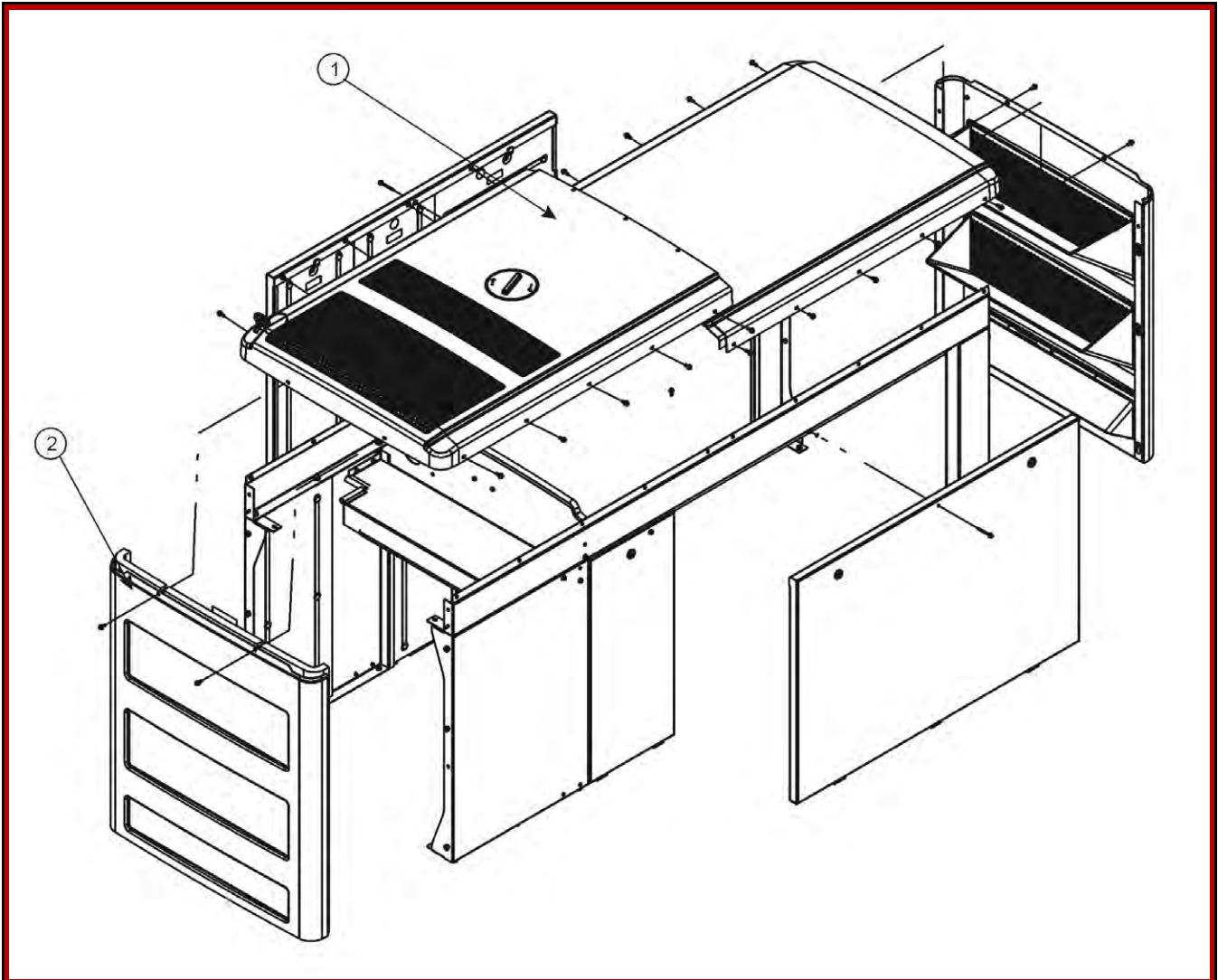
NOTICE

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.

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 20. 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.

Install Enclosure End Panel

1. Place the end panel (2) on each side panel locating pin. Refer to [Figure 20](#).

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.

Dust Laden Environments

Specific Instructions for the Cleaning of Radiator Cores Used in an Environment Subjected to Crushed Aggregate or Ceramic Dust Contamination

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator.

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

Unless the radiator can be dismantled and the core treated in a professional caustic immersion cleaning system, the radiator should not be “wet” cleaned. This is because of the tendency of this type of contamination to coalesce and become extremely difficult to remove.

The correct procedure is to regularly blow through the entire core area with low pressure compressed air (against the direction of cooling airflow). It is very important to ensure that resultant debris blown from the core is subsequently removed and disposed of before engine start-up. An industrial vacuum cleaner will achieve this requirement. In most installations, it will be necessary to remove cowls and guarding.

To prevent damage to fins and resultant loss of cooling, it is important to ensure that the air gun used is maintained at right angles to the core face.

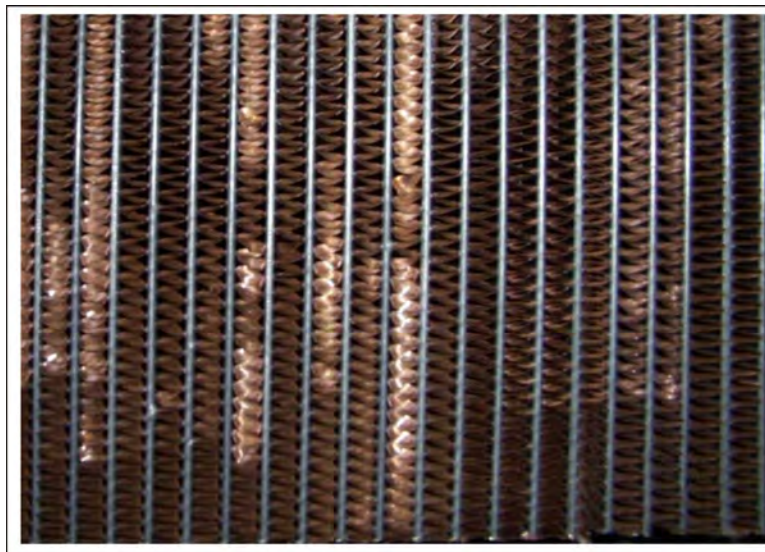


FIGURE 21. FINS DAMAGED BY COMPRESSED AIR AT ACUTE ANGLES TO CORE FACE

After this procedure has been effectively carried out with only the lightest of dust remaining, follow it immediately (if necessary) by cleaning the radiator cores using pressurized water equipment.

Replace the end panel(s) where necessary.

NOTICE

It is vitally important that the core is thoroughly dried before start-up.

Radiator Assembly Removal and Installation



1. Remove the enclosure doors, as applicable.

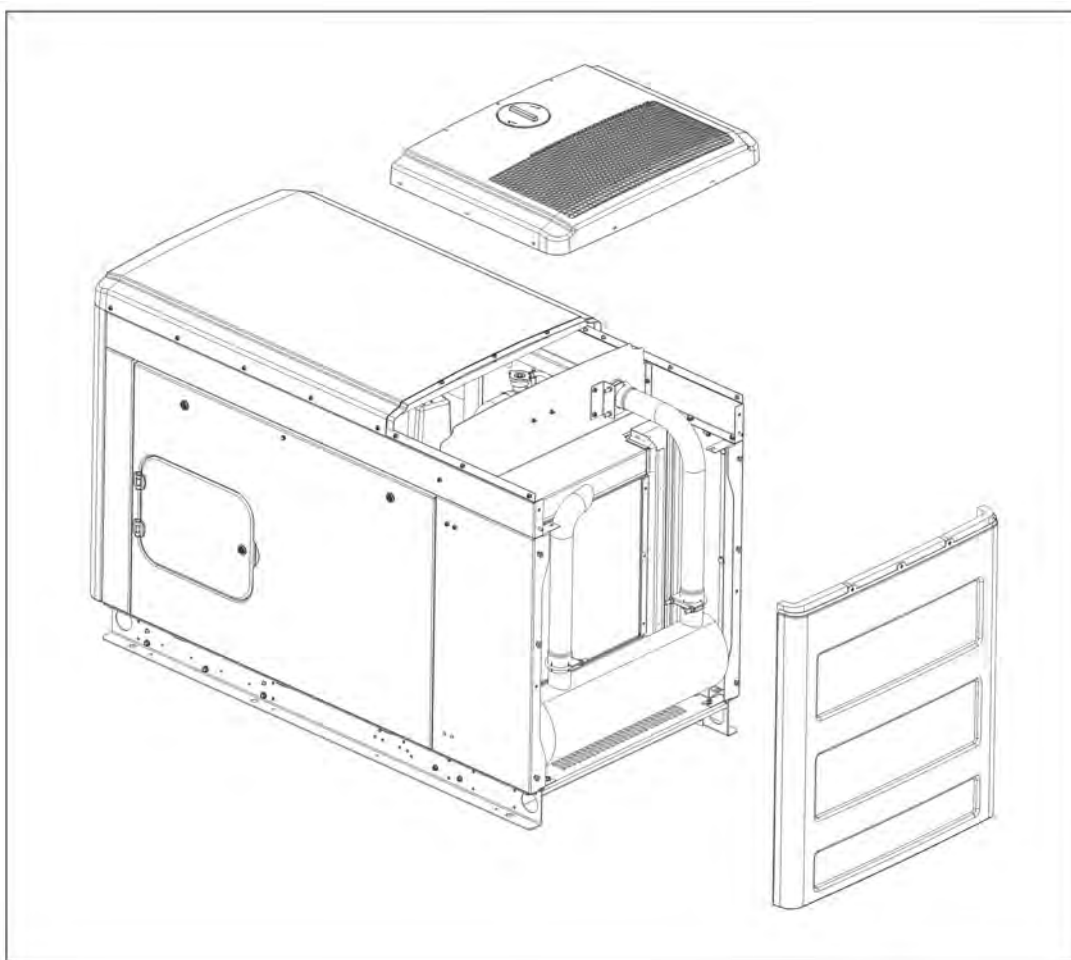


FIGURE 22. ENCLOSURE DOOR REMOVAL

2. Disconnect the battery connections.
3. Drain the coolant.
4. Drain the engine oil (if an oil cooler is equipped).

5. Remove the coolant connections.
6. Remove the oil cooler connections (if the oil cooler is equipped).

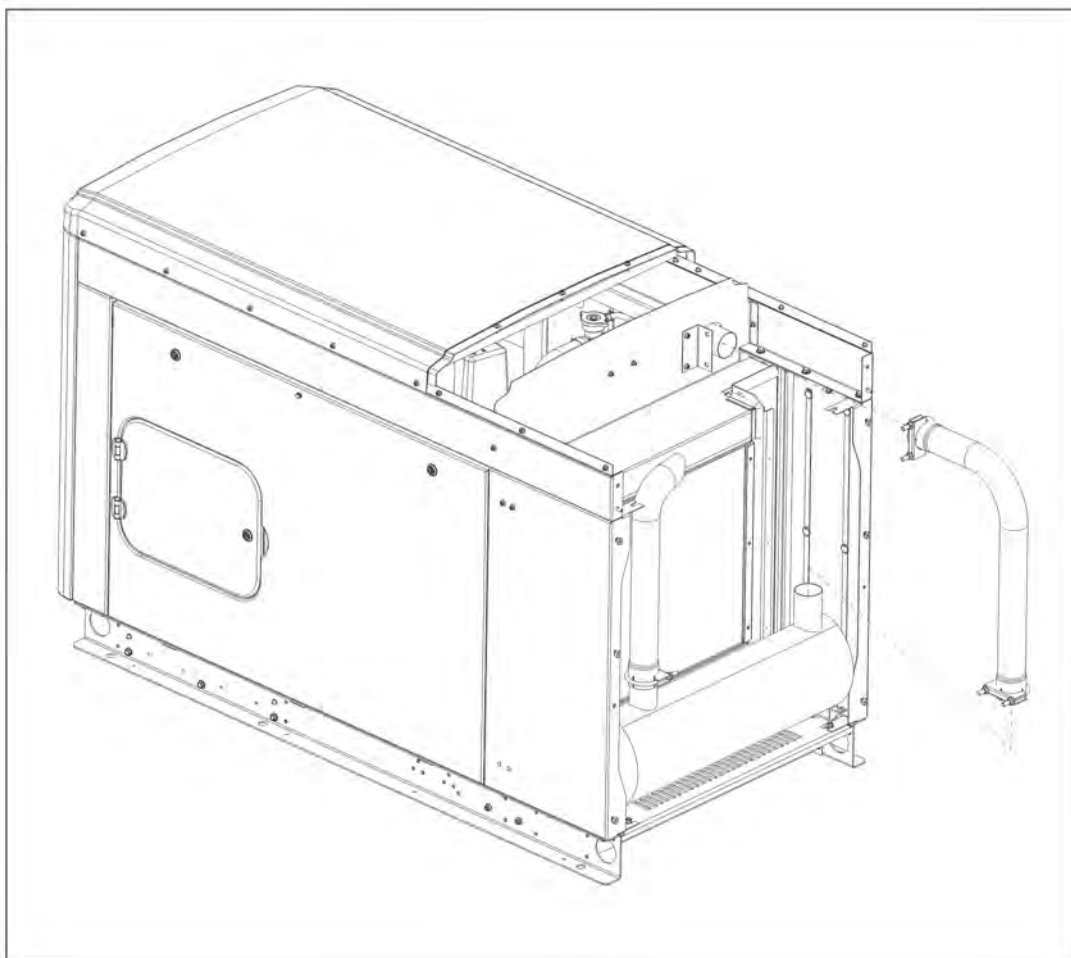


FIGURE 23. CONNECTIONS

7. Disengage the coolant reservoir bottle from the fan guard (do not disconnect).

NOTICE

Torque bottle bolt to bracket 3 to 4 Nm. Torque bottle bracket bolt to fan guard 10 to 12 Nm.

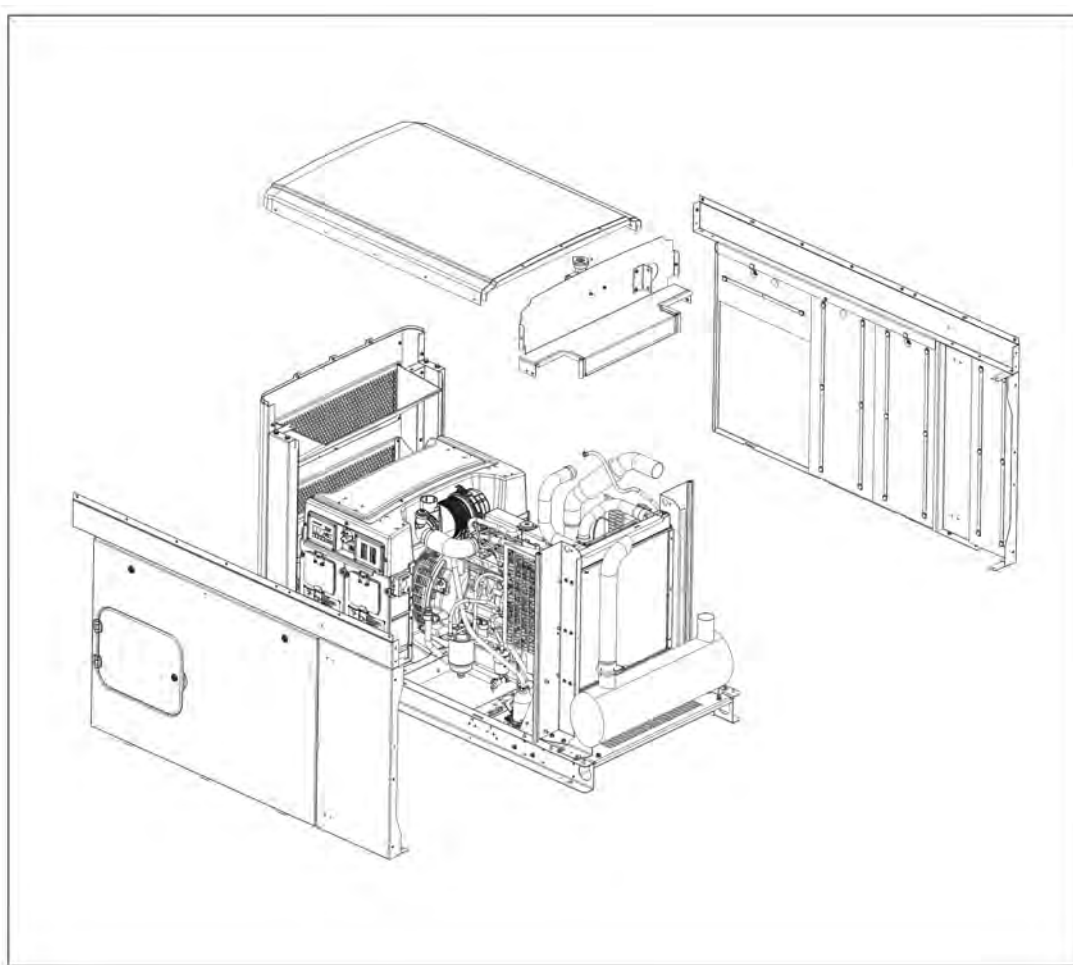


FIGURE 24. COOLANT RESERVOIR BOTTLE

8. Remove the exhaust connection and the bulkhead.

NOTICE

Torque clamps 24 to 29 Nm.

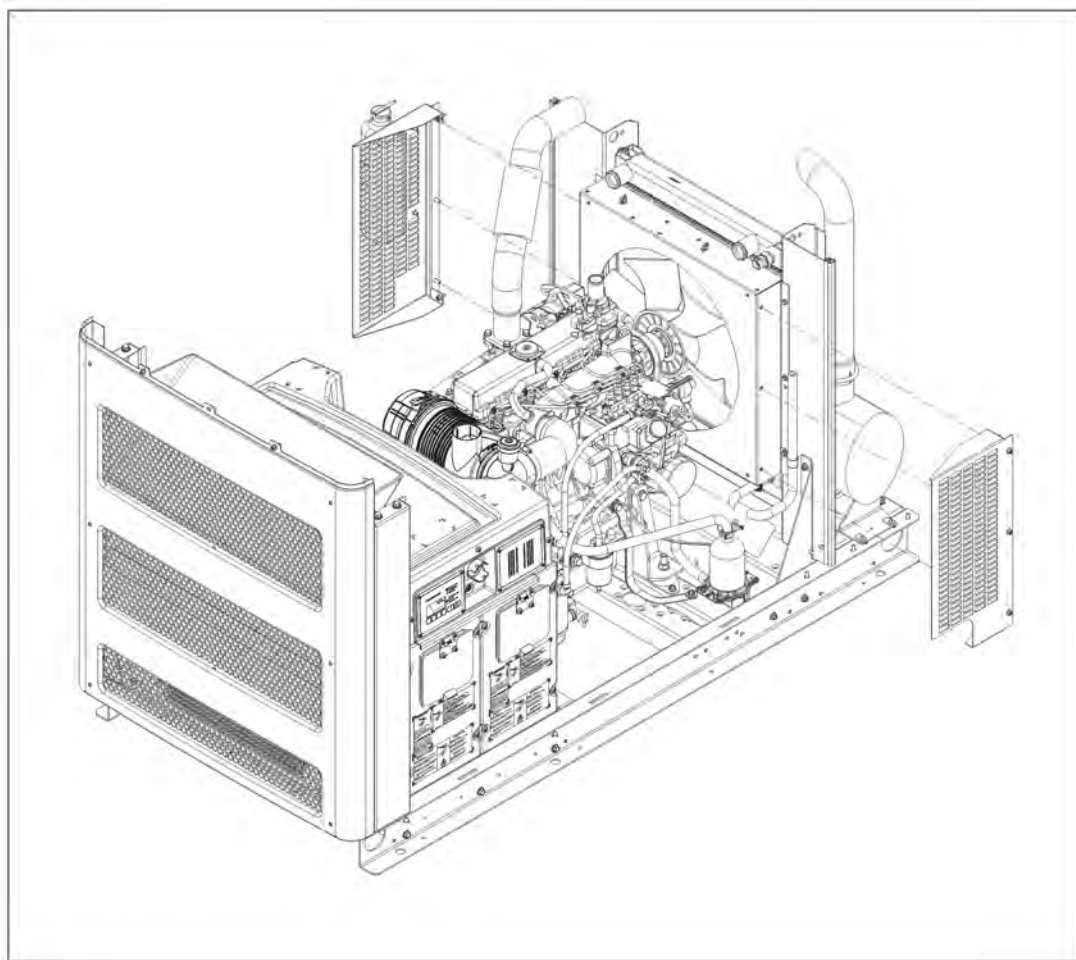


FIGURE 25. EXHAUST CONNECTION AND BULKHEAD

9. Remove the radiator assembly after removing the bolts for the side brackets.

NOTICE

Torque 24 to 29 Nm.

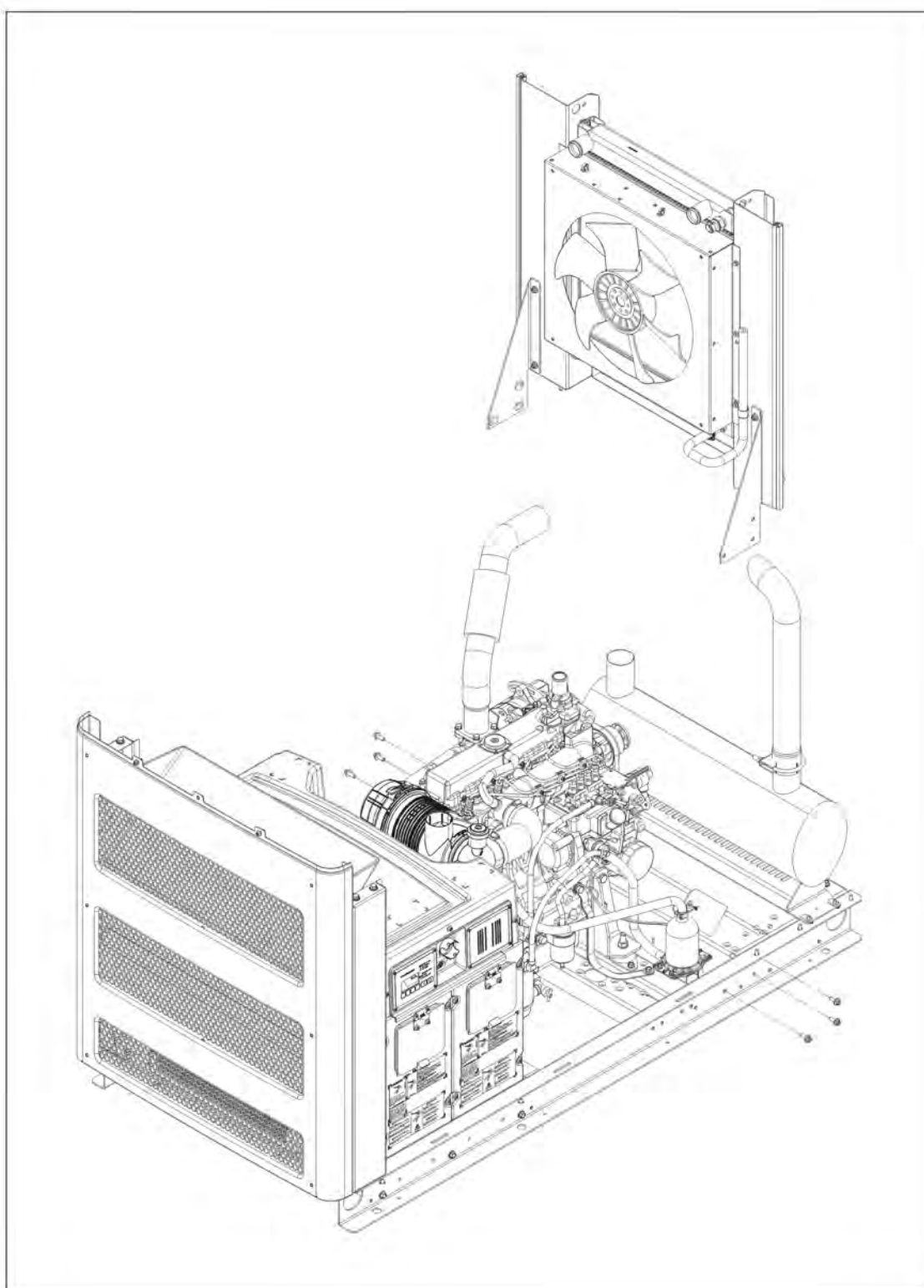


FIGURE 26. SIDE BRACKETS



For radiator assembly installation, follow the previous steps in reverse order.

13 Engine and Accessories

13.1 Engine Removal and Installation

1. Remove the enclosure covers as applicable.

NOTICE
Torque M6 hex head screws 9.8 to 11.9 Nm.

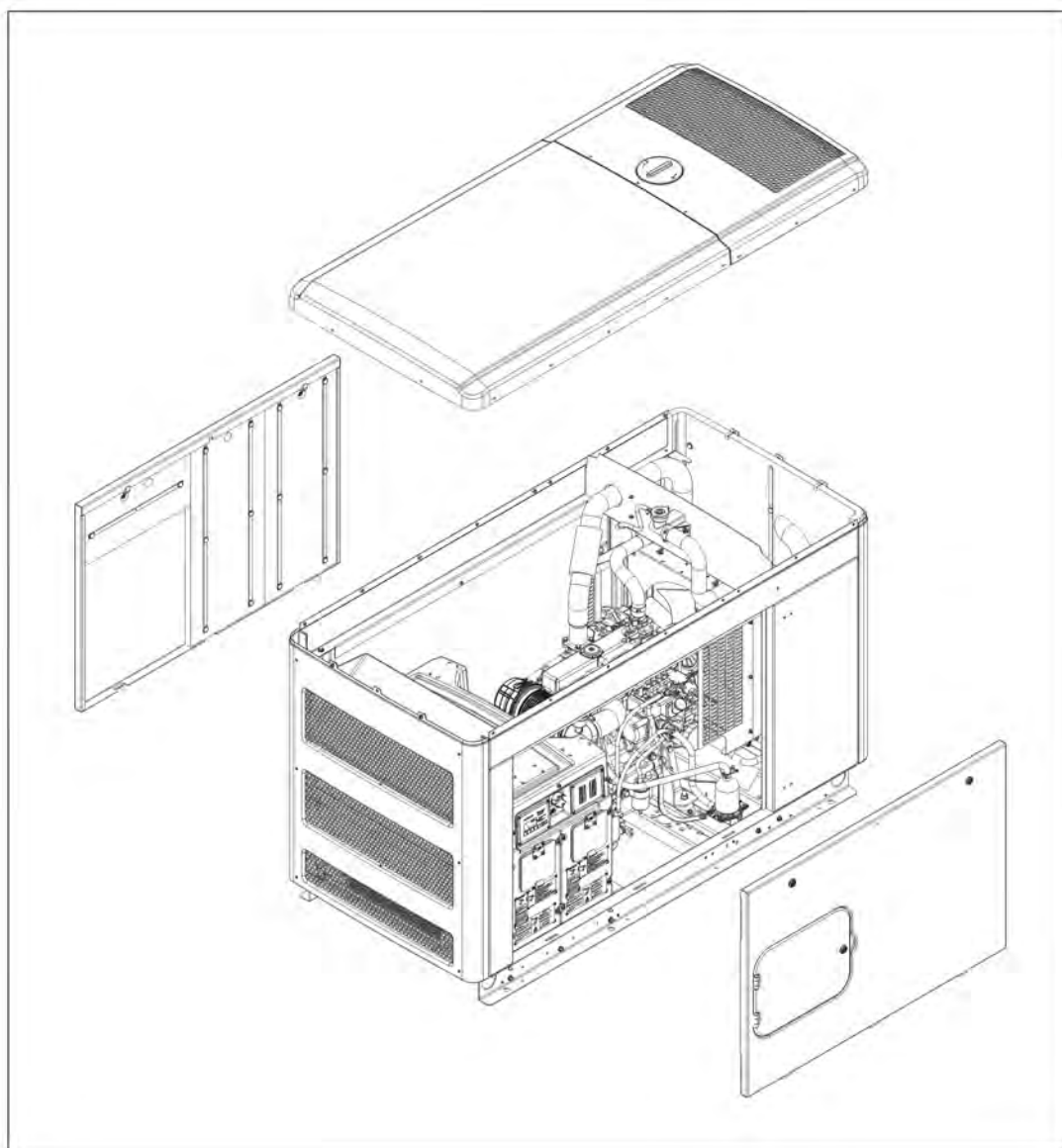


FIGURE 27. ENCLOSURE COVERS

2. Disconnect the battery connections.

3. Disconnect all harness connections between the engine and other systems of the generator set.
4. Drain the coolant.
5. Drain the engine oil (if equipped with an oil cooler).
6. Disconnect the coolant heater connections.
7. Disconnect the oil cooler connections (if equipped)
8. Disconnect the fuel tank connections.
9. Disengage the coolant reservoir bottle from the fan guard (do not disconnect).

NOTICE

Torque bottle bolt to bracket 3 to 4 Nm. Torque bottle bracket bolt to fan guard 10 to 12 Nm.

10. Disconnect coolant connections from the engine.
11. Disconnect exhaust connections from the engine.

NOTICE

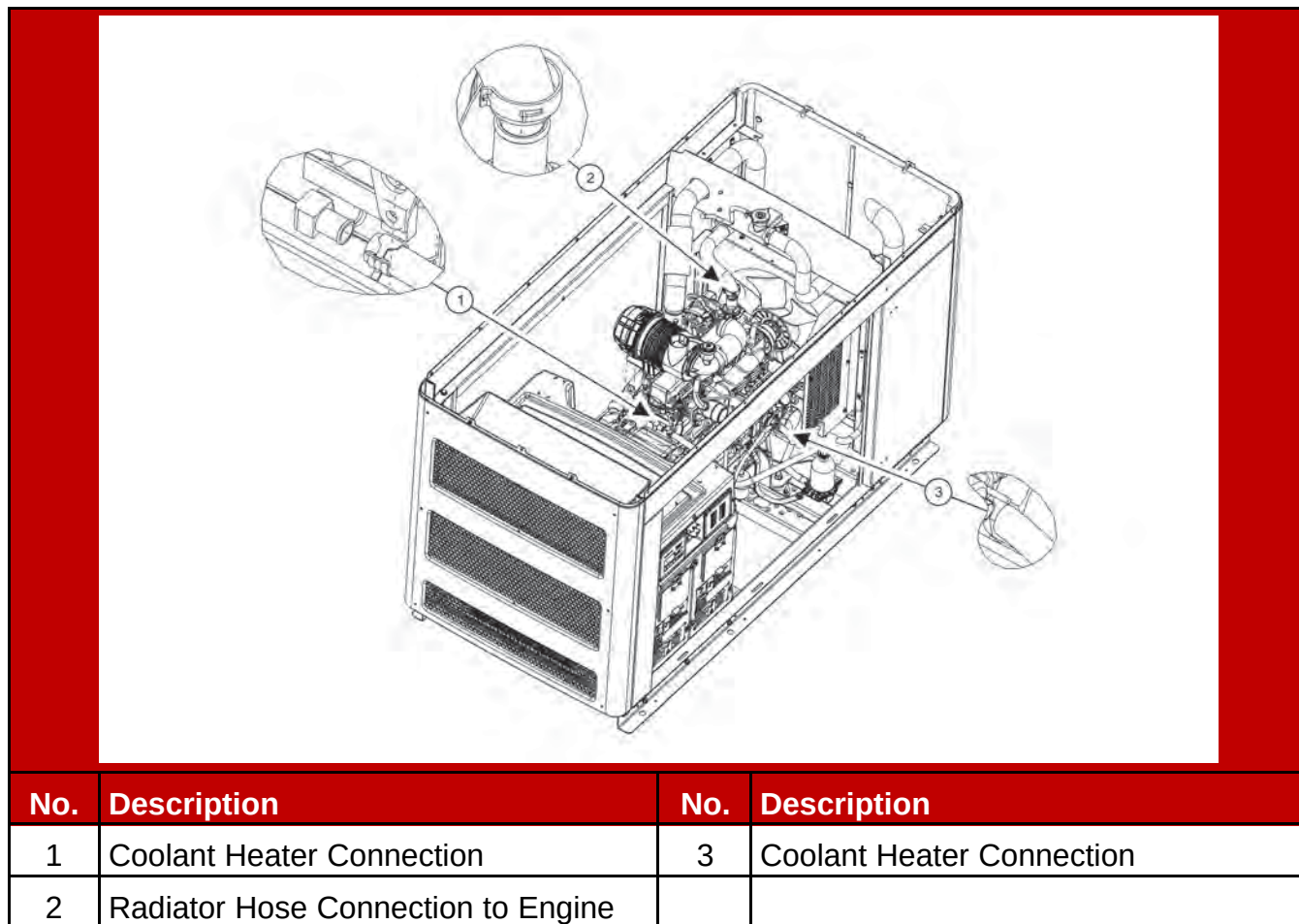
Torque 24 to 29 Nm.

12. Remove the fan and keep it in the shroud.

NOTICE

Torque fan to hub bolt 7.9 to 9.3 Nm.

13. Remove the fan guards (if required).

**FIGURE 28. ENGINE CONNECTIONS**

14. Remove the alternator fan guard and bolts.

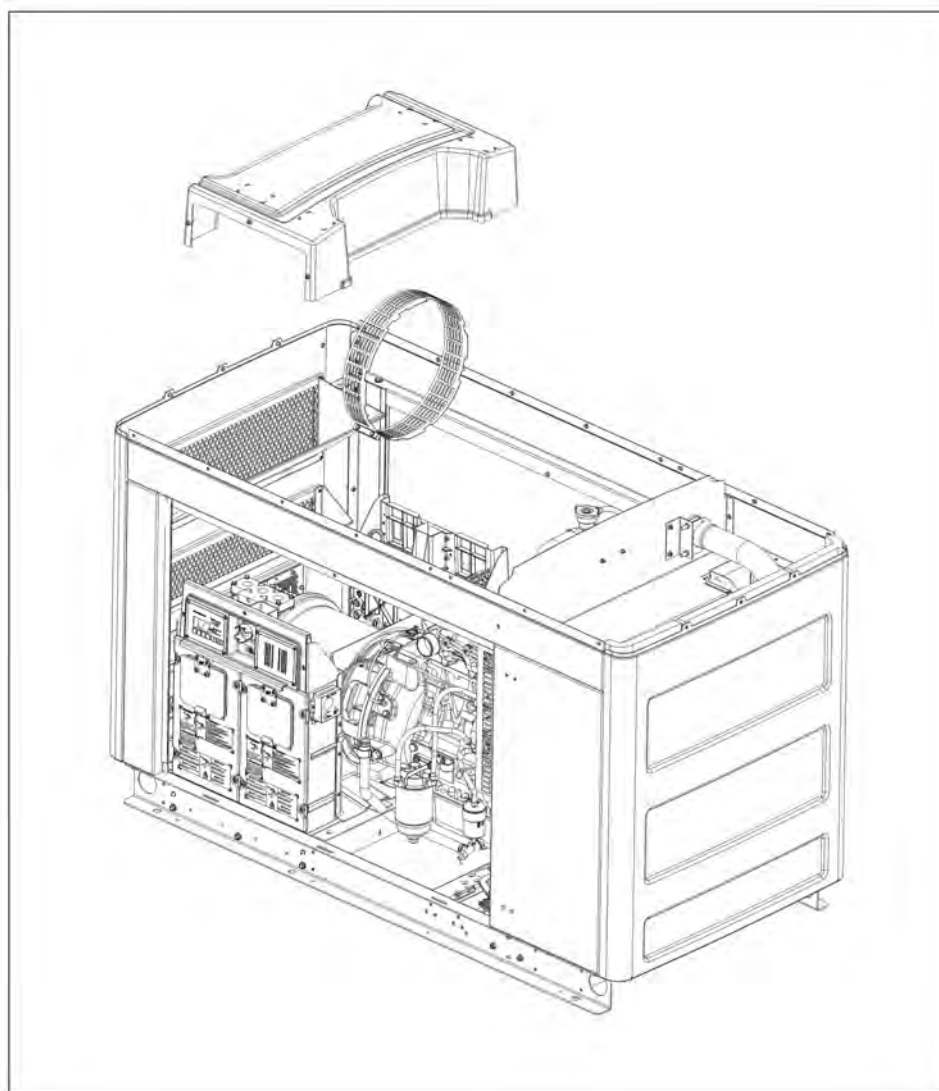


FIGURE 29. ALTERNATOR FAN GUARD DETAIL

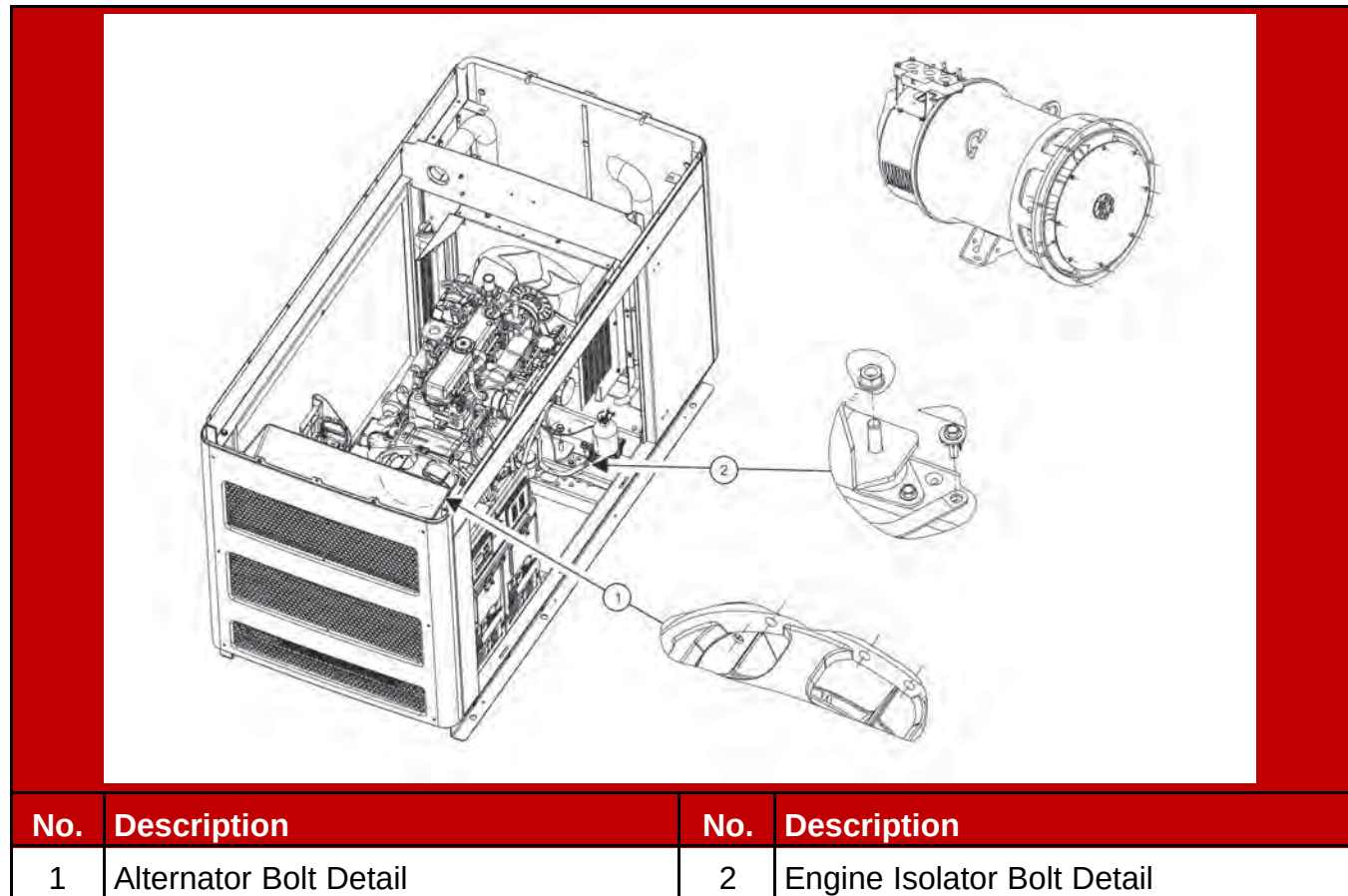


FIGURE 30. ALTERNATOR BOLTS AND ENGINE ISOLATOR BOLTS

15. Securely support the non-drive end of the alternator.
16. Securely support the engine using a suitable above-the-engine lifting device.

NOTICE

The engine can weigh up to 410 pounds. A Cummins lifting kit (part number A048V805) can be used for lifting the engine.

17. Remove the alternator drive disc bolts first and then remove the alternator adaptor bolts.
18. Loosen the nuts that secure the engine mounts to the isolator studs.

NOTICE

Torque the nuts that secure the engine mounts to the isolator studs 82 to 100 Nm.

19. Remove the bolts securing the engine mounting feet to the engine.

NOTICE

Torque the bolts on the engine mounting brackets to the engine 124 to 151 Nm.

20. Carefully move the engine away from the alternator.

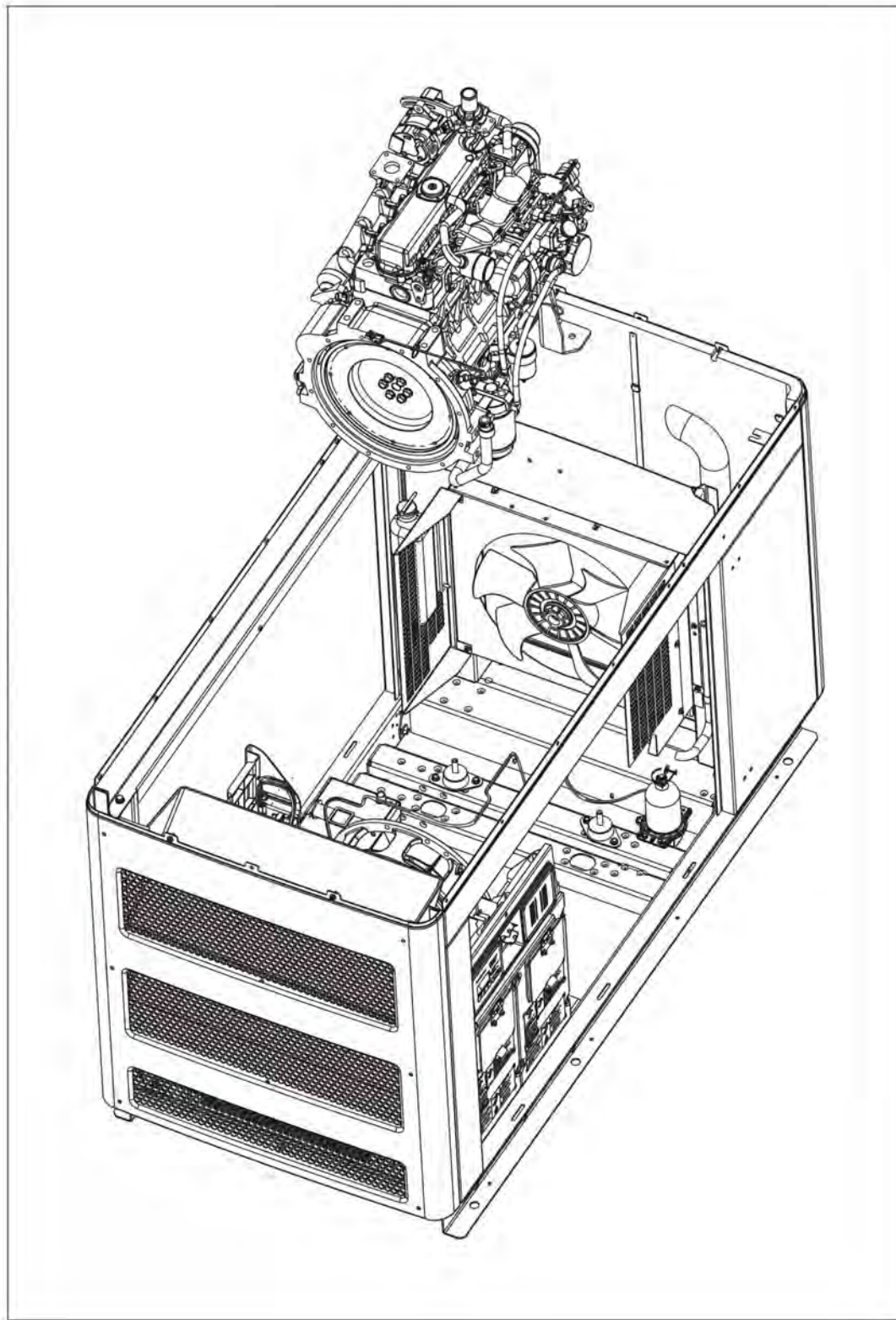


FIGURE 31. ENGINE REMOVAL

NOTICE

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 47 to 57 Nm.

NOTICE

The alternator can weigh up to 309 pounds.

NOTICE

The engine can weigh up to 410 pounds. A Cummins lifting kit (part number A048V805) can be used for lifting the engine.



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

14 Alternator

14.1 General Description

CA115 Generator

The CA115 generator is of brushless rotating field design, available up to 600V/60 Hz (1800 RPM, 4 pole).

14.2 Air Flow

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

14.3 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.

14.4 Anti-Condensation Heaters

DANGER

Live Electrical Conductors

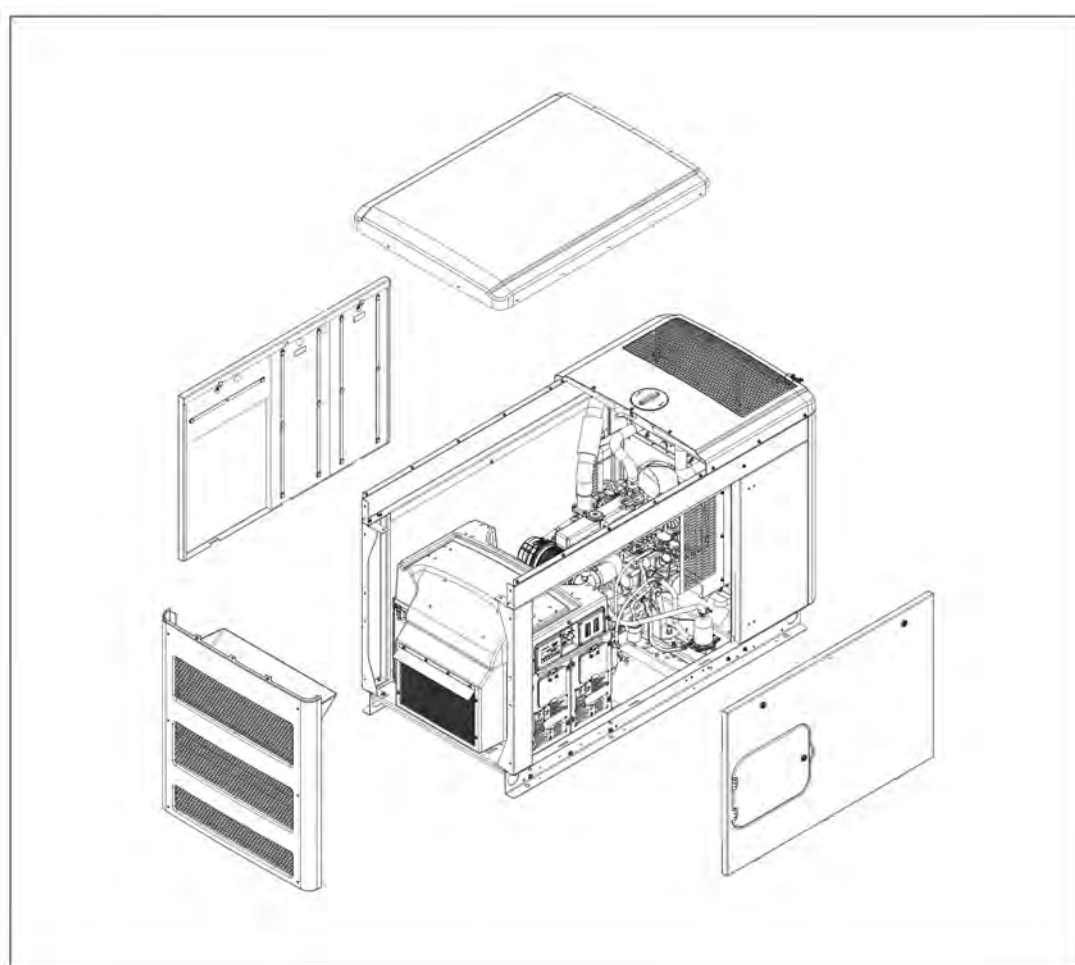
Live electrical conductors can cause serious injury or death by electric shock and burns.

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.

14.5 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 32. ALTERNATOR AREA****b. Remove covers, panels, and plates:**

- i. Remove the terminal box cover and 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 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 the connectors J17, J18 and J22 from the control board. Push the wires through the terminal box to disconnect the terminal box from the alternator.
- vii. 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.

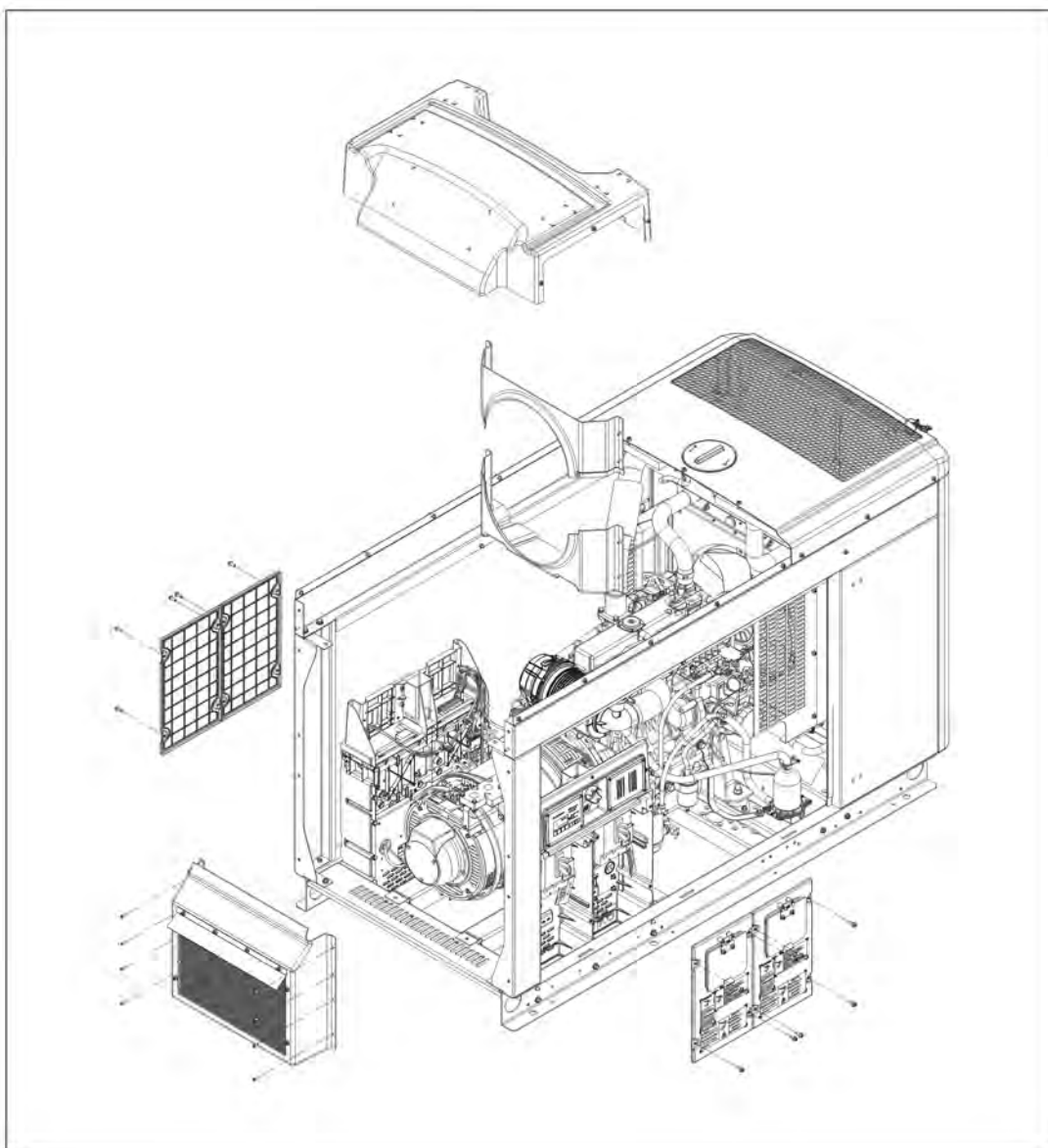


FIGURE 33. TERMINAL BOX REMOVAL

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

NOTICE

Torque 12.3 to 15 Nm.

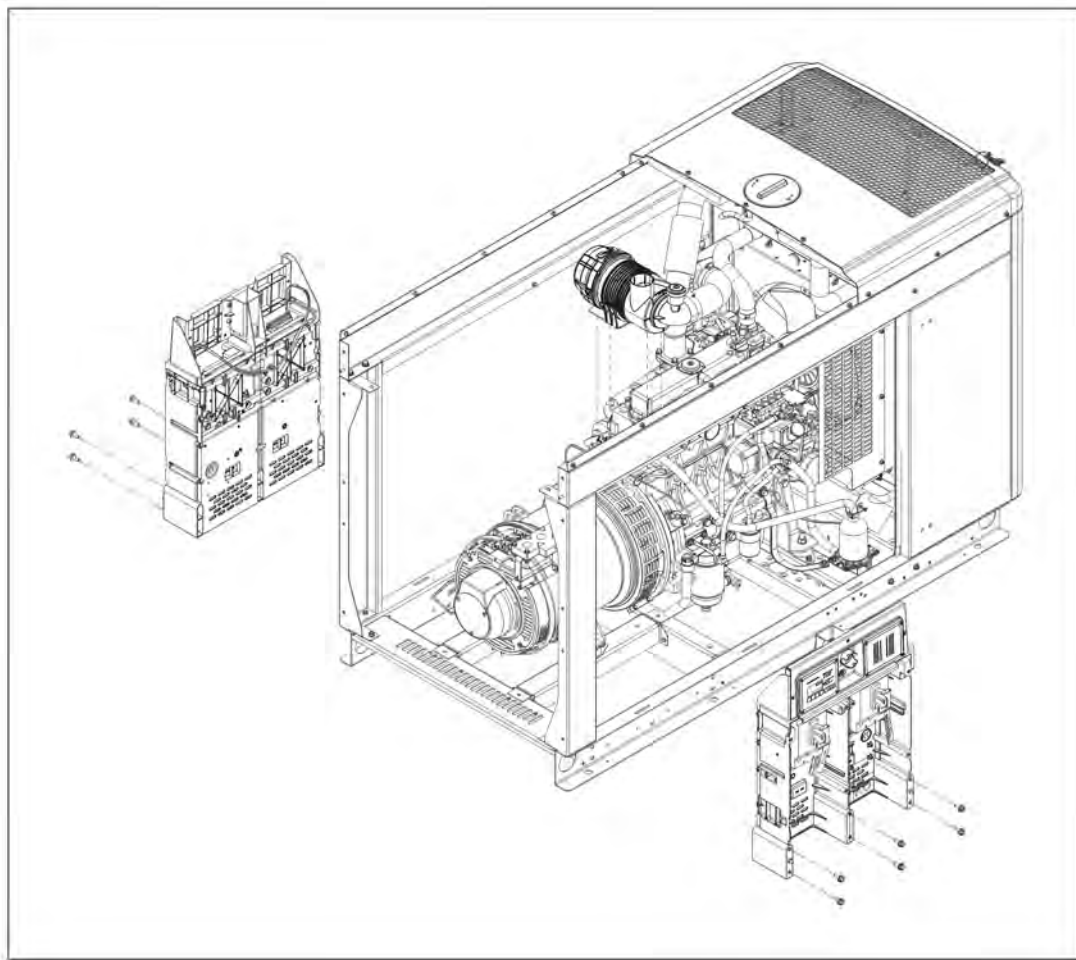


FIGURE 34. TERMINAL BOX MOUNTING BOLTS

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 the alternator:
 - a. Loosen the alternator and engine isolator bolts on both sides.

NOTICE

Torque the isolator nut 82 to 100 Nm.

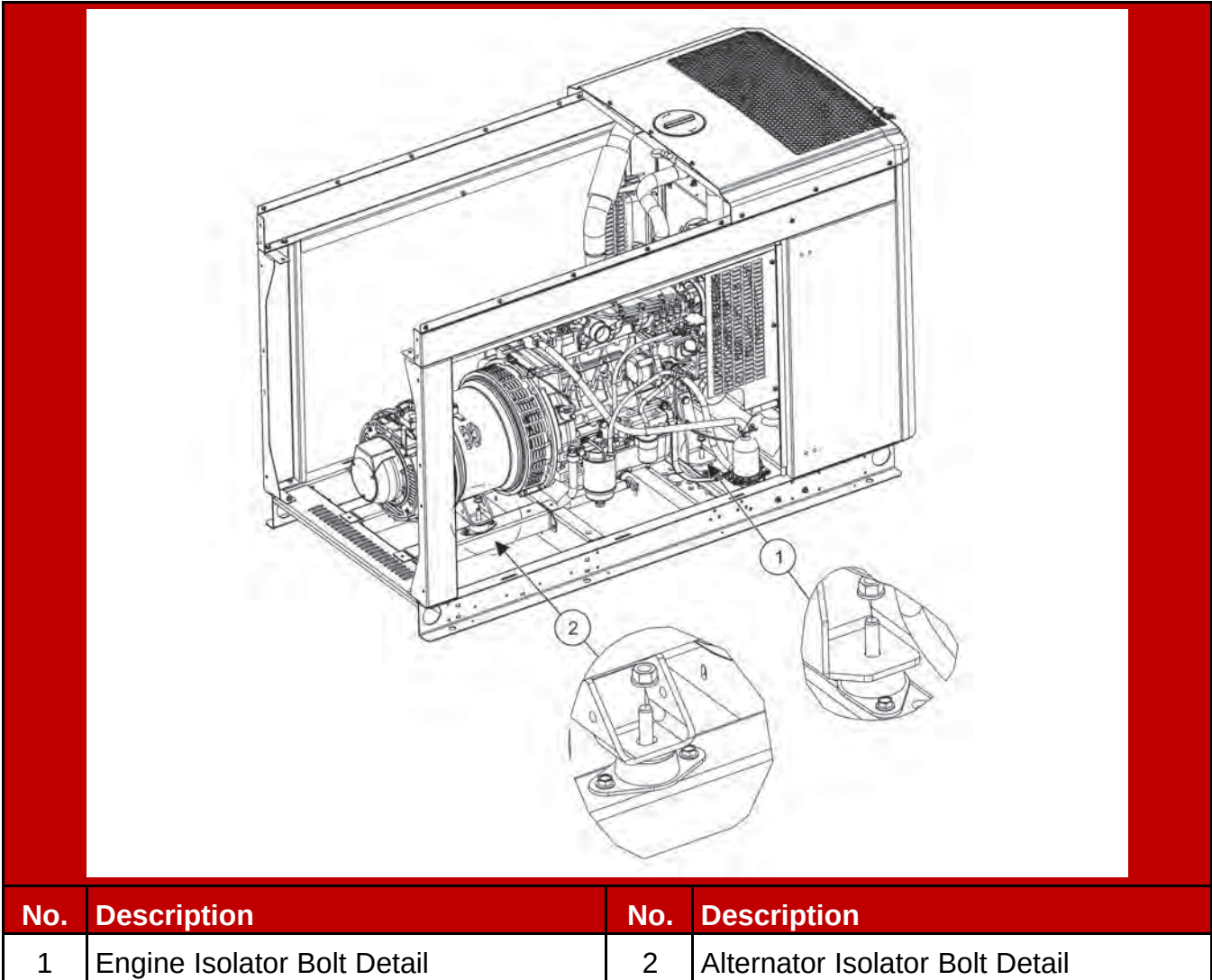


FIGURE 35. ALTERNATOR AND ENGINE ISOLATOR BOLTS

- b. Securely support the engine with appropriate blocking which provides approximately 2° front to back tilt of the engine and alternator (with the alternator end higher). This should be enough to allow removal of the alternator from the isolator studs.

NOTICE
The engine weighs up to 410 pounds.

- c. Secure the alternator with an appropriate lifting device. It is highly recommended that a 3-point lift be used.

NOTICE
The alternator weighs up to 309 pounds.

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

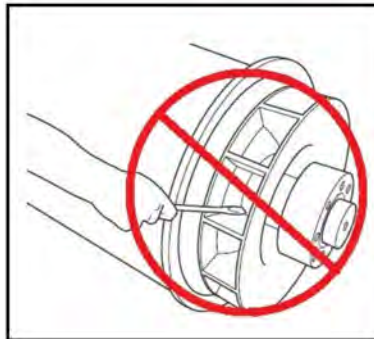


FIGURE 36. DO NOT ROTATE ROTOR USING FAN

⚠ 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 52 Nm +/- 5 Nm.

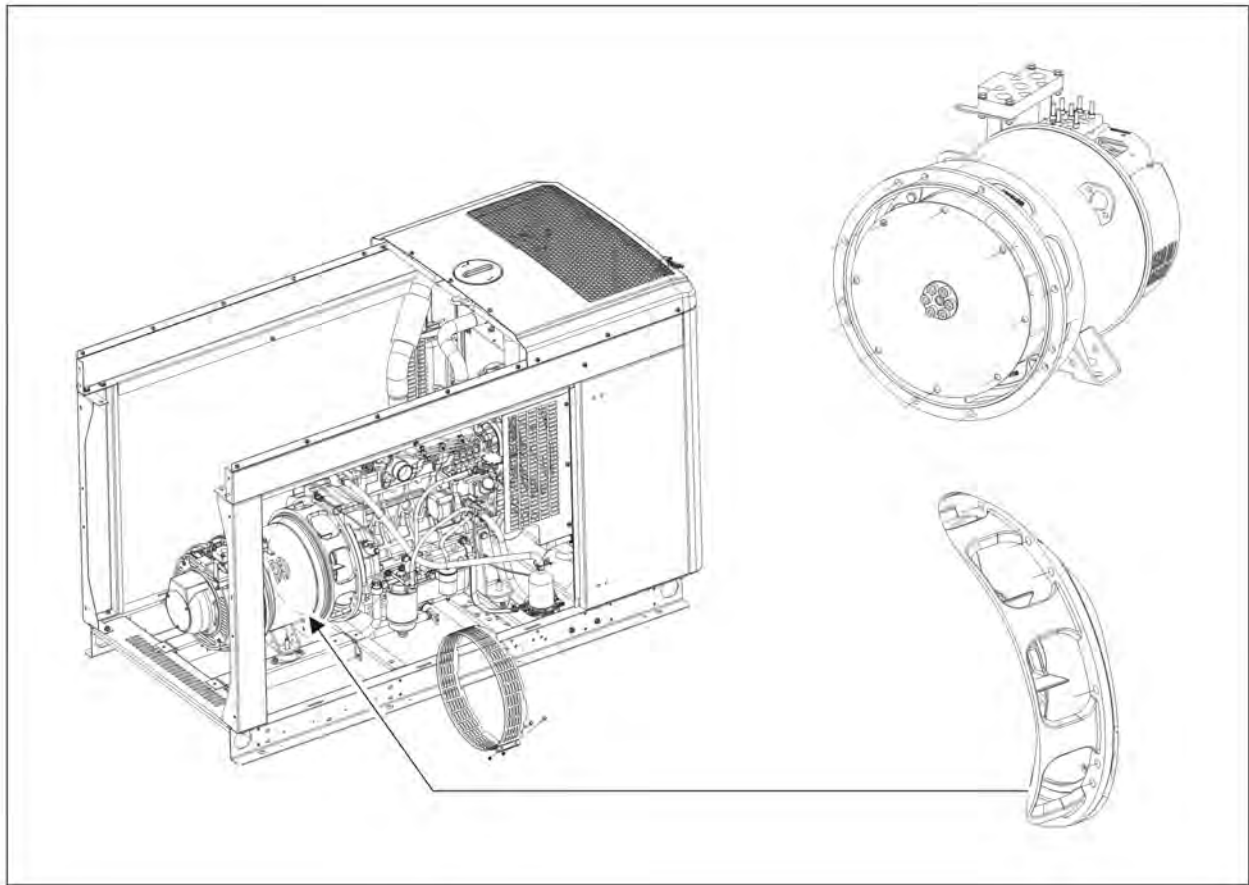


FIGURE 37. ALTERNATOR FAN GUARD WITH DETAIL

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

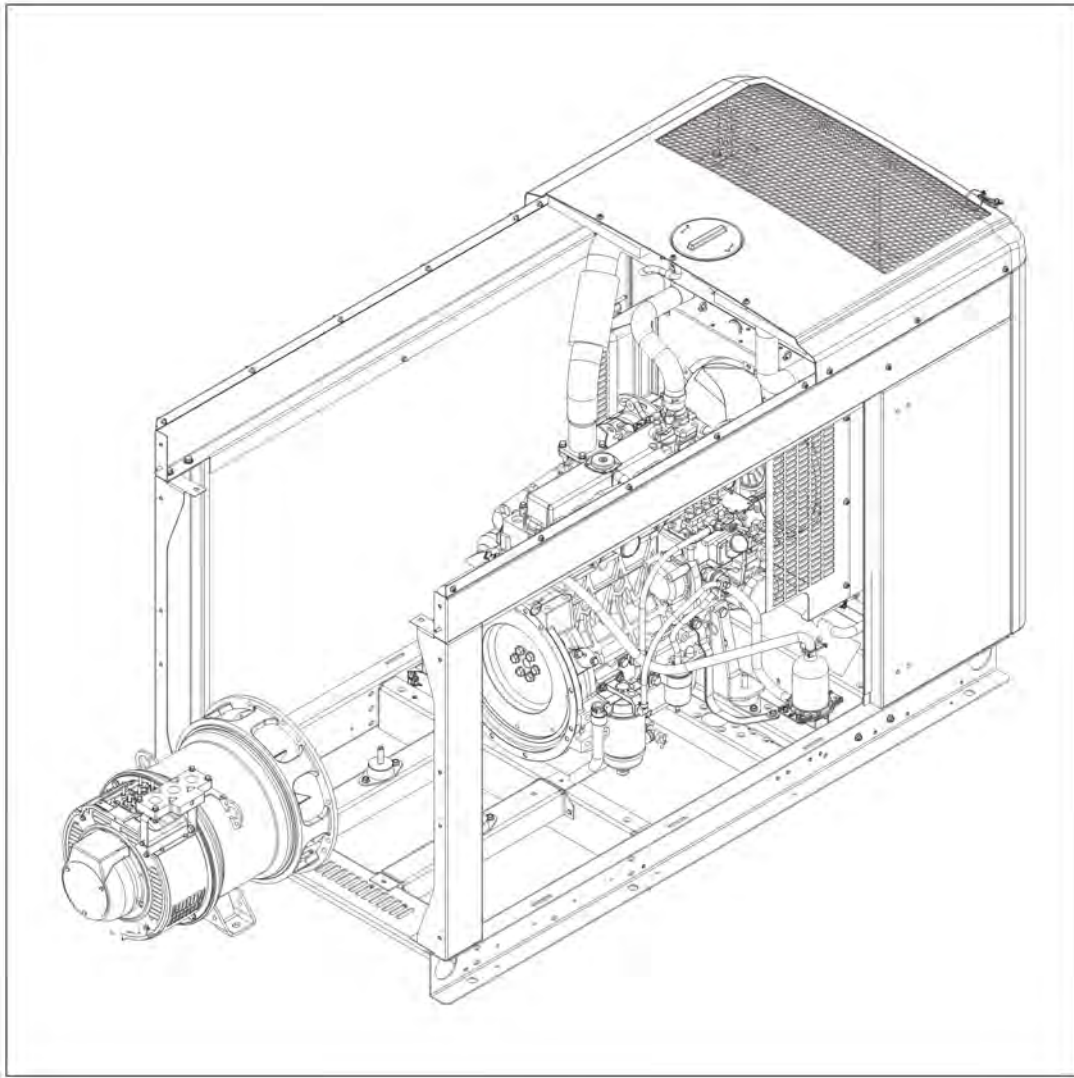


FIGURE 38. MOVING THE ALTERNATOR

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

14.6 Bearings

Sealed Bearings

Inspect sealed-for-life bearings periodically, according to the recommended service schedule in this manual. 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.

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.

14.7 Generator Set Coupling

NOTICE

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



FIGURE 39. DO NOT ROTATE ROTOR USING FAN

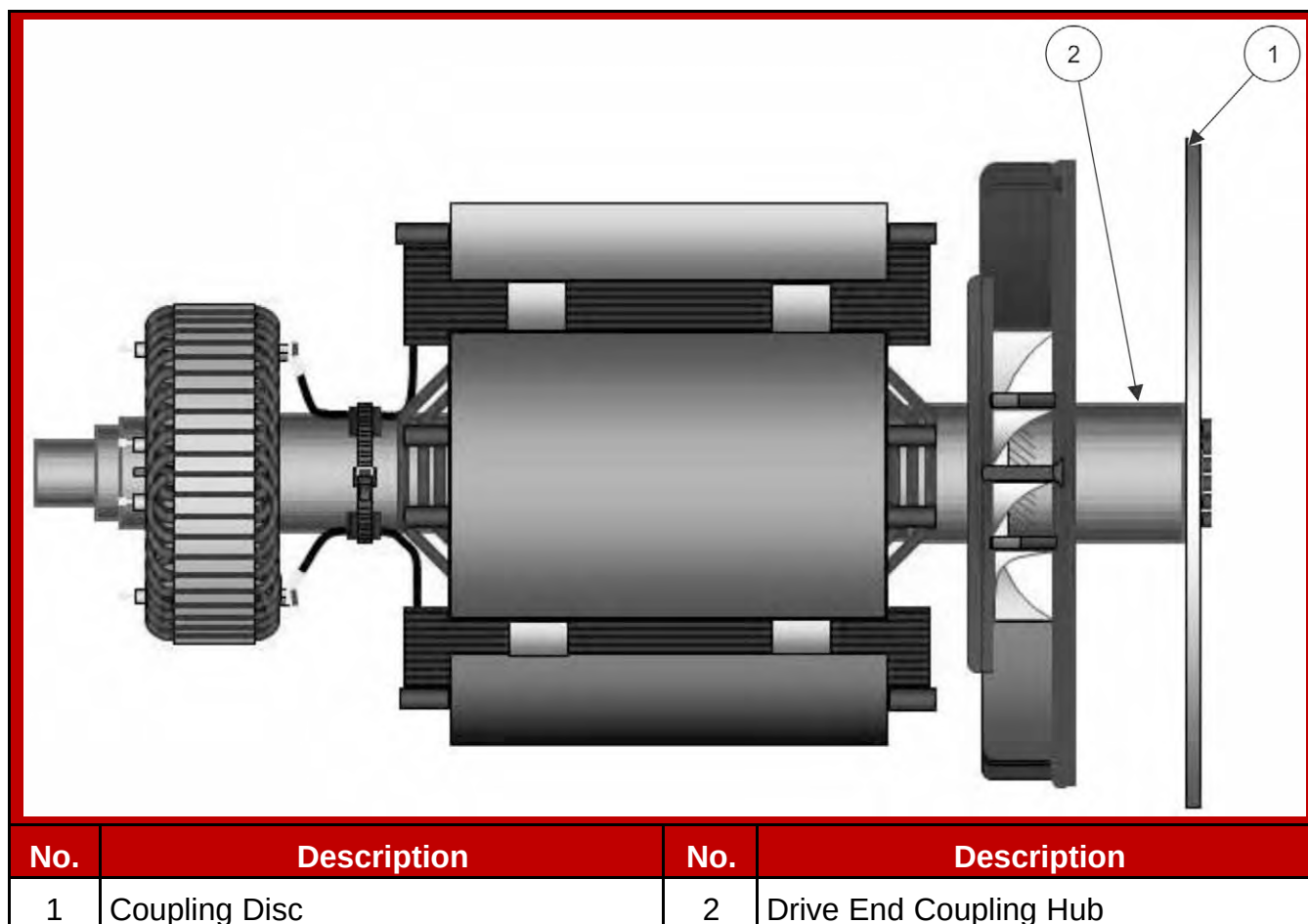


FIGURE 40. SINGLE BEARING GENERATOR ROTOR SHOWING COUPLING DISC BOLTED TO DRIVE END COUPLING HUB (AT RIGHT)

14.8 Service and Maintenance

Parts Identification

CA115 Single Bearing Alternator

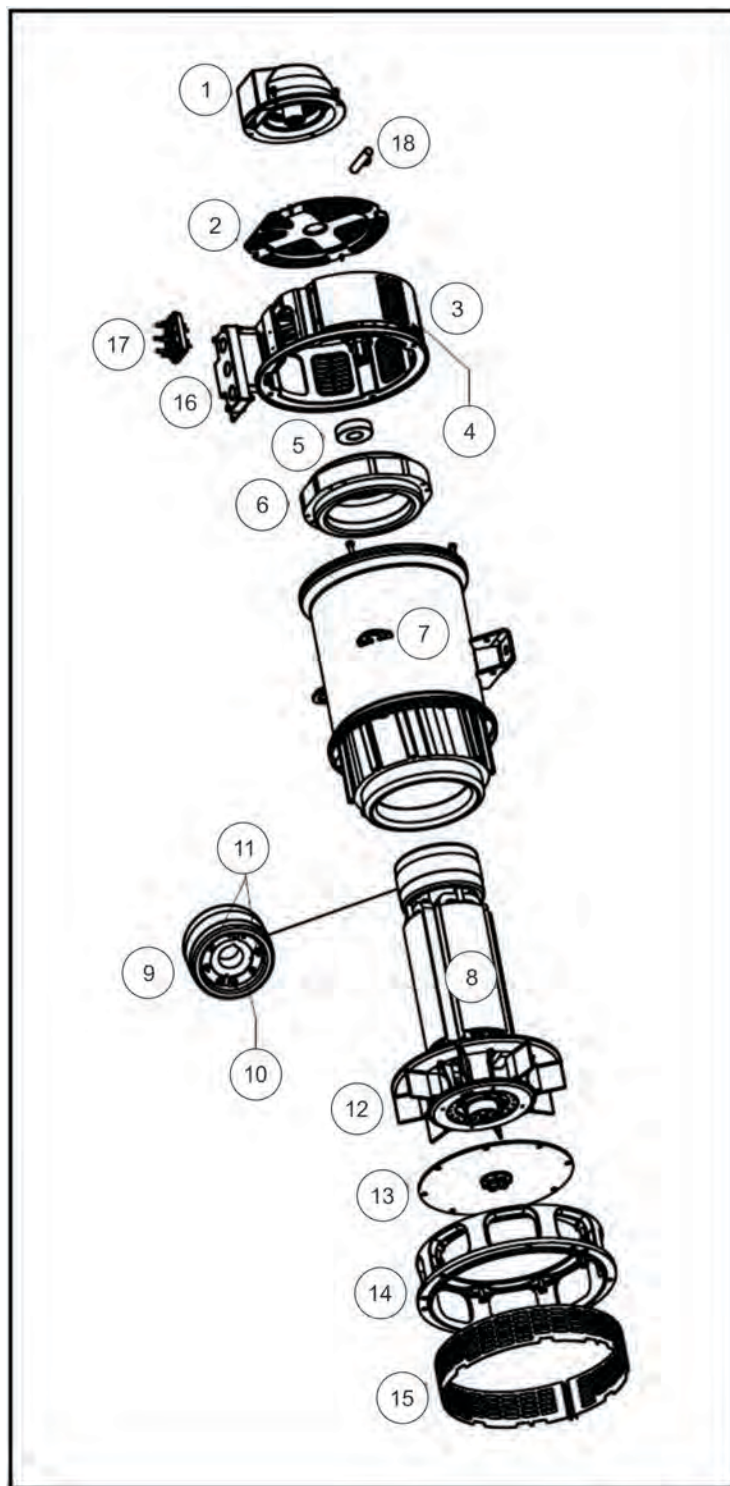


TABLE 17. CA115 PARTS AND FASTENERS

Reference	Component
1	Excitation Boost System (EBS)
2	NDE Cover (without EBS)
	NDE Cover (with EBS)
3	NDE Bracket M/C (New Cast Iron)
	NDE Bracket M/C (New GDC)
4	NDE Bottom Access Screen LHS
	NDE Bottom Access Screen RHS
5	Bearing
6	Exciter Stator
7	Stator Frame Assembly
8	Rotor Shaft Assembly
9	Excitor Rotor Assembly
10	Rotating Rectifier Assembly
11	Diode (Forward/Reverse) & Varistor Assembly
12	Fan
13	Coupling Disc (SAE 10, 1.5 THK)
14	Adapter Kit
15	DE Screen
16	Current Transformer Assembly
17	Terminal Board
18	Heater

14.9 Rectifier System

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).

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.

Requirements

TABLE 18. RECTIFIER SYSTEM: TEST AND REPLACE COMPONENT REQUIREMENTS

Type	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

Type	Description
Tools	Multimeter
	Insulation tester
	Torque wrench

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.

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.

14.10 Windings

Introduction

NOTICE

Disconnect all control wiring and customer load leads from alternator winding connections before conducting these tests.

NOTICE

The Automatic Voltage Regulator (AVR) contains electronic components which would be damaged by high voltage applied during insulation resistance tests. The AVR 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.

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.

Requirements

TABLE 19. WINDING TEST REQUIREMENTS

Type	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

Test the Insulation Resistance of Windings

NOTICE

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

TABLE 20. 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

- Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
- For main stators:
 - Disconnect the neutral to earth conductor (if equipped).
 - Connect together the three leads of all phase windings (if possible).
 - Apply the test voltage from the table between any phase lead and earth.
 - 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.
 - Discharge the test voltage with an earth rod for 5 minutes.
 - If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, and then repeat the method.
 - If minimum resistance is not above listed, replace the main stator.
 - Reconnect neutral to earth conductor (if equipped).
- For exciter stators, and combined exciter and main rotors:
 - Connect together both ends of the winding (if possible).
 - Apply the test voltage from the table between the winding and earth.
 - Measure the winding insulation resistance after 1 minute, IR_{1min} . Insulation should be measured with winding temperatures of 20 °C.
 - Discharge the test voltage with an earth rod for 5 minutes.
 - 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.

Remove Main Rotor

NOTICE

The rotor is heavy, with a small clearance to the stator. Windings will be damaged if the rotor drops or swings in the crane sling and hits the stator or frame. To avoid damage, fit support packing and carefully guide the rotor ends throughout. Do not allow the sling to touch the fan.

NOTICE

To remove the main rotor safely and easily, use the following special tools: a rotor extension stub shaft, a rotor extension tube (of similar length to the rotor shaft) and a height-adjustable V roller extension tube support. Refer to the factory for the availability and specification of these tools.

1. Remove non-drive end bracket, see **Remove Non-Drive End** section.
2. For a one bearing alternator, remove drive end adapter as follows:
 - a. Disconnect the alternator from the prime mover.
 - b. Remove the DE adapter.
3. Fix the rotor shaft extension stub shaft to the main rotor at the non-drive end.
4. Fix the extension tube to the stub shaft.
5. Position the V roller support underneath the shaft extension tube, close to the alternator frame.
6. Raise the V roller support to lift the extension tube a small amount, to support the weight of the main rotor at the non-drive end.
7. Use a crane sling to lift the rotor at the drive end a small amount, to support its weight.
8. Carefully move the crane sling away so that the rotor withdraws from the alternator frame, as the extension tube rolls on the V rollers, until the rotor windings are fully visible.
9. Support the rotor on wooden blocks to prevent it rolling and damaging the windings.
10. Tightly bind the crane sling near the middle of the main rotor windings, near the rotor center of gravity.
11. Use a crane sling to lift the rotor a small amount, to test the rotor weight is balanced. Adjust the crane sling as necessary.
12. Carefully move the crane sling away so that the rotor withdraws completely from the alternator frame.

13. Lower the rotor onto wooden block supports and prevent it rolling and damaging the windings.
14. Remove the extension tube and stub shaft, as necessary.
15. Mark the position of the sling (to assist re-assembly) and remove the crane sling, as necessary.

Install Main Rotor

NOTICE

The rotor is heavy, with a small clearance to the stator. Windings will be damaged if the rotor drops or swings in the crane sling and hits the stator or frame. To avoid damage, fit support packing between the rotor and stator and carefully guide the rotor ends throughout. Do not allow the sling to touch the fan.

NOTICE

To install the main rotor safely and easily, use the following special tools: a rotor extension stub shaft, a rotor extension tube (of similar length to the rotor shaft) and a height-adjustable V roller extension tube support. Refer to the factory for the availability and specification of these tools.

1. Fix the rotor shaft extension stub shaft to the main rotor at the non-drive end (or to the NDE bearing cartridge on some alternator models).
2. Fix the extension tube to the stub shaft.
3. Tightly bind the crane sling near the middle of the main rotor windings near the rotor center of gravity.
4. Use a crane sling to lift the rotor a small amount, to test the rotor weight is balanced. Adjust the crane sling as necessary.
5. Position the V roller support at the non-drive end, close to the alternator frame.
6. Carefully use the crane sling to insert the rotor into the alternator frame, extension tube first.
7. Guide the extension tube onto the V roller support. Adjust the height of the V roller support as necessary.
8. Insert the rotor into the alternator frame, until the crane sling meets the frame.
9. Lower the rotor onto wooden blocks to prevent it rolling and damaging the windings.
10. Reposition the crane sling at the drive end of the rotor shaft.
11. Use the crane sling to lift the rotor at the drive end a small amount, to support its weight.
12. Carefully move the crane sling towards the alternator frame, as the extension tube rolls on the V rollers, until the rotor windings are fully inserted.

13. Gently lower the crane sling to put the rotor weight onto the support packing and remove the sling.
14. For a one bearing alternator, assemble the drive end as follows:
 - a. Refit the DE adapter
 - b. Couple the alternator to the prime mover.
 - c. Refit the upper and lower air outlet screen covers.
15. Refit the non-drive end bracket, see **Assemble Non-Drive End** section.
16. Remove the rotor shaft extension tube.
17. Remove the rotor shaft extension stub shaft.
18. Remove the V roller support.

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Appendix A. Wiring Diagrams

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Figure 41. Wiring Diagram (Sheet 1 of 8) 193

Figure 42. Wiring Diagram (Sheet 2 of 8) 194

Figure 43. Wiring Diagram (Sheet 3 of 8) 195

Figure 44. Wiring Diagram (Sheet 4 of 8) 196

Figure 45. Wiring Diagram (Sheet 5 of 8) 197

Figure 46. Wiring Diagram (Sheet 6 of 8) 198

Figure 47. Wiring Diagram (Sheet 7 of 8) 199

Figure 48. Wiring Diagram (Sheet 8 of 8) 200

Figure 49. Harness, Control (Sheet 1 of 3) 201

Figure 50. Harness, Control (Sheet 2 of 3) 202

Figure 51. Harness, Control (Sheet 3 of 3) 203

Figure 52. Harness, Generator Electrical (Emergency Stop) (Sheet 1 of 1) 204

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

A.1 Wiring Diagrams

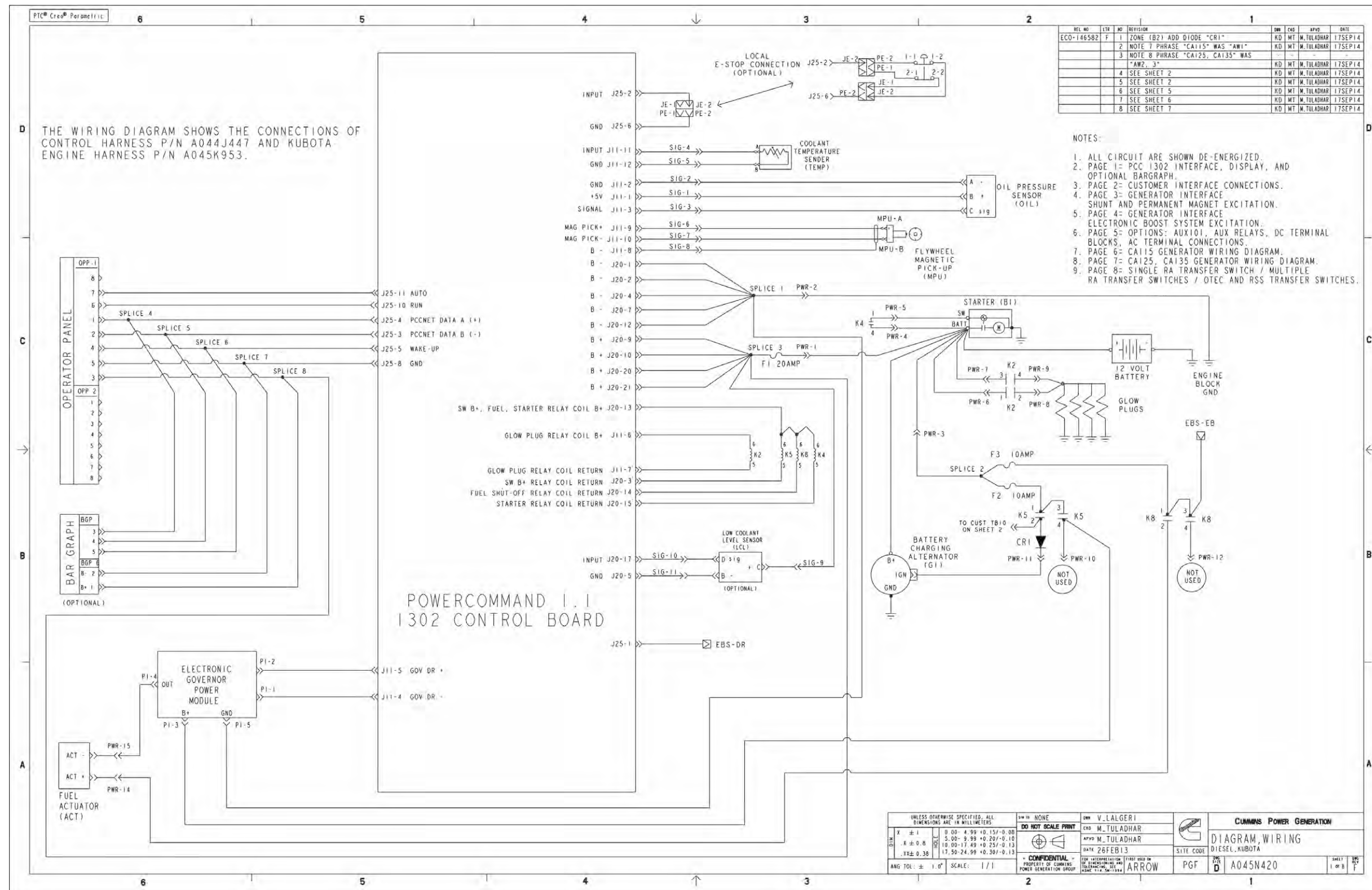


FIGURE 41. WIRING DIAGRAM (SHEET 1 OF 8)

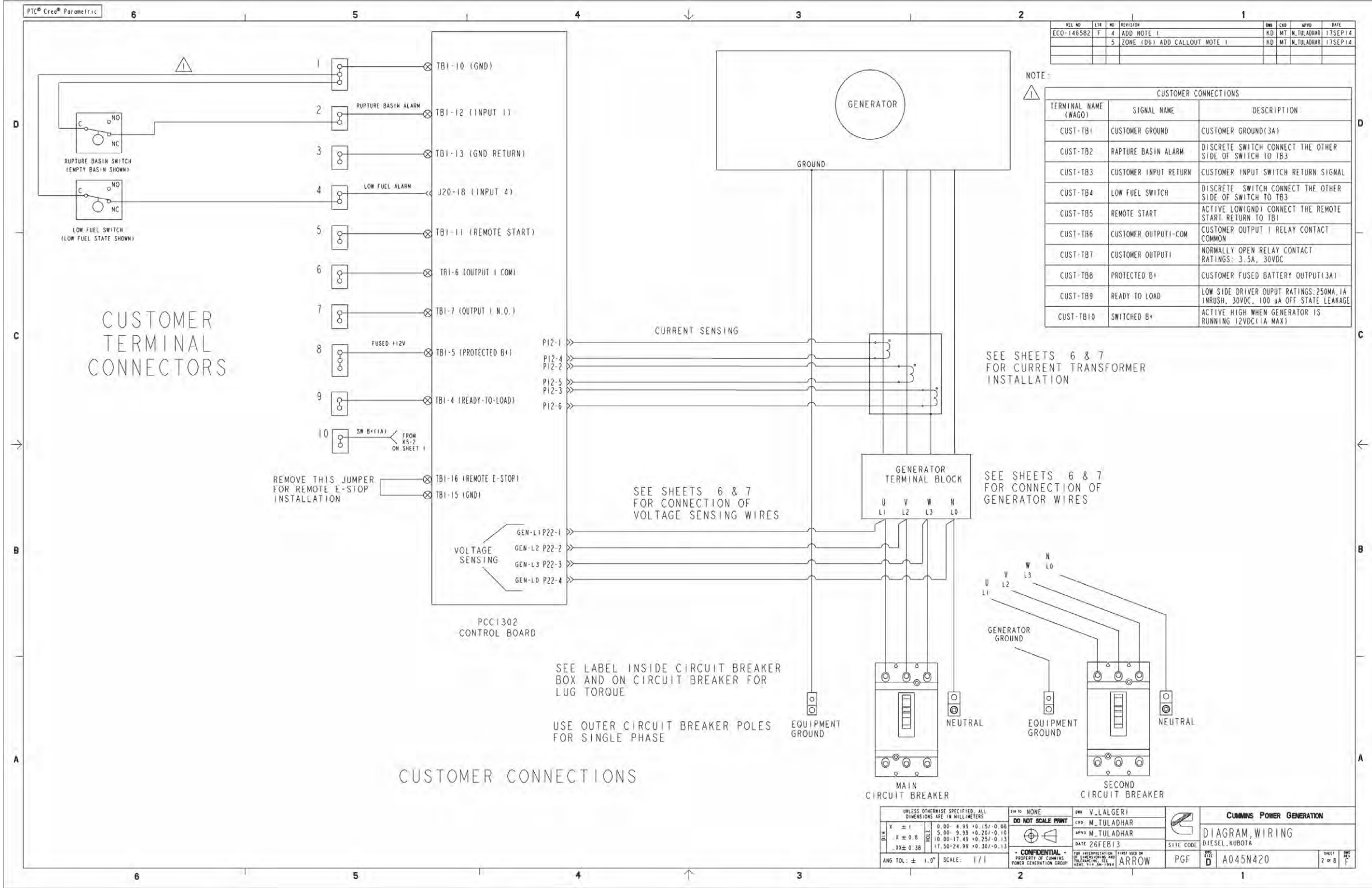


FIGURE 42. WIRING DIAGRAM (SHEET 2 OF 8)

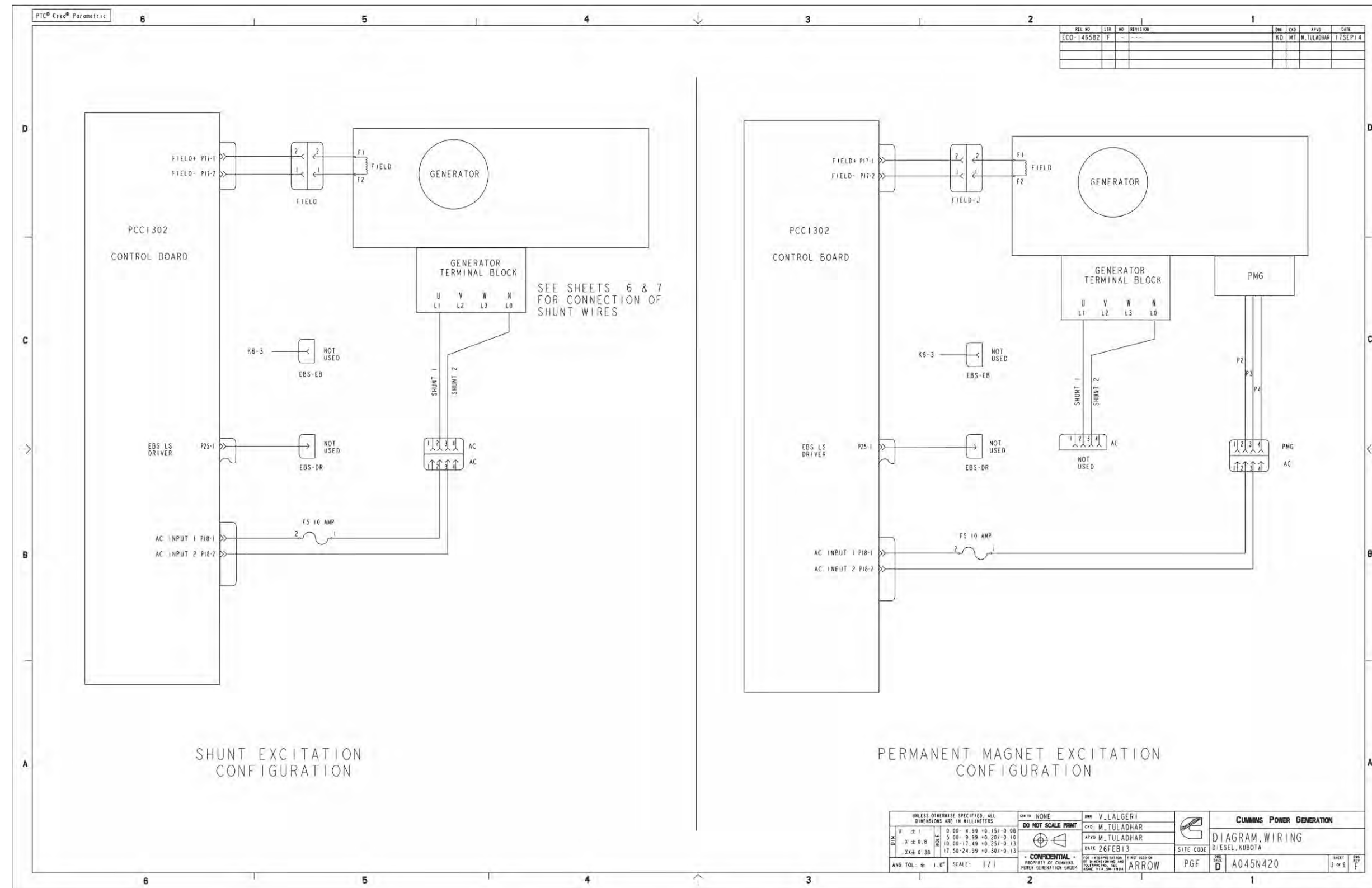


FIGURE 43. WIRING DIAGRAM (SHEET 3 OF 8)



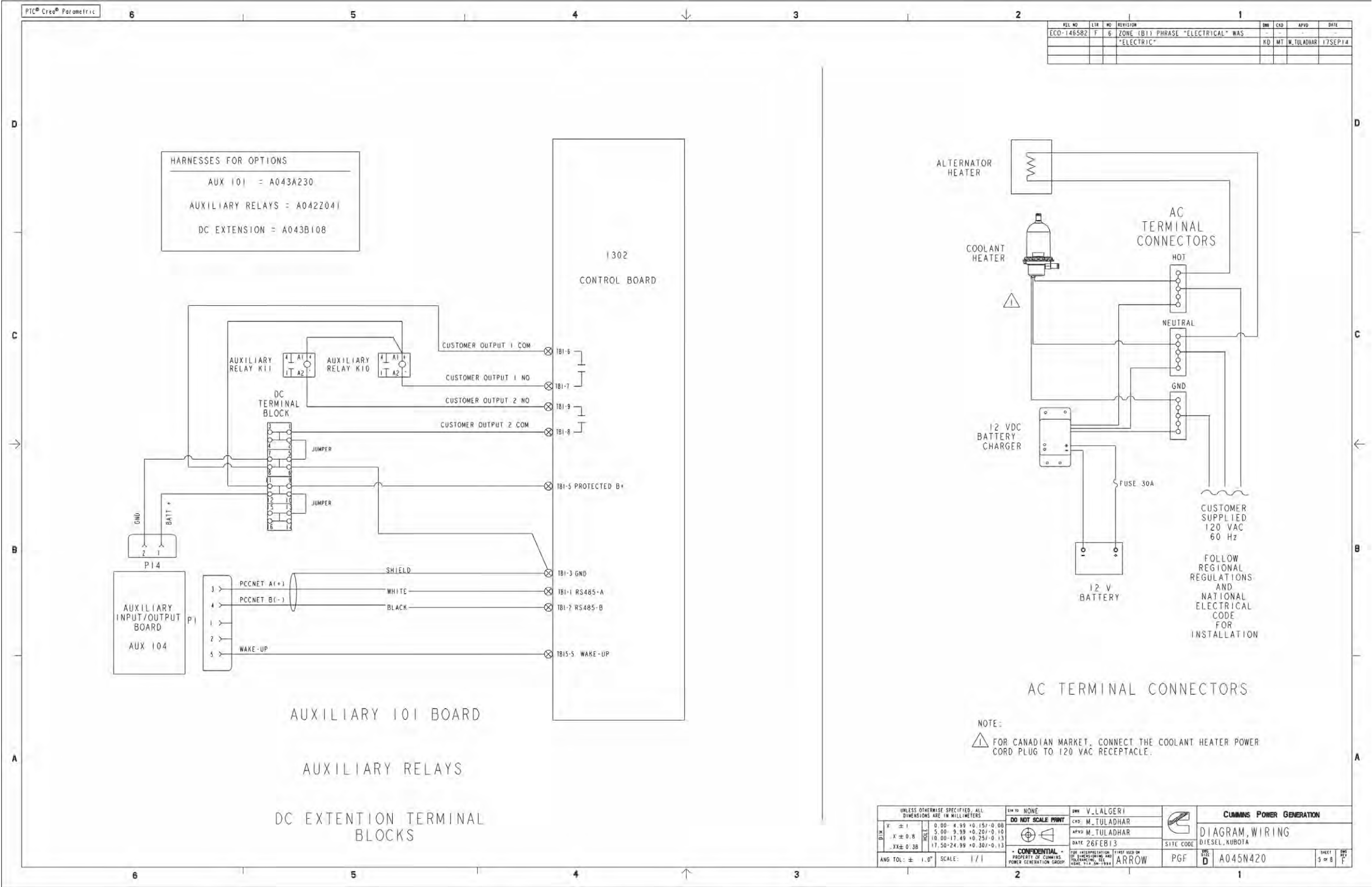


FIGURE 45. WIRING DIAGRAM (SHEET 5 OF 8)

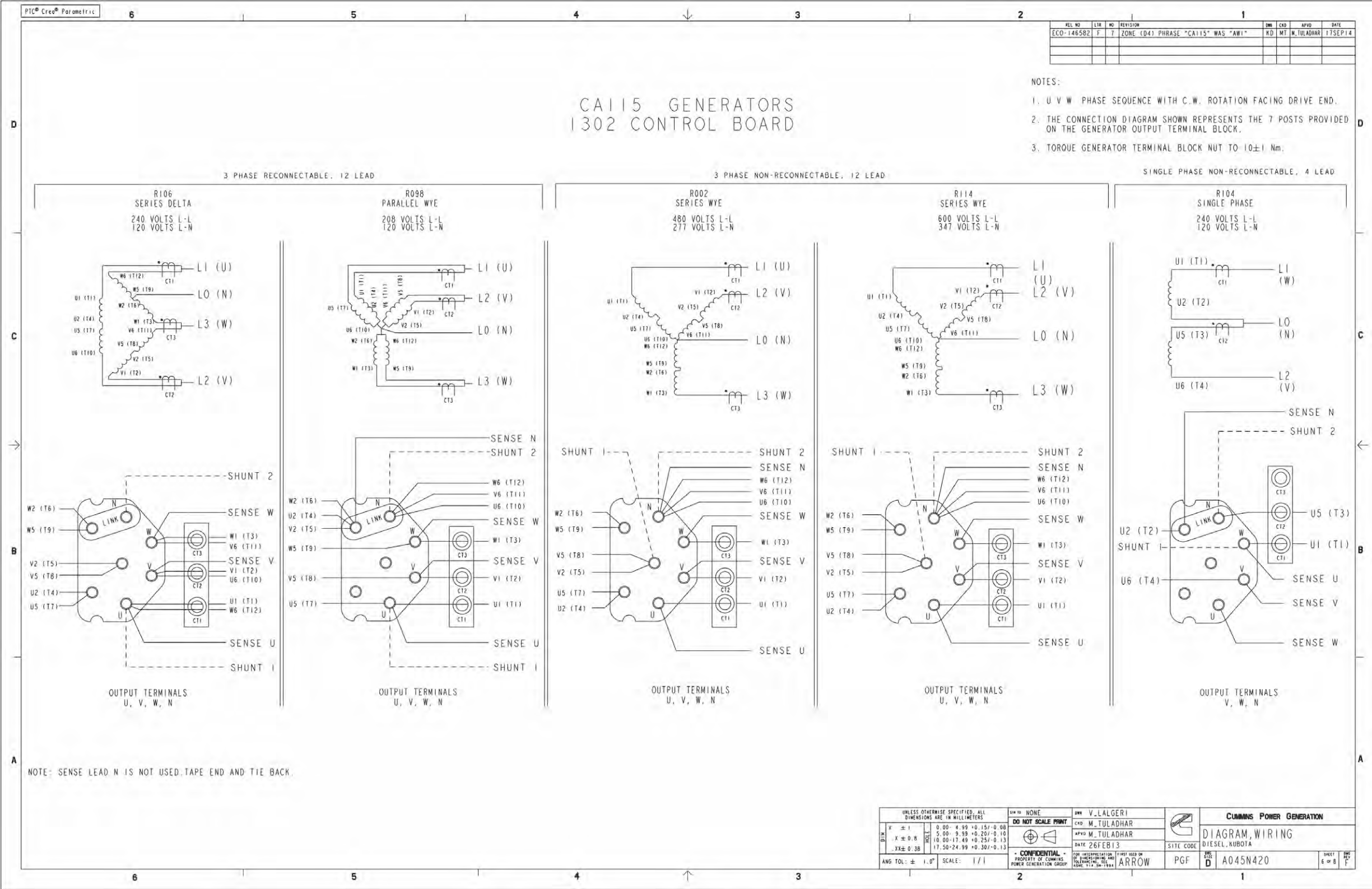


FIGURE 46. WIRING DIAGRAM (SHEET 6 OF 8)

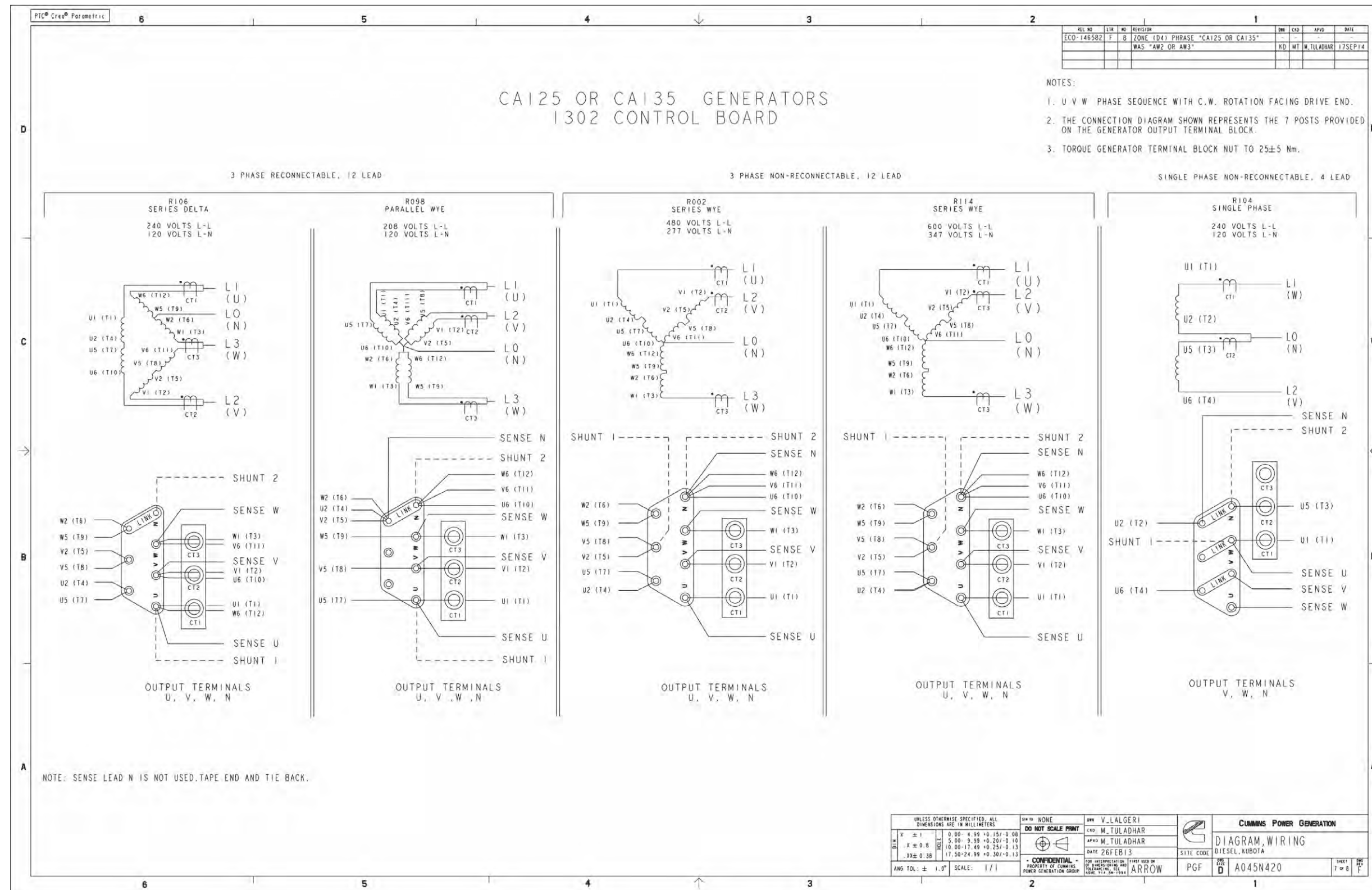


FIGURE 47. WIRING DIAGRAM (SHEET 7 OF 8)

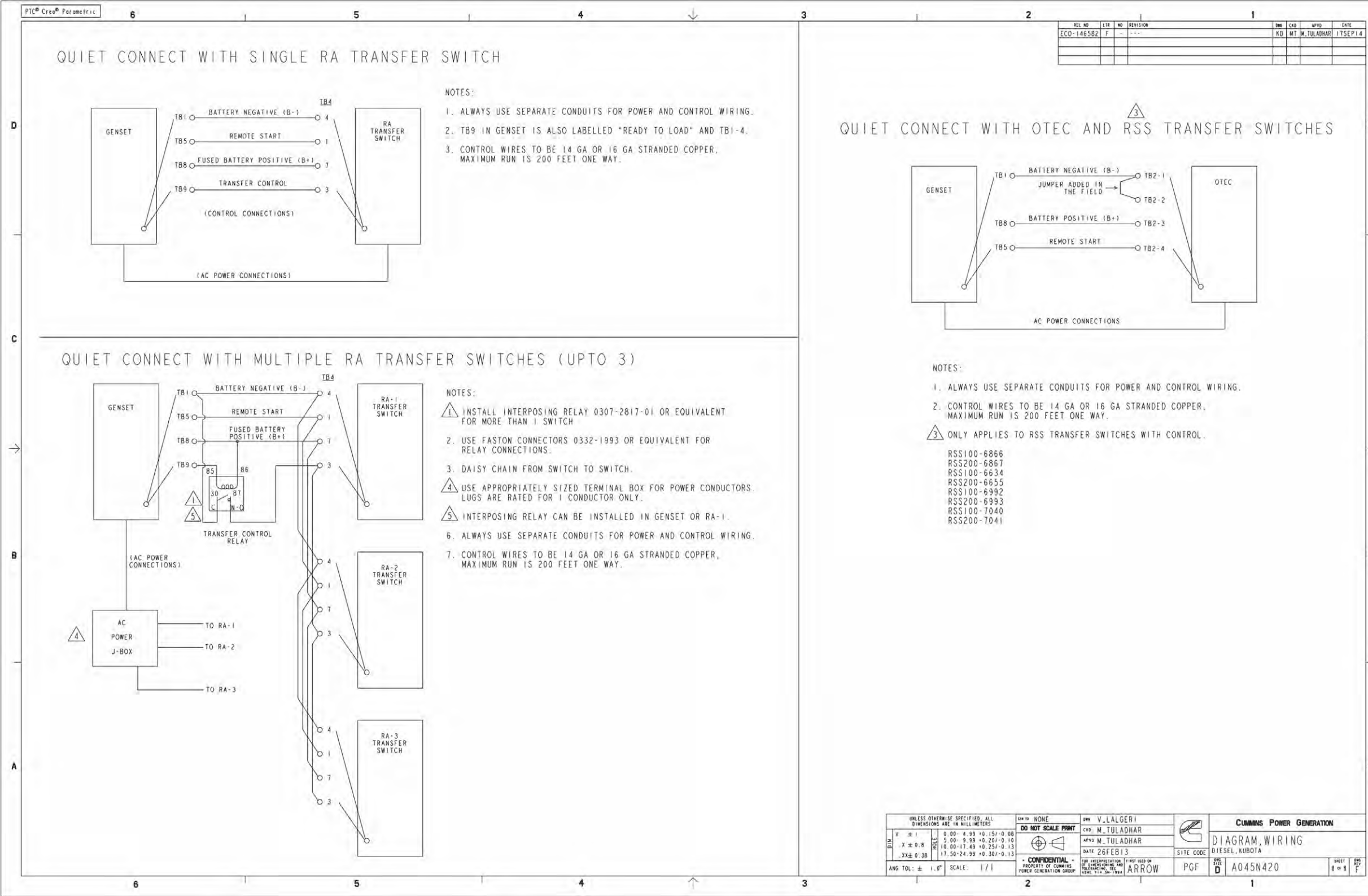


FIGURE 48. WIRING DIAGRAM (SHEET 8 OF 8)

TO/FROM WIRE LIST												
INDEX	WIRE NAME	FROM				TO				WIRE		
		CONNECTOR NAME	CONNECTOR PART NUMBER	FROM STATION	PIN	CONNECTOR NAME	CONNECTOR PART NUMBER	TO STATION	PIN	SPOOL	WIRE SIZE (AWG)	LENGTH (REFERENCE ONLY) DO NOT CUT WIRE TO THIS LENGTH
1	W-01	PCC-P20	0323.2446	PCC-P20-10	0323-2466	SP8	0332.3638	SP8-1	NOT APPLY	0334-2226-01	18	274
2	W-02	SP8	0332.3638	SP8-1	NOT APPLY	PCC-P20	0323.2446	PCC-P20-21	0323-2466	0334-2226-01	18	280
3	W-03	PCC-P20	0323.2446	PCC-P20-20	0323-2466	SP8	0332.3638	SP8-1	NOT APPLY	0334-2226-01	18	362
4	W-04	SP8	0332.3638	SP8-2	NOT APPLY	PCC-P20	0323.2446	PCC-P20-9	0323-2466	0334-2226-01	18	326
5	W-05	K5-6	0332.1992	K5-6-1	NOT APPLY	PCC-P20	0323.2446	PCC-P20-3	0323-2466	0334-1207	18	467
6	W-06	PCC-P20	0323.2446	PCC-P20-12	0323-2466	EJ2	A043T411	EJ2-5	A043H311	0334-1207	18	779
7	W-07	EJ2	A043T411	EJ2-6	A043H311	PCC-P20	0323.2446	PCC-P20-7	0323-2466	0334-1207	18	775
8	W-08	EJ2	A043T411	EJ2-7	A043H311	PCC-P20	0323.2446	PCC-P20-4	0323-2466	0334-1207	18	785
9	W-09	PCC-P20	0323.2446	PCC-P20-2	0323-2466	EJ2	A043T411	EJ2-8	A043H311	0334-1207	18	785
10	W-10	EJ2	A043T411	EJ2-12	A043H309	PCC-P20	0323.2446	PCC-P20-1	0323-2466	0334-1208	16	774
11	W-11	EJ2	A043T411	EJ2-11	A043H311	PCC-P20	0323.2446	PCC-P20-17	0323-2466	0334-0157	18	753
12	W-12	EJ2	A043T411	EJ2-13	A043H311	PCC-P20	0323.2446	PCC-P20-18	0323-2466	0334-0157	18	770
13	W-13	PE	0323.2098	PE-1	0323-2332	PCC-P11	0323.2161	PCC-P11-22	0323-2466	0334-2226-01	16	1479
14	W-14	K6-6	0332.1992	K6-6-1	NOT APPLY	PCC-P11	0323.2161	PCC-P11-21	0323-2466	0334-1207	18	432
15	W-15	SP8	0332.3638	SP8-2	NOT APPLY	DISPLAY-P1	0323.2011	DISPLAY-P1-3	0323-2466	0334-2226-01	18	1585
16	W-16	F3-2	0332.1993	F3-2-1	NOT APPLY	SP8	0332.3638	SP8-2	NOT APPLY	0334-2228-01	16	88
17	W-17	SP11	0332.3638	SP11-2	NOT APPLY	PCC-P11	0323.2161	PCC-P11-20	0323-2466	0334-1354	18	201
18	W-18	PCC-P11	0323.2161	PCC-P11-19	0323-2466	SP12	0332.3638	SP12-2	NOT APPLY	0334-1354	18	200
19	W-19	PCC-P11	0323.2161	PCC-P11-17	0323-2466	SP18	0332-0430	SP18-2	NOT APPLY	0334-1354	18	201
20	W-20	SP11	0332.3638	SP11-1	NOT APPLY	EJ2	A043T411	EJ2-1	A043H311	0334-1354	18	672
21	W-21	DISPLAY-P1	0323.2011	DISPLAY-P1-2	0323-2466	SP4	0332.3638	SP4-1	NOT APPLY	0334-0756	20	254
22	W-22	SP4	0332.3638	SP4-2	NOT APPLY	PCC-P25	0323.2445	PCC-P25-3	0323-2466	0334-0756	20	1138
23	W-23	DISPLAY-P1	0323.2011	DISPLAY-P1-1	0323-2466	SP5	0332.3638	SP5-1	NOT APPLY	0334-0756	20	241
24	W-24	SP5	0332.3638	SP5-2	NOT APPLY	PCC-P25	0323.2445	PCC-P25-4	0323-2466	0334-0756	20	1157
25	W-25	DISPLAY-P1	0323.2011	DISPLAY-P1-4	0323-2466	SP6	0332.3638	SP6-1	NOT APPLY	0334-0756	20	242
26	W-26	SP6	0332.3638	SP6-2	NOT APPLY	PCC-P25	0323.2445	PCC-P25-5	0323-2466	0334-0756	20	1137
27	W-27	DISPLAY-P1	0323.2011	DISPLAY-P1-6	0323-2466	PCC-P25	0323.2445	PCC-P25-10	0323-2466	0334-0756	20	1381
28	W-28	DISPLAY-P1	0323.2011	DISPLAY-P1-5	0323-2466	SP7	0332.3638	SP7-1	NOT APPLY	0334-1206	20	246
29	W-29	SP7	0332.3638	SP7-2	NOT APPLY	PCC-P25	0323.2445	PCC-P25-6	0323-2466	0334-1208	16	1132
30	W-30	DISPLAY-P1	0323.2011	DISPLAY-P1-7	0323-2466	PCC-P25	0323.2445	PCC-P25-11	0323-2466	0334-0756	20	1379
31	W-31	BGRAPH-P6	0323.1678.01	BGRAPH-P6-1	0332-3491-01	PCC-P25	0323.2445	PCC-P25-12	0323-2466	0334-2226-01	18	1484
32	W-32	JE	0323.2237	JE-2	A040M659	PCC-P25	0323.2445	PCC-P25-6	0323-2466	0334-0757	18	1216
33	W-33	PCC-P25	0323.2445	PCC-P25-2	0323-2466	PE	0323.2098	PE-2	0323-2332	0334-0757	18	1161
34	W-34	BGRAPH-P1	0323.2192.04	BGRAPH-P1-5	0323-2466	SP6	0332.3638	SP6-2	NOT APPLY	0334-0756	20	433
35	W-35	BGRAPH-P1	0323.2192.04	BGRAPH-P1-3	0323-2466	SP5	0332.3638	SP5-2	NOT APPLY	0334-0756	20	433
36	W-36	BGRAPH-P1	0323.2192.04	BGRAPH-P1-4	0323-2466	SP4	0332.3638	SP4-2	NOT APPLY	0334-0756	20	425
37	W-37	F2-1	0332.1993	F2-1-1	NOT APPLY	K2-1	0332.1993	K2-1-1	NOT APPLY	0334-2228-01	16	300
38	W-38	F2-2	0332.1992	F2-2-1	NOT APPLY	EJ1	A043G964	EJ1-5	A043U187	0334-2228-01	16	645
39	W-39	SP2	0332.3638	SP2-1	NOT APPLY	EJ1	A043G964	EJ1-1	A043U187	0334-2228-01	16	601
40	W-40	SP2	0332.3638	SP2-2	NOT APPLY	F1-1	0332.1993	F1-1-1	NOT APPLY	0334-2228-01	16	69
41	W-41	F1-2	0332.1993	F1-2-1	NOT APPLY	SP1	0332.3638	SP1-2	NOT APPLY	0334-2228-01	16	60
42	W-42	EJ1	A043G964	EJ1-4	A043U187	SP1	0332.3638	SP1-1	NOT APPLY	0334-2226-01	18	612
43	W-43	K2-5	0332.1992	K2-5-1	NOT APPLY	SP1	0332.3638	SP1-1	NOT APPLY	0334-2226-01	18	253
44	W-44	K2-4	0332.1993	K2-4-1	NOT APPLY	SP2	0332.3638	SP2-1	NOT APPLY	0334-2228-01	16	215
45	W-45	EJ2	A043T411	EJ2-4	A043H311	K2-6	0332.1992	K2-6-1	NOT APPLY	0334-1207	18	500
46	W-46	EJ2	A043T411	EJ2-10	A043H311	SP17	0332.3638	SP17-1	NOT APPLY	0334-2226-01	18	781
47	W-47	K5-5	0332.1992	K5-5-1	NOT APPLY	SP17	0332.3638	SP17-1	NOT APPLY	0334-2226-01	18	926
48	W-48	K5-4	0332.1993	K5-4-1	NOT APPLY	SP17	0332.3638	SP17-1	NOT APPLY	0334-2228-01	16	236
49	W-49	SP7	0332.3638	SP7-2	NOT APPLY	BGRAPH-P6	0323.1678.01	BGRAPH-P6-2	0332-3491-01	0334-1206	20	452
50	W-50	K4-1	0332.1993	K4-1-1	NOT APPLY	EJ1	A043G964	EJ1-3	A043U187	0334-2228-01	16	488
51	W-51	EJ1	A043G964	EJ1-7	A043U187	F3-1	0332.1993	F3-1-1	NOT APPLY	0334-2228-01	16	678
52	W-52	K6-5	0332.1992	K6-5-1	NOT APPLY	JE	0323.2237	JE-1	A040M659	0334-2226-01	18	1688
53	W-53	K5-2	0332.1993	K5-2-1	NOT APPLY	SP17	0332.3638	SP17-1	NOT APPLY	0334-2228-01	16	241
54	W-54	EJ1	A043G964	EJ1-6	A043U187	K5-3	0332.1993	K5-3-1	NOT APPLY	0334-2228-01	16	680
55	W-55	SP12	0332.3638	SP12-1	NOT APPLY	EJ2	A043T411	EJ2-2	A043H311	0334-1354	18	649
56	W-56	EJ2	A043T411	EJ2-3	A043H311	SP18	0332-0430	SP18-1	NOT APPLY	0334-1354	18	614
57	W-57	K6-4	0332.1995	K6-4-1	NOT APPLY	EJ1	A043G964	EJ1-2	A043U187	0334-2228-01	16	922
58	W-58	K6-1	0332.1993	K6-1-1	NOT APPLY	F4-1	0332.1993	F4-1-1	NOT APPLY	0334-2228-01	16	570
59	W-59	K4-4	0332.1993	K4-4-1	NOT APPLY	K6-4	0332-1992	K6-4-1	NOT APPLY	0334-2228-01	16	105
60	W-60	K4-5	0332.1992	K4-5-1	NOT APPLY	PCC-P20	0323.2446	PCC-P20-13	0323-2466	0334-2226-01	18	549
61	W-61	K4-6	0332.1992	K4-6-1	NOT APPLY	PCC-P20	0323.2446	PCC-P20-15	0323-2466	0334-1207	18	105
62	W-62	EJ1	A043G964	EJ1-8	A043U187	CR1	0332-1992	CR1-C	NOT APPLY	0334-0757	18	620
63	W-63	CR1	0332-1992	CR1-A	NOT APPLY	K5-1	0332-0041	K5-1-1	NOT APPLY	0334-0757	18	280
64	W-64	TB5	A034P713	TB5-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-10	0332-3491-01	0334-0757	18	659
65	W-65	TB2	A034P713	TB2-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-12	0332-3491-01	0334-0757	18	677
66	W-66	TB7	A034P713	TB7-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-7	0332-3491-01	0334-0757	18	685
67	W-67	PCC-TB15	0323.2192.04	PCC-TB15-5	0332-3491-01	SERVICE-J3	A044B973	SERVICE-J3-5	A040B973	0334-0757	18	1528
68	W-68	SERVICE-J3	A044B973	SERVICE-J3-4	A040B973	PCC-TB15	0323.2192.04	PCC-TB15-4	0332-3491-01	0334-0757	18	1542
69	W-69	SERVICE-J3	A044B973	SERVICE-J3-3	A040B973	PCC-TB15	0323.2192.04	PCC-TB15-3	0332-3491-01	0334-0757	18	1540
70	W-71	PCC-TB15	0323.2192.04	PCC-TB15-1	0332-3491-01	SERVICE-J3	A044B973	SERVICE-J3-1	A040B973	0334-0757	18	1524
71	W-72	PCC-TB1	0323.1678.15	PCC-TB1-5	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-16	0332-3491-01	0334-0757	18	147
72	W-73	PCC-P18	0323.2444	PCC-P18-1	0323-2466	F5-1	0332.1993	F5-1-1	NOT APPLY	0334-2228-03	16	576
73	W-74	PCC-P18	0323.2444	PCC-P18-2	0323-2466	AC-P	A042N319	AC-P-3	A043L492	0334-2228-05	16	1421
74	W-76	F5-2	0332.1993	F5-2-1	NOT APPLY	AC-P	A042N319	AC-P-2	A043L492	0334-2228-03	16	1045
75	W-78	PCC-P25	0323.2445	PCC-P25-1	0323-2466	EBS-DR	0332.2430	EBS-DR-1	NOT APPLY	0334-1207	18	506
76	W-79	PCC-P11	0323.2161	PCC-P11-6	0323-2466	EBS-EB	0332.1992	EBS-EB-1	NOT APPLY	0334-2226-01	18	841
77	W-80	TB6	A034P713	TB6-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-6	0332-3491-01	0334-0757	18	679
78	W-81	TB8	A034P636	TB8-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-5	0332-3491-01	0334-2226-01	18	675
79	W-82	TB4	A034P713	TB4-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-14	0332-3491-01	0334-0757	18	713
80	W-83	SP8	0332.3638	SP8-2	NOT APPLY	EJ2	A043T411	EJ2-15	A043H311	0334-2226-01	18	702
81	W-84	TB3	A034P713	TB3-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-13	0332-3491-01	0334-0757	18	663
82	W-87	TB9	A034P713	TB9-1	0332-3491-01	PCC-TB1	0323.1678.15	PCC-TB1-4	0332-3491-01	0334-0757	18	666
83	W-88	F4-2	0332.1993	F4-2-1	NOT APPLY	SP17	0332.3638	SP17-2	NOT APPLY	0334-2228-01	16	366
84	WA	R01	0351.1596.59	R01-2	NOT APPLY	SP12	0332.3638	SP12-1	NOT APPLY	0334-1207	18	72
85	WB	R01	0351.1596.59	R01-1	NOT APPLY	SP11	0332.3638	SP11-1	NOT APPLY	0334-1207	18	13
86	W-89	TB10	A043P713	TB10-1	0332-3491-01	K5-1	(0332-4041)	K5-1-1	NOT APPLY	0334-0757	18	550

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

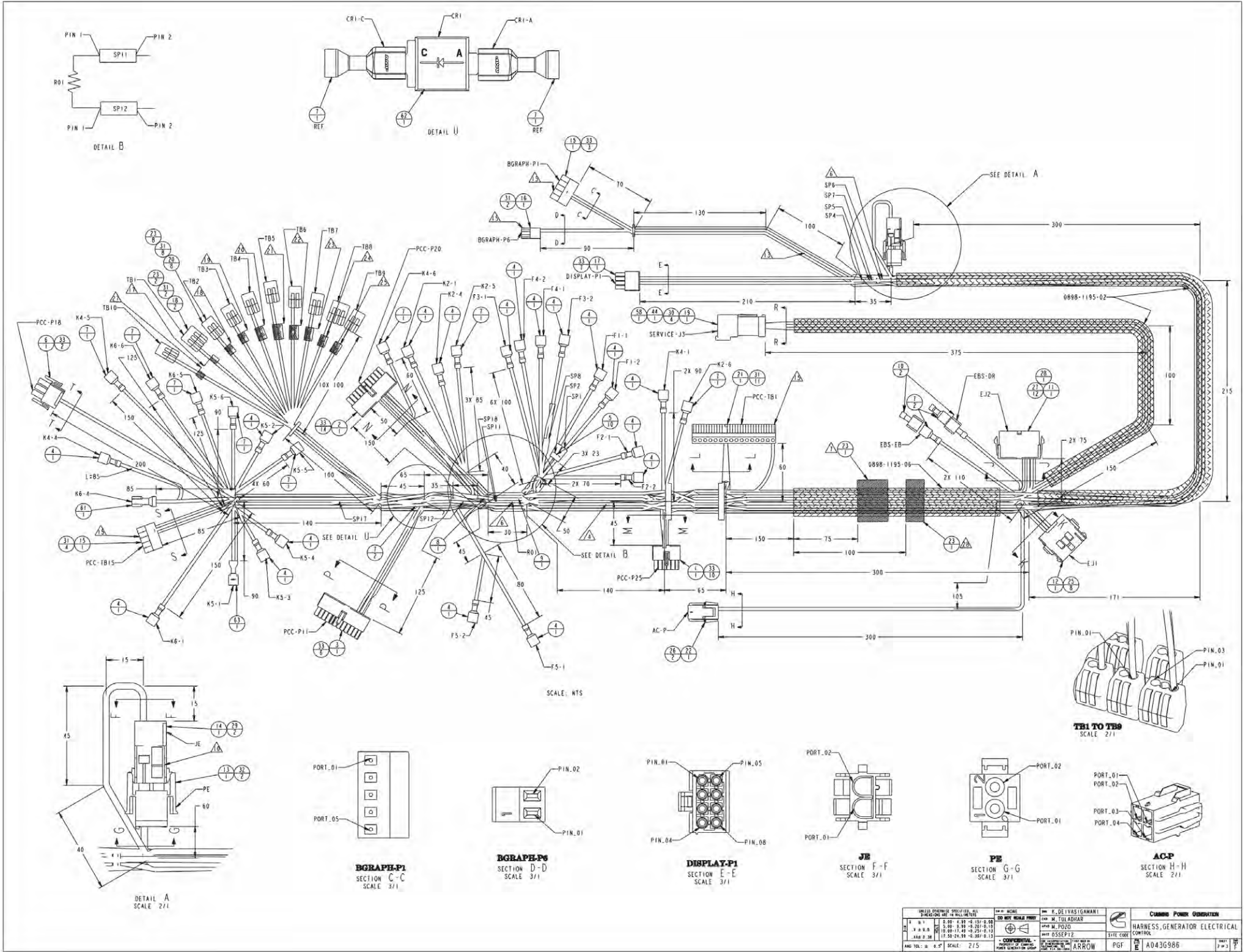


FIGURE 50. HARNESS, CONTROL (SHEET 2 OF 3)

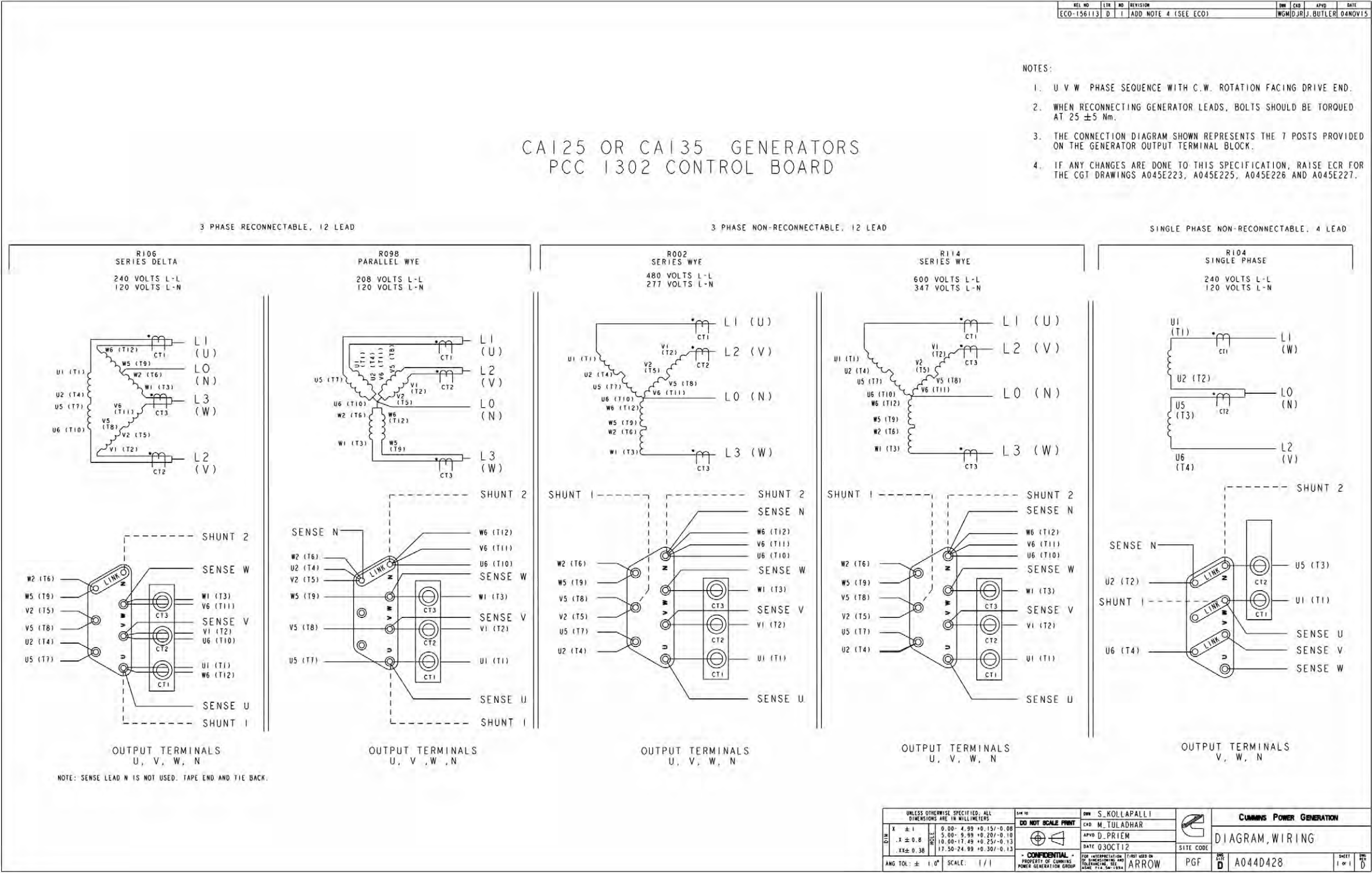
Appendix B. Alternator Reconnect Drawing

Table of Contents

Figure 53. Alternator Reconnect, Wiring Diagram for AW1 (Sheet 1 of 1) 207

Figure 54. Alternator Reconnect, Wiring Diagram for AW2 and AW3 (Sheet 1 of 1) 208

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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