# Service Manual

## Generator Set

### QSJ2.4 Engine with PowerCommand® 1.1 Control

C20 N6 (Spec A), C22 N6 (Spec A)
C25 N6 (Spec A), C30 N6 (Spec A)
C36 N6 (Spec A), C40 N6 (Spec A)
C30 N6H (Spec A), C36 N6H (Spec A)
C40 N6H (Spec A), C45 N6H (Spec A)
C50 N6H (Spec A), C60 N6H (Spec A)

English
Original Instructions

8-2019

A045R243 (Issue 20)

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

# 1.3 Generator Set Safety Code

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

**⚠ WARNING**

***Electrical Generating Equipment***

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

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

## 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.

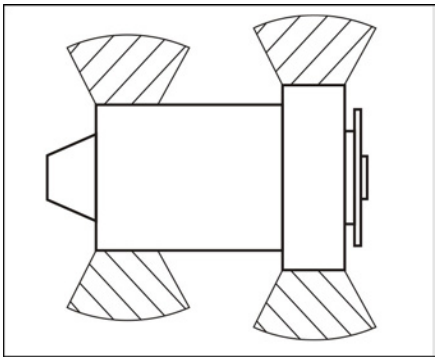

**FIGURE 1. HATCHED AREAS**

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**

***Electric Shock Hazard***

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

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

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

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

Guidelines to follow when working on energized electrical systems:

***NOTICE***

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

***NOTICE***

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

In summary:

- Do not tamper with or bypass interlocks unless you are authorized to do so.

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

### 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***<br>***Contact with high voltages can cause severe electrical shock, burns, or death.***<br>***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.

### Gaseous Fuels

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

### 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.

 

### 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 persons in accordance with the installation instructions and all applicable codes.***

## 2.1 About This Manual

This manual provides troubleshooting and repair information for the generator sets listed on the front cover.

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

This manual does not include instructions for servicing printed circuit board assemblies. After determining that a printed circuit board assembly is faulty, replace it. Do not repair it. Attempts to repair a printed circuit board can lead to costly damage to the equipment.

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

Operating and basic maintenance instructions are in the applicable generator set operator manual. Read and carefully observe all instructions and precautions in this manual.

 

## 2.2 Test Equipment

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

- True RMS meter for accurate measurement of small AC and DC voltages
- Grounding wrist strap to prevent circuit board damage due to electrostatic discharge (ESD)
- Battery hydrometer
- Jumper leads
- Tachometer or frequency meter
- Wheatstone bridge or digital ohmmeter
- Variac
- Load test panel
- Megger or insulation resistance meter
- InPower service tool (PC based generator set service tool)
- GCP display service tool
- Engine display harness

## 2.3 Schedule of Abbreviations

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

| Abbr. | Description | Abbr. | Description |
|---|---|---|---|
| AC | Alternating Current | LED | Light-Emitting Diode |
| AMP | AMP, Inc. (part of Tyco Electronics) | MFM | Multifunction Monitor |
| ANSI | American National Standards Institute | Mil Std | Military Standard |
| ASOV | Automatic Shut Off Valve | MPU | Magnetic Pickup |
| ASTM | American Society for Testing and Materials (ASTM International) | NC | Normally Closed |
| ATS | Automatic Transfer Switch | NC | Not Connected |
| AVR | Automatic Voltage Regulator | NFPA | National Fire Protection Agency |
| AWG | American Wire Gauge | NO | Normally Open |

| Abbr. | Description | Abbr. | Description |
|---|---|---|---|
| CAN | Controlled Area Network | NWF | Network Failure |
| CB | Circuit Breaker | OEM | Original Equipment Manufacturer |
| CE | Conformité Européenne | OOR | Out Of Range |
| CCA | Cold Cranking Ampere | OORH/ ORH | Out Of Range High |
| CFM | Cubic Feet per Minute | OORL/ORL | Out Of Range Low |
| CGT | Cummins Generator Technologies | PB | Push Button |
| CMM | Cubic Meters per Minute | PCC | PowerCommand® Control |
| CT | Current Transformer | PGI | Power Generation Interface |
| DC | Direct Current | PGN | Parameter Group Number |
| DEF | Diesel Exhaust Fluid | PI | Proportional/Integral |
| DPF | Diesel Particulate Filter | PID | Proportional/Integral/ Derivative |
| EBS | Excitation Boost System | PLC | Programmable Logic Controller |
| ECM | Engine Control Module | PMG | Permanent Magnet Generator |
| ECS | Engine Control System | PPE | Personal Protective Equipment |
| 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 |

 

| Abbr. | Description | Abbr. | Description |
|---|---|---|---|
| GCP | Generator Control Panel | SAE | Society of Automotive Engineers |
| GND | Ground | scfh | Standard Cubic Feet of gas per Hour |
| HMI | Human-Machine Interface | SCR | Selective Catalytic Reduction |
| IC | Integrated Circuit | SPN | Suspect Parameter Number |
| ISO | International Organization for Standardization | SW_B+ | Switched B+ |
| LBNG | Lean-Burn Natural Gas | UL | Underwriters Laboratories |
| LCD | Liquid Crystal Display | UPS | Uninterruptible Power Supply |
| LCT | Low Coolant Temperature | | |

## 2.4 Related Literature

The literature provided with the generator set is as follows:

- Installation Manual (A045R241)
- Operator Manual (A045R242)

**⚠ CAUTION**

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

***The Health and Safety Manual must be read in conjunction with this manual for the safe operation of the generator set:***

- ***Health and Safety Manual (0908-0110)***
- ***Warranty Statement (A040H442)***
- ***Emissions Component Defect Warranty Statement (A028X278)***

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

- Service Manual (A045R243)
- Parts Manual (A046Z094)
- EControls, Inc. Service Manual (A035C596)

- Global Control Platform (GCP) Engine Display Interface Software (EDIS) Training Manual (A035C608)
- RA Series Transfer Switch Owner Manual (A046S594) (if applicable)
- PowerCommand® 1302 Controller Owner's Manual (900-0661)
- Standard Repair Times (SRT) Manual (A046Z674)
- Application Manual T-030 - for application information (A040S369)
- Service Tool Manual (A043D529)

# 2.5 Specifications

## Model Specifications

**TABLE 1. 2.4L MODEL VARIATIONS**

| Models | Description |
|---|---|
| C20 N6, C22 N6, C25 N6, C30 N6, C36 N6, C40 N6 | 60 Hz, 1800 RPM |
| C30 N6H, C36 N6H, C40 N6H, C45 N6H, C50 N6H, C60 N6H | 60 Hz, 3600 RPM |

**TABLE 2. COLD WEATHER SPECIFICATIONS (ALL MODELS)**

| Temperature | Description | Battery Type | Group |
|---|---|---|---|
| Above 4 °C (40 °F) | No starting aids required. | Standard | 26 |
| -17 to 4 °C (0 to 40 °F) | Additional coolant heater and battery charger recommended for starting. Factory options available. | Standard | 26 |
| Below -17 °C (0 °F) | All starting aides (battery heater, coolant heater, battery charger) recommended. Factory options available. | Larger | 34 |

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

 

**TABLE 3. FUEL SPECIFICATIONS 60 HZ, 1800 RPM**

| | C20 N6 | C22 N6 | C25 N6 | C30 N6 | C36 N6 | C40 N6 |
|---|---|---|---|---|---|---|
| Full Load (Propane) | 105.1 scfh 265,000 BTU/hr | 112.7 scfh 285,000 BTU/hr | 125.4 scfh 315,000 BTU/hr | 164.1 scfh 410,000 BTU/hr | 182.7 scfh 460,000 BTU/hr | 193.6 scfh 490,000 BTU/hr |
| Full Load (Natural Gas) | 259.6 scfh 270,000 BTU/hr | 278.8 scfh 290,000 BTU/hr | 309.5 scfh 320,000 BTU/hr | 380.9 scfh 395,000 BTU/hr | 472.3 scfh 490,000 BTU/hr | 519 scfh 540,000 BTU/hr |
| Fuel Pressure | 6-13 inches of water column (1.5 - 3.2 kPa) under any condition | | | | | |

**TABLE 4. FUEL SPECIFICATIONS 60 HZ, 3600 RPM**

| | C30 N6H | C36 N6H | C40 N6H | C45 N6H | C50 N6H | C60 N6H |
|---|---|---|---|---|---|---|
| Full Load (Propane) | 195.5 scfh 490,000 BTU/hr | 219.6 scfh 550,000 BTU/hr | 236.2 scfh 595,000 BTU/hr | 256.9 scfh 645,000 BTU/hr | 289.5 scfh 725,000 BTU/hr | 324.6 scfh 820,000 BTU/hr |
| Full load (Natural Gas) | 476.1 scfh 495,000 BTU/hr | 533.3 scfh 555,000 BTU/hr | 573.2 scfh 595,000 BTU/hr | 623.0 scfh 645,000 BTU/hr | 704.7 scfh 730,000 BTU/hr | 814.2 scfh 840,000 BTU/hr |
| Fuel Pressure | 6-13 inches of water column (1.5 - 3.2 kPa) under any condition | | | | | |

**TABLE 5. ENGINE SPECIFICATIONS (ALL MODELS)**

| Specification | Value |
|---|---|
| Engine | 4 cylinder-in-line, SOHC, liquid-cooled, 4-stroke, spark ignited |
| Displacement | 2351 cc (144 $in^3$) |
| Spark Plug Gap | 1.0 mm (0.040 in) (NA)<br>0.76 mm (0.030 in) (T/TAA) |
| Spark Plug Torque | 20 Nm (15 ft-lb) |
| Coolant | 50/50 coolant solution (50% pure water and 50% ethylene glycol) |
| High Crankcase Pressure | No higher than 1.5 kPa |
| Compression | 135 psi (dry test) or higher with less than 15 psi range between cylinders |
| Oil Capacity | 4.3 L (4.54 quarts) |
| Oil Recommendation | 5W30 API SM or newer |

### TABLE 6. GENERATOR SET SIZE SPECIFICATIONS WITH SOUND LEVEL 1 ENCLOSURE (L X W X H)

| kW | RPM | mm | in |
|---|---|---|---|
| 20-25 | 1800 | 1830 x 864 x 1152 | 72 x 34 x 45.2 |
| 30 | 3600 | | |
| 30-40 | 1800 | 2384 x 864 x 1152 | 94 x 34 x 45.2 |
| 36-60 | 3600 | | |

### TABLE 7. GENERATOR SET WEIGHT 60 HZ, 1800 RPM

| Sound Level 1 (Wet) | C20 N6 | C22 N6 | C25 N6 | C30 N6 | C36 N6 | C40 N6 |
|---|---|---|---|---|---|---|
| kg | 503 | 503 | 520 | 580 | 615 | 646 |
| lb | 1109 | 1109 | 1147 | 1279 | 1356 | 1424 |

### TABLE 8. GENERATOR SET WEIGHT 60 HZ, 3600 RPM

| Sound Level 1 (Wet) | C30 N6H | C36 N6H | C40 N6H | C45 N6H | C50 N6H | C60 N6H |
|---|---|---|---|---|---|---|
| kg | 514 | 567 | 635 | 635 | 635 | 648 |
| lb | 1134 | 1249 | 1399 | 1399 | 1399 | 1429 |

### TABLE 9. ALTERNATOR SPECIFICATIONS 60 HZ, 1800 RPM

| | C20 N6 | C22 N6 | C25 N6 | C30 N6 | C36 N6 | C40 N6 |
|---|---|---|---|---|---|---|
| Alternator | Brushless, 4-pole rotating field, single bearing | | | | | |
| Power (kVa): | | | | | | |
| 1-Phase | 20 | 22 | 25 | 30 | 36 | 40 |
| 3-Phase | 25 | 27.5 | 31.3 | 37.5 | 45 | 50 |
| Rated Voltages (V): | | | | | | |
| 1-Phase | 120/240 | | | | | |
| 3-Phase | 120/240<br>120/208<br>277/480<br>347/600 | | | | | |

 

## TABLE 10. ALTERNATOR SPECIFICATIONS 60 HZ, 3600 RPM

| | C30 N6H | C36 N6H | C40 N6H | C45 N6H | C50 N6H | C60 N6H |
|---|---|---|---|---|---|---|
| Alternator | Brushless, 2-pole rotating field, single bearing | | | | | |
| Power (kVa): | | | | | | |
| 1-Phase | 30 | 36 | 40 | 45 | 50 | 60 |
| 3-Phase | 37.5 | 45 | 50 | 56.3 | 62.5 | 75 |
| Rated Voltages (V): | | | | | | |
| 1-Phase | 120/240 | | | | | |
| 3-Phase | 120/240<br>120/208<br>277/480 | | | | | |

| *NOTICE* |
|---|
| **Maximum $I_2$ = 8%.** |

## TABLE 11. GENERATOR SET DERATING GUIDELINES

| | | Engine Power Available Up To... | | Derate At… | |
|---|---|---|---|---|---|
| Model | Fuel | Elevation | Ambient Temperature | Elevation | Temperature |
| C20 N6 | NG, LP | 1005 m (3300 ft) | 40 °C (104 °F) | 4% per 305 m (1000 ft) | 2% per 10 °C (18 °F) above 40 °C (104 °F) |
| C22 N6 | NG | 670.5 m (2200 ft) | 40 °C (104 °F) | | |
| C22 N6 | LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C25 N6 | NG | 0 m (0 ft) | 25 °C (77 °F) | | |
| C25 N6 | LP | 114 m (375 ft) | 25 °C (77 °F) | | 2% per 10 °C (18 °F) above 25 °C (77 °F) |
| C30 N6 | NG | 762 m (2500 ft) | 40 °C (104 °F) | | 2% per 10 °C (18 °F) above 40 °C (104 °F) |
| C30 N6 | LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C36 N6 | NG, LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C40 N6 | NG, LP | 114 m (375 ft) | 40 °C (104 °F) | | |
| C30 N6H | NG, LP | 945 m (3100 ft) | 40 °C (104 °F) | | |
| C36 N6H | NG, LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C40 N6H | NG, LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C45 N6H | LP | 1005 m (3300 ft) | 40 °C (104 °F) | | |
| C45 N6H | NG, LP | 914 m (3000 ft) | 40 °C (104 °F) | | |
| C50 N6H | NG, LP | 114 m (375 ft) | 25 °C (77 °F) | | 2% per 10 °C (18 °F) above 25 °C (77 °F) |
| C60 N6H | NG, LP | 114 m (375 ft) | 40 °C (104 °F) | | 2% per 10 °C (18 °F) above 40 °C (104 °F) |

## TABLE 12. CONTROL SPECIFICATION (ALL MODELS)

| Specification |
|---|
| Integrated microprocessor based engine, generator, transfer switch control |

 

**TABLE 13. DC SYSTEM SPECIFICATIONS (ALL MODELS)**

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

## CA115 Winding Resistances

**TABLE 14. 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 |

| 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-V14** | 0.119 | 0.175 | 0.259 | 0.048 | 21.27 | 0.224 | 0.944 | 12.9 |

## CA125 Winding Resistances

**TABLE 15. CA125 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) | PMG Stator, L-L (Ohms) |
| | 311 | 41 | 17 | 06 | | | | |
| **CA125-G14** | - | - | - | 0.048 | 20.76 | 0.142 | 0.594 | 3.8 |
| **CA125-J14** | 0.094 | 0.122 | 0.192 | - | 20.76 | 0.142 | 0.640 | 3.8 |
| **CA125-L14** | 0.078 | 0.105 | 0.160 | 0.032 | 20.87 | 0.156 | 0.736 | 3.8 |
| **CA125-P14** | - | - | - | 0.028 | 20.87 | 0.142 | 0.800 | 3.8 |

 

## CA135 Winding Resistances

**TABLE 16. CA135 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 (0hms) | PMG Stator, L-L (Ohms) |
| | 311 | 41 | 17 | 06 | | | | |
| **CA135-E12** | 0.061 | 0.094 | - | 0.029 | 23.55 | 0.082 | 1.279 | 3.8 |

# 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 service provider. See power.cummins.com/sales-service-locator for service locations that service this application. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your Cummins service provider.

## Warranty

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

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

Extended warranty coverage is also available.

For further warranty details, contact your authorized service provider.

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

### Warranty Limitations

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

## How to Obtain Service

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

### Service Technician Support

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

 

## Manufacturing Facilities

| Facility | Address | Phone Numbers |
|---|---|---|
| U.S. and CANADA | Cummins Inc.<br>1400 73rd Ave. NE<br>Minneapolis, MN 55432 USA | Toll Free 1-800-CUMMINS™<br>(1-800-286-6467)<br>Phone +1 763-574-5000<br>Fax +1 763-574-5298 |
| EMEA, CIS | Cummins Inc.<br>Columbus Avenue<br>Manston Park<br>Manston, Ramsgate<br>Kent CT12 5BF<br>United Kingdom<br>----------<br>Cummins Inc.<br>Royal Oak Way South<br>Daventry<br>Northamptonshire<br>NN11 8NU<br>United Kingdom | Phone +44 1843 255000<br>Fax +44 1843 255902 |
| ASIA PACIFIC | Cummins Inc.<br>10 Toh Guan Road #07-01<br>TT International Tradepark<br>Singapore 608838 | Phone +65 6417 2388<br>Fax +65 6417 2399 |
| BRAZIL | Rua Jati, 310, Cumbica<br>Guarulhos, SP 07180-900<br>Brazil | Phone +55 11 2186 4195<br>Fax +55 11 2186 4729 |
| CHINA | Cummins Inc.<br>2 Rongchang East Street,<br>Beijing Economic – Technological Development Area<br>Beijing 100176, P.R. China | Phone 86 10 59023001<br>Fax +86 10 5902 3199 |
| INDIA | Cummins Inc.<br>Plot No B-2, SEZ Industrial Area,<br>Village-Nandal & Surwadi, Taluka- Phaltan<br>Dist- Satara, Maharashtra 415523<br>India | Phone<br>+91 021 66305514 |
| LATIN AMERICA | 3350 Southwest 148th Ave.<br>Suite 205<br>Miramar, FL 33027 USA | Phone +1 954 431 551<br>Fax +1 954 433 5797 |

| Facility | Address | Phone Numbers |
|---|---|---|
| MEXICO | Eje 122 No. 200 Zona Industrial<br>San Luis Potosi, S.L.P. 78395<br>Mexico | Phone +52 444 870 6700<br>Fax +52 444 824 0082 |

 

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# 3 Maintenance

## 3.1 Maintenance Safety

**⚠ WARNING**

***Automated Machinery***

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

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

**⚠ WARNING**

***Hydrogen Gas***

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

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

**⚠ WARNING**

***Explosive Fumes***

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

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

**⚠ WARNING**

***Working at Heights***

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

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

**⚠ WARNING**

***Access***

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

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

**⚠ WARNING**

***Exposed Terminations***

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

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

***NOTICE***

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

***NOTICE***

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

***NOTICE***

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

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

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

Make sure that adequate lighting is available.

# Locking the Generator Set Out of Service

| NOTICE |
| --- |
| **Automated Machinery**<br>**Accidental or remote starting of the generator set can cause severe personal injury or death.**<br>**Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables, negative (–) cable first.** |

Before any work is carried out for maintenance, etc., the generator set must be immobilized. Even if the generator set is put out of service by pressing the Off switch on the Operator Panel (or the STOP button if applicable), the generator set cannot be considered safe to work on until the engine is properly immobilized, as detailed in the following procedure.

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

To immobilize the generator set:

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

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

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

# 3.2 Periodic Maintenance

**⚠ WARNING**

***Electrical Generating Equipment***

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

***Before working on the generator set, make sure that the generator set is in Off mode, disable the battery charger, and remove the negative (–) battery cable from the battery to prevent starting.***

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

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

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

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

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

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

## 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.

# Periodic Maintenance Schedule

| NOTICE |
| --- |
| **Perform maintenance tasks as specified using the period of operation that occurs first.** |

**TABLE 17. PERIODIC MAINTENANCE SCHEDULE**

| Maintenance Item | Daily or After 24 Hours | Weekly or After 50 Hours | 100 Hours | 1 Year or After 200 Hours[1] | 2 Years[1] | 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 air intake system for leaks: Visually inspect the air intake system for signs of wear or damage. Check audibly when the generator set is running. Replace worn or damaged components. | ■ | | | | | |
| Check operation of operator panel: Check display (the system will perform a control panel test on initial activation). Replace component if not functioning properly. | ■ | | | | | |

| Maintenance Item | Daily or After 24 Hours | Weekly or After 50 Hours | 100 Hours | 1 Year or After 200 Hours[1] | 2 Years[1] | 4000 Hours |
|---|---|---|---|---|---|---|
| Check coolant level of radiator(s) (water jacket & LTA): If low, top up to coolant system specifications level, with Cummins recommended coolant mix. | ■ | | | | | |
| Check cooling fan blades: Visually inspect the fan blades through the guarding for signs of wear or damage. | ■ | | | | | |
| Check drive belt, condition and tension: Visually check belt for evidence of wear or slippage. | ■ | | | | | |
| Check coolant lines and radiator hoses for leaks, wear, and cracks: Visually check for leaks, worn or damaged hoses. | ■ | | | ■ | | |
| Check radiator air flow: Visually inspect the radiator through the guarding for blockage, build-up of debris, signs of wear or damage. | ■ | | | | | |

| Maintenance Item | Daily or After 24 Hours | Weekly or After 50 Hours | 100 Hours | 1 Year or After 200 Hours[1] | 2 Years[1] | 4000 Hours |
|---|---|---|---|---|---|---|
| Verify that the coolant heater has power and is running (where fitted). Check for evidence of leaks. Remove any corrosion from fittings. | ■ | | | | | |
| Check engine oil level: If low, top up to engine specifications level, with recommended oil. | ■ | | | | | |
| Check fuel lines and hoses: Visually check for leaks, worn or damaged hoses. | ■ | | | | | |
| Check charge alternator: Check visually and audibly when the generator set is running. | ■ | | | | | |
| 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 | 1 Year or After 200 Hours[1] | 2 Years[1] | 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. | ■ | | | | | |
| Check operation of Emergency Stop Button (where fitted): With the generator set running, press the **Emergency Stop** button. Check all systems, before resetting the fault. | | ■ | | | | |
| Replace engine oil and filters. Refer to the procedure in the Engine Oil section. | | ■[2] | | ■[2] | | |
| Check battery: Check connections to verify that they are secure. | | ■ | | ■ | | |
| Replace air cleaner. | | | ■ | | | |
| Clean radiator core. | | | | ■[3] | | |
| Check charge air cooler for damage and debris (where fitted). | | | | ■ | | |

| Maintenance Item | Daily or After 24 Hours | Weekly or After 50 Hours | 100 Hours | 1 Year or After 200 Hours[1] | 2 Years[1] | 4000 Hours |
|---|---|---|---|---|---|---|
| Check water pump for leaks. Check weep holes for evidence of leaks. Replace if leaking. | | | | ■ | | |
| 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. | | | | ■ | | |
| Check turbocharger (where fitted) for signs of leakage. Listen for excessive noise when test running the generator set. | | | | ■ | | |
| Check timing belt condition. Visually inspect. | | | | ■ | | |
| Inspect spark plugs. Replace if showing signs of excessive wear, carbon deposits, oil accumulation or damaged. | | | | ■ | | |
| Check battery condition. | | | | ■ | | |

| Maintenance Item | Daily or After 24 Hours | Weekly or After 50 Hours | 100 Hours | 1 Year or After 200 Hours[1] | 2 Years[1] | 4000 Hours |
|---|---|---|---|---|---|---|
| Check electrical connections (battery, starter motor, alternator connections). Check for tight connections, general condition and remove any corrosion. | | | | ■ | | |
| Check alternator heater (where fitted). Check general condition and wiring connections. | | | | ■ | | |
| Check battery heater (where fitted). Check general condition and wiring connections. | | | | ■ | | |
| Replace cooling system coolant. | | | | | ■ | |
| Inspect all sealed bearings every 4000 to 4500 hours | | | | | | ■[4] |
| [1] To be performed by a qualified Service Technician. | | | | | | |
| [2] After the initial 50 hour interval and every 200 hours thereafter. | | | | | | |
| [3] Cleaning schedule may be reduced depending on operating conditions/environment. | | | | | | |
| [4] Replace all bearings every 30000 hours or 5 years (or if necessary after 10000 hours or 2 years). | | | | | | |

# 3.3 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. The generator set is shipped with engine oil (5W30 API SM or newer engine oil is recommended).

# Checking Engine Oil Level

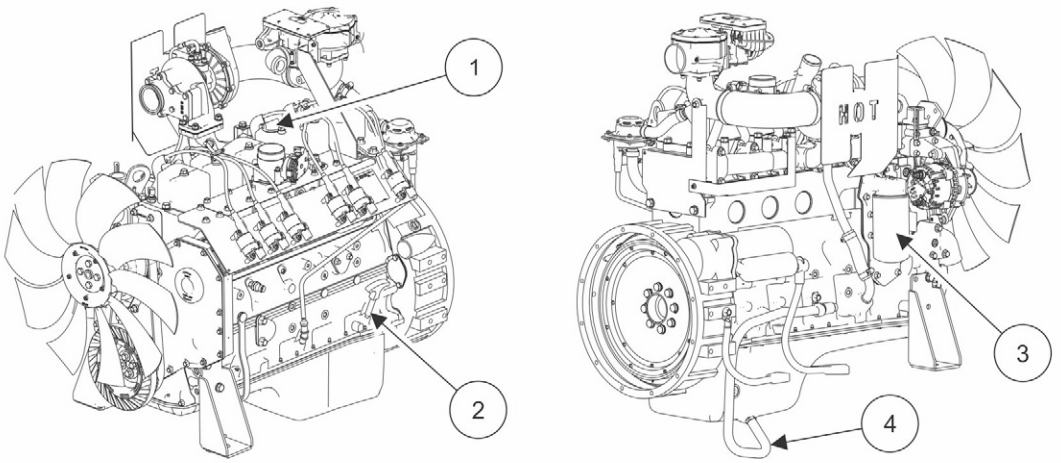
| *NOTICE* |
| --- |
| **Check the engine oil level when the engine is not running and is out of Auto mode.** |

| ⚠ 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 (or press the STOP button if applicable) before starting work.*** |




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Fill Cap | 3 | Oil Filter |
| 2 | Dipstick | 4 | Oil Drain Hose |

**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.

| *NOTICE* |
|---|
| **The engine oil level indicated on the dipstick should be between the High (4.3 L or 4.5 qt) and Low (3.8 L or 4.0 qt) marks.** |

6. Reinsert and fully seat the dipstick.


| No. | Description | No. | Description |
|---|---|---|---|
| 1 | High Oil Level (4.3 L or 4.5 qt) | 2 | Low Oil Level (3.8 L or 4.0 qt) |

**FIGURE 3. ENGINE OIL DIPSTICK**

## 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**

***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. 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 (or press the STOP button if applicable) before starting work.***

**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 140 °F (60 °C).
2. Turn off the generator set.
3. Drain the 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. 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.
6. Close the oil drain valve.
7. Refill with oil until full.

   **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.**

8. Operate generator set with no load to inspect for leaks at the lubricating oil filter and the drain plug.
9. 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.
10. Check and repair any leaks identified.
11. Dispose of the used oil and oil filter according to local environmental regulations.

# 3.4 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.***

Always:

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

***NOTICE***

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

# 3.5 Spark Plugs

***NOTICE***

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

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

1. Set the generator set control to the Off position before checking the spark plugs.
2. To prevent cross-threading a spark plug, always thread it in by hand until it seats. Torque the spark plug to 20 Nm (15 lb-ft).
3. Return the generator set control to the desired setting when finished performing maintenance.

# 3.6 Cooling System Maintenance

This section provides information on cleaning the radiator.

## 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.

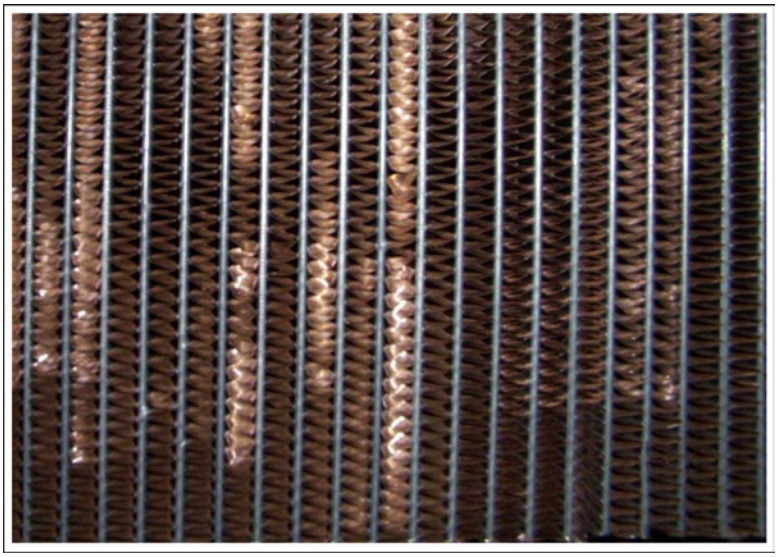


**FIGURE 4. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE**

**⚠ 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.***

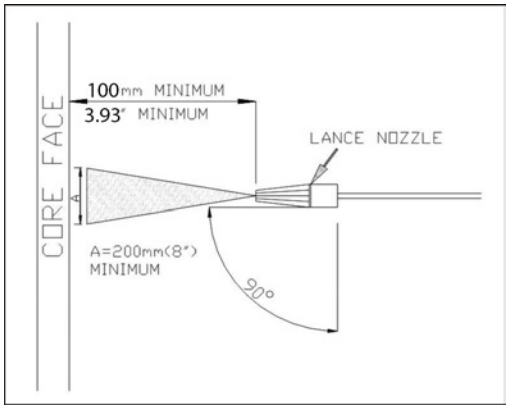



**FIGURE 5. PRESSURE WASHER NOZZLE POSITIONING**

**⚠ 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***

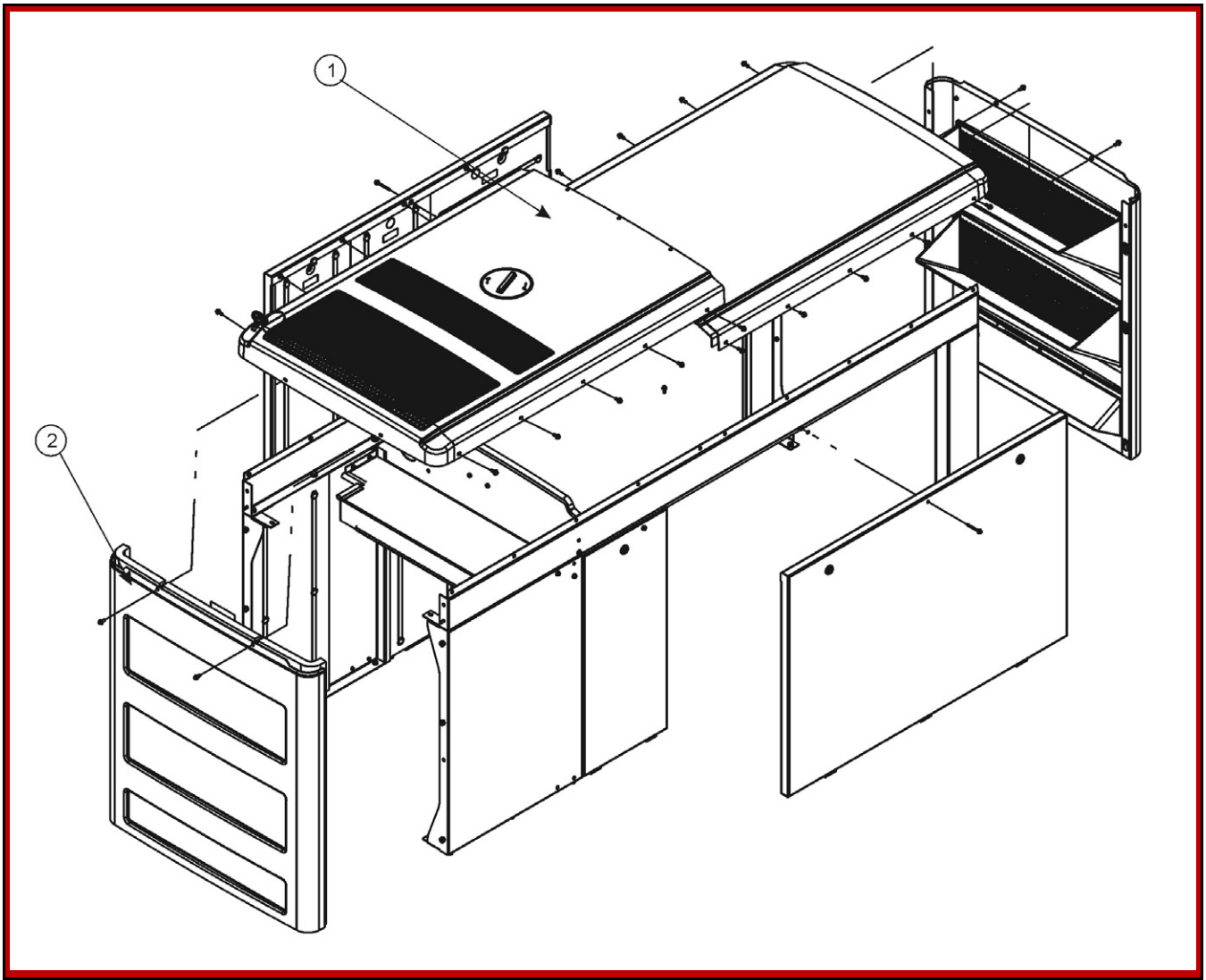
**Always follow the pressure washer manufacturer's Health and Safety Guidelines.**

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 6. 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 48**.
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.

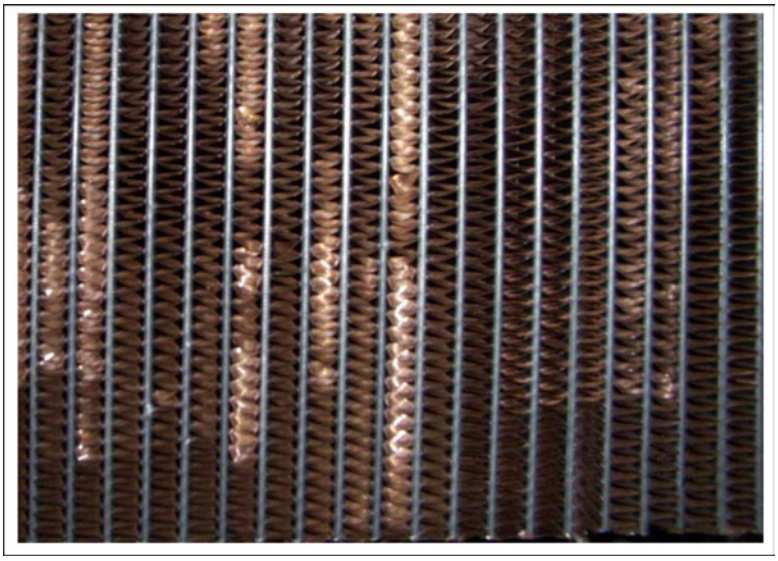


**FIGURE 7. FINS DAMAGED BY COMPRESSED AIR AT ACUTE ANGLES TO CORE FACE**

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.**

# 3.7 Air Intake System

The direct flow air cleaner consists of a primary filter and a secondary filter within the air cleaner housing. The air cleaner has been designed for a maximum restriction, at which point the filter elements should be changed. Refer to the Model Specifications section.

## Normal Duty Air Cleaner

### Normal Duty Air Cleaner Element Replacement

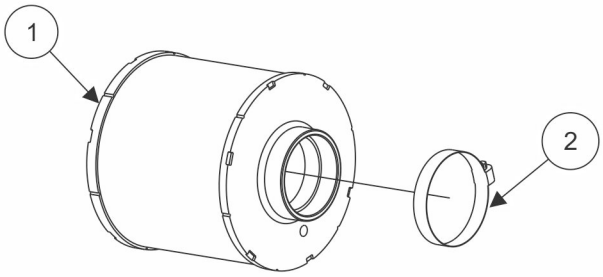
**NOTICE**

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

**NOTICE**

**Cummins does not recommend cleaning paper-type air cleaner elements.**

1. Remove the existing air cleaner:
   a. Loosen the strap clamp (2).
   b. Wipe away any debris accumulated around the air cleaner connection to the engine. Ensure that no debris is allowed to enter the body of the air cleaner or the connection on the engine.
   c. Remove the dirty air cleaner (1).
   d. Dispose of the dirty element in accordance with local environmental agency requirements.
2. Install the replacement air cleaner (1) as follows:
   a. Install the air cleaner (1).
   b. Tighten strap clamp (2). Torque to 2.5 - 3.3 ft-lb (4.3 - 4.65 Nm).




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

**FIGURE 8. EXAMPLE OF NORMAL DUTY AIR CLEANER**

# Heavy Duty Air Cleaner

## Heavy Duty Air Cleaner Maintenance

**⚠ WARNING**

***Fall Hazard***
***Falls can result in severe personal injury or death.***
***Make sure that suitable equipment for performing tasks at height are used in accordance with local guidelines and legislation.***

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

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

## Heavy Duty Air Cleaner Element Replacement

**⚠ CAUTION**

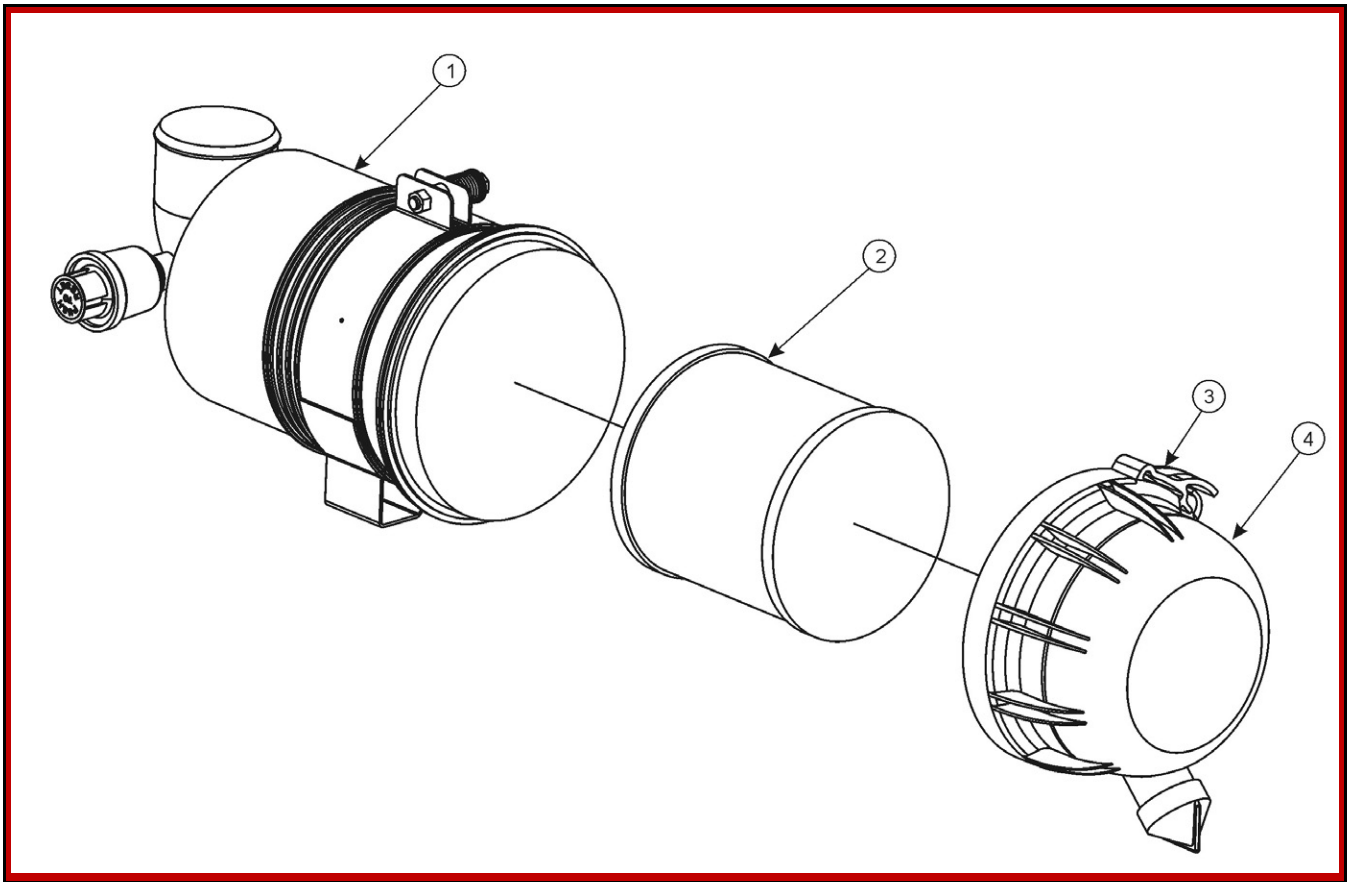
***Holes, loose-end seals, dented sealing surfaces, corrosion of pipes, and other forms of damage render the air cleaner inoperative and require immediate element replacement or engine damage can occur.***

**NOTICE**

**Cummins does not recommend cleaning paper-type air cleaner elements.**

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




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

**FIGURE 9. EXAMPLE OF HEAVY DUTY AIR CLEANER**

# 3.8 Exhaust System Maintenance

**⚠ WARNING**

***Hot Exhaust Components***

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

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

**⚠ WARNING**

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

**⚠ WARNING**

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

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

# 3.9 Generator Set Output - AC Electric System Checks

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

**TABLE 18. AC ELECTRIC SYSTEM CHECKS**

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

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

# 3.10 DC Electrical System

**⚠ WARNING**

***Combustible Gases***

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

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

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

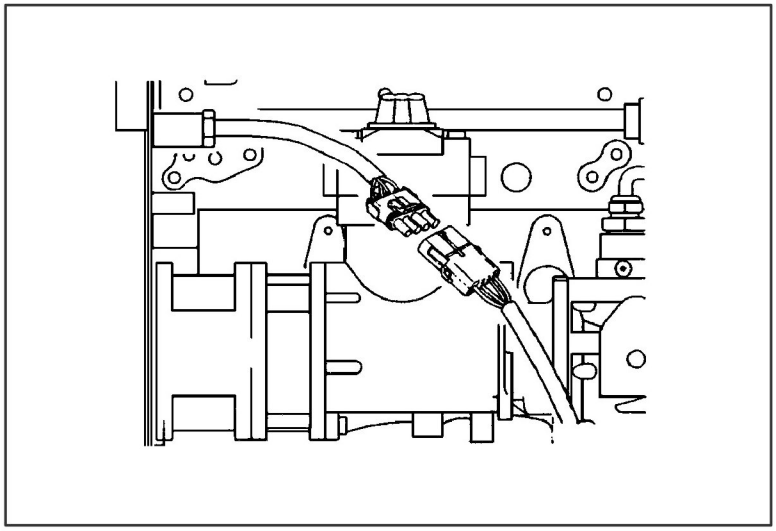


**FIGURE 10. CHECK HARNESS CONNECTIONS**

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

# 3.11 Batteries

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

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

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

## Storage

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

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

## General Precautions for Maintenance-Free Batteries

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

**⚠ WARNING**

***Arcing Hazard***

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

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

**⚠ WARNING**

***Electric Shock Hazard***

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

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

**⚠ CAUTION**

***Toxic Hazard***

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

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

***NOTICE***

**Keep batteries upright to prevent spillage.**

## Fire Hazard

**⚠ WARNING**

***Combustible Gases***

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

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

**⚠ WARNING**

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

**⚠ WARNING**

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

## Vented Batteries

**⚠ WARNING**

***Toxic Hazard***

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

***Always:***

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

# Battery Maintenance

**⚠ WARNING**

***Automated Machinery***

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

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

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

***Make sure the generator set is shut down and disabled:***

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

Always:

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

***NOTICE***

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

# Charging

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

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

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

Follow the battery charger operating instructions for proper use.

### Battery Replacement

| ⚠ WARNING |
| --- |
| ***Combustible Liquid***<br>***Burning the battery may cause an explosion. Damage to the casing will release electrolytes which is harmful to the skin and eyes.***<br>***When disposing of a battery, do not mutilate or burn it. Comply with all local health and safety regulations/codes during handling or disposal.*** |

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

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

## 3.12 Spark Plugs

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

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

1. Set the generator set control to the Off position before checking the spark plugs.
2. To prevent cross-threading a spark plug, always thread it in by hand until it seats. Torque the spark plug to 20 Nm (15 lb-ft).
3. Return the generator set control to the desired setting when finished performing maintenance.

## 3.13 Cleaning the Generator Set Housing

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

# 3.14 Complete System Test

**NOTICE**

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

A complete system test is recommended to verify that the electrical system is working properly. Testing the system once every 200 hours or every 2 years is required to make sure the transfer switch will transfer the load to the generator set if there is a utility power failure. For more information, see the transfer switch owner manual.

To initiate a complete system test:

1. Before starting:
   - Check the oil level.
   - Verify that fuel related components, such as manual valves, outside of the generator set are open.
   - See the Checklist section in the installation manual.
2. Place the generator set in Standby mode.
3. Switch the main utility disconnect from the ON to the OFF position.
4. Make sure the following occurs:
   a. The generator set starts.
   b. After the generator set starts and stabilizes, the load is transferred from the utility to the generator set.
5. Switch the main utility disconnect from the OFF to the ON position.
6. Make sure the following occurs:
   a. After approximately 5 minutes, the load is transferred back to the utility.
   b. Once the transfer switch is connected to utility power, after approximately 5 minutes, the generator set stops.

**NOTICE**

**If the test fails, call your authorized Cummins service provider to fix the problem.**

# 4 Service

## 4.1 Engine Control Module (ECM)

### Engine Control Module (ECM)

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

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

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

- Light Duty Fuel System Service Manual Supplement (A035C596)
- *If applicable:* Global Control Platform (GCP) Engine Display Interface Software (EDIS) Training Manual (A035C608)

All of these manuals can be found in QuickServe OnLine (QSOL).

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

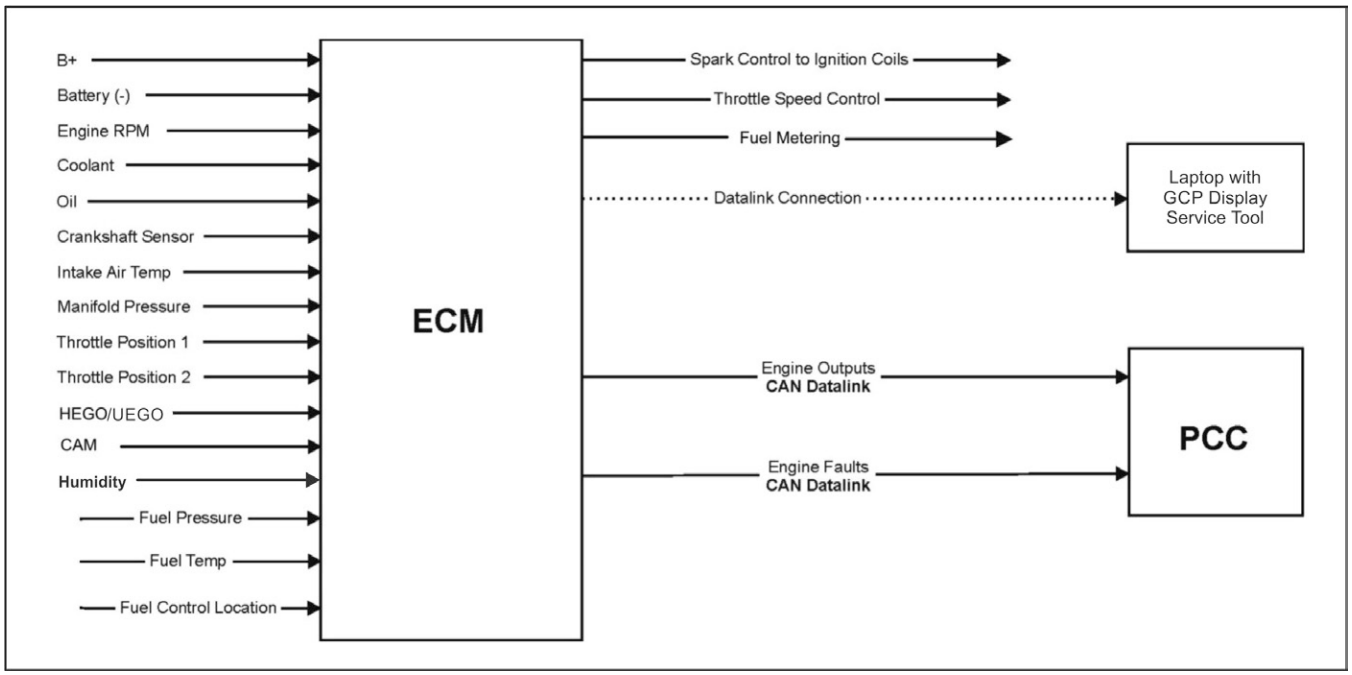



**FIGURE 11. ECM INPUTS AND OUTPUTS**

## Keyswitch Control

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

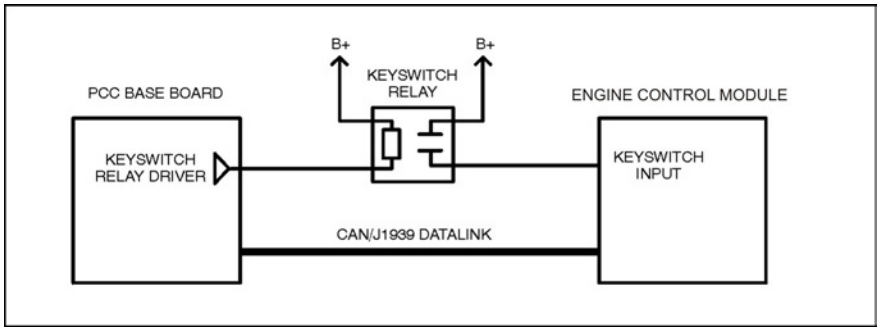



**FIGURE 12. CONTROL SYSTEM BLOCK DIAGRAM**

## Reprogram ECMs

### Reprogram GCP ECM

1. Obtain the latest revision of ECM calibration from the InCal website at http://incal.cummins.com.
2. Save the file on a laptop.
3. Make sure the generator set is stopped, is off (that is, in Off mode), and the breaker is in the open position.
4. If the unit is connected to a fuel supply, shut off the fuel supply.
5. Connect the ECM to the laptop using an EControls GCP E-Com USB interface cable (part number A047A982).
6. Log in using one of the following passwords:

| Tool | Password |
|---|---|
| GCP | DD3F-OSHY-VJLV-IPGC |

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

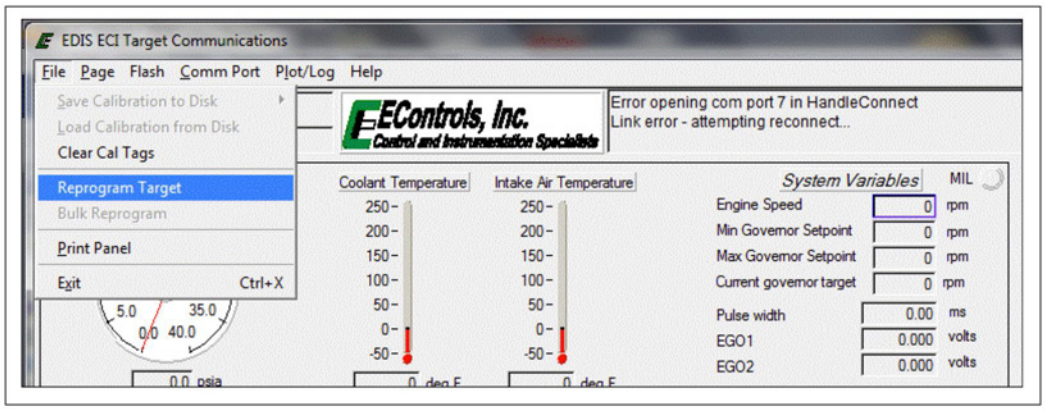



**FIGURE 13. PULL DOWN REPROGRAM TARGET SELECTION**

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

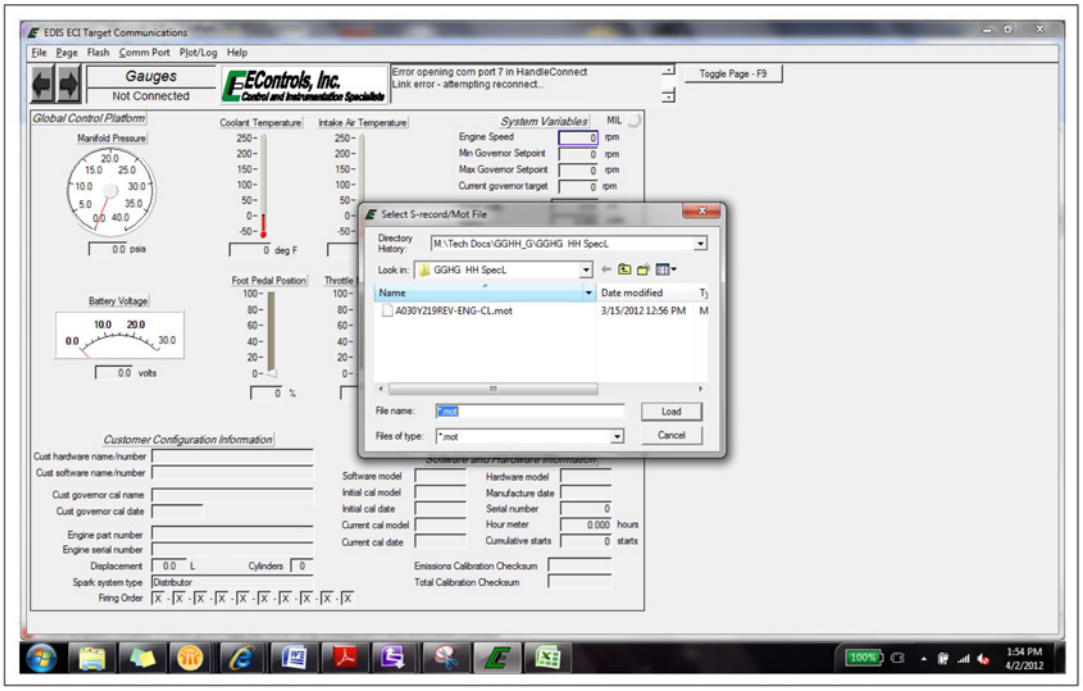



**FIGURE 14. MOT FILE**

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

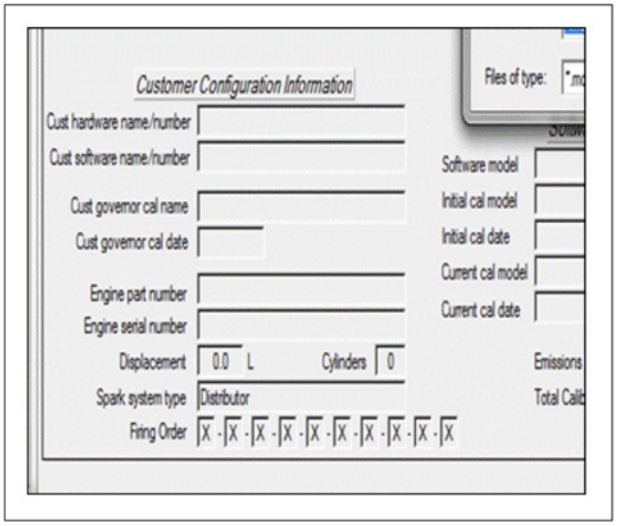



**FIGURE 15. ECM UPDATE DOWNLOAD CONFIRMATION**

## Reprogram 4G ECM

1. Obtain the latest revision of ECM calibration from the InCal website at **http://incal.cummins.com**.
2. A zip file is download. Unzip the folder for the model number of the generator set and save it to a local file on a laptop.
3. Make sure the generator set is stopped, is off (that is, in Off mode), and the breaker is in the open position.
4. If the unit is connected to a fuel supply, shut off the fuel supply.
5. Connect the ECM to the laptop using an EControls E-Com USB interface cable (part number A047A982).
6. Log in using the following password:

| Tool | Password |
|---|---|
| EControls Inc 4G Display | GLTX-0BIS-534R-SVUX |

7. Open the 4G Display service tool.
8. Select **File** on the upper left of the screen and select **Reprogram Target** in the pull-down menu.

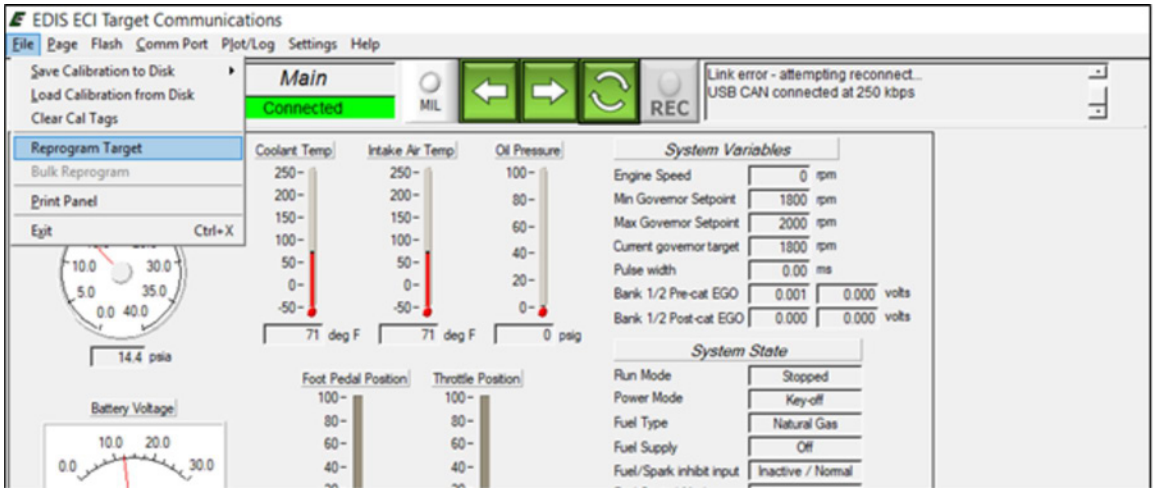



**FIGURE 16. REPROGRAM TARGET SELECTION**

9. In the Select S-record/Mot File popup window, locate the saved unzipped folder, select the latest revision of the .mot file, and select **Load**.

| ***NOTICE*** |
| --- |
| **Make sure to select the correct .mot file depending on if the Oil Pressure Sensor Type is Sender or Switch.** |

10. Select **Yes** in the Configuration confirmation box to perform the download. The Target Reprogram Progress bar shows the download status.
11. When the Successful message is displayed, select **OK**.

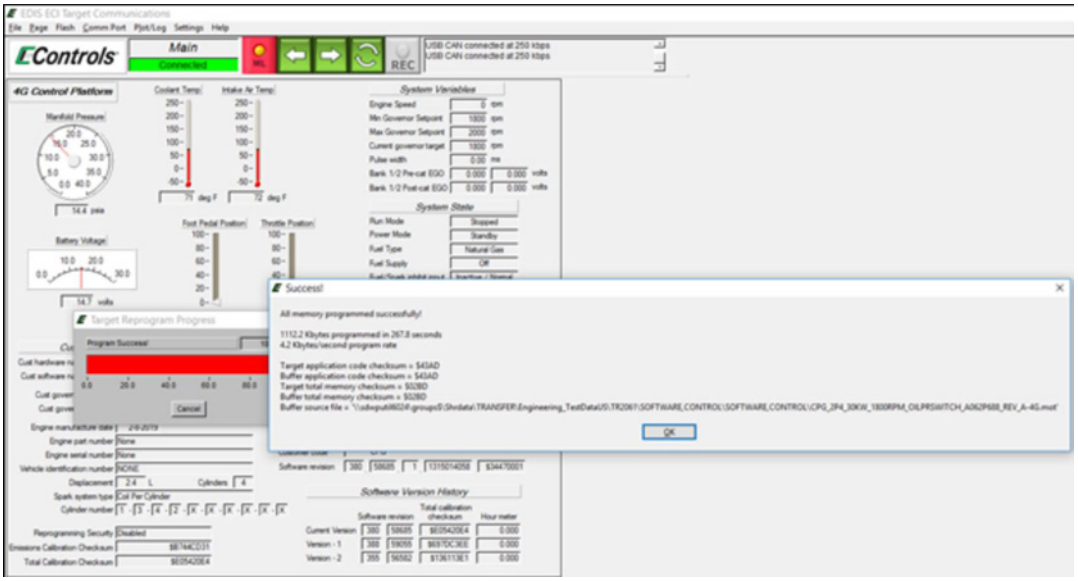



**FIGURE 17. DOWNLOAD COMPLETE**

12. Check the Customer Configuration information section to confirm that the software name/number is correct.

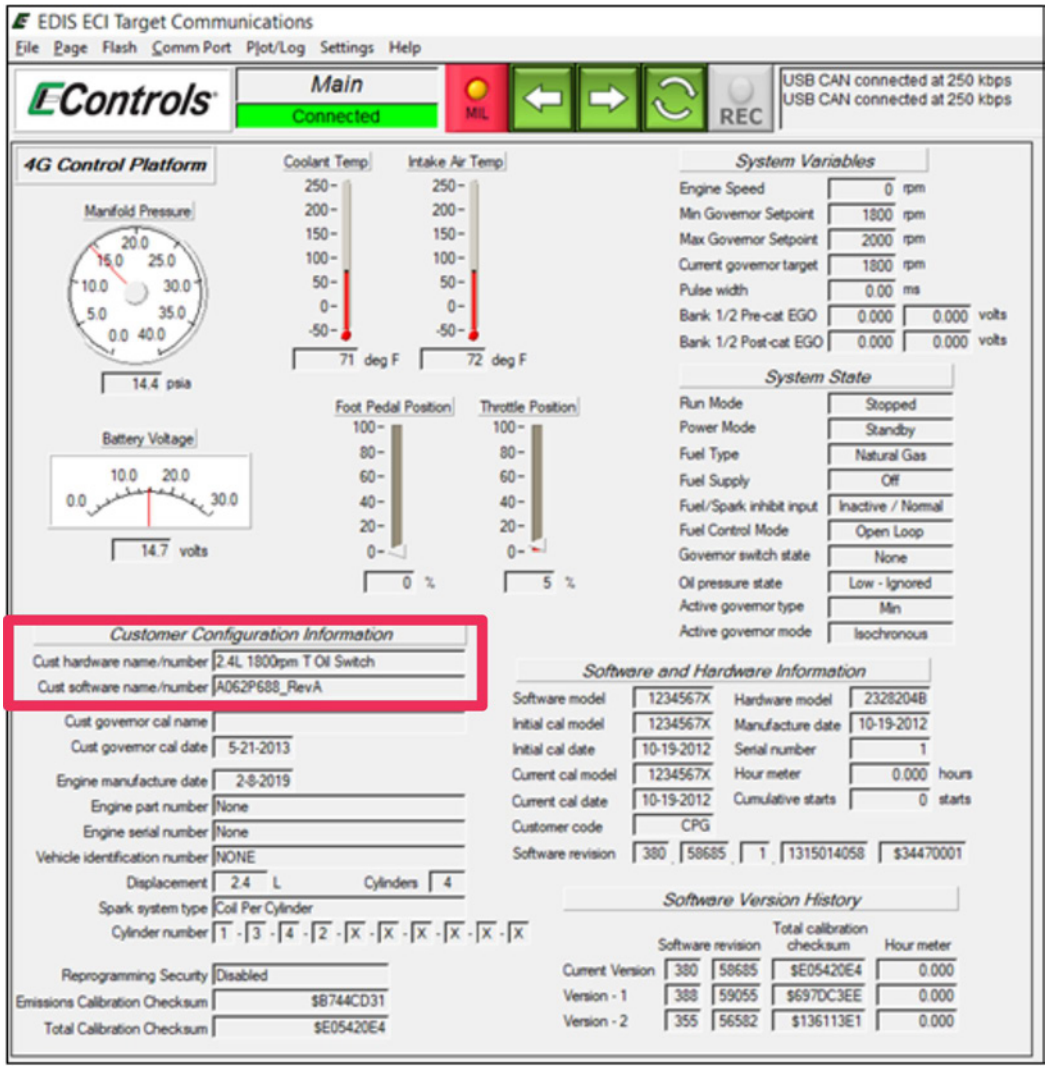



**FIGURE 18. SOFTWARE NAME/NUMBER CONFIRMATION**

## Viewing Engine Faults

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

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

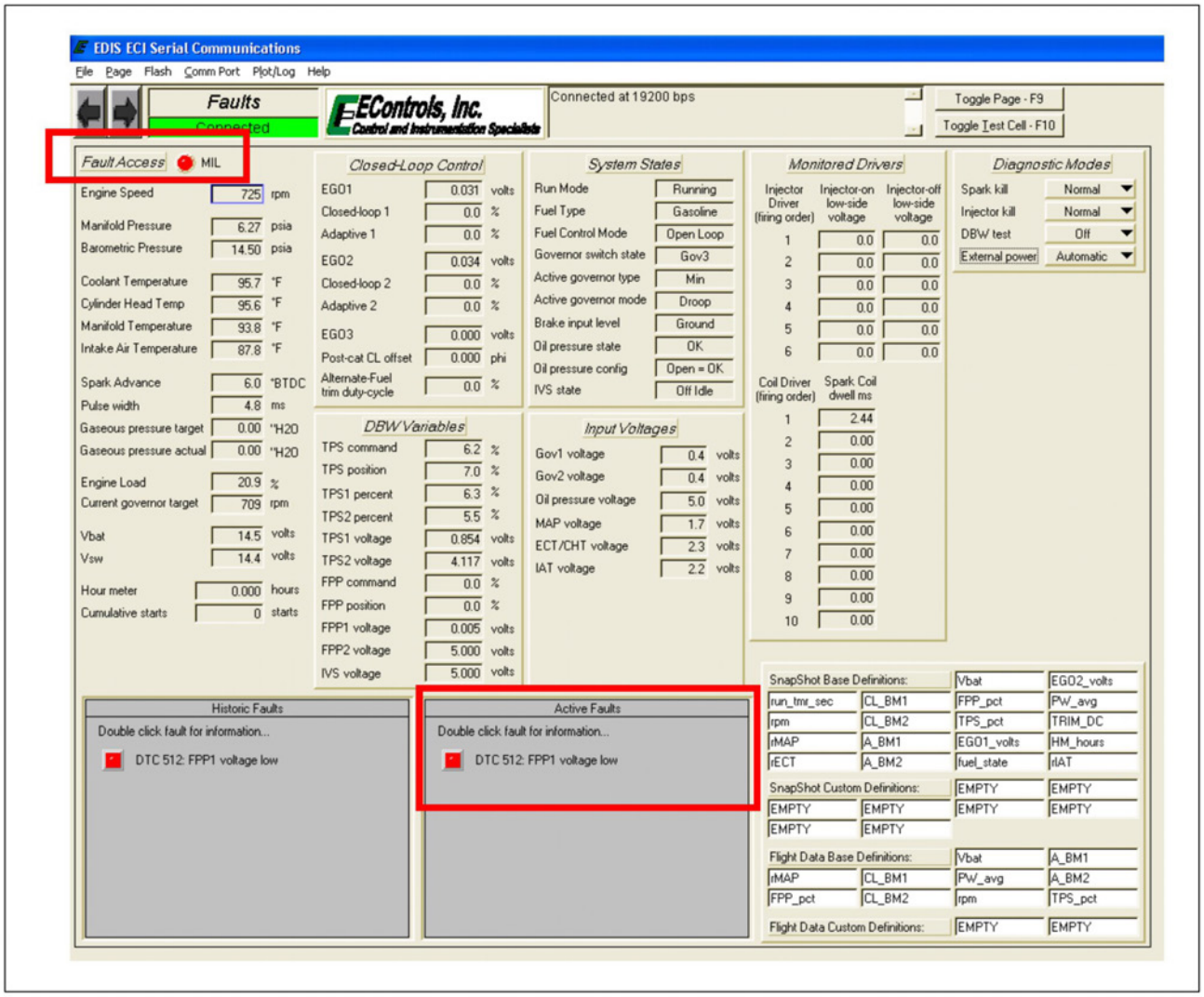



**FIGURE 19. FAULTS PAGE WITH ACTIVE FAULT MESSAGE**

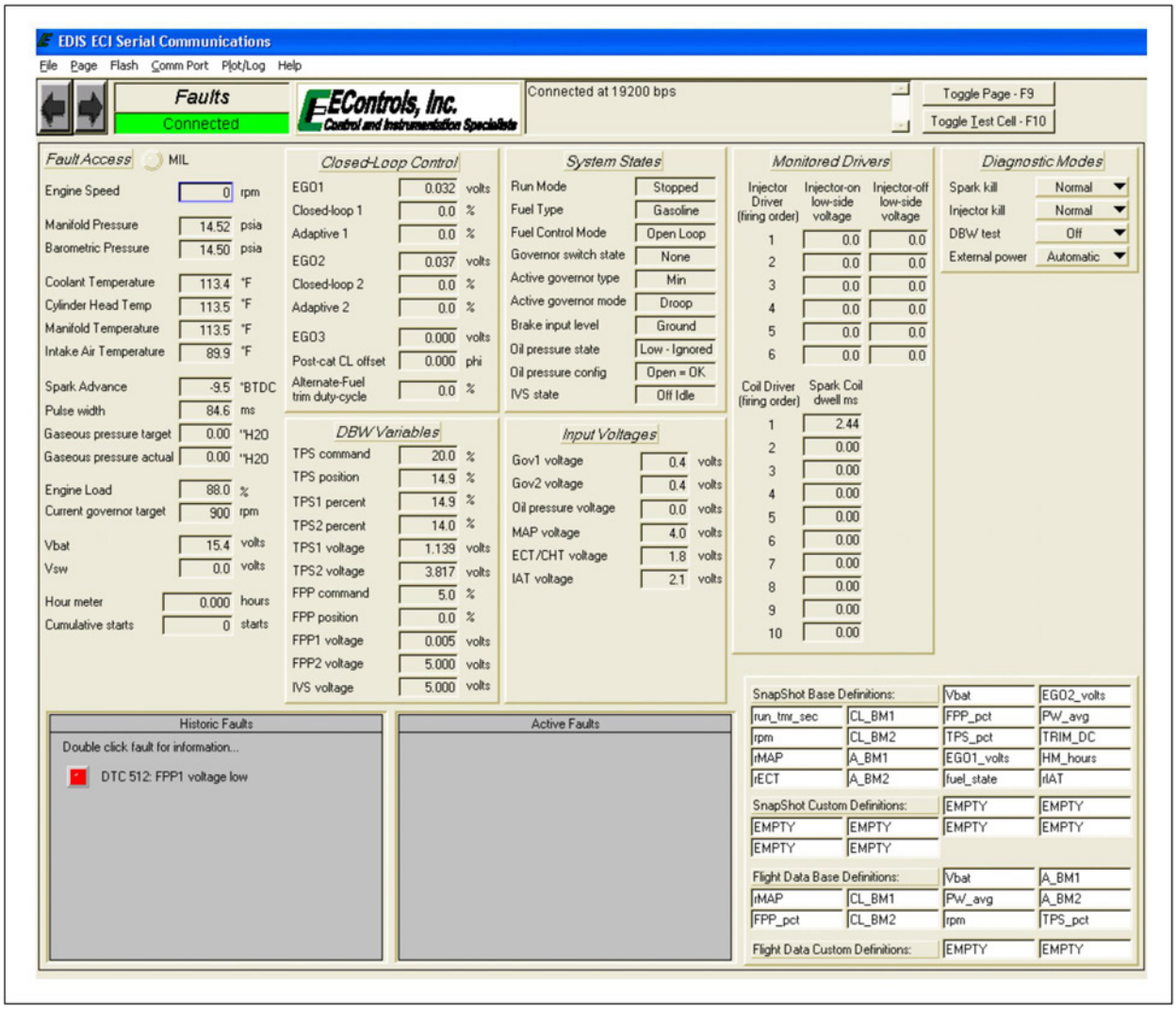



**FIGURE 20. FAULTS PAGE WITH HISTORIC FAULT MESSAGE**

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

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

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

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

## Accessing Fault Information

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

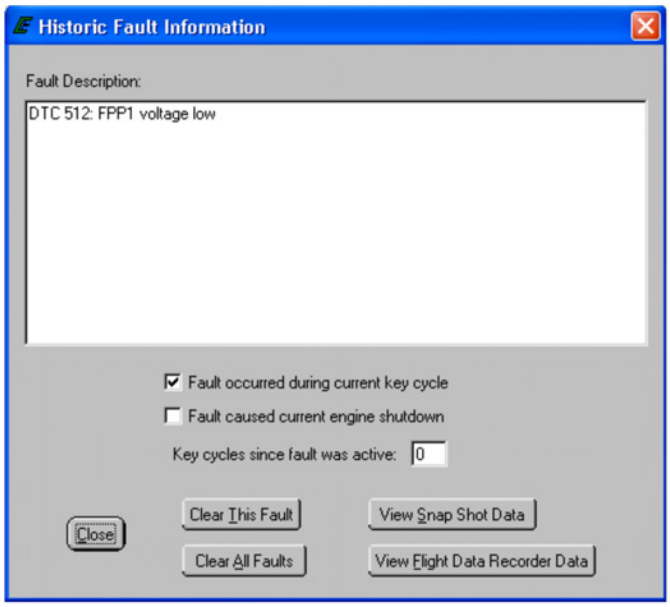



**FIGURE 21. HISTORIC FAULT INFORMATION INTERFACE**

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

**TABLE 19. HISTORIC FAULT INFORMATION INTERFACE FUNCTIONS**

| Fault Description Message Box | Customized Text that References the DTC Flash Code and Describes the Fault |
|---|---|
| *Fault During Key Cycle* Checkbox | Informs that the fault occurred during the current key-on event. |
| *Fault Caused Engine Shutdown* Checkbox | Informs that the fault caused the engine to shutdown. |
| *Key Cycles Since Fault Active* Indicator | Displays the amount of key-on events since the fault was last active. |
| *Clear This Fault* Button* | Erases the selected historic fault from the ECM. |
| *Clear All Faults* Button* | Erases all historic faults from the ECM. |

| Fault Description Message Box | Customized Text that References the DTC Flash Code and Describes the Fault |
|---|---|
| *View Snap Shot Data* Button | Retrieves a data “snap shot” from the ECM for variables defined in the base and custom snapshot variable definition lists. |
| *View Flight Data Recorder Data* Button | Retrieves a 10-second data strip chart (8 seconds prior, 2 seconds after fault trigger) from the ECM for variables defined in the base and custom flight data recorder definition lists. An example. |
| *Close* Button | Exits the Historic Fault Information interface. DOES NOT cancel or clear any faults. |
| * Snapshot and flight data recorder data for historic faults is erased if the fault is cleared from memory. | |

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

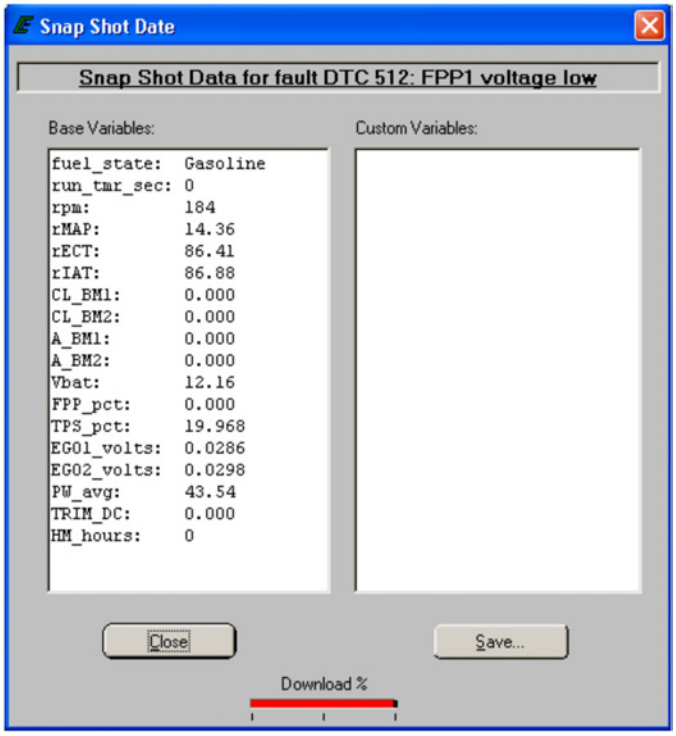



**FIGURE 22. SNAPSHOT DATA INTERFACE**

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


**FIGURE 23. FLIGHT DATA RECORDER INTERFACE**

For more information regarding the GCP Display service tool, refer to the following document:

- *If applicable:* Global Control Platform (GCP) Engine Display Interface Software (EDIS) Training Manual

## ECM Fault Codes

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

| Code | Fault Name | Additional Information |
| --- | --- | --- |
| DTC-16 | Crank and/or Cam Could Not Synchronize During Start | Hall-Effect sensor on Crankshaft, MPU sensor on camshaft |
| DTC-107 | MAP low voltage | |
| DTC-108 | MAP High Pressure | |
| DTC-111 | IAT higher than expected Stage 1 | |
| DTC-112 | IAT low voltage | |

| Code | Fault Name | Additional Information |
|---|---|---|
| DTC-113 | IAT high voltage | |
| DTC-116 | ECT higher than expected Stage 1 | |
| DTC-117 | ECT / CHT low voltage | |
| DTC-118 | ECT / CHT high voltage | |
| DTC-121 | TPS1 % lower than TPS2 % | TPSs are potentiometers, with 1 starting 'low' at 0 resistance. |
| DTC-122 | TPS1 Signal Voltage Low | |
| DTC-123 | TPS1 Signal Voltage High | |
| DTC-127 | IAT higher than expected Stage 2 | |
| DTC-129 | BP low pressure | |
| DTC-134 | EGO1 open / lazy (HO2S1) | |
| DTC-217 | ECT higher than expected 2 | |
| DTC-221 | TPS1 % higher than TPS2 % | TPSs are potentiometers, with 1 starting 'low' at 0 resistance. |
| DTC-222 | TPS2 Signal Voltage Low | |
| DTC-223 | TPS2 Signal Voltage High | |
| DTC-336 | Crank Input Signal Noise | Hall-Effect sensor used |
| DTC-337 | Loss of Crankshaft Input Signal | Hall-Effect sensor used |
| DTC-341 | Camshaft Input Signal Noise | MPU sensor used |
| DTC-342 | Loss of Camshaft Input Signal | MPU sensor used |
| DTC-359 | Fuel run-out longer than expected | See DTC-1181 |
| DTC-520 | Oil pressure low stage 1 (sender) | see DTC-524 |
| DTC-522 | Oil pressure sender low voltage | see DTC-524 |
| DTC-523 | Oil pressure sender high voltage | see DTC-524 |
| DTC-524 | Oil Pressure Low | inspect the sensor: 1 wire= normally open switch, three wire= pressure sensor |
| DTC-562 | Battery Voltage (VBat) Low | < 7.5 VDC |
| DTC-563 | Battery Voltage (VBat) High | > 16.5 VDC |
| DTC-601 | Microprocessor Failure - Flash | |
| DTC-604 | Microprocessor Failure - RAM | |
| DTC-606 | Microprocessor Failure - COP | |
| DTC-642 | Sensor Supply Voltage 1 Low (5Vext1) | |

| Code | Fault Name | Additional Information |
|---|---|---|
| DTC-643 | Sensor Supply Voltage 1 High (5Vext1) | |
| DTC-1151 | Closed Loop High (LPG) | |
| DTC-1152 | Closed Loop Low (LPG) | |
| DTC-1153 | Closed Loop High (Natural Gas) | |
| DTC-1154 | Closed Loop Low (Natural Gas) | |
| DTC-1161 | Adaptive Learn High (LPG) | |
| DTC-1162 | Adaptive Learn Low (LPG) | |
| DTC-1163 | Adaptive Learn High (NG) | |
| DTC-1164 | Adaptive Learn Low (NG) | |
| DTC-1171 | MegaJector/EPR delivery pressure higher than expected | EPR is integrated in the ECM in some units |
| DTC-1172 | MegaJector/EPR delivery pressure lower than expected | EPR is integrated in the ECM in some units |
| DTC-1173 | MegaJector/EPR comm lost | EPR is integrated in the ECM in some units. If this fault occurs, replace the ECM/EPR module. |
| DTC-1174 | MegaJector/EPR voltage supply high | Ensure that pressure regulator valve moves freely. If so, replace ECM/EPR module |
| DTC-1175 | MegaJector/EPR voltage supply low | |
| DTC-1176 | MegaJector/EPR internal actuator fault detection | |
| DTC-1177 | MegaJector/EPR internal circuitry fault detection | |
| DTC-1178 | MegaJector/EPR internal comm fault detection | |
| DTC-1183 | MegaJector autozero / lockoff failed | See DTC-1181 |
| DTC-1612 | Microprocessor Failure - RTI 1 | |
| DTC-1613 | Microprocessor Failure - RTI 2 | |
| DTC-1614 | Microprocessor Failure - RTI 3 | |
| DTC-1615 | Microprocessor Failure - A/D | |
| DTC-1616 | Microprocessor Failure - Interrupt | |
| DTC-2111 | Unable to reach lower TPS | |
| DTC-2112 | Unable to reach higher TPS | |

| Code | Fault Name | Additional Information |
|---|---|---|
| DTC-2135 | TPS1/2 simultaneous voltages out of range | |
| DTC-2229 | BP high pressure | 26 psig for >2 seconds |
| DTC-9999 | RPM higher than expected | See DTC-219 |

# 4.2 SAE J1939 CAN (Controlled Area Network)

## SAE J1939 CAN (Controlled Area Network)

The following section describes the function and operation of the J1939 Controlled Area Network (CAN) datalink, as it applies to this generator set. The engine control module (ECM) communicates to the generator set controller (PCC) over this network.

CAN communications follow the SAE J1939 communication protocol standard. The CAN datalink is based on a main trunk no more than 131 feet (40 meters) long and with 30 devices that is terminated by a 120 Ohm resistor at each end. Stubs no longer than 3.3 feet (1 meter) extend from the main trunk to each module in the bus.

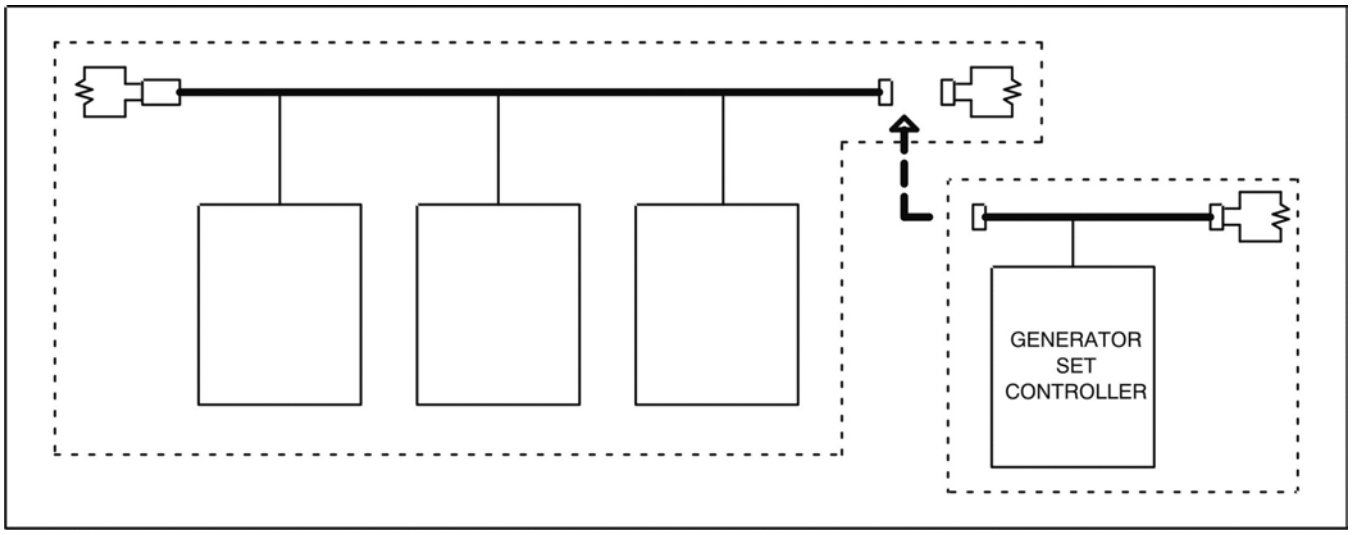



**FIGURE 24. CAN DATALINK**

## CAN Datalink Signals

The CAN datalink carries the binary signal between the ECM (Engine Control Module) and the PCC controller. The binary signal is expressed by a change in voltage. The table below shows how the generator set controller distinguishes between the voltage signals.

**TABLE 20. CAN DATALINK VOLTAGE DIFFERENTIALS**

| Signal | 0 | 1 |
|---|---|---|
| J1939 High (+) | 2.5 V | 3.5 V |
| J1939 Low (-) | 2.5 V | 1.5 V |
| Voltage Differential | 0 V | 2 V |

The CAN datalink transmits the signal at 250 KBaud, or 250 kilobits per second. Hence, it is possible for the voltages on J1939 High (+) and J1939 Low (-) to change 250,000 times per second.

The figures below show examples of good and bad datalink signals, on a high-resolution oscilloscope. The bad signal is caused by termination problems (no termination, wrong termination, or bad termination).

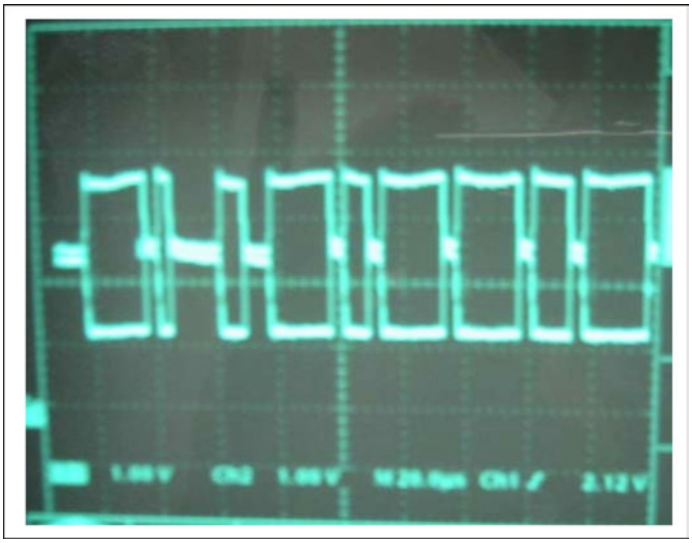


**FIGURE 25. CAN DATALINK: GOOD SIGNAL**

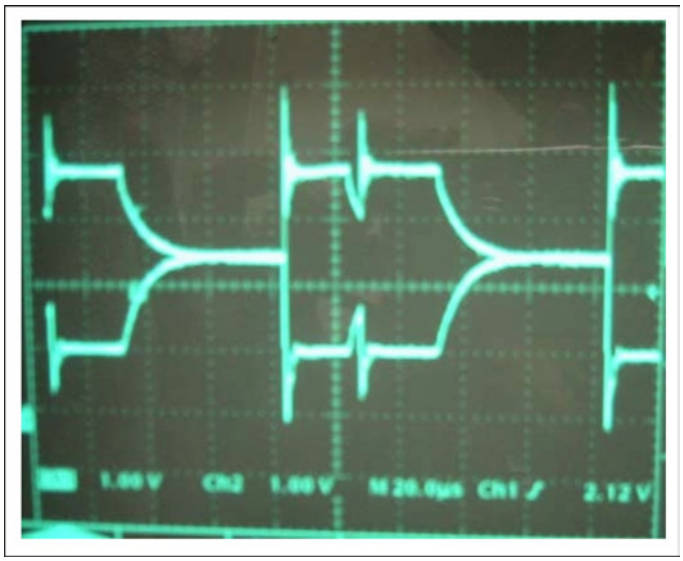


**FIGURE 26. CAN DATALINK: BAD SIGNAL**

## J11 Connections

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

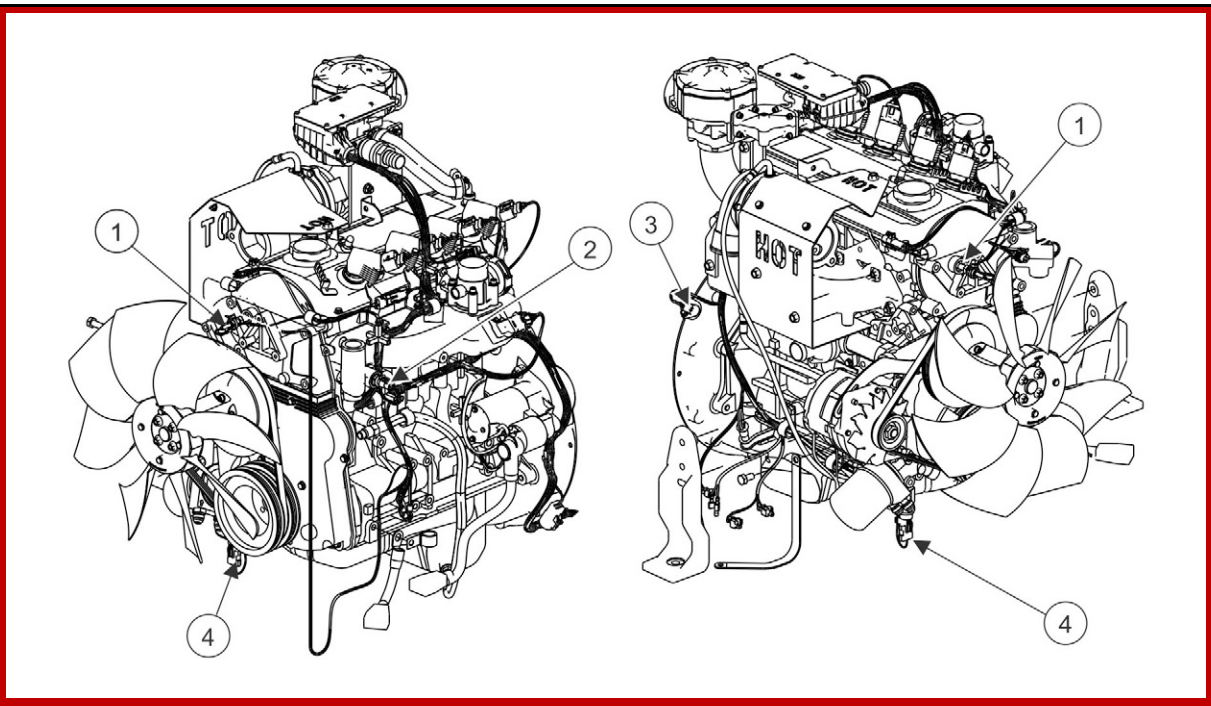
**TABLE 21. CONNECTOR J11**

| Description | Pin |
|---|---|
| CAN + | 20 |
| CAN - | 19 |
| CAN Shield | 17 |
| Keyswitch + | 22 |
| Keyswitch - | 21 |

The PCC uses this data to display engine status (sensor, warning and shutdown conditions). The datalink must remain active at all times. If not, the PCC will detect the inactive datalink and display a datalink error shutdown condition.

# 4.3 Sensors

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




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Camshaft Position Sensor | 3 | Crankshaft Position Sensor |
| 2 | Coolant Temperature Sensor | 4 | Oil Pressure Sensor |

**FIGURE 27. QSJ2.4 ENGINE SENSOR LOCATIONS**

## Oil Pressure Sensor

The oil pressure sensor is a normally open switch. When engine oil pressure falls below 6 PSI, the switch closes. Once the ECM detects that the switch is grounded it sends a shutdown signal to the engine. The ECM will allow the engine to be restarted but will continue to send a shutdown signal if the pressure remains below 6 PSI.

## Engine Coolant Temperature (ECT) Sensor

The PCC monitors the engine coolant temperature though 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.

## Crankshaft Position (CKP) Sensor

The crankshaft position sensor (CKP) is used to determine engine RPM and crankshaft position. The CKP uses a Hall Effect type sensor which generates a square wave form. The CKP is located next to the trigger wheel mounted on the end of the crankshaft. The trigger wheel contains 60 teeth spaced 6 degrees apart with two teeth missing. By magnetically locating the empty space on each revolution, the ECM can determine the position of the crankshaft and engine speed.

## Camshaft Position (CMP) Sensor

The camshaft position sensor (CMP) is a magnetic pickup (MPU) sensor. The CMP is used to determine when cylinder 1 reaches its compression stroke. The ECM uses this information to control fuel delivery to the proper cylinder.

## Camshaft Position (CMP) Sensor

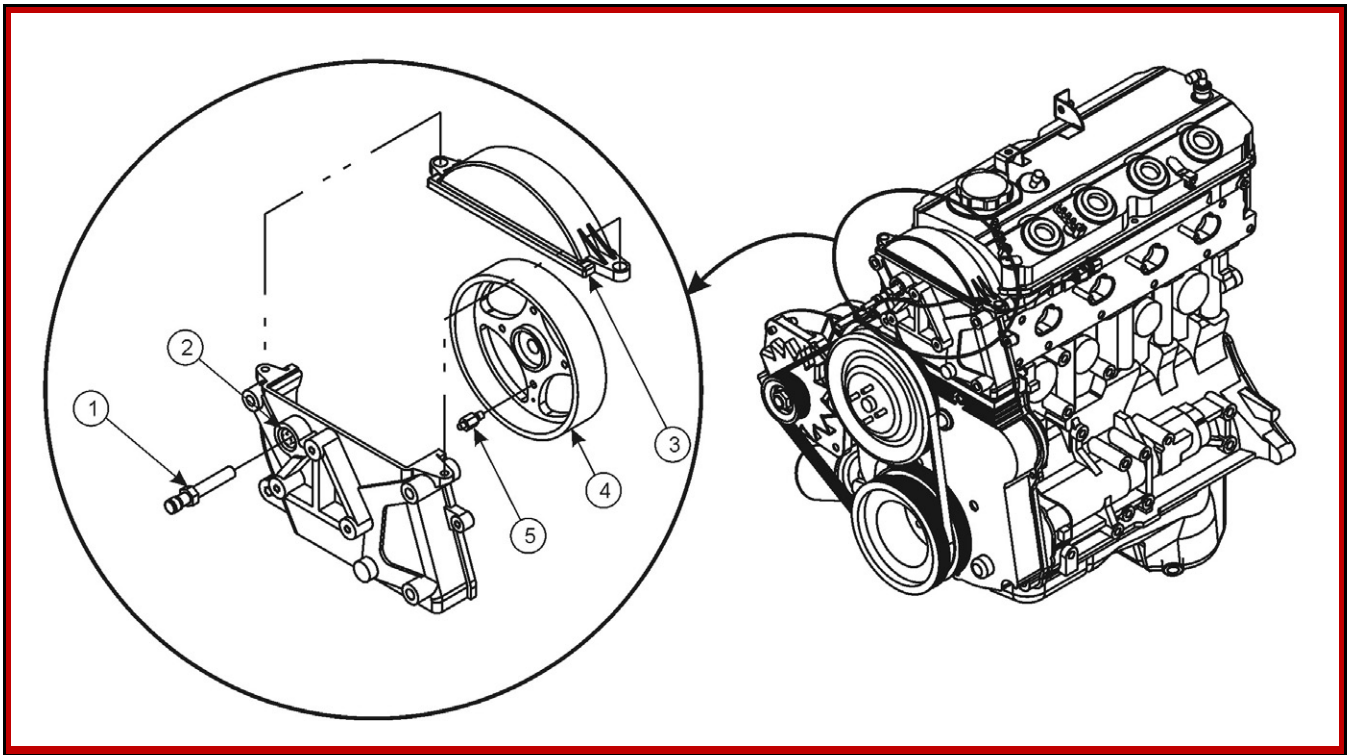
The camshaft position sensor (CMP) is a Hall Effect type sensor. The CMP is used to determine when cylinder 1 reaches its compression stroke. The ECM uses this information to control fuel delivery to the proper cylinder.

## Heated Exhaust Gas Oxygen (HEGO) Sensor

The Heated Exhaust Gas Oxygen Sensor (HEGO), also referred to as an $O_2$ sensor, is mounted before the catalyst in the exhaust system. The HEGO monitors the amount of oxygen in the exhaust system versus ambient conditions and generates a voltage output relative to the reading. This information is used to determine a rich or lean condition in the engine. In the event of a rich mixture, the typical HEGO output is 0.8 to 0.9 VDC. In the event of a lean mixture, the voltage drops to between 0.1 to 0.3 VDC. The ECM communicates with the HEGO, and adjusts the fuel system to maintain the proper air/fuel mixture. At a perfectly balanced mixture the HEGO should produce approximately 0.45 VDC.

## Camshaft Sensor Replacement

1. Measure the resistance of the Camshaft Position Sensor (1), which is the CMP (described above). If the resistance is not between 900 Ohms and 1000 Ohms, the MPU should be replaced.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | CMP Sensor | 4 | Engine Cam Gear |
| 2 | Mounting Hole | 5 | Timing Pin |
| 3 | Upper Cover | | |

**FIGURE 28. CMP SENSOR**

2. Remove the CMP (1) from the generator set.
3. Bar the engine until a timing pin (5) on the engine cam gear (4) lines up in the center of the mounting hole (2).
4. Thread the CMP (1) in gently by hand until it just touches the pin (5).
5. Back it out 1/4 turn and set the locknut.

**⚠ CAUTION**

***Do not use the fan blade to bar over the engine. Doing that can damage blades and cause property damage and personal injury.***

6. After adjustment, make sure the output voltage of the CMP (1) is correct. If the output voltage at cranking speed is less than 0.5 VAC, replace the CMP (1).

### Additional Sensors

In addition to the sensors already mentioned, the ECM monitors a throttle position sensor (TIP) and temperature manifold absolute pressure (TMAP) sensor to maintain fuel control and emissions.

# 4.4 Fuses and Relays

## Fuses and Relays

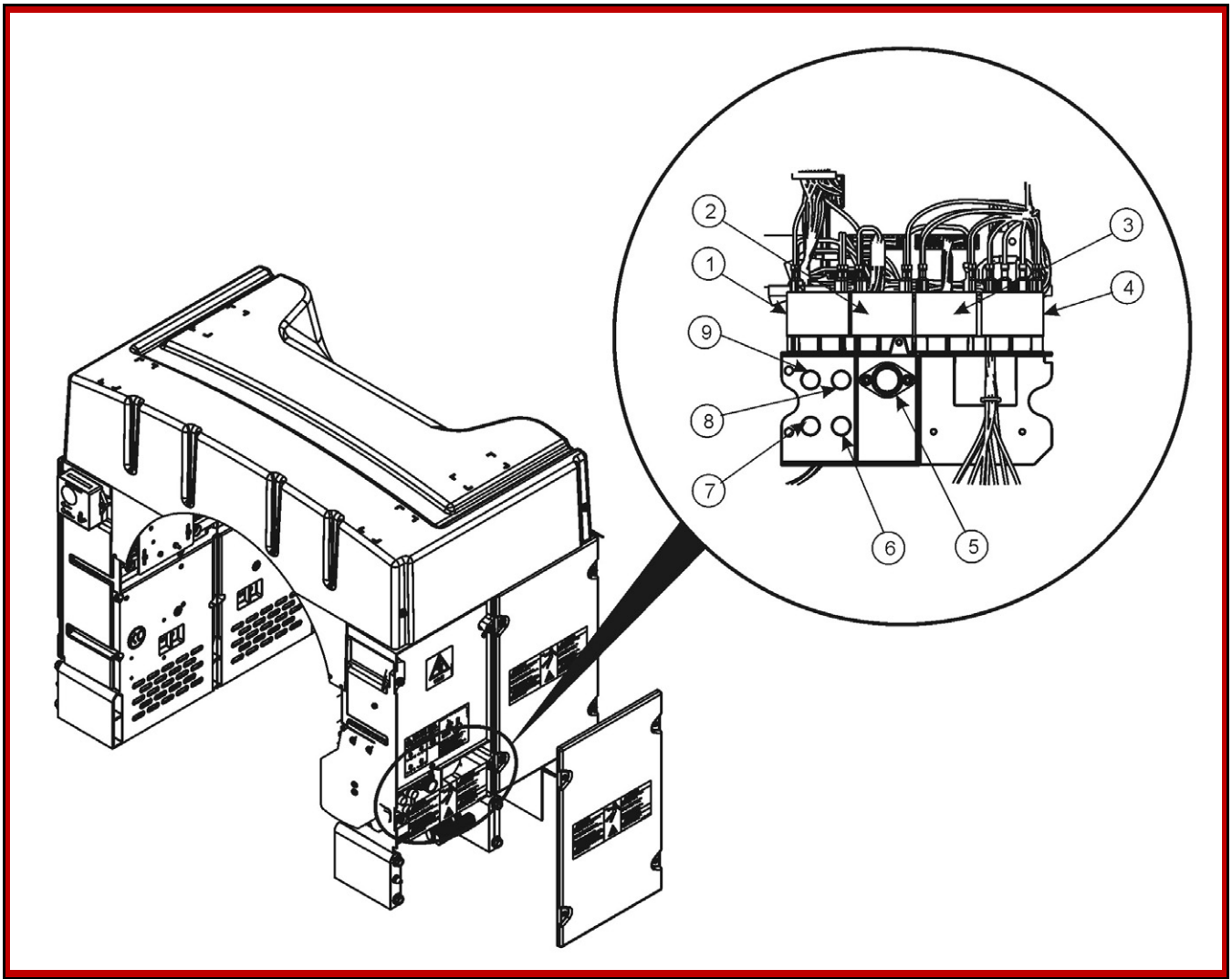
**⚠ WARNING**

***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.***

## Fuse and Relay Locations




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Power Relay (K2) | 6 | Fuse, 10A, 250 VDC (F4) |
| 2 | Power Relay (K4) | 7 | Fuse, 20A, 32 VDC (F3) |
| 3 | Power Relay (K6) | 8 | Fuse, 15A, 32 VDC (F2) |
| 4 | Power Relay (K5) | 9 | Fuse, 10A, 250 VDC (F1) |
| 5 | Fuse, 10A, 600 VAC (F5) | | |

## Fuse and Relay Replacement

1. Disconnect the negative (-) cable from the battery first.
2. Remove the positive (+) cable from the battery.
3. Remove the fuse or relay box cover.
4. Remove the faulty fuse or relay.

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

# 4.5 Fuel System

## Fuel System Drawings

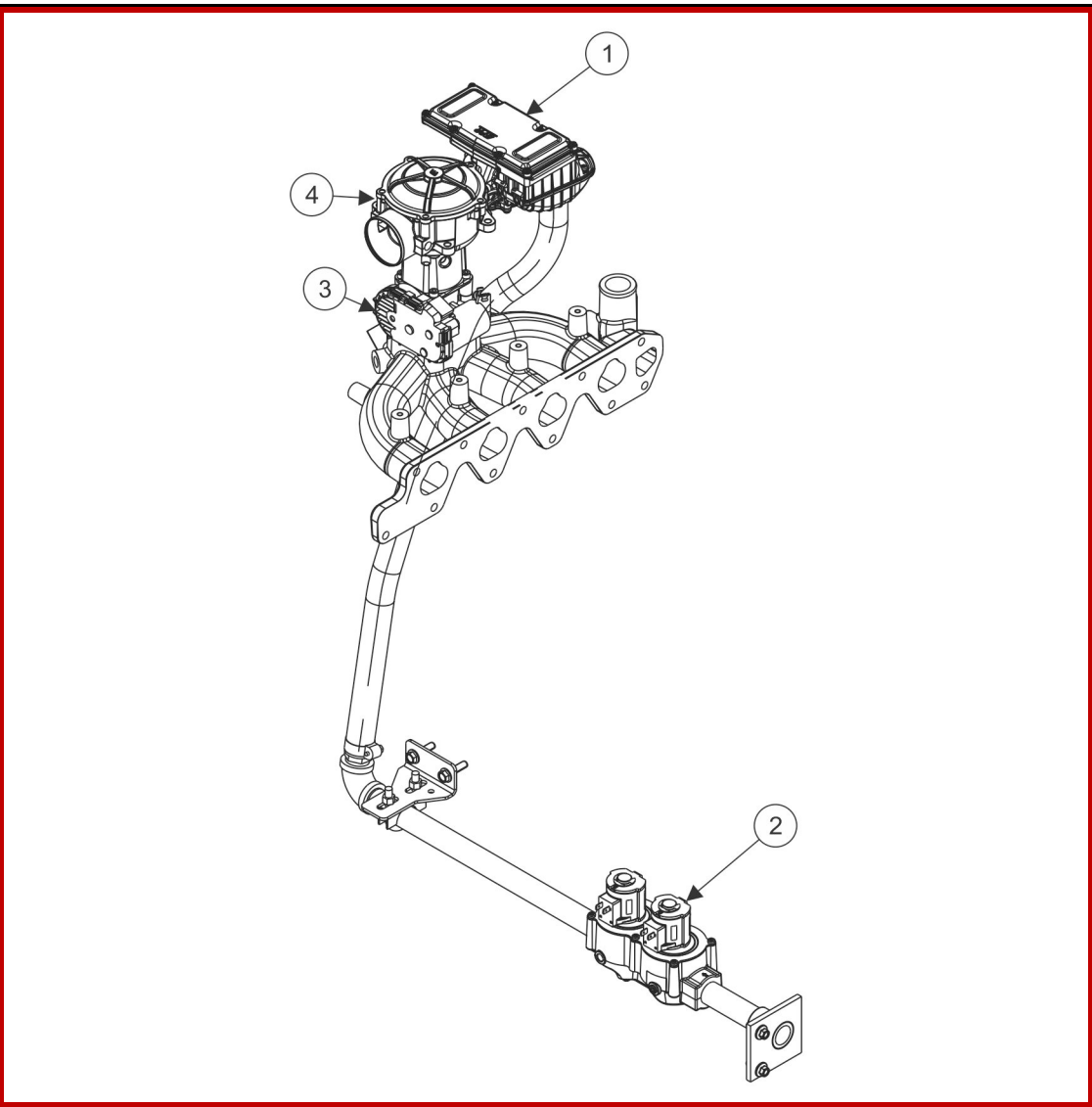
The engine is equipped with a fuel mixer to run on natural gas or propane vapor.

**⚠ WARNING**

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

**⚠ CAUTION**

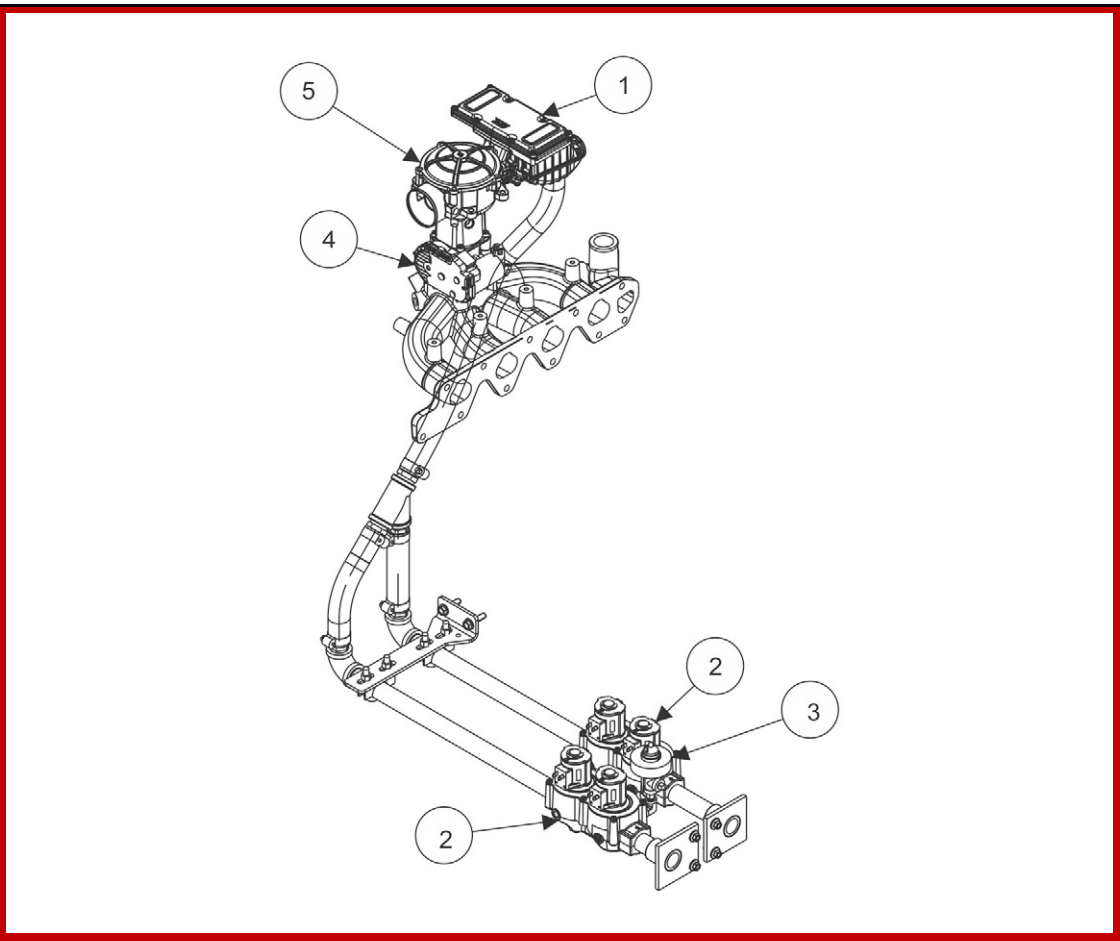
***Do not attempt to correct power by adjusting fuel system before determining that the engine and the ignition system are functioning properly. Be sure to check if there is air cleaner restriction due to dirt accumulation.***




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Integrated Electronic Pressure Regulator (IEPR) | 3 | Throttle Body |
| 2 | Shutoff Solenoid Valve | 4 | Mixer Assembly |

**FIGURE 29. PROPANE VAPOR OR NATURAL GAS FUEL SYSTEM**




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Integrated Electronic Pressure Regulator (IEPR) | 4 | Throttle Body |
| 2 | Shutoff Solenoid Valves | 5 | Mixer Assembly |
| 3 | Low Pressure Sensor | | |

**FIGURE 30. DUAL FUEL NATURAL GAS AND PROPANE VAPOR FUEL SYSTEM**

## Fuel System Adjustments

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

## Fuel Pressure Requirements

The minimum pressure refers to supply pressure under rated load (maximum gas flow).

Make sure that pipeline quality gas is used.

For the required fuel pressure supply range for propane vapor or natural gas, see the Model Specifications section.

# Fuel System Components and Operation

This generator set is equipped for natural gas, propane or both, with automatic changeover. Each fuel has a fuel shutoff solenoid. Generator sets utilizing liquid withdrawal of propane are equipped with a converter that vaporizes the fuel with hot engine coolant.

A generator set equipped for natural gas and propane has a Direct Electronic Pressure Regulator, Mixer Assembly and Electronic Throttle Body that serves both fuels. A fuel pressure switch detects the loss of natural gas (primary fuel) for automatic change over to propane while the engine is running.

## Converting the Fuel System Type

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

1. Enter the Fuel System Menu.
    a. From any Info Menu, hold down the up and down arrows simultaneously for two seconds. The Service Menu appears.
    b. Select **Setup Menus**.
    c. Enter the password **574** on the Password screen. The Setup Menu appears.
    d. Select **Genset Service**.
    e. Select **Genset**.
    f. Advance through the screens until the Fuel System Setup Menu appears.
2. Update the Fuel System Type on the Fuel System Setup Menu. See the figure below.
    a. Press **Adjust** on the Fuel System Menu.
    b. Edit the Fuel System using the horizontal arrow key. Change the field value by using the +/- keys.

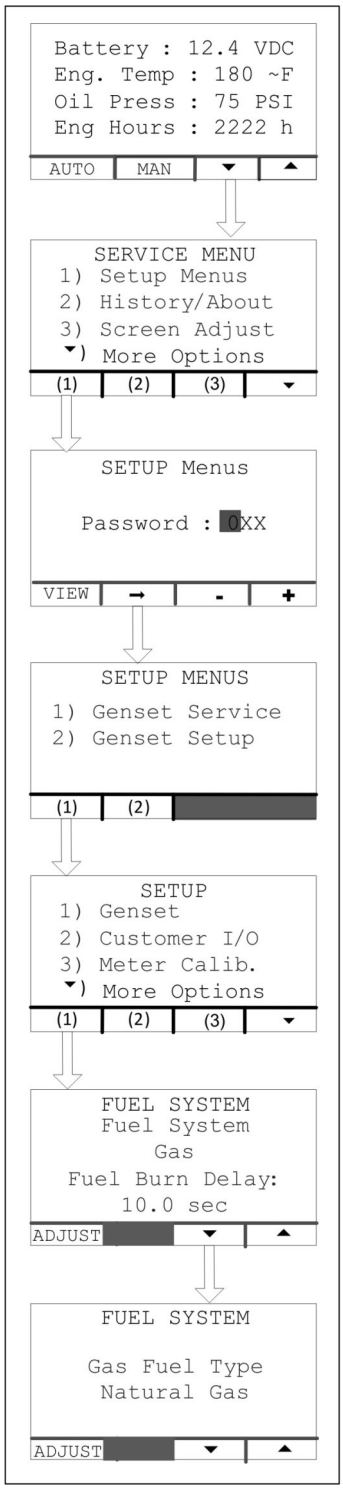



**FIGURE 31. FUEL SYSTEM TYPE**

3. Update the Gas Fuel Type on the Fuel System Menu.
   a. When changing the Fuel System, a second Fuel System Menu is enabled. Advance to this menu by pressing the down arrow after saving any changes.
   b. Press **Adjust** on the Fuel System Menu.
   c. Edit the Gas Fuel Type by using the horizontal arrow key. See the figure below.

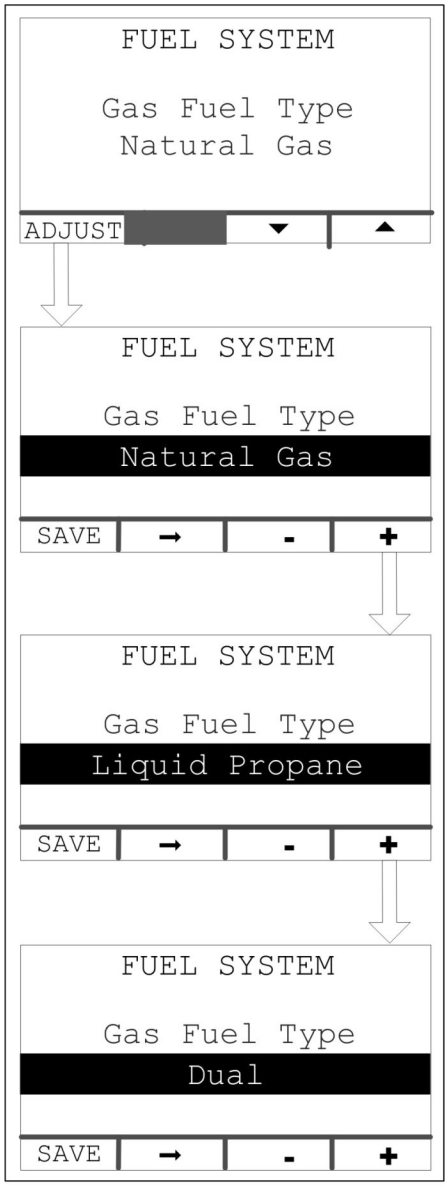



**FIGURE 32. GAS FUEL TYPE**

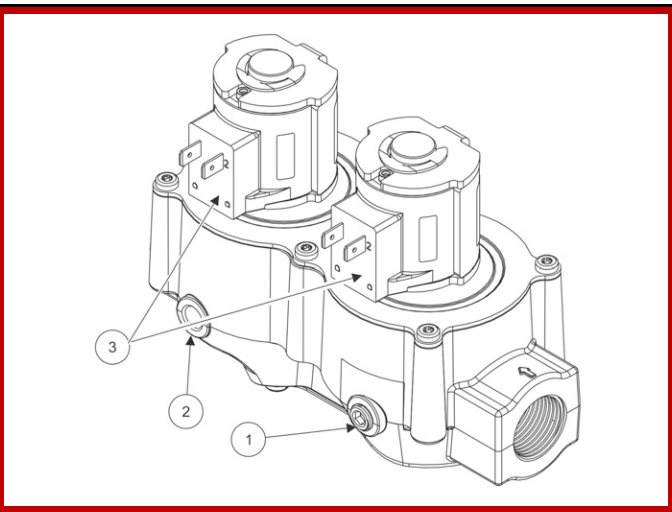
   d. Change the field value to Natural Gas, Liquid Propane, or Dual by using the +/- keys.
   e. Select **Save** to save the changes.

## Fuel Shutoff Solenoid Valve

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

There are two pressure ports on each side of the solenoid. The inlet and outlet valve flange also include a pressure port. The two in-line pressure ports on the valve body side correspond to each flange pressure port. The corresponding side and flange ports will give the same pressure reading. The top valve body side pressure port measures the pressure between the two shut-off valves. This port is used to determine if the first valve is leaking.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Inlet Pressure Port | 3 | Power Plug |
| 2 | Outlet Pressure Port | | |

**Note:** Test port threads are G-1/8" and not 1/8" NPT. For test purposes only, a 1/8" ISO male to 1/8" NPT female adapter may be used.

**FIGURE 33. FUEL SHUTOFF SOLENOID VALVE**

## Fuel Shutoff Solenoid Troubleshooting

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

1. Disconnect the terminals between the wire harness going to the valve assembly and the engine harness.
2. Check for voltage at the solenoid coils. Use a multi-meter to measure 12 VDC between the B+ wire and ground of the engine harness.
   - If no voltage is measured, check for blown fuses or bad wiring while cranking.

- If voltage is less than or equal to 10.2 VDC, check for bad wiring or low battery voltage.
- If voltage is greater than 10.2 VDC, check for correct solenoid operation

3. Check for solenoid operation.
   a. While holding onto the solenoid, apply 12 VDC to a coil on one of the solenoids.
   b. Listen and feel for the solenoid to activate.
   c. Repeat applying the voltage a few times to be sure the solenoid operates.
   d. Repeat these steps for all solenoids.
   e. If either solenoid does not activate, use a multi-meter to measure resistance of the coil. The resistance should be 11 Ohms.
      - If the resistance is not 11 Ohms, replace the solenoid.
      - If the resistance is 11 Ohms, replace the gas valve assembly.
4. Check for fuel leaks at the solenoid. With a soapy water solution, check pipe threads and areas around the base of the solenoid for gas leakage.
   - If a pipe thread is showing bubbles, tighten the pipe connection.
   - If anywhere on the gas valve shows bubbles or leakage, replace the complete gas valve assembly.

## Coil Assembly Replacement

To remove the coil assembly:

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

To reinstall the coil assembly:

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

## Integrated Electronic Pressure Regulator (IEPR)

The Integrated Electronic Pressure Regulator (IEPR) utilized on US emission certified engines is a critical part of the certified emissions system and does not require any periodic adjustment.

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

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

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

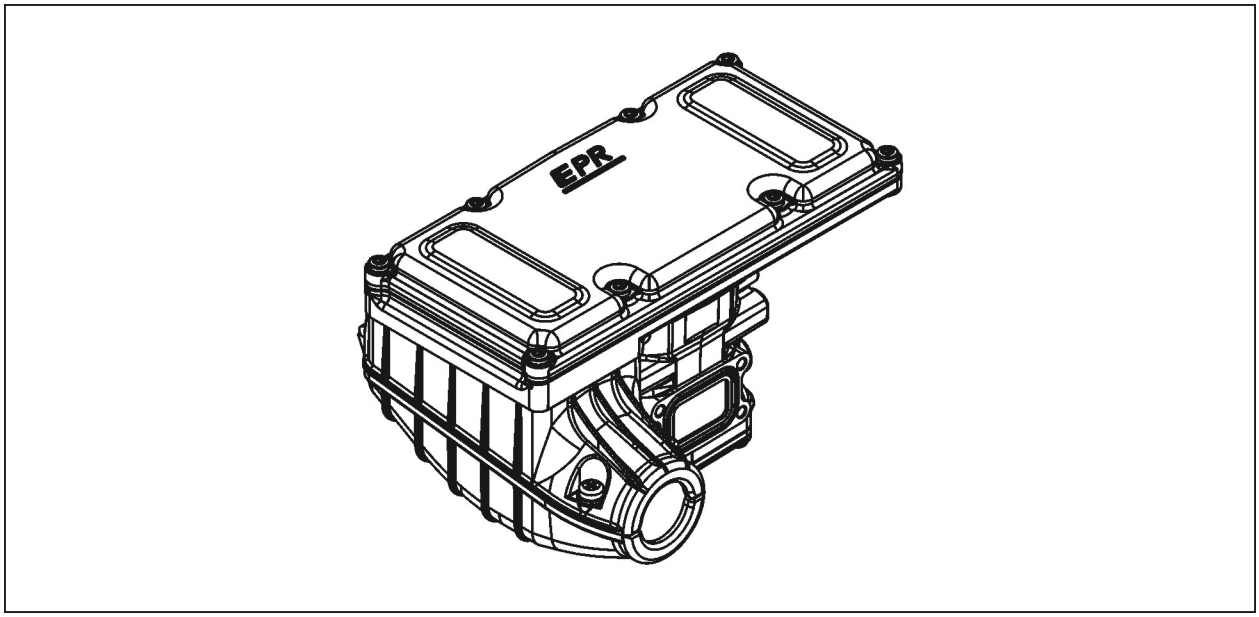



**FIGURE 34. INTEGRATED ELECTRONIC PRESSURE REGULATOR (IEPR)**

## Mixer Assembly

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

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

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

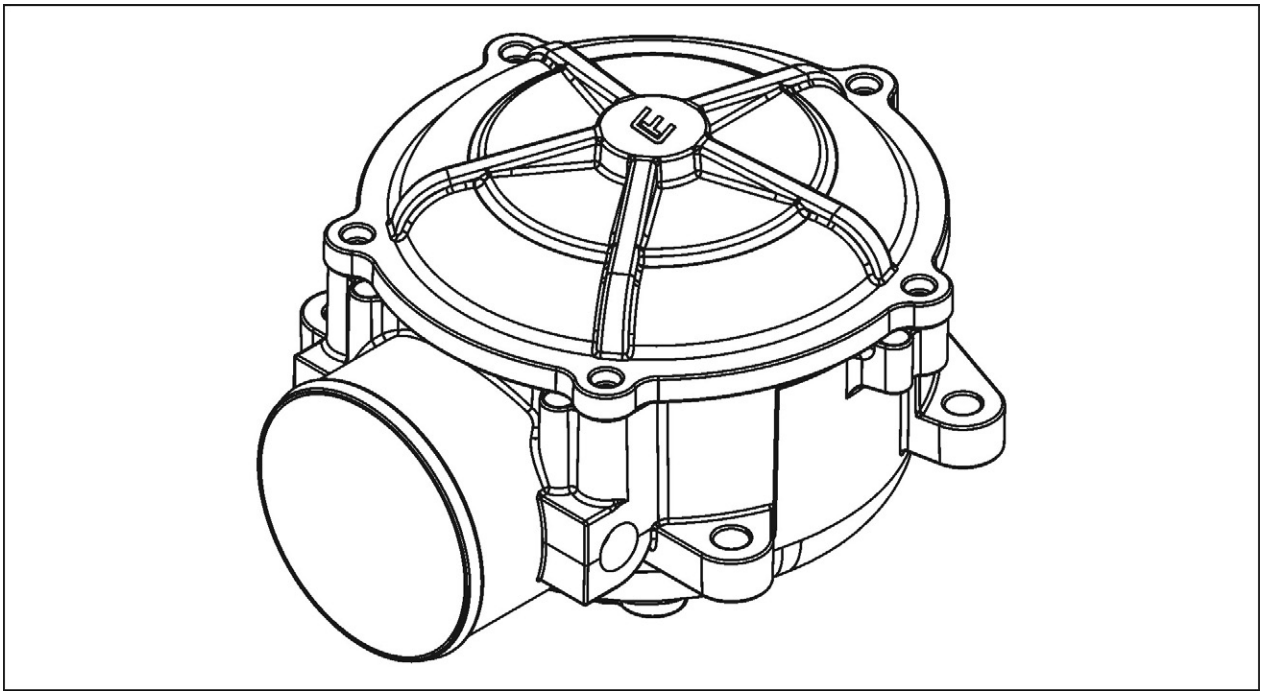


**FIGURE 35. MIXER ASSEMBLY**

## Electronic Throttle Body (ETB)

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

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

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

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

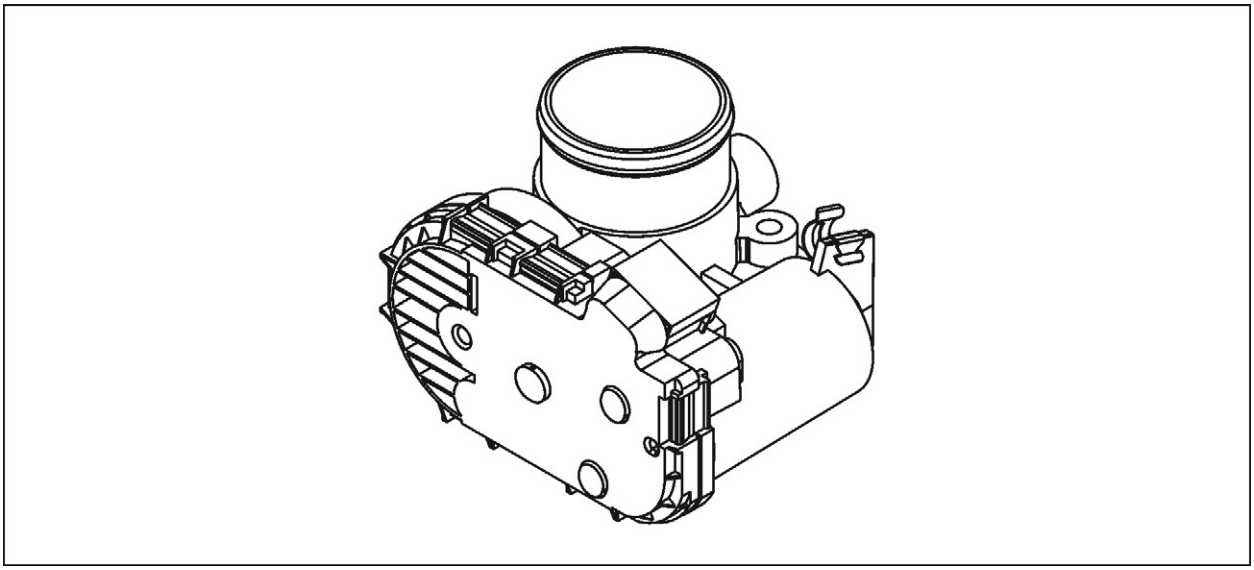
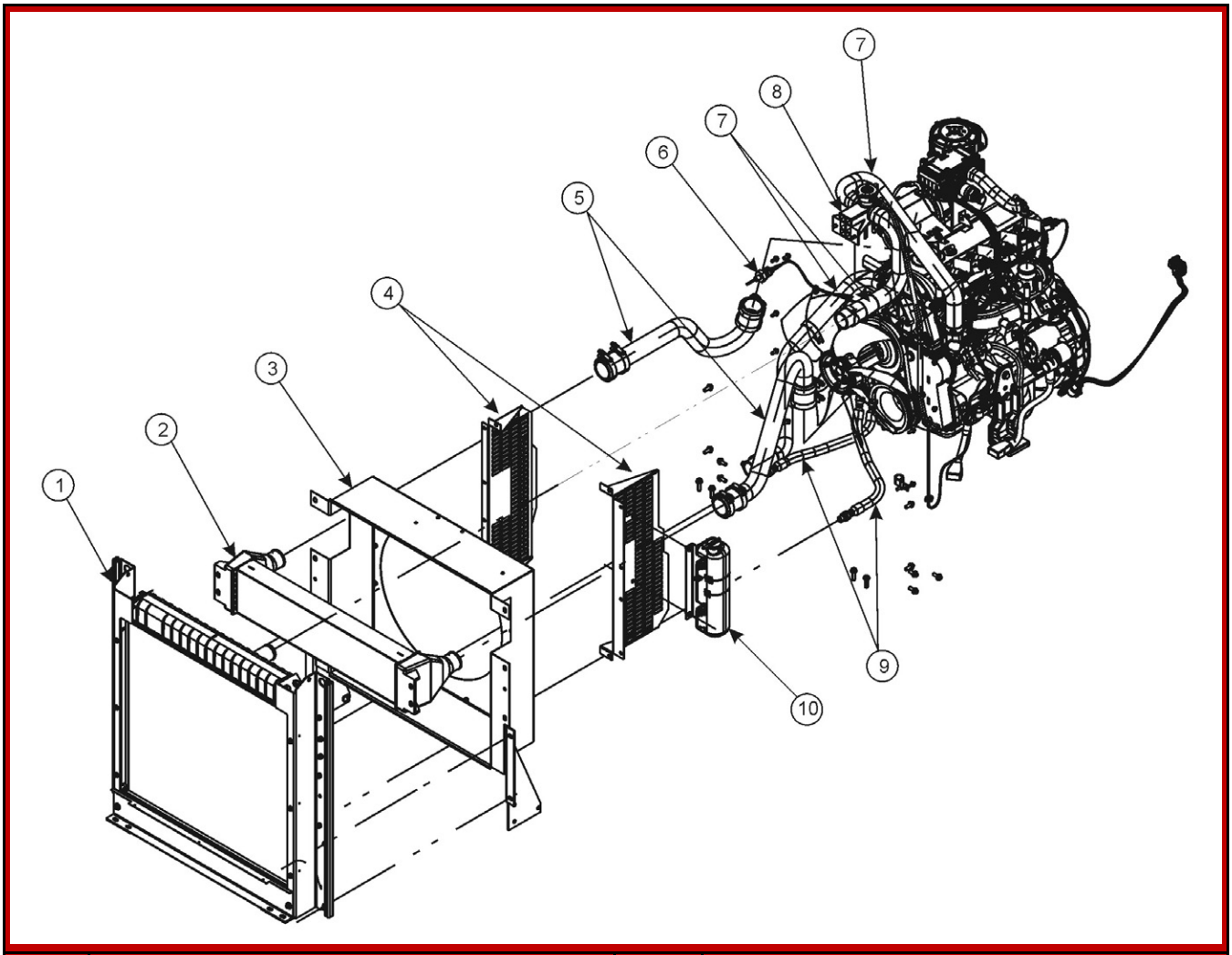


**FIGURE 36. ELECTRONIC THROTTLE BODY (ETB)**

# 4.6 Cooling System

## Cooling System Components

Cooling system components are shown below:




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Radiator | 6 | Coolant Level Sensor |
| 2 | Charging Air Cooler/After Cooler (Where Fitted) | 7 | Coolant Hose |
| 3 | Shroud | 8 | Coolant Fill Housing |
| 4 | Radiator Guard | 9 | Oil Cooler Hose (Where Fitted) |
| 5 | Air Hose | 10 | Coolant Bottle |

**FIGURE 37. COOLING SYSTEM COMPONENTS**

## 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.**

## Radiator Assembly Removal and Installation

Follow these steps to remove the radiator assembly:

1. Remove the enclosure doors, as applicable. See the figure below.

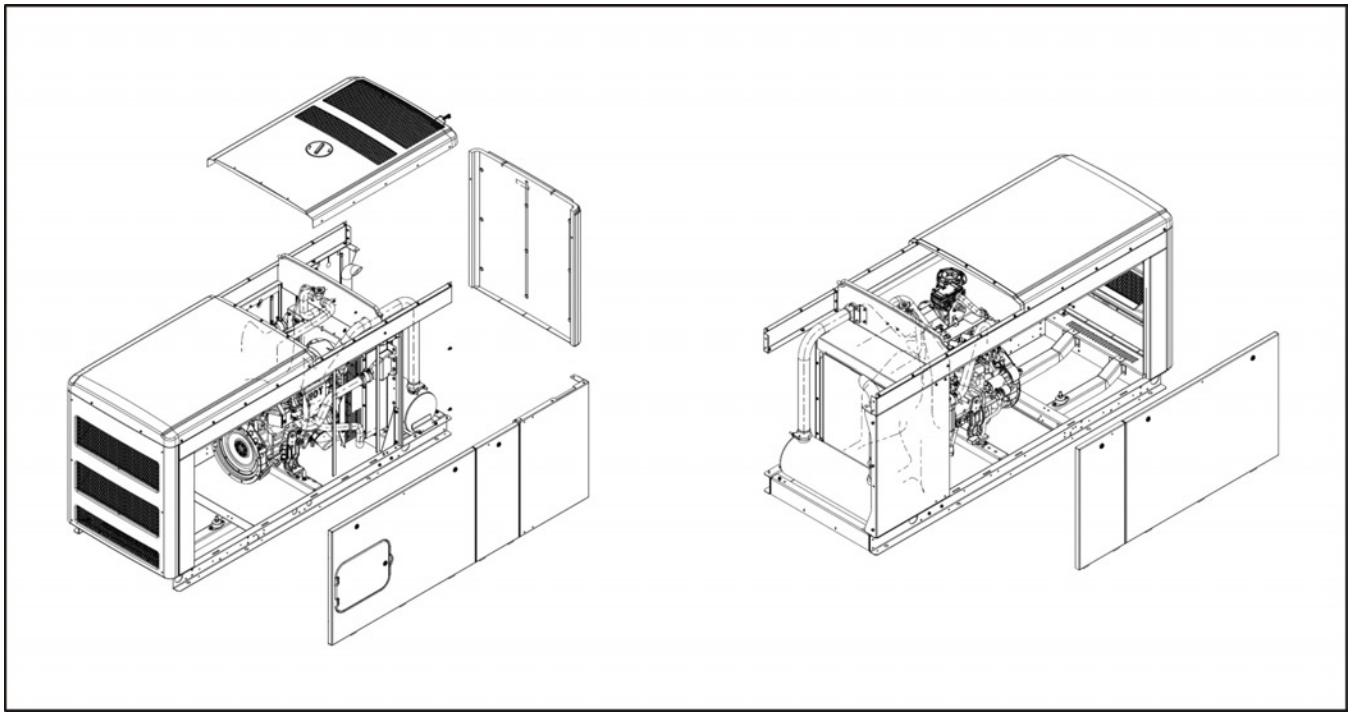


**FIGURE 38. ENCLOSURE DOOR REMOVAL**

2. Disconnect the battery connections. See the figure below.

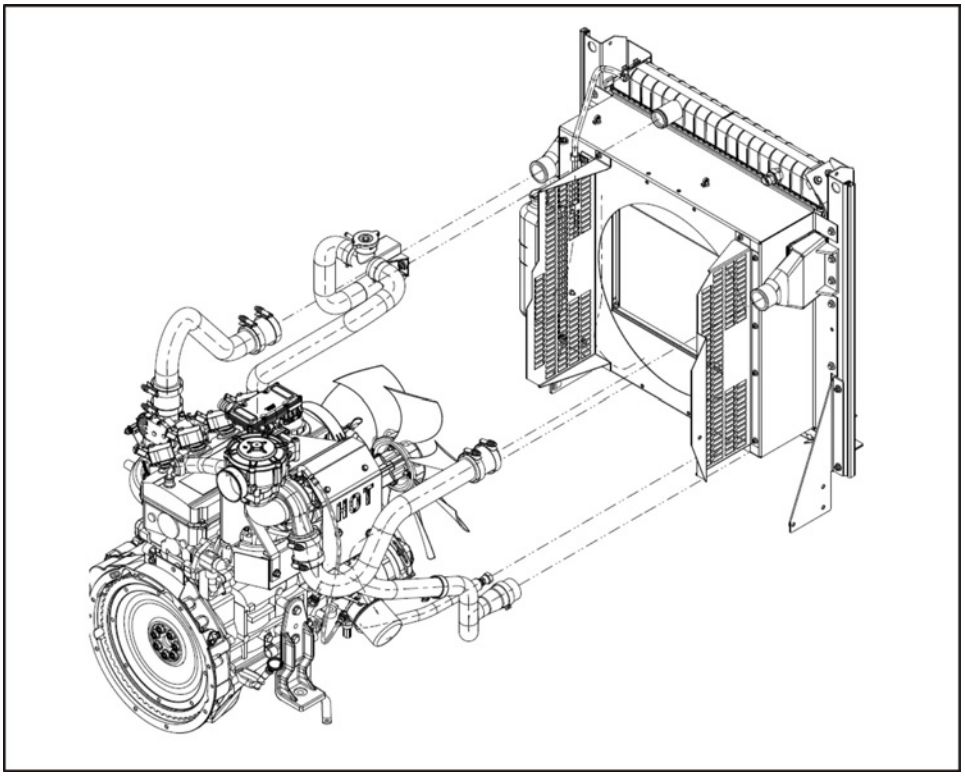


**FIGURE 39. REMOVE CONNECTIONS**

3. Drain the coolant.
4. Drain the engine oil (if an oil cooler is equipped).
5. Remove the CAC inlet and outlet connections (if equipped with a turbocharger and after cooler).
6. Remove the coolant connections.
7. Remove the oil cooler connections (if the oil cooler is equipped).
8. Remove the coolant reservoir bottle from the fan guard.
9. Remove the fan guards. See the figure below.

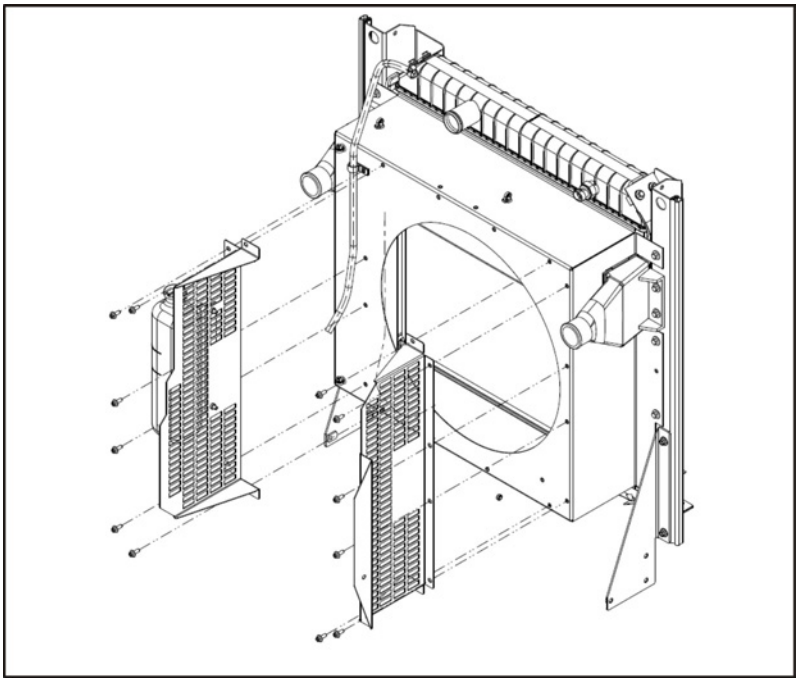


**FIGURE 40. REMOVE FAN COMPONENTS**

10. Remove the side bolts for the support brackets. See the figure below.

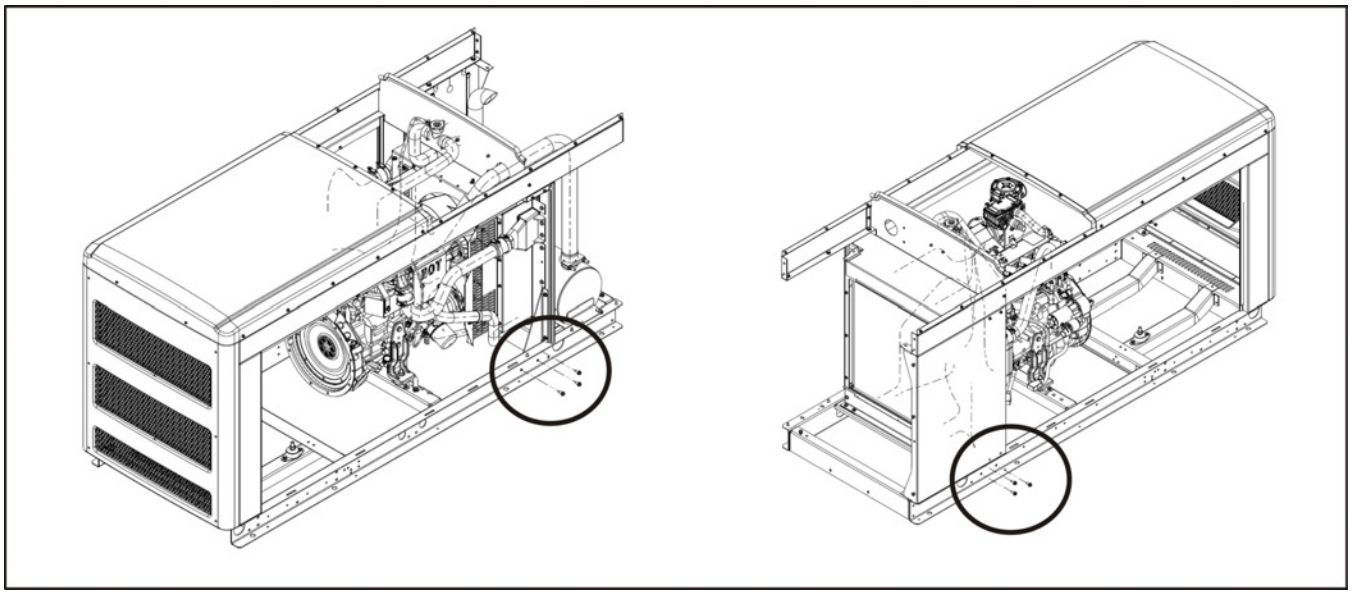


**FIGURE 41. SUPPORT BRACKETS**

11. Remove the side support brackets.
12. Remove the bolts for the bottom bracket. See the figure below.

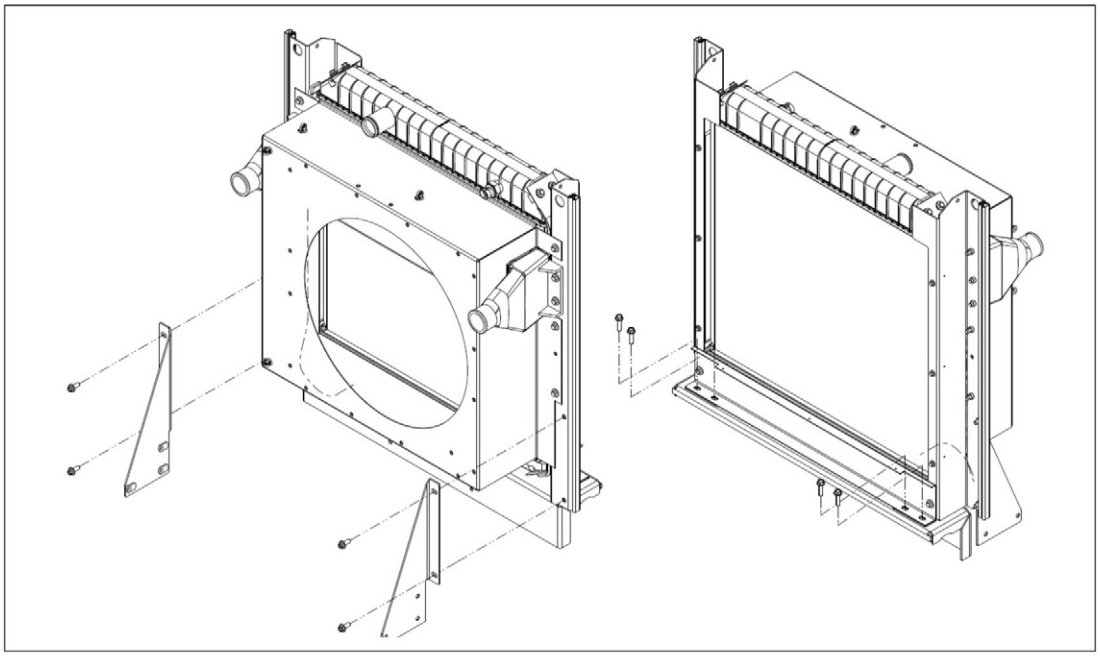


**FIGURE 42. SUPPORT BRACKETS AND BOTTOM BRACKET**

13. Remove the radiator assembly on the side. See the figure below.

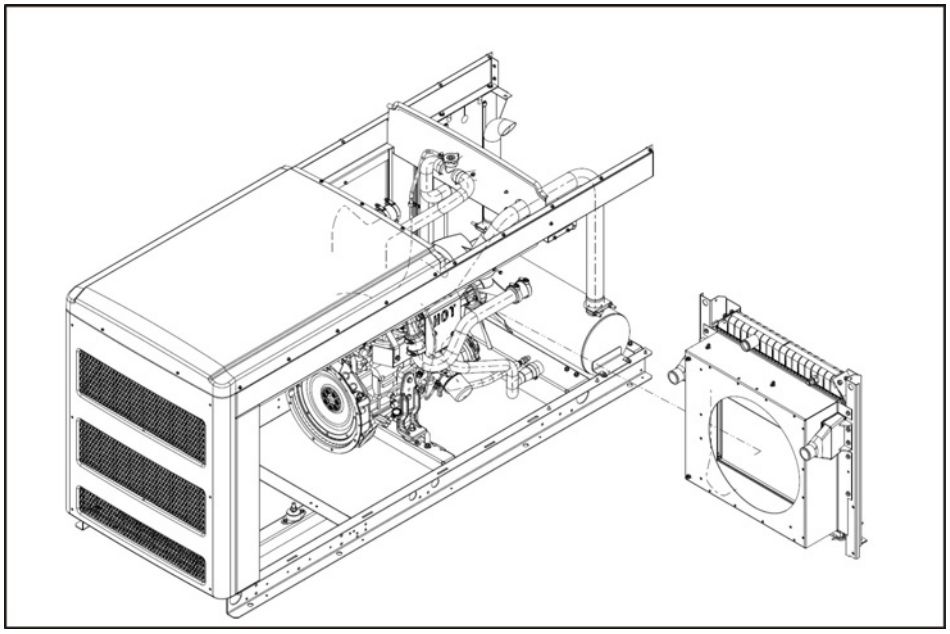


**FIGURE 43. REMOVE RADIATOR**

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

| *NOTICE* |
| --- |
| **Alternator disc bolts and adapter bolts are all 52 Nm torque with +/- 5 Nm (38.5 ft-lb with +/- 3.7 ft-lb) tolerances.** |

## Water Pump Removal and Installation

### Water Pump Removal

1. Drain the coolant.
2. Remove radiator hose from inlet of water pump.
3. Remove the timing belt.
4. Remove the water pump bolts.
5. Remove the water pump.

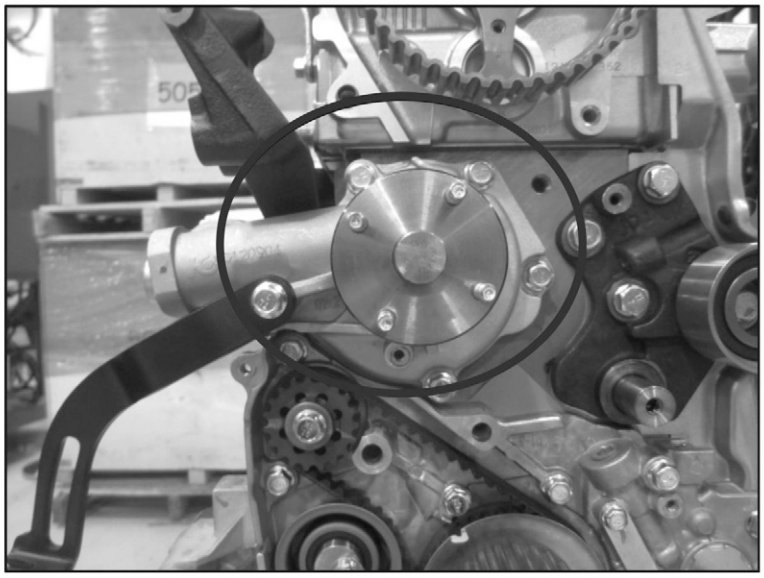


**FIGURE 44. WATER PUMP**

### Water Pump Installation

1. Install the water pump with a new gasket.
2. Tighten the water pump bolts to 14 Nm (10.4 ft-lb).
3. Install the radiator hose.
4. Install the timing belt.

## Thermostat Installation

1. Check that the rubber ring is undamaged and seated correctly in the thermostat flange. See the figure below.

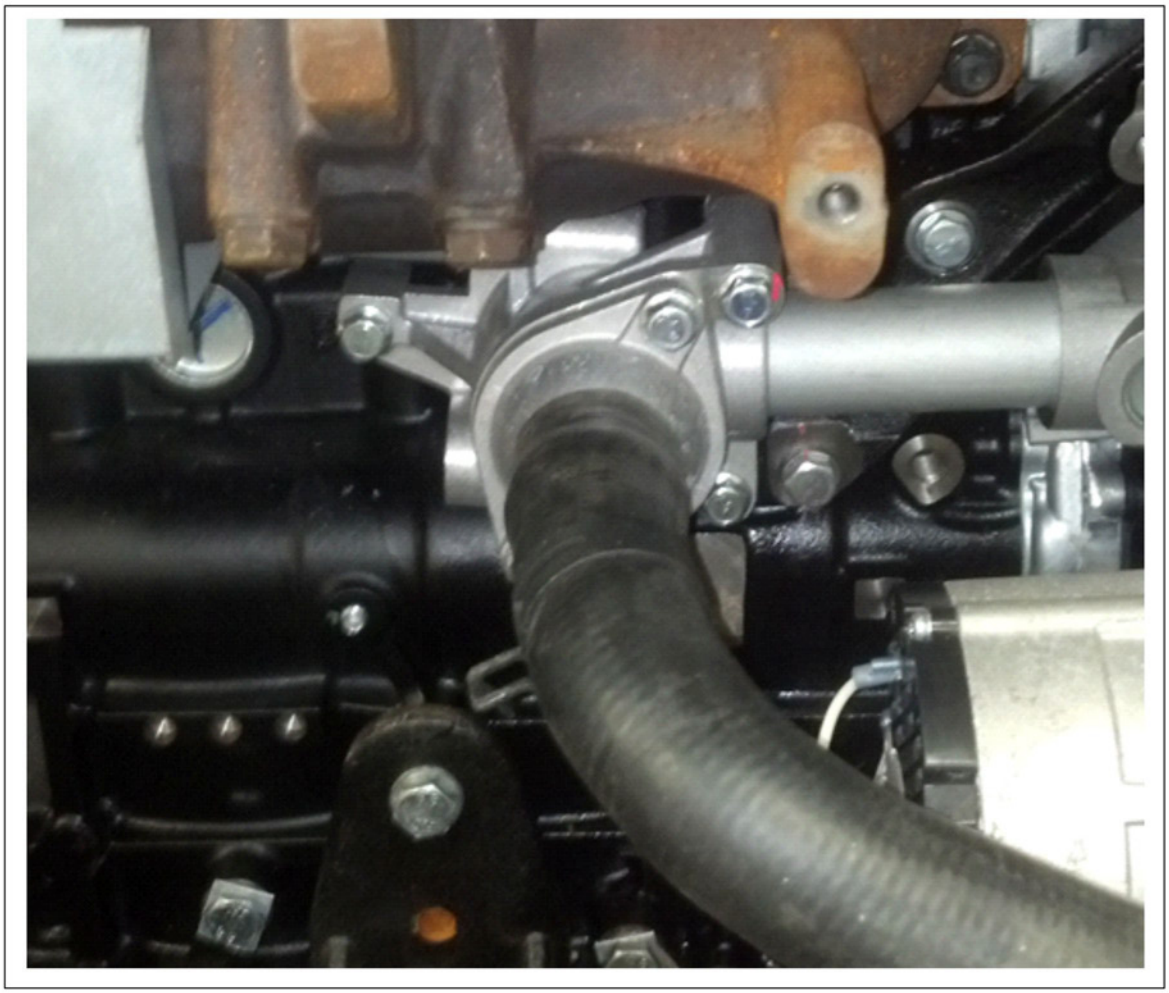


**FIGURE 45. THERMOSTAT HOUSING LOCATION**

2. Install the thermostat. Make sure that the jiggle valve is at the uppermost position. Tightening torque: 24 Nm. See the figure below.

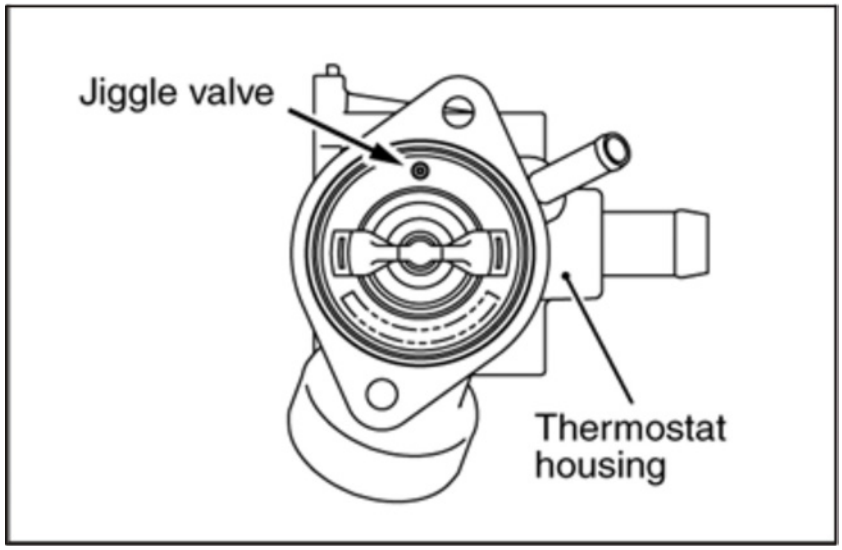



**FIGURE 46. THERMOSTAT**

# 4.7 Exhaust System

## Overview

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

The exhaust system is comprised of up to three active components - the turbocharger (if equipped), the oxygen sensor, and the muffler/catalytic converter (if equipped) - in addition to manifold(s) and piping connecting the components.

## Oxygen Sensor

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

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

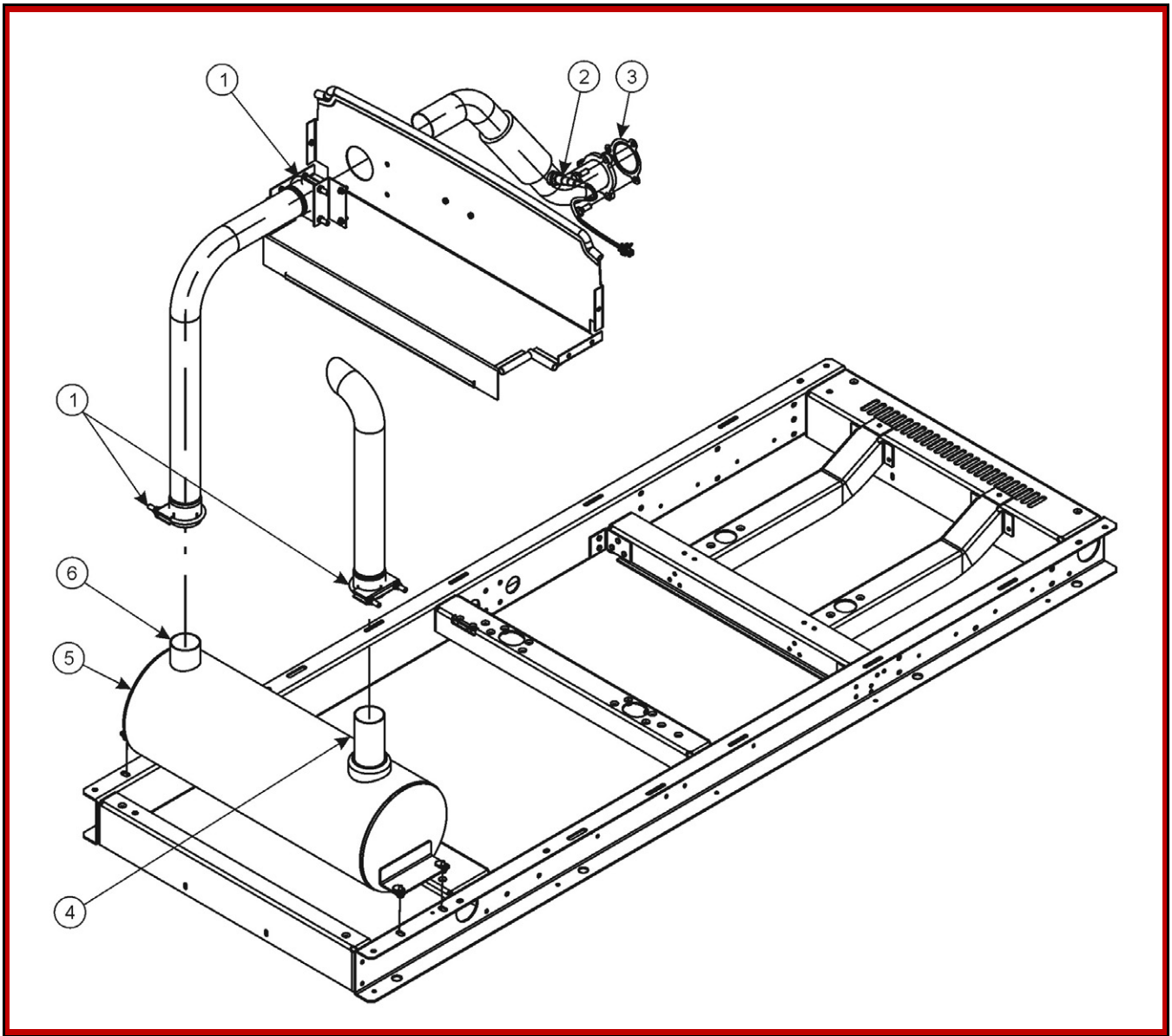
Proper operation of the oxygen sensor depends on three conditions:

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

Your authorized Cummins Inc. distributor can monitor fuel system/oxygen sensor operation using the GCP Display service tool and the ECM.

# Exhaust System Graphic




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Clamp | 4 | Muffler Out |
| 2 | Oxygen Sensor | 5 | Muffler |
| 3 | Gasket | 6 | Muffler In |

**FIGURE 47. EXHAUST SYSTEM**

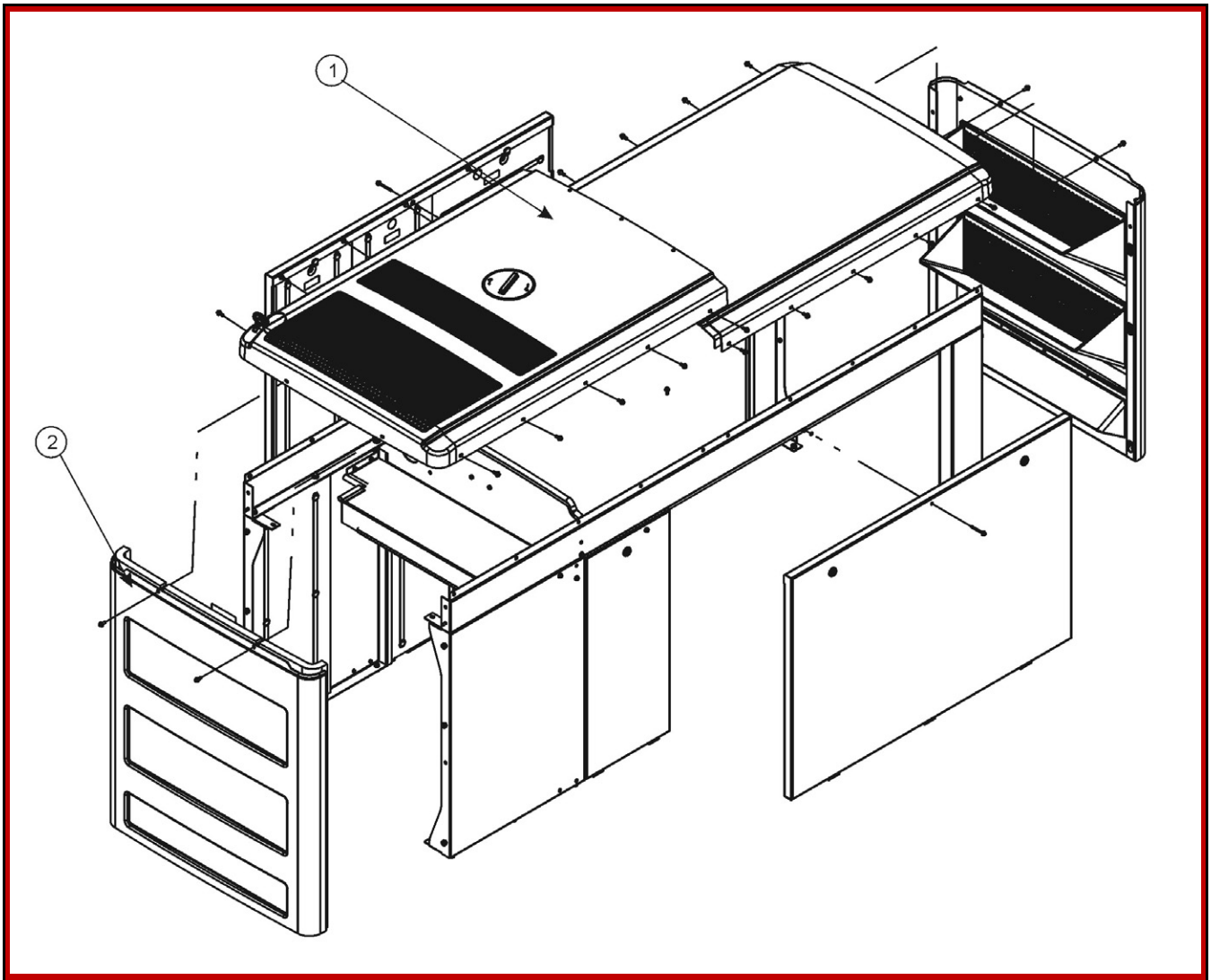
# Muffler Removal

**⚠ 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).




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

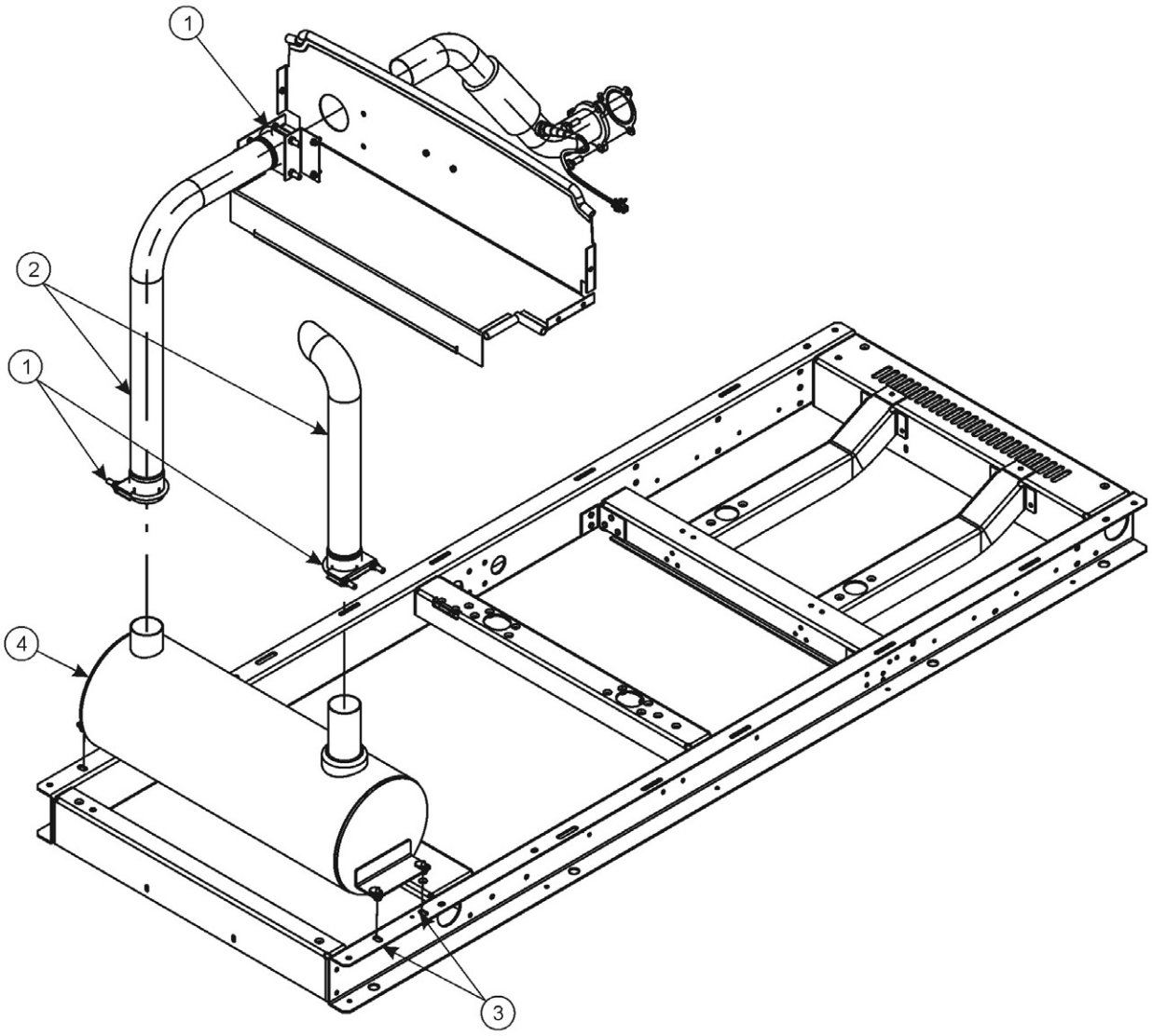
**FIGURE 48. ENCLOSURE END PANEL REMOVAL**

2. Remove top panel (1).

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

## Remove Muffler




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Clamps | 3 | Bolts |
| 2 | Exhaust Pipe | 4 | Muffler |

**FIGURE 49. MUFFLER REMOVAL**

1. Remove three clamps (1).
2. Remove exhaust pipes (2) from muffler (4).
3. Remove two bolts (3) from each end of muffler (4).

4. Remove muffler (4) from enclosure.

## Muffler Installation

### Install Muffler

1. Place the muffler (4) over the four bolt holes in the skid. Refer to **Figure 49**.
2. Attach the muffler (4) with two bolts (3) on each end of muffler (4).
3. Install exhaust pipes (2) on the muffler (4).
4. Install three clamps (1).

### Install Enclosure End Panel

1. Place the end panel (2) on each side panel locating pin. Refer to **Figure 48**.
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.

# 4.8 Engine and Accessories

## Timing Belt Removal (A)

1. Remove the enclosure covers. See the figure below.

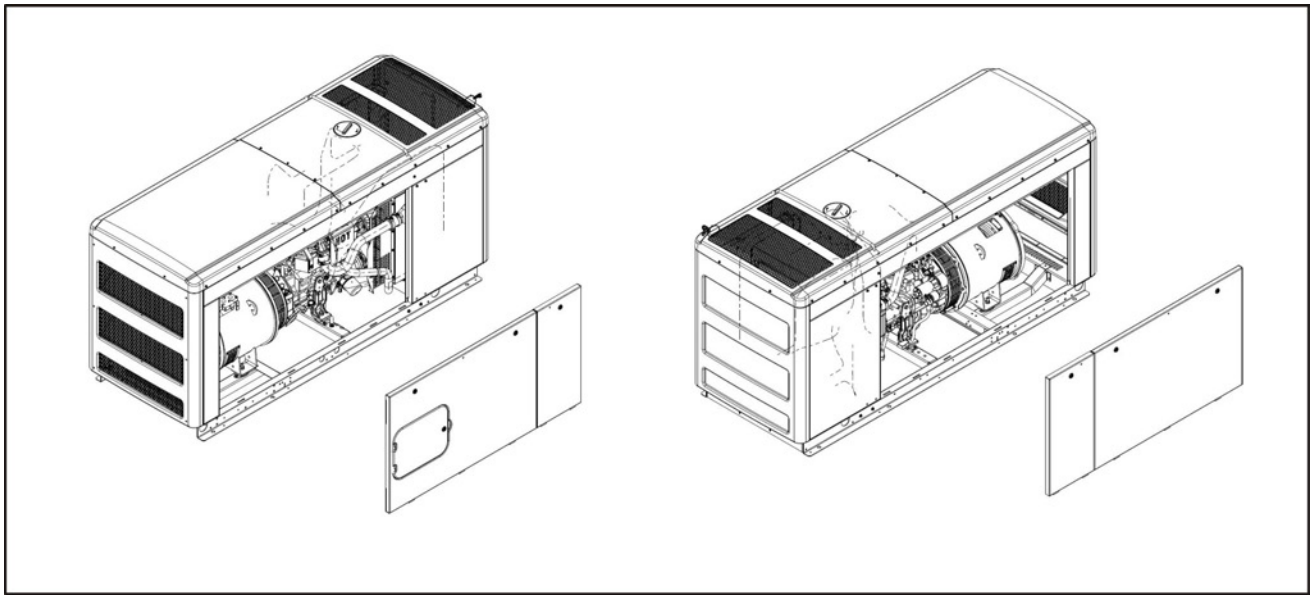


**FIGURE 50. ENCLOSURE COVER REMOVAL**

2. Disconnect the battery connections.
3. Remove CAC inlet and outlet connections (if equipped with turbocharger and after cooler).
4. Remove the coolant reservoir bottle from fan guard, but do not disconnect.

5. Remove the fan guards. See the figure below.

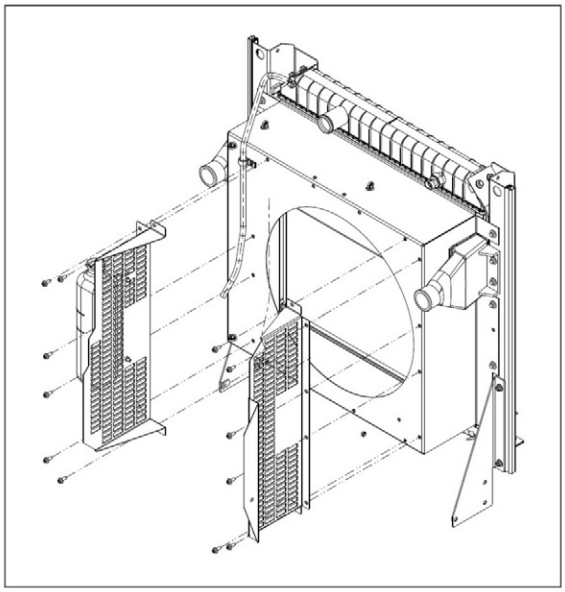


**FIGURE 51. FAN GUARD REMOVAL**

6. Remove the fan. See the figure below.

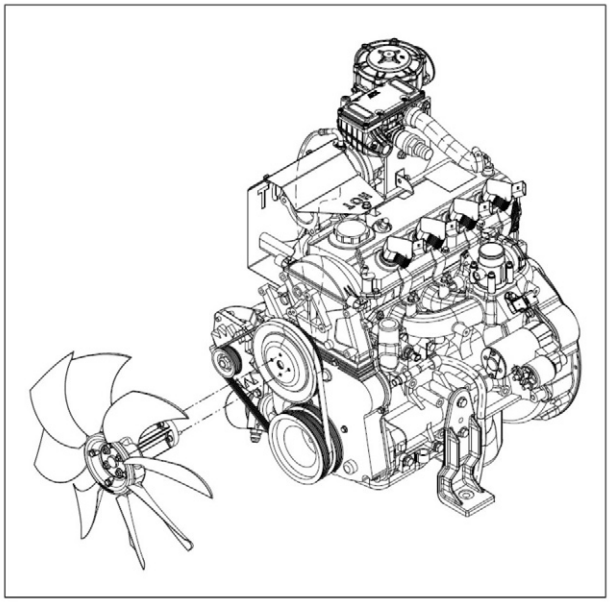


**FIGURE 52. FAN REMOVAL**

7. Remove the water pump, fan, and battery charging alternator belt. See the figure below.

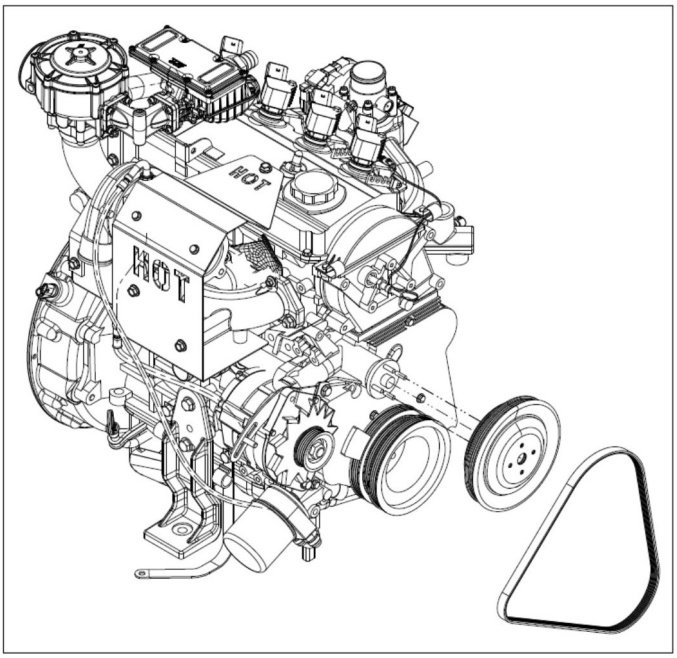



**FIGURE 53. WATER PUMP, FAN, AND BATTERY CHARGING ALTERNATOR BELT**

8. Remove all of the ignition coils and spark plugs. See the figure below.

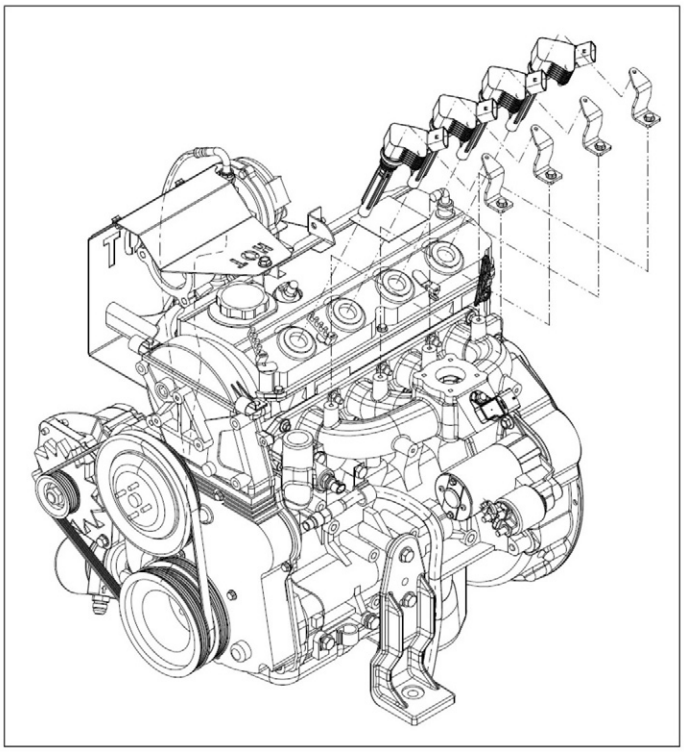


**FIGURE 54. IGNITION COILS AND SPARK PLUGS**

9. Remove the timing belt upper covers. See the figure below.

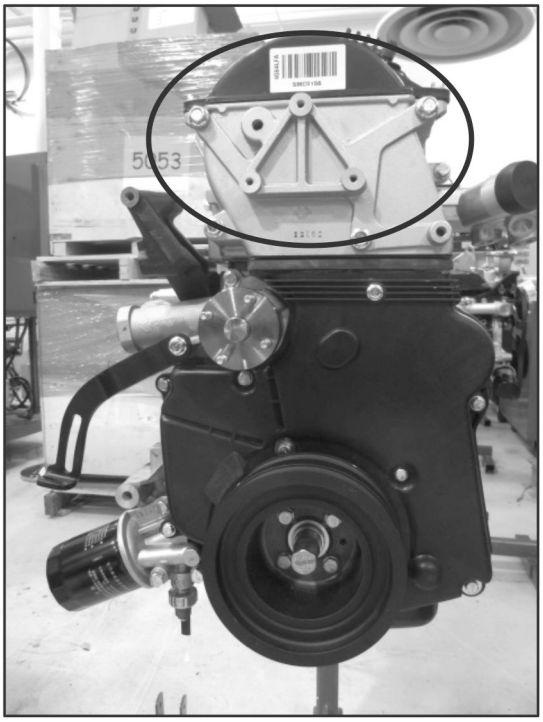


**FIGURE 55. TIMING BELT UPPER COVER REMOVAL**

10. Remove the crankshaft pulley.
11. Remove the cylinder block plug as shown in the figure below.

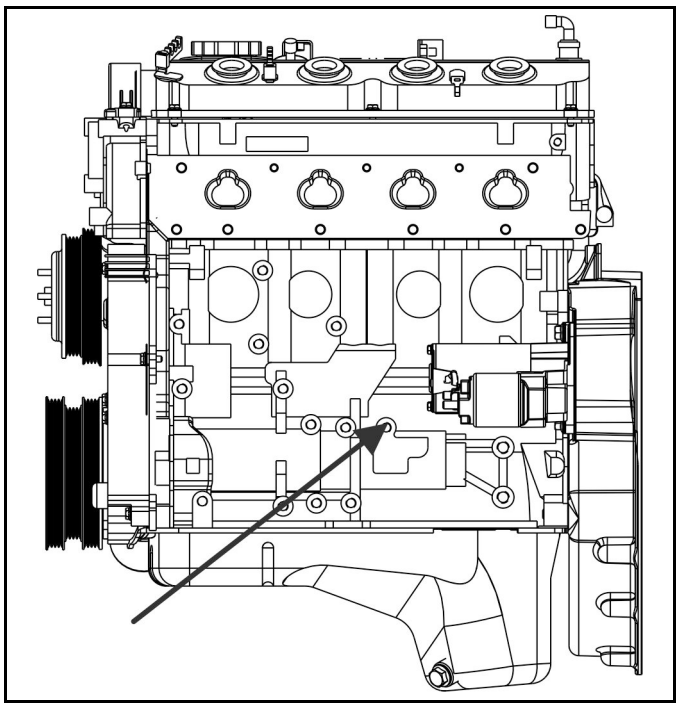


**FIGURE 56. CYLINDER BLOCK PLUG**

12. Check the orientation of the balance shaft by inserting a Phillips screwdriver with a shaft diameter of 8 mm (0.32 in).
    - The correct orientation of the balance shaft allows the screwdriver to be inserted 60 mm (2.36 in) before contacting the balance shaft.
    - The incorrect orientation of the balance shaft will only allow the screwdriver to be inserted 20 - 25 mm (0.79 - 0.98 in) before contacting the balance shaft.

    If the balance shaft orientation is incorrect, rotate the oil pump sprocket 1 full revolution and re-check the balance shaft orientation. Repeat until the balance shaft is correctly oriented.

| *NOTICE* |
| --- |
| **Do not remove the screwdriver until after the timing belt has been installed.** |

13. Remove the timing belt lower cover. See the figure below.

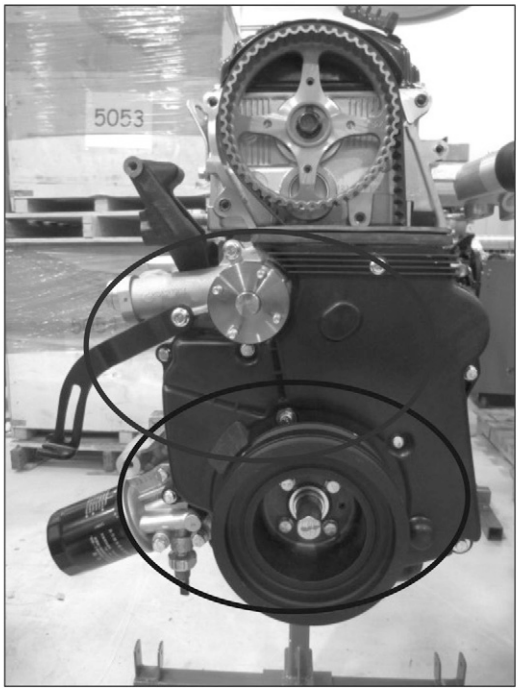



**FIGURE 57. TIMING BELT LOWER COVER REMOVAL**

14. Rotate the engine, and ensure that all of the timing marks are aligned. See the figure below.

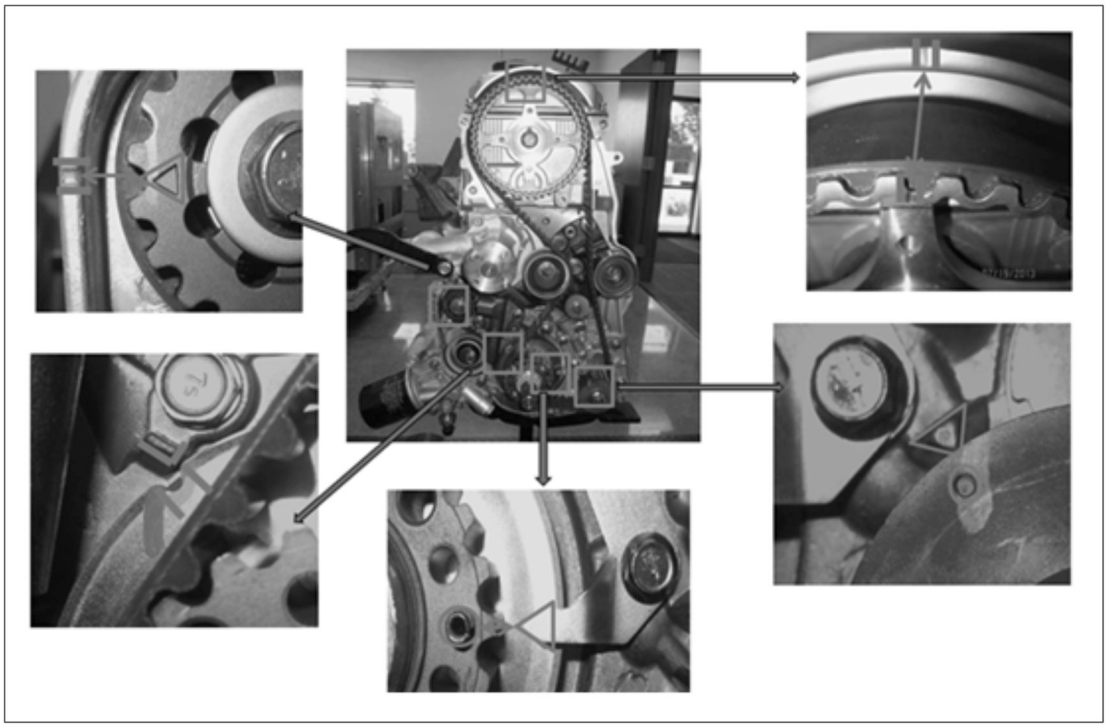


**FIGURE 58. TIMING MARK ALIGNMENT**

15. Mark the arrow on the belt if the belt is going to be reused. See the figure below.

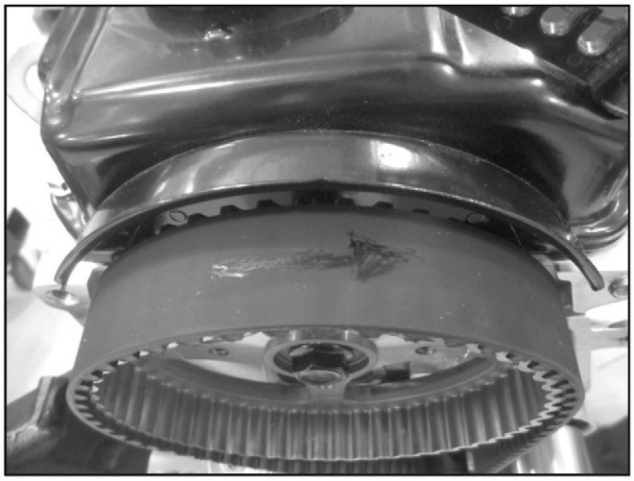
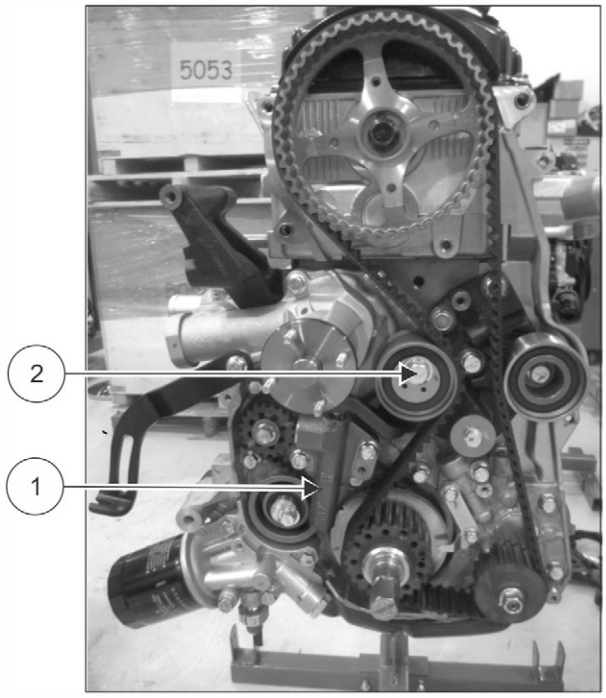


**FIGURE 59. ARROW MARK**

| *NOTICE* |
| --- |
| **Water or oil on the belt shortens its life drastically, so wash or immerse the removed timing belt, sprocket, and tensioner in solvent. Replace parts if contaminated. If there is oil or water on any part, check the front case oil seals, camshaft oil seal, and water pump for leaks.** |

16. Remove the autotensioner on the front case.

17. Loosen the center bolt on the tensioner pulley. See the figure below.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Autotensioner | 2 | Center Bolt |

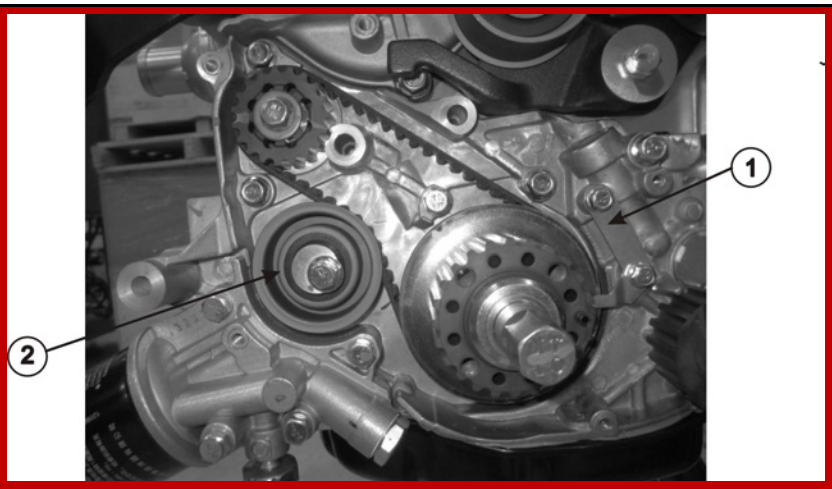
**FIGURE 60. AUTOTENSIONER**

18. Remove the timing belt.

## Timing Belt Removal (B)

1. See the procedures in the Timing Belt Removal (A) section.
2. Remove the timing belt indicator.
3. Loosen the center bolt on the tensioner pulley.
4. Remove the timing belt. See the figure below.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Timing Belt Indicator | 2 | Timing Belt B Tensioner |

**FIGURE 61. TENSIONER PULLEY**

## Timing Belt Installation (A)

| *NOTICE* |
|---|
| **Special tool(s) required: Tension Pulley Wrench (part number A044J293)** |

1. If timing belt B was removed, refer to the Timing Belt Installation (B) section before installing timing belt A.
2. Install the tensioner pulley. See the figure below.

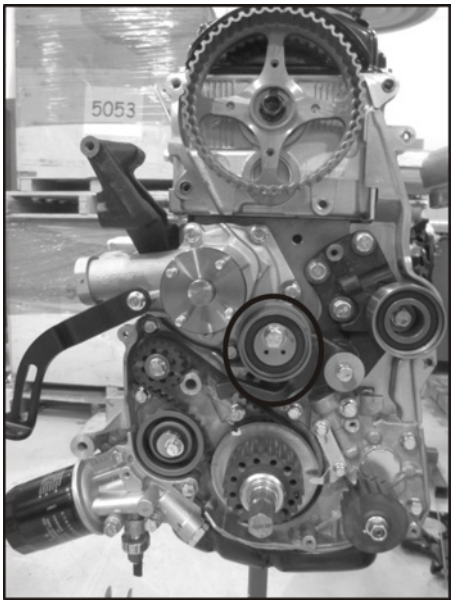



**FIGURE 62. TENSIONER PULLEY**

3. If the autotensioner rod is fully extended, clamp it in a vise with soft jaws. See the figure below.

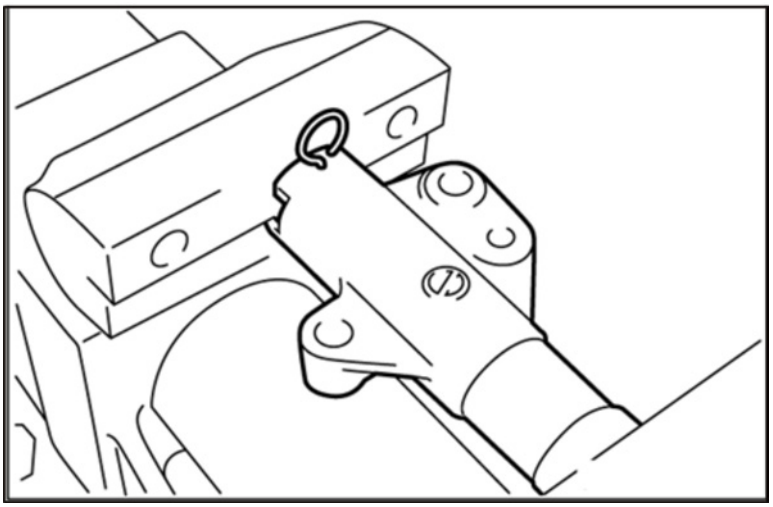


**FIGURE 63. AUTOTENSIONER IN VISE**

4. Push in the rod slowly with the vise until the set hole A in the rod is aligned with hole B in the cylinder. See the figure below.

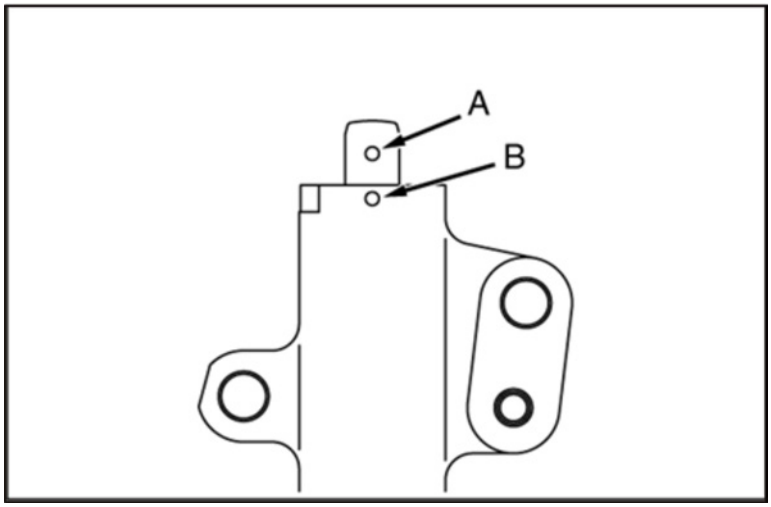



**FIGURE 64. HOLE ALIGNMENT**

5. Insert a wire (1.4 mm in diameter) into the set holes. This autotensioner setting wire is used during timing belt alignment.
6. Unclamp the autotensioner from the vise.
7. Install the autotensioner onto the front case and tighten. Torque 24± 3 Nm (17.8 ft-lb +/- 2.2 ft-lb). See the figure below.

| *NOTICE* |
| --- |
| **Leave the wire installed in the autotensioner.** |

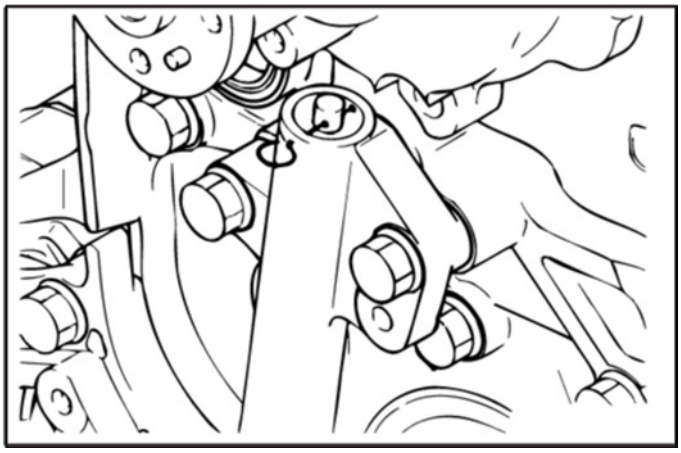


**FIGURE 65. INSTALL AUTOTENSIONER**

8. Align the timing mark on the camshaft sprocket with the timing mark on the rocker cover. See the figure below.

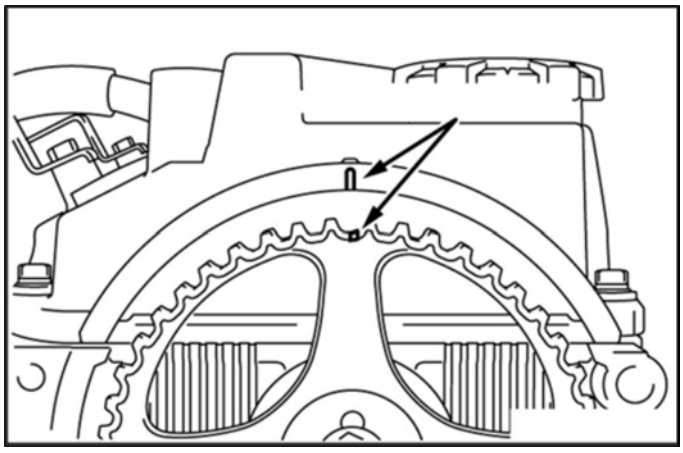


**FIGURE 66. CAMSHAFT SPROCKET AND ROCKER COVER TIMING MARKS**

9. Align the timing mark on the crankshaft sprocket with the timing mark on the front case. See the figure below.

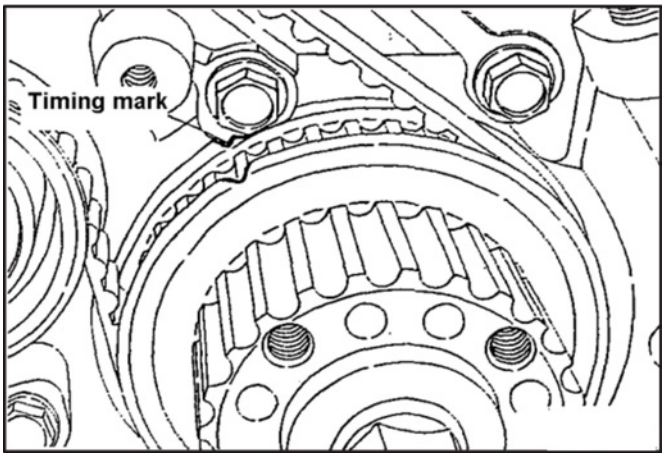



**FIGURE 67. CRANKSHAFT SPROCKET AND FRONT CASE TIMING MARKS**

10. Align the timing mark on oil pump sprocket with its mating mark. See the figure below.

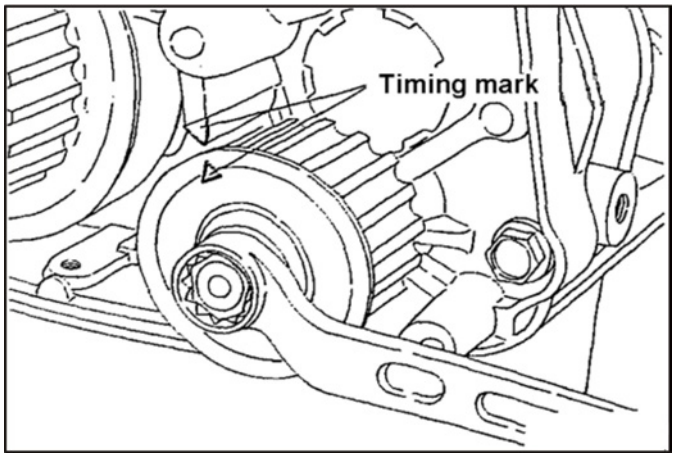



**FIGURE 68. OIL PUMP SPROCKET AND MATING TIMING MARKS**

11. In the following order, install the timing belt on the crankshaft sprocket, oil pump sprocket, idler pulley, camshaft sprocket, and tensioner pulley. Ensure that all timing marks are aligned and that there is no slack on the tension side. See the figure below.


**FIGURE 69. TIMING BELT A TENSION SIDE**

12. Lift up the tensioner pulley in the direction of the arrow and tighten the center bolt. See the figure below.

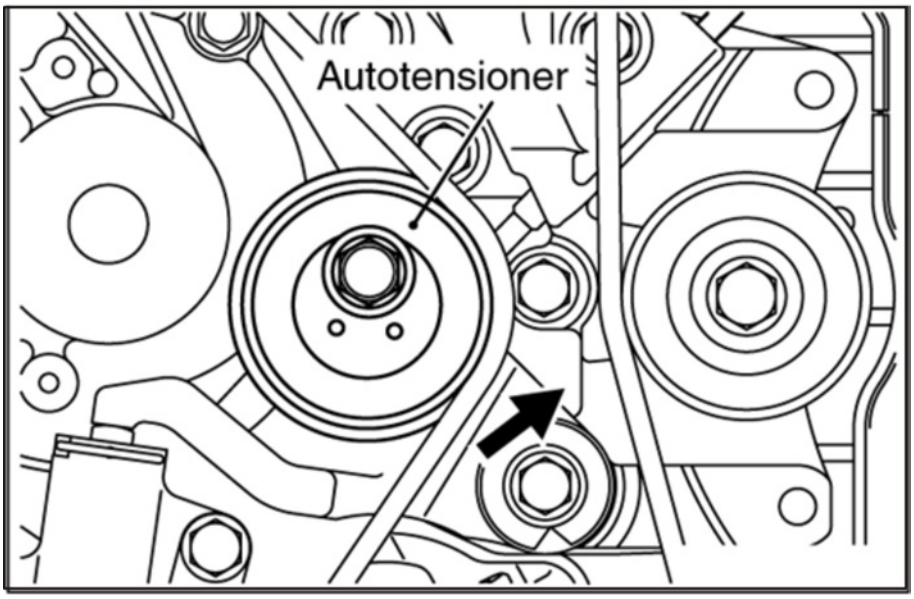



**FIGURE 70. AUTOTENSIONER DIRECTION**

13. Check that all timing marks are aligned.
14. Turn the crankshaft a quarter turn counterclockwise. Then, turn it clockwise until the timing marks are aligned again.
15. Install special tool tension pulley socket wrench. See the figure below.

**FIGURE 71. AUTOTENSIONER WITH SOCKET WRENCH**

16. With the special tool tension pulley socket wrench, socket wrench, and torque wrench, loosen the tensioner pulley center bolt. Use a beam or dial style torque wrench that can measure 0 to 5.0 Nm (0 to 3.7 ft-lb). See the figure below.

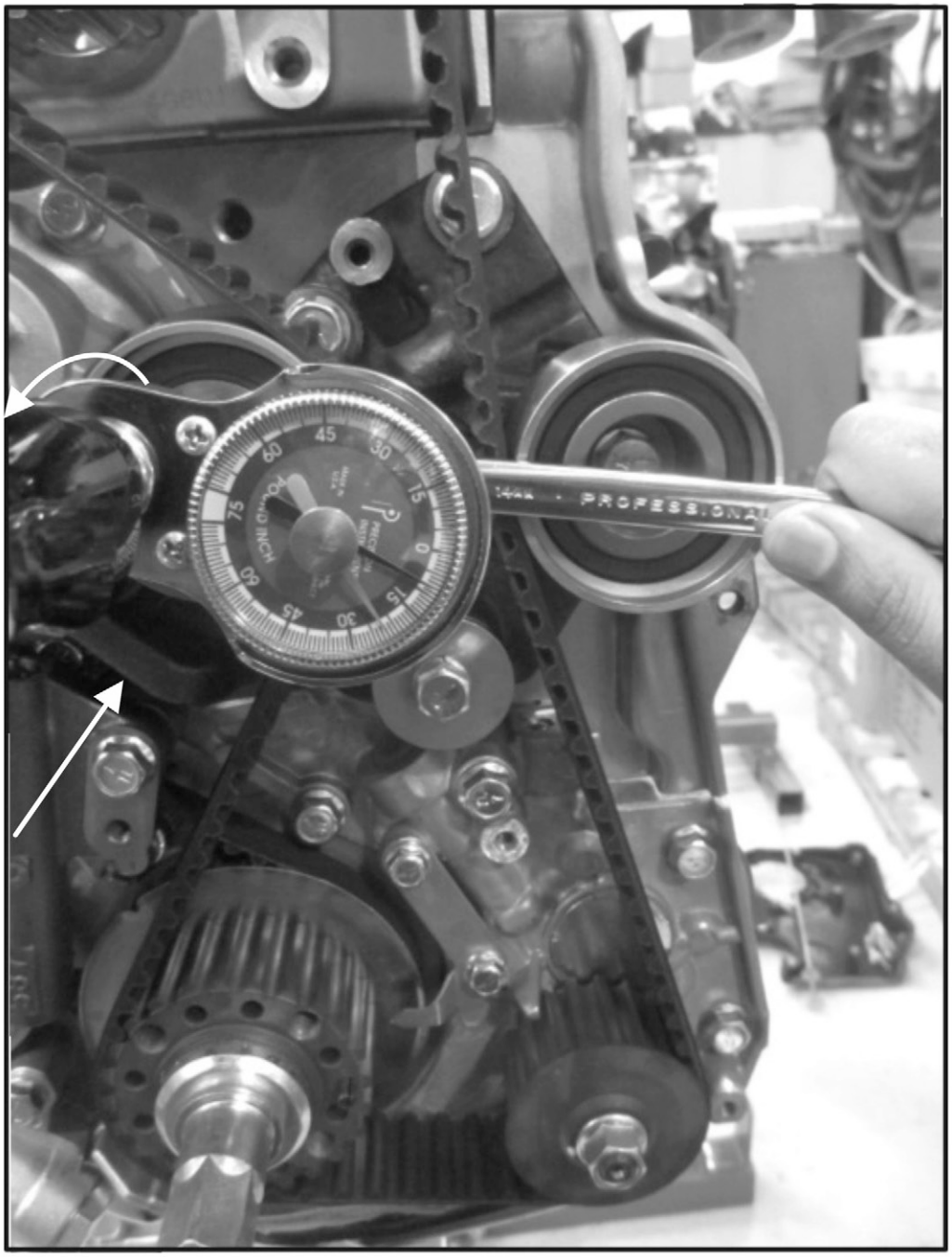



**FIGURE 72. AUTOTENSIONER WITH SOCKET WRENCH (WITH BELT TENSIONING ARM)**

17. Torque counter-clockwise (as shown in the figure above) to 2.5 to 2.6 Nm (1.85 to 2 ft-lb) with the torque wrench so that the belt tensioning arm puts pressure on the autotensioner when released.
18. Holding the tensioner pulley with the special tool and torque wrench, tighten the center bolt to 48 ± 5 Nm (36 +/- 3.7 ft-lb).
19. Pull out the wire inserted at the autotensioner assembly. See the figure below.

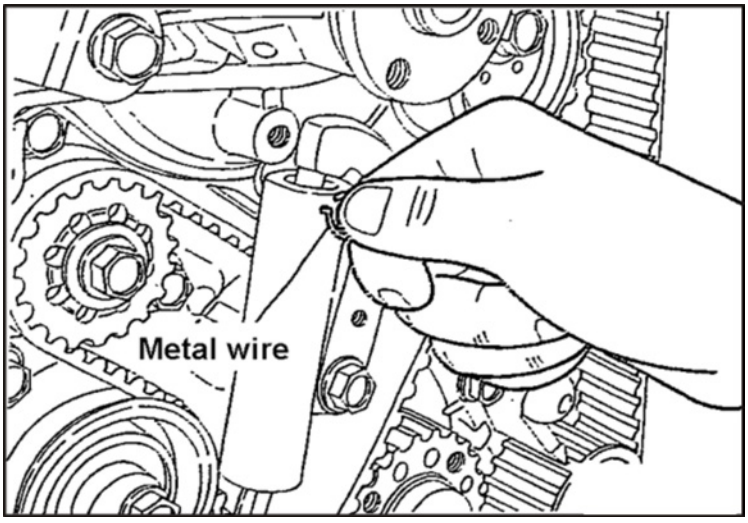



**FIGURE 73. REMOVE METAL WIRE**

20. Give two clockwise turns to the crankshaft. Wait 15 minutes.
21. Check that the rod protrusion of the auto-tensioner is within the standard value, which is 3.8 to 4.5 mm (0.15 to 0.18 in).
22. If the protrusion is not to specification, repeat the previous steps until the standard value is obtained as measured by the rod projection of the autotensioner rod.
23. Install the cover. Torque 11 Nm (8.1 ft-lb).
24. Install the crank pulley. Torque 25 Nm (18.5 ft-lb).
25. Install the timing belt front upper cover. Torque 11 Nm (8.1 ft-lb).
26. Install the spark plugs. Torque 22.5 Nm (16.7 ft-lb).
27. Install the engine bracket to the intake manifold. Torque 11 Nm ± 1 Nm (8.1 +/- 0.74 ft-lb).
28. Install the ignition coil to the engine bracket. Torque 5 Nm ± 0.3 Nm (3.7 +/- 0.2 ft-lb).

## Timing Belt Installation (B)

1. Align timing marks on the crankshaft sprocket and counterbalance shaft sprocket with the marks on the front case. See the figure below.

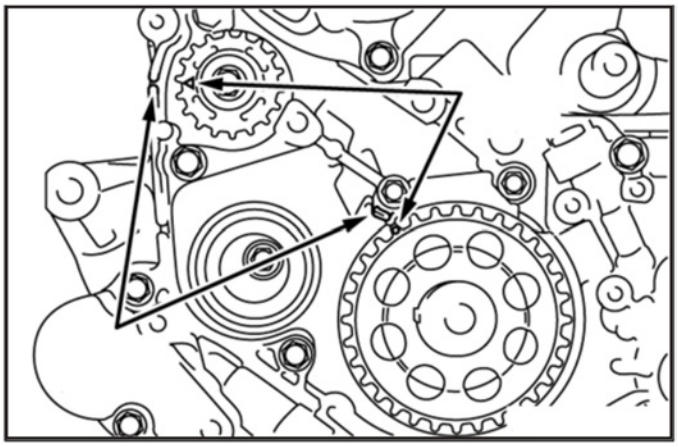


**FIGURE 74. TIMING MARKS**

2. Install the timing belt on the crankshaft sprocket and counterbalance shaft sprocket. Make sure that there is no slack on the tension side.
3. Make sure that the tensioner pulley center and the bolt center are positioned as shown in the figure below. See the figure below.

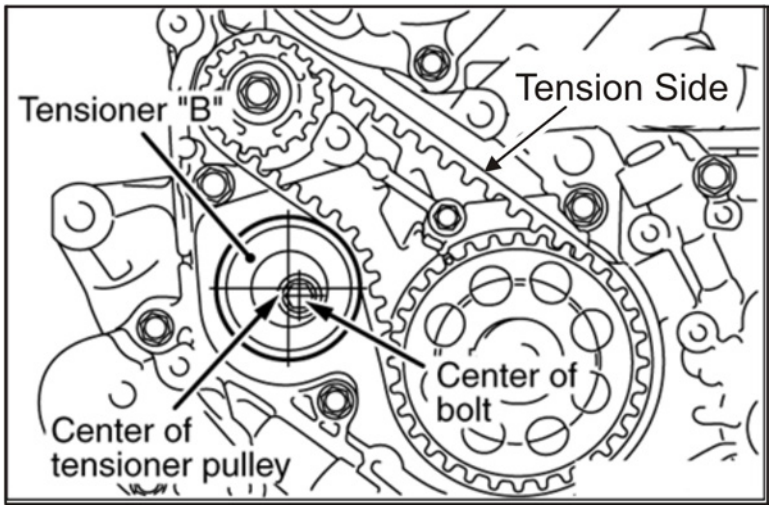



**FIGURE 75. TENSIONER PULLEY CENTER**

4. Move the tensioner in the direction of the arrow while lifting with your finger to give sufficient tension to the tension side of timing belt, and tighten the bolt to secure tensioner. Torque to 19 ± 3 Nm (14 +/- 2.2 ft-lb). See the figure below.

| *NOTICE* |
| --- |
| **When the bolt is tightened, use care to prevent the tensioner pulley shaft from turning with the bolt. If the shaft is turned with the bolt, the belt will be over tensioned.** |

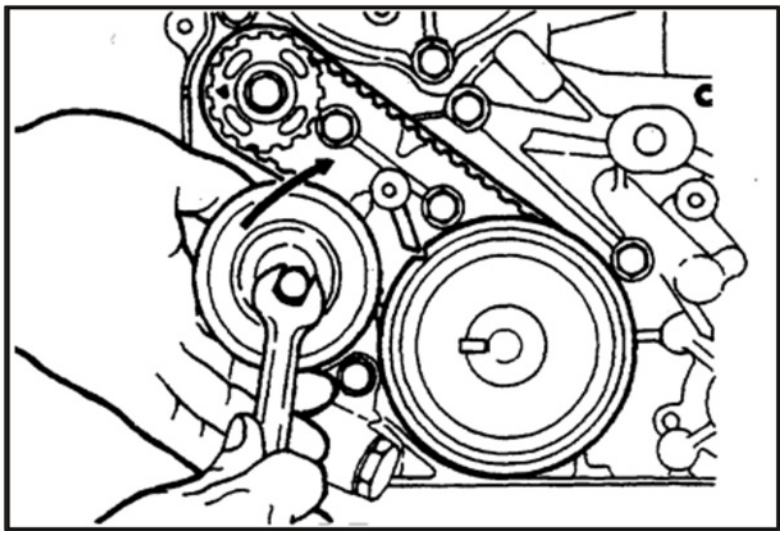


**FIGURE 76. TENSIONER DIRECTION**

5. Check that timing marks on the sprockets are aligned with the timing marks on the front case.
6. With your index finger, press the midway of span on the tension side of timing belt. The belt must deflect 5 to 7 mm. See the figure below.

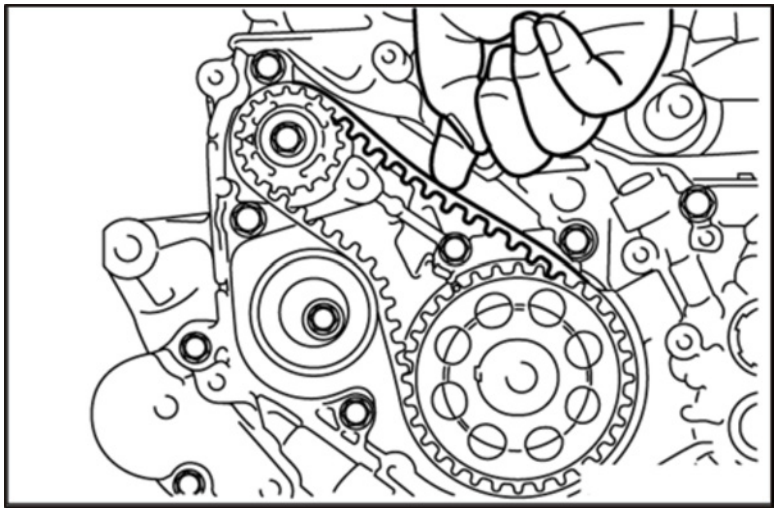


**FIGURE 77. CHECK TIMING BELT TENSION**

## Cylinder Head Assembly Torquing

Special tool(s) required: Cylinder Bolt Wrench (part number A044J309)

1. Install the cylinder head bolt.
   a. If reusing the removed cylinder head bolts, check that the shank length of each bolt meets the limit 3.9 in (99.4 mm). If it exceeds the limit, replace the bolts.
   b. Apply engine oil to the thread of the bolts and to the washers. See the figure below.

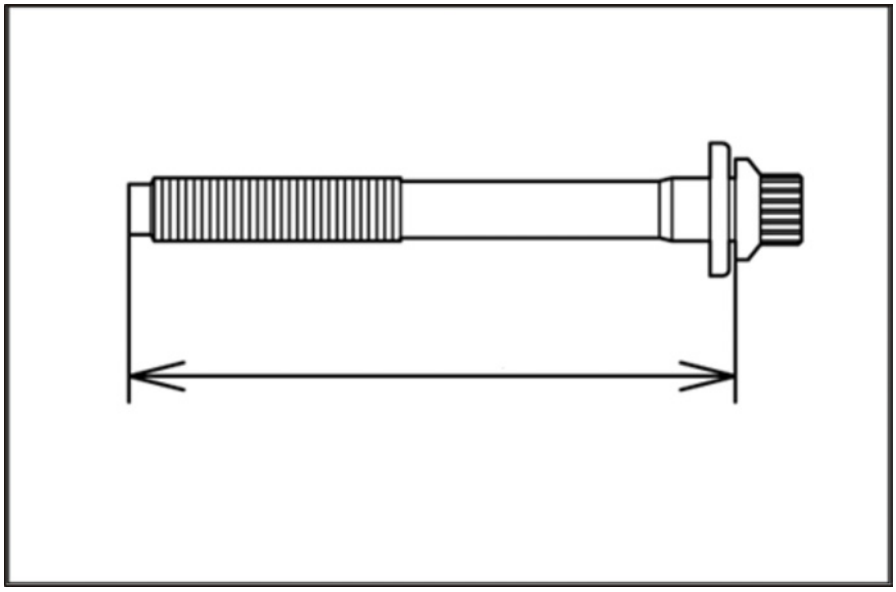


**FIGURE 78. SHANK LENGTH**

2. Using special tool cylinder head bolt wrench, tighten the bolts to the specified torque, using the tightening sequence shown below. Torque to 78 ± 2 Nm (58 ± 1.5 ft-lb). See the figure below.

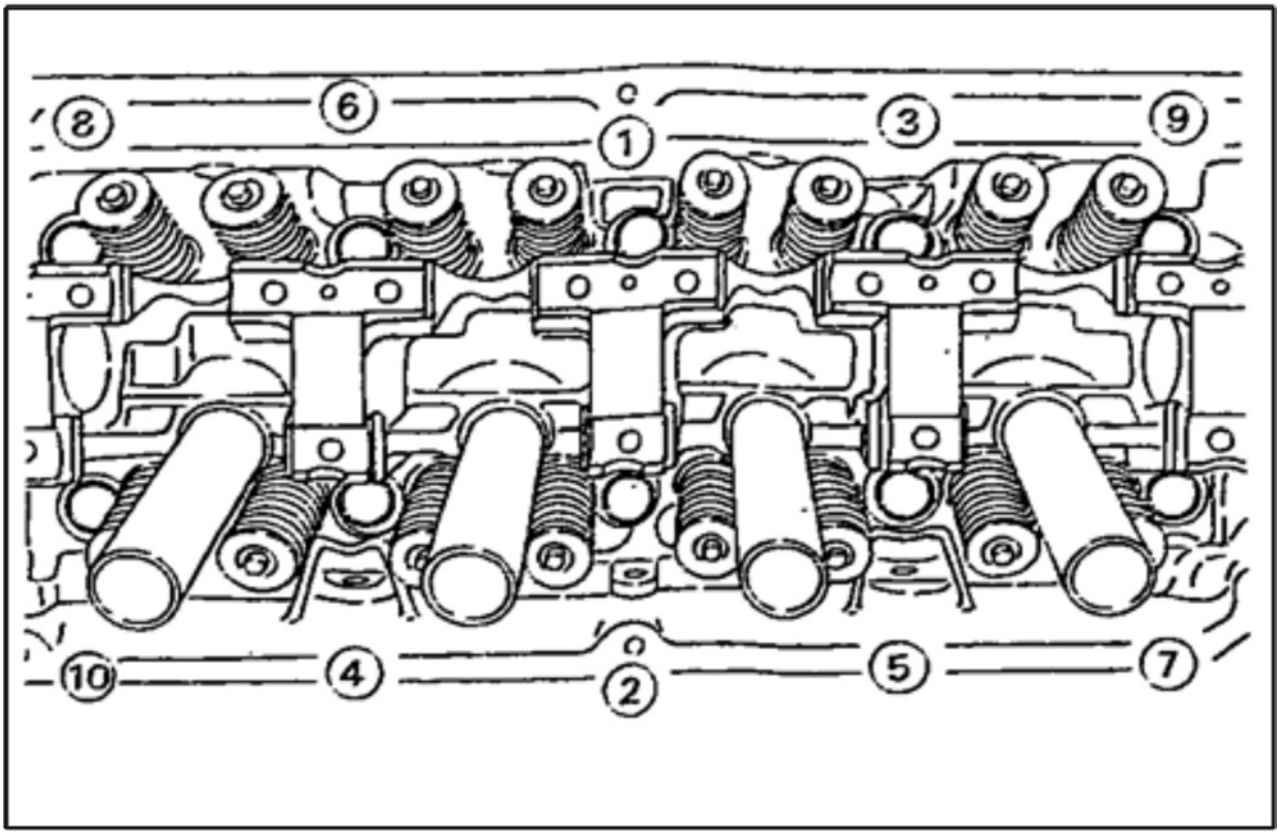



**FIGURE 79. TORQUE SEQUENCE**

3. Loosen all bolts fully in the reverse order of tightening.

4. Retighten the loosened bolts to in the tightening sequence shown. Torque to 20 ± 2 Nm (14.8 +/- 1.48 ft-lb).
5. Use a torque angle gauge or make a paint mark across each bolt head and cylinder head.
6. Tighten the cylinder head bolts 90° in the specified order.
7. Tighten the bolts another 90° in the same order sequence as referenced above, and check that the paint marks on the cylinder head bolt are aligned with the paint marks on the cylinder head. See the figure below.

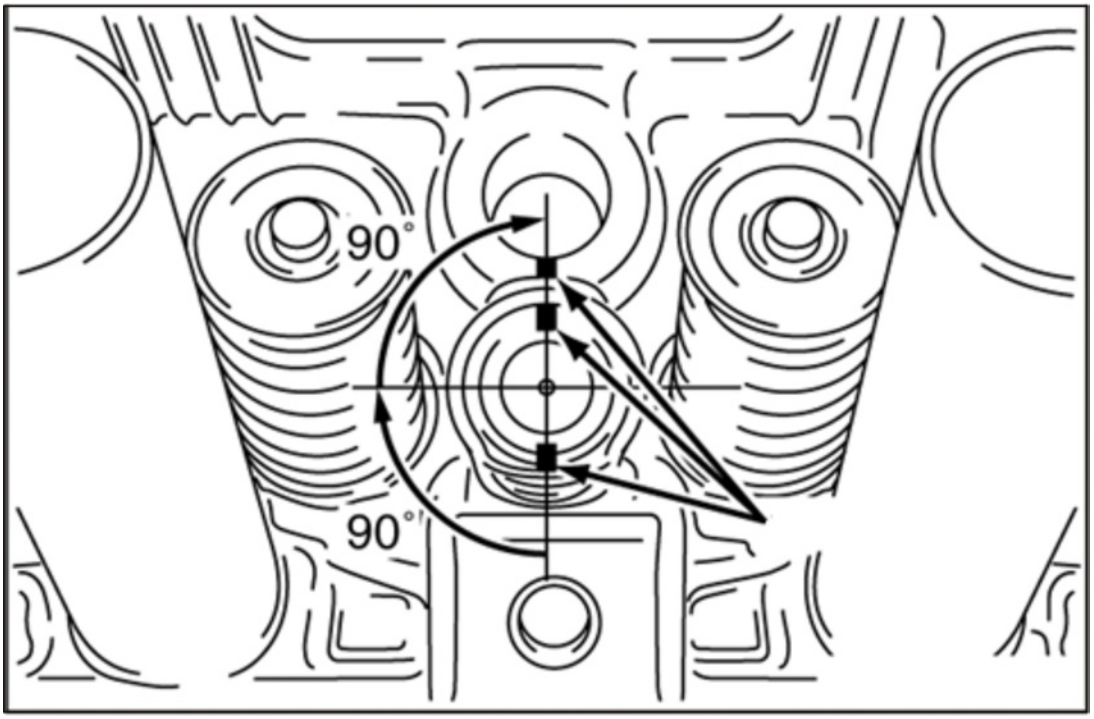



**FIGURE 80. PAINT MARK ALIGNMENT**

| *NOTICE* |
| --- |
| **If the bolt is turned less than 90°, proper fastening performance may not be achieved. Be careful to turn each bolt exactly 90°. If the bolt is overtightened, loosen the bolt completely and then retighten it by repeating the tightening procedure.** |

8. Install the camshaft pin if the cylinder head was replaced. See the figure below.
   a. Apply thread adhesive to the pin threads.
   b. Install the pin into the dimpled spoke on the camshaft sprocket. Torque to 11 Nm (8.1 ft-lb).

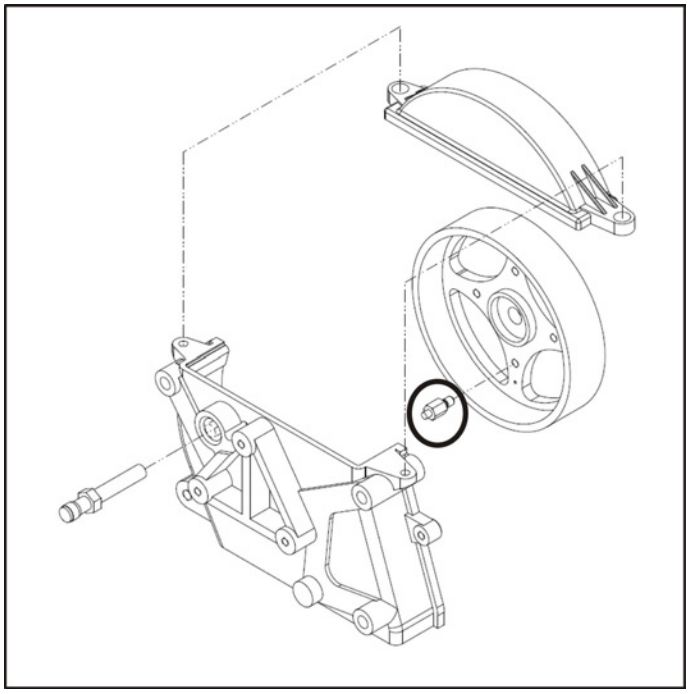


**FIGURE 81. CAMSHAFT PIN MOUNTING**

## Front Seal Installation

Special tool(s) required: Crankshaft Sprocket Puller (part number A044H748) and Crankshaft Front Oil Seal Installer (part number A044J299)

1. Remove the timing belts (A and B).
2. Loosen the crankshaft bolt, and remove the crankshaft bolt and washer. See the figure below.

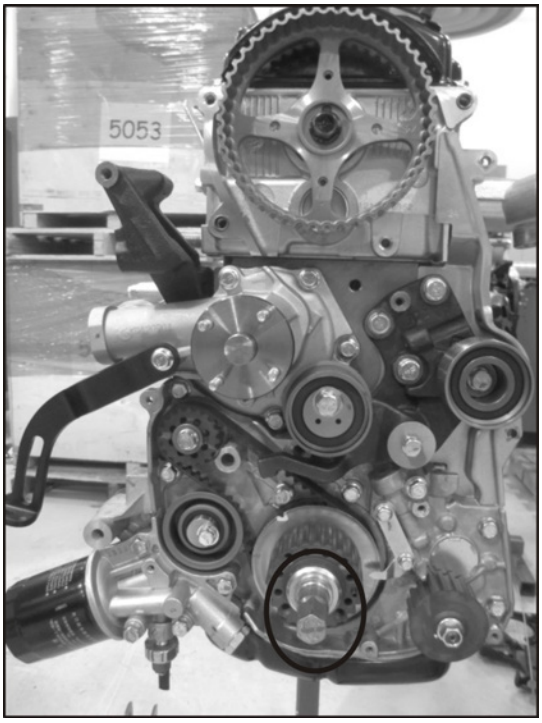



**FIGURE 82. CRANKSHAFT BOLT AND WASHER**

3. Remove the crankshaft sprocket. See the figure below.
   a. Set the special crankshaft sprocket puller tool.
   b. Screw in the center bolt of the special tool to remove the crankshaft sprocket.
   c. Repeat this procedure for the other crankshaft sprocket.

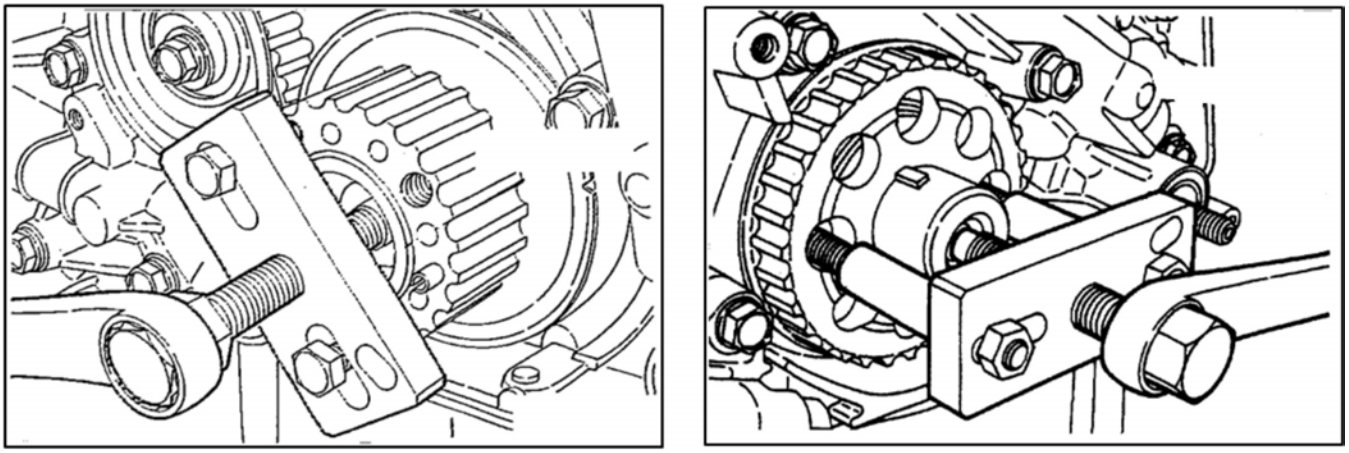


**FIGURE 83. CRANKSHAFT SPROCKET REMOVAL**

4. Install the crankshaft front oil seal into the front case using the special tool. See the figure below.

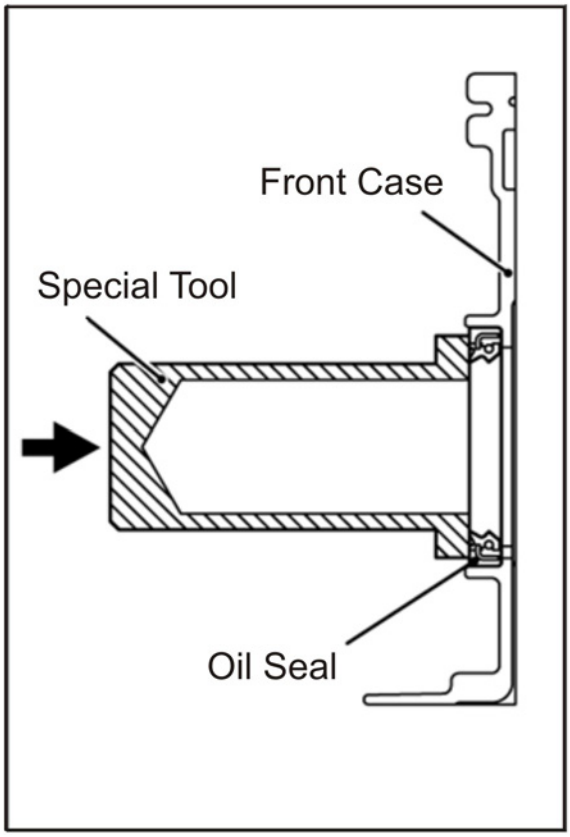



**FIGURE 84. CRANKSHAFT FRONT OIL SEAL**

## Engine Removal and Installation

Follow these steps to remove the engine:

| *NOTICE* |
| --- |
| **For models C20 N6, C22 N6, C25 N6, and C30 N6H, the terminal boxes will need to be removed to more readily access the alternator adaptor and drive disk bolts.** |

1. Remove the enclosure covers as applicable. See the figure below.

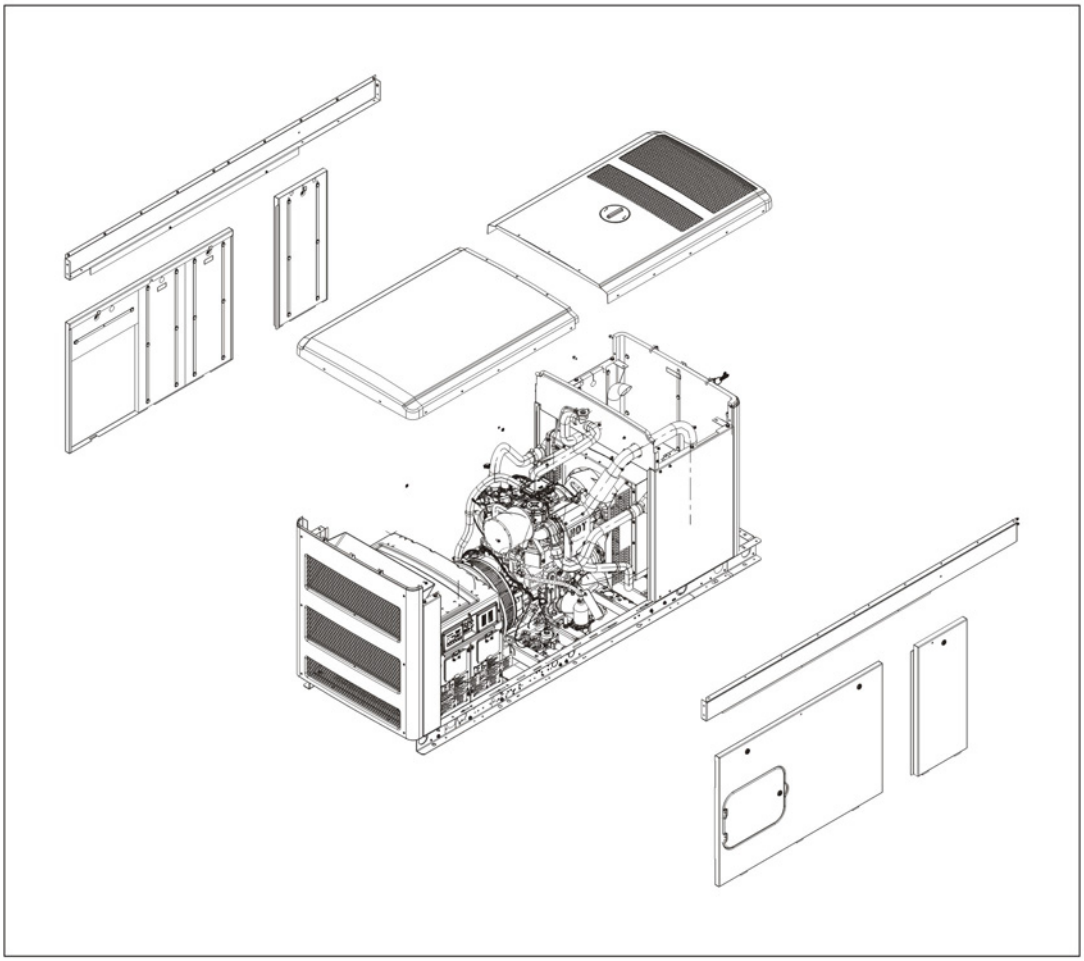


**FIGURE 85. REMOVAL OF ENCLOSURE COVERS**

2. Disconnect the following:
   a. Disconnect the battery connections.
   b. Disconnect all harness connections between engine and other systems of generator set.
   c. Drain the coolant.
   d. Drain the engine oil (if equipped with oil cooler).
   e. Disconnect coolant heater connections.
   f. Disconnect CAC inlet and outlet connections (if equipped with turbocharger and after cooler).
   g. Disconnect oil cooler connections.
3. Do the following:
   a. Disengage the coolant reservoir bottle from fan guard (do not disconnect).
   b. Disconnect coolant connections from the engine.
   c. Disconnect exhaust connections from the engine.
   d. Remove the fan belt.

e. Remove the fan and keep it in the shroud. See the figure below.

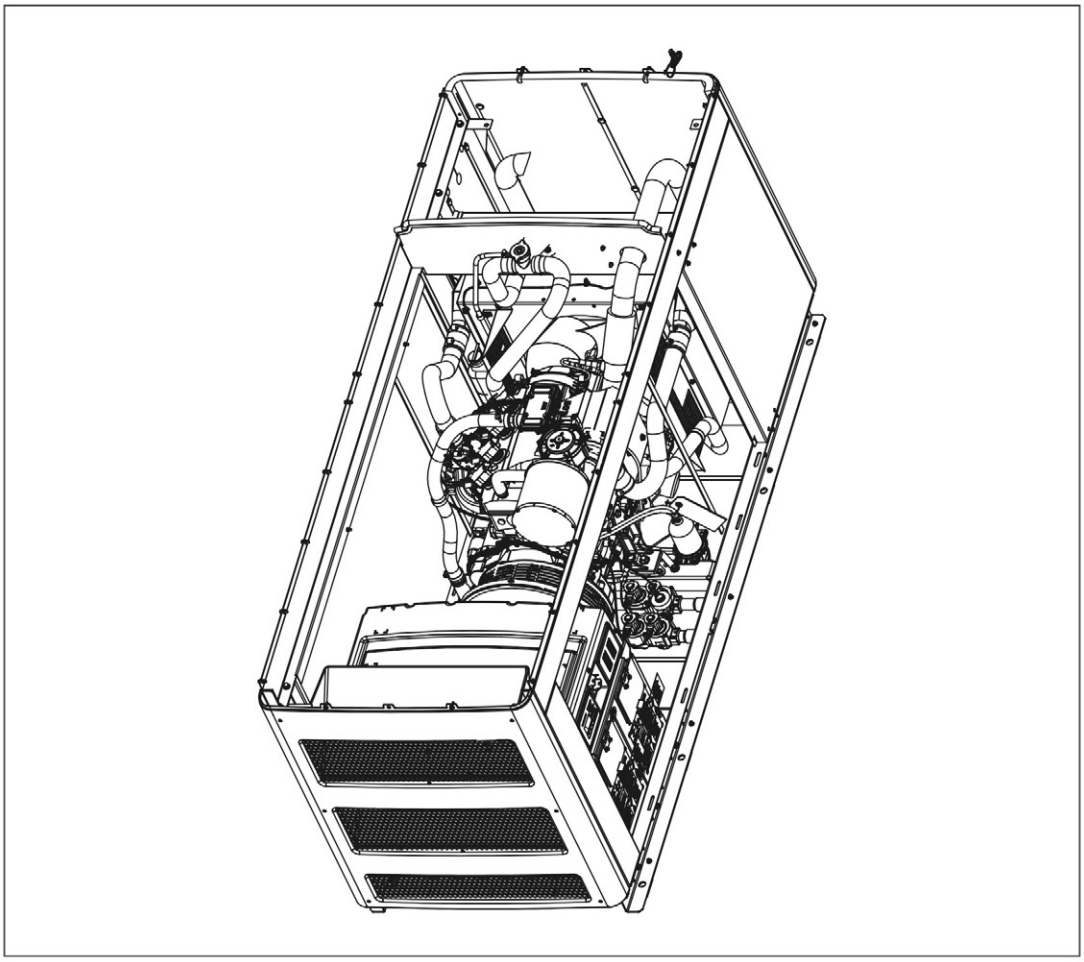


**FIGURE 86. DISCONNECTION OF ENGINE SYSTEMS**

4. Remove the terminal box cover/dome and alternator fan cover. See the figure below.

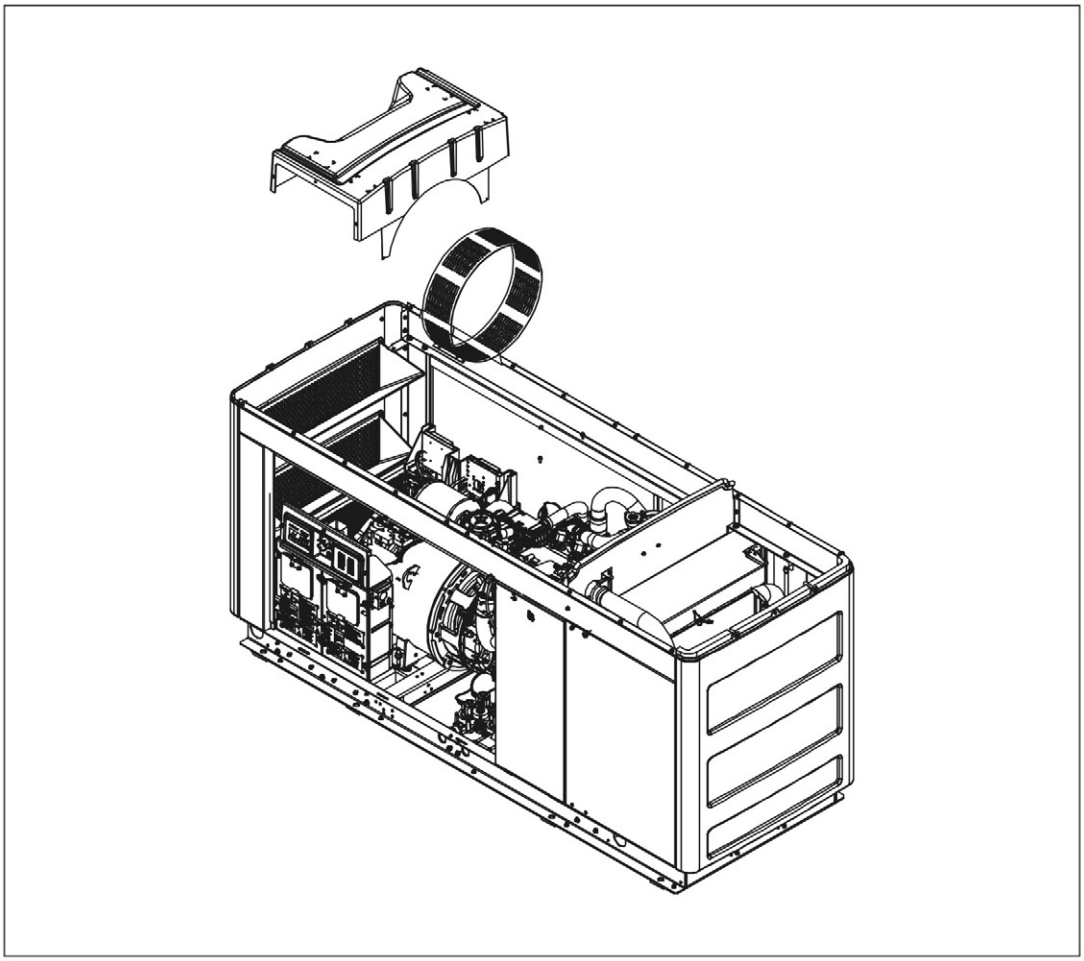


**FIGURE 87. REMOVAL OF TERMINAL BOX COVER AND DOME**

5. Position the fixture and remove bolts:

   a. Securely support the engine with appropriate blocking which provides approximately 2° before and after the tilt of the engine/generator (with the generator end higher). This should be enough to allow removal of the engine from the studs.

   b. Remove the alternator drive disc bolts first and then remove the alternator adaptor bolts. See the figure below.

| *NOTICE* |
| --- |
| **Alternator drive disc bolts and adaptor bolts should be torqued to 52 Nm +/- 5 Nm (38.5 +/- 3.7 ft-lb).** |

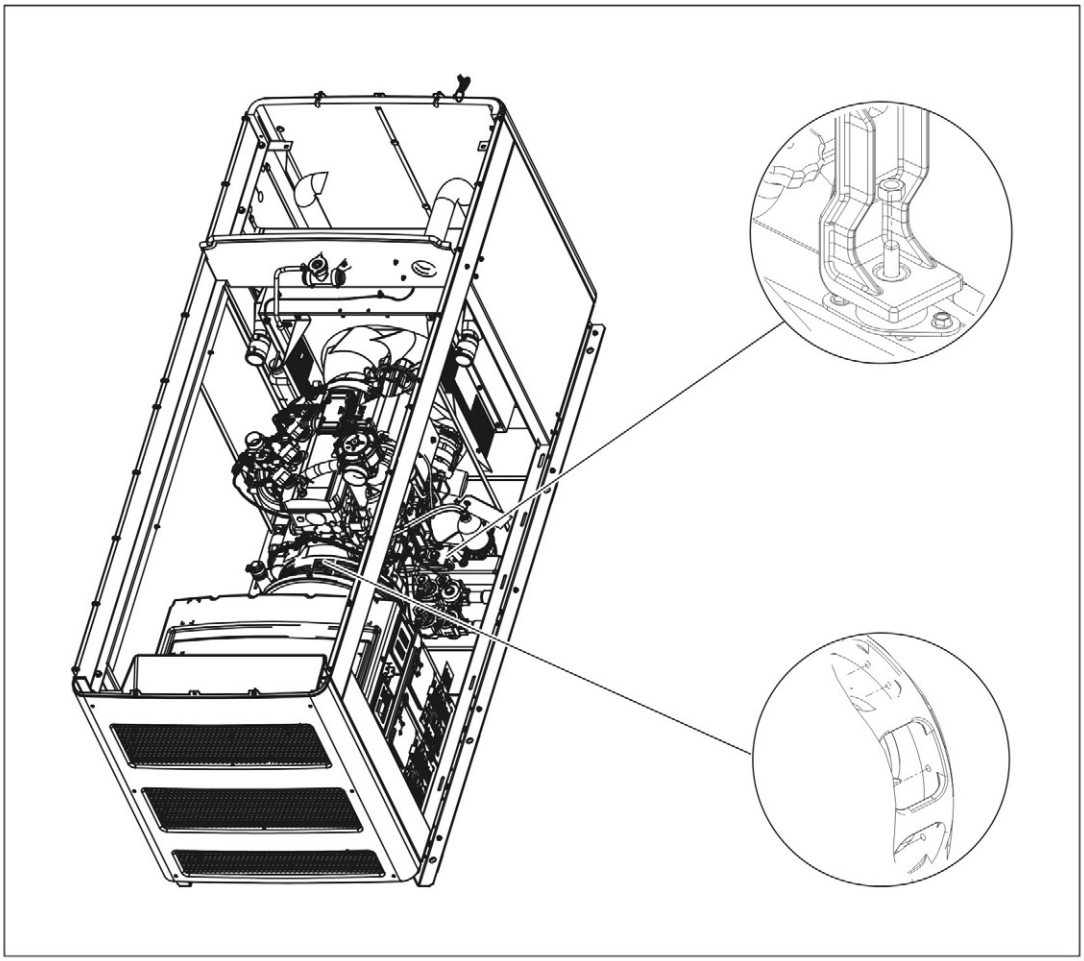


**FIGURE 88. DISENGAGEMENT OF ENGINE AND ALTERNATOR**

6. Secure the alternator with an appropriate lifting device. Pay attention to engine tilts and potential damage to other nearby components. See the figure below.

| *NOTICE* |
| --- |
| **Engine weight is approximately 450 pounds.** |

| *NOTICE* |
| --- |
| **A Cummins lifting kit (part number A046P026) can be used for lifting the engine.** |

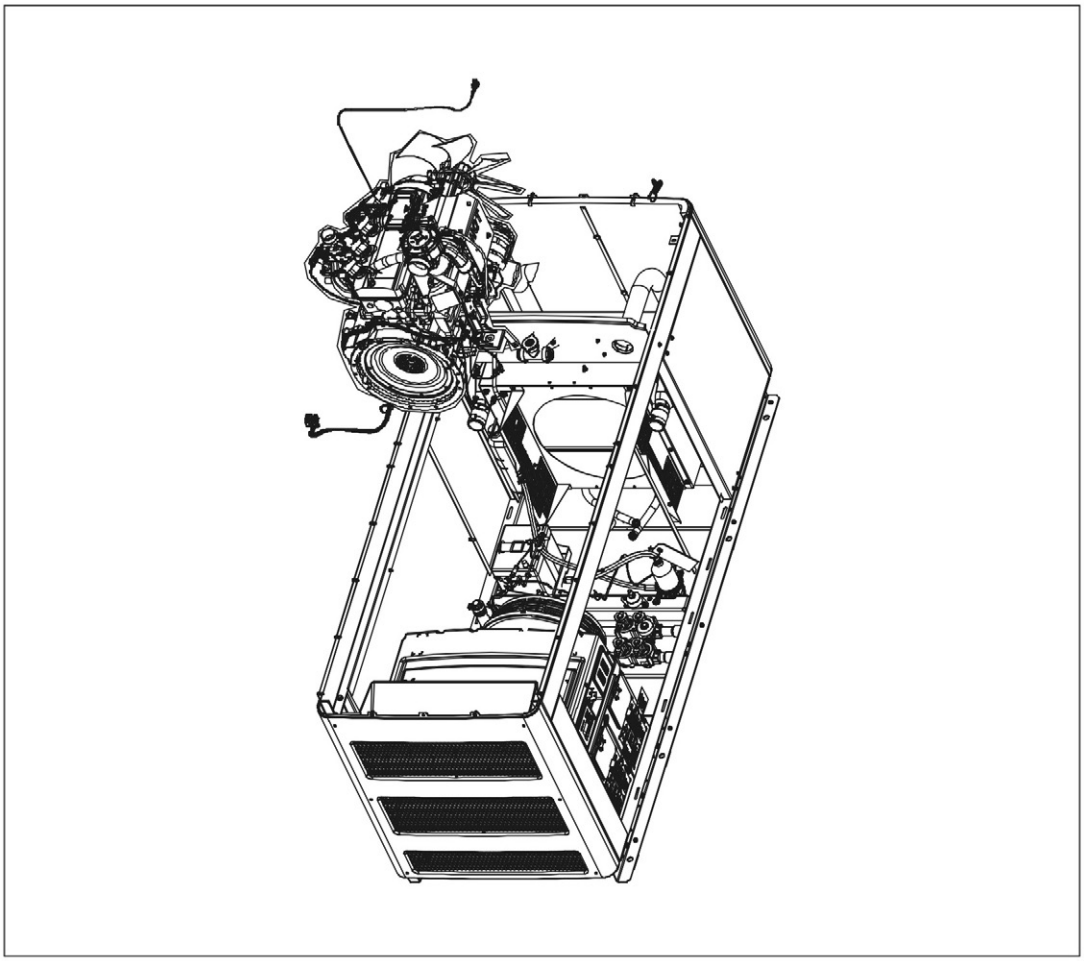


**FIGURE 89. ENGINE REMOVAL**

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

| *NOTICE* |
| --- |
| **Alternator drive disc bolts and adaptor bolts should be torqued to 52 Nm +/- 5 Nm (38.5 +/- 3.7 ft-lb).** |

## QSJ2.4 Engine Torque Specifications

| Item | Nm | ft-lb | Angular |
| --- | --- | --- | --- |
| **Ignition System** | | | |
| Ignition coil | 10 | 7.2 | |
| Spark plugs | 24.5 | 18.08 | |
| **Exhaust Manifold** | | | |
| Thermostat housing bolts | 23.5 | 17.36 | |

| Item | Nm | ft-lb | Angular |
|---|---|---|---|
| **Timing Belt** | | | |
| Auto-tensioner bolts | 23.5 | 17.36 | |
| Camshaft sprocket bolt | 88.5 | 65.1 | |
| Counterbalance shaft sprocket bolt | 45 | 33.27 | |
| Crankshaft pulley bolts | 24.5 | 18.08 | |
| Crankshaft bolt | 117.5 | 86.8 | |
| Engine support bracket bolt | 48 | 35.44 | |
| Idler pulley bolt | 35.5 | 26.4 | |
| Oil pump sprocket nut | 54 | 39.78 | |
| Tensioner "B" bolt | 18.5 | 13.74 | |
| Tensioner arm bolt | 21.5 | 15.91 | |
| Tensioner pulley bolt | 48 | 35.44 | |
| Timing belt cover bolts (bolt, washer assembly) | 11 | 7.96 | |
| Timing belt cover bolts (flange bolt and nut) | 11 | 7.96 | |
| **Inlet Manifold and Water Pump** | | | |
| Water pump bolts | 14 | 10.4 | |
| Water pump pulley bolts | 9 | 6.51 | |
| Engine hanger bolt | 18.5 | 13.74 | |
| Oil pressure switch | 10 | 7.2 | |
| Water temp gauge | 29.5 | 21.7 | |
| Water outlet fitting bolts | 19.5 | 14.5 | |
| **Rocker Arms and Camshaft** | | | |
| Rocker arms and rocker arm shaft bolts | 31.5 | 23.14 | |
| Rocker cover bolts | 4 | 2.89 | |
| Thrust screw | 18.5 | 13.74 | |
| **Cylinder Head and Valves** | | | |
| Cylinder head bolts | 196 | 144.7 | +90° to 100° |
| **Oil Pan and Oil Pump** | | | |
| Drain plug | 44 | 32.55 | |
| Flange bolt | 36.5 | 26.76 | |

| Item | Nm | ft-lb | Angular |
|---|---|---|---|
| Front case bolts | 23.5 | 17.36 | |
| Oil filter bracket bolts | 18.5 | 13.74 | |
| Oil filter | 18.5 | 13.74 | |
| Oil pan bolts | 7 | 5.06 | |
| Oil pump cover bolts | 15.5 | 11.57 | |
| Oil pump cover screws | 10 | 7.2 | |
| Oil screen bolts | 18.5 | 13.74 | |
| Plug | 23.5 | 17.36 | |
| Relief plug | 44 | 32.55 | |
| **Piston and Connecting Rod** | | | |
| Connecting rod cap nuts | 196 | 144.7 | +90° to 100° |
| **Crankshaft and Cylinder Block** | | | |
| Bearing cap bolts | 24.5 | 18.08 | +90° to 100° |
| Bell housing cover bolts | 9 | 6.51 | |
| Oil seal case bolts | 11 | 7.96 | |
| Rear plate bolts | 11 | 7.96 | |

# 4.9 Alternator Service

## General Description

### CA115 Alternator

The CA115 alternator is of brushless rotating field design, available up to 600V, 60Hz (1800 RPM, 4 pole and 3600 RPM, 2 pole), and built to meet B.S. 5000 Part 3 and other international standards.

Standard CA115 alternators are self-excited, with excitation power derived from the main output windings using either an AS480 AVR or PCC controller. A permanent magnet generator (PMG) powered excitation system is available as an option with either an AS480 AVR or PCC controller.

### CA125 Alternator

The CA125 alternator is of brushless rotating field design, available up to 600V/60Hz (1800 RPM), and built to meet BS5000 Part 3 and international standards.

The standard CA125 alternator is self-excited, with excitation power derived from the main output windings using an SX460 AVR, AS440 AVR, or PCC controller.

A permanent magnet generator (PMG) powered excitation system is available as an option using an MX341 AVR, MX321 AVR, or PCC controller.

### CA135 Alternator

The CA135 alternator is of brushless rotating field design, available up to 600V/60Hz (3600 RPM), and built to meet BS5000 Part 3 and international standards.

The CA135 alternator is self-excited, with excitation power derived from the main output windings using an SX460 AVR, AS440 AVR or PCC controller.

## Air Flow

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

## 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.

## 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.

## Alternator Removal and Installation

The following instructions describe alternator removal and installation.

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

***NOTICE***

**Torque enclosure panel fasteners 9.8 to 11.9 Nm.**

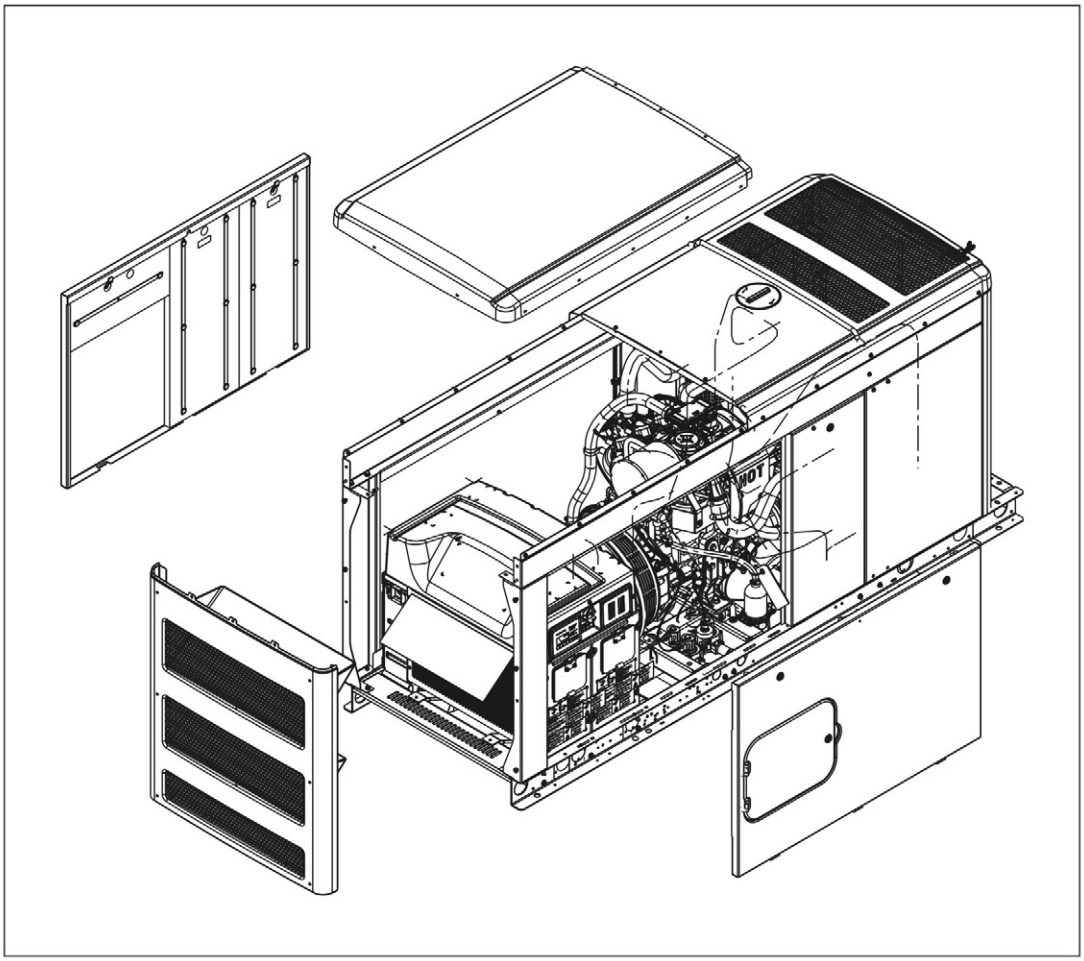


**FIGURE 90. REMOVE ENCLOSURE**

b. Remove covers, panels and plates:

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

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

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

| *NOTICE* |
| --- |
| **Torque 4.7 to 5.7 Nm.** |

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

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

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

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

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

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

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

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

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

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

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

| NOTICE |
| --- |
| **Torque 12.3 to 15 Nm.** |

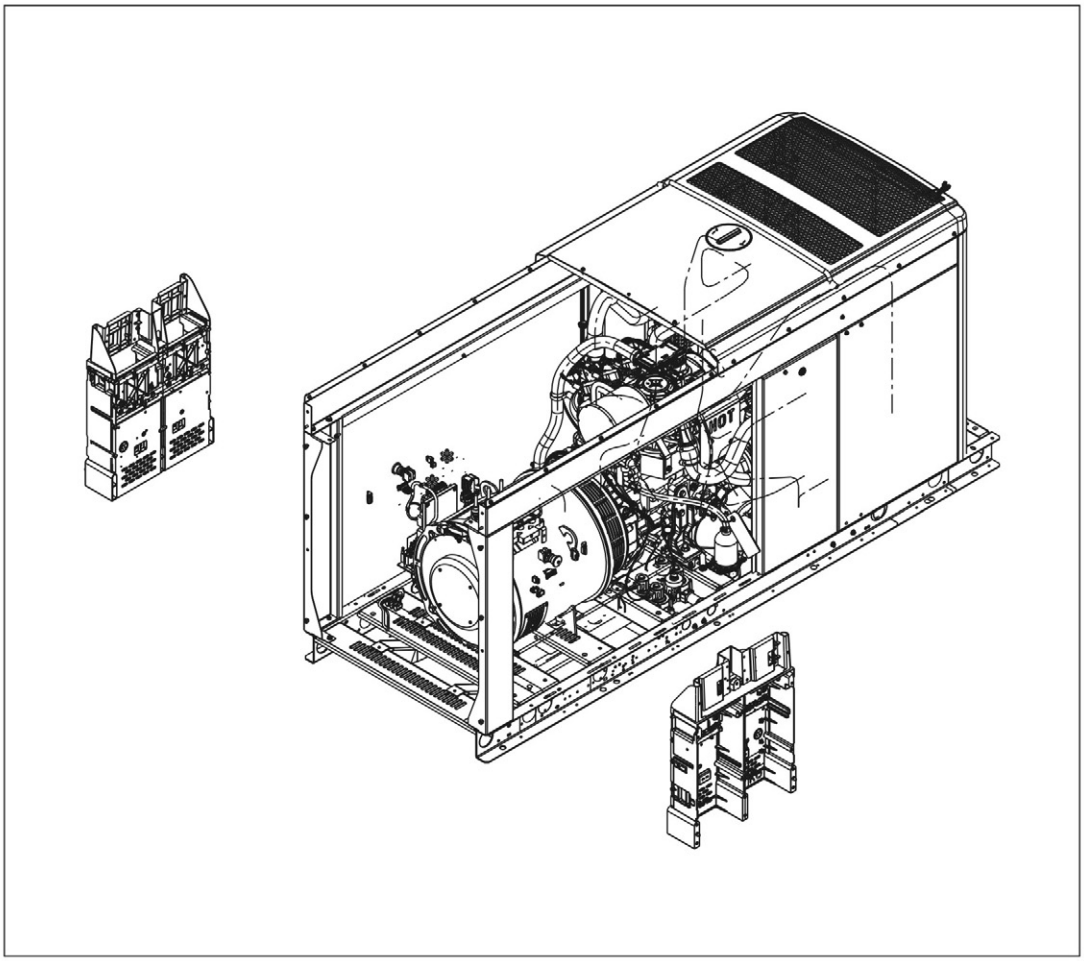


**FIGURE 91. REMOVE TERMINAL BOX MOUNTING BOLTS**

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

| *NOTICE* |
| --- |
| **Torque each isolator nut 82 to 100 Nm.** |

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

**NOTICE**

**The alternator weighs up to 600 pounds.**

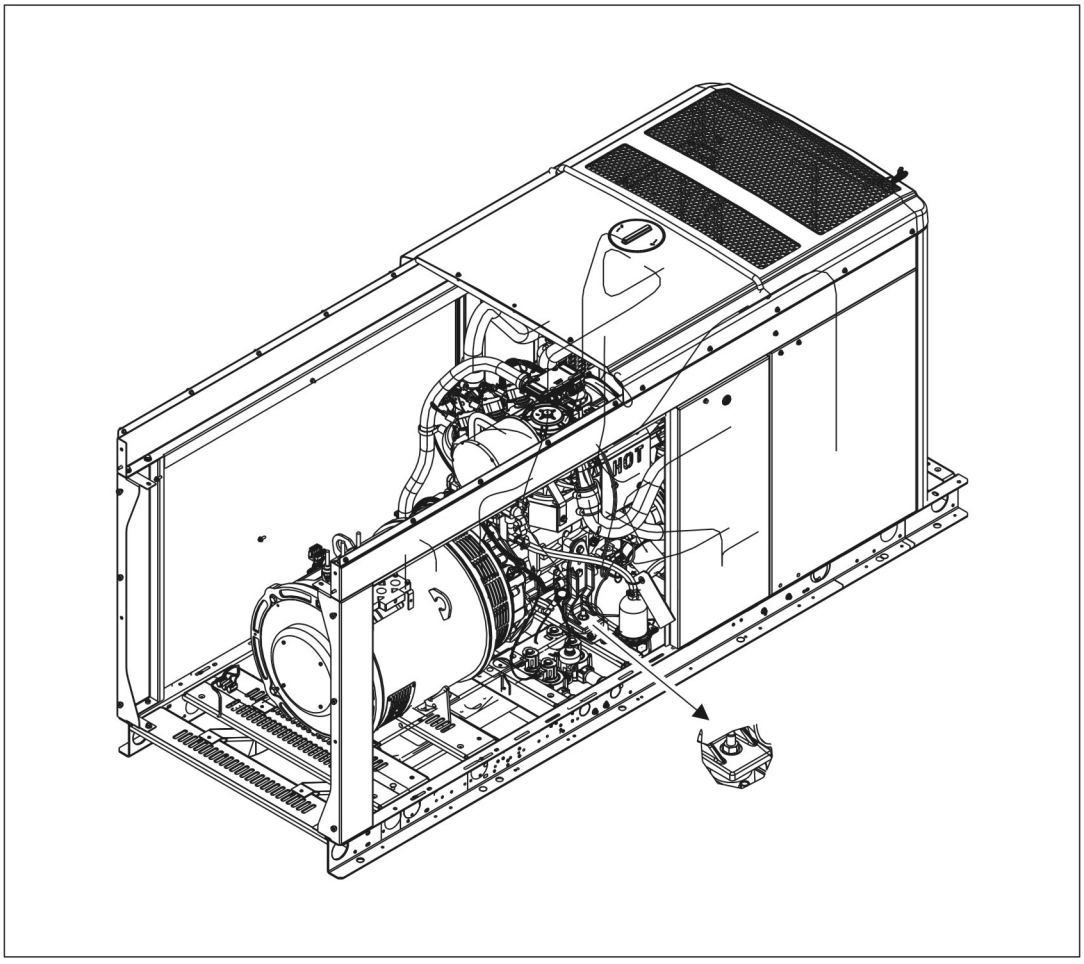



**FIGURE 92. REMOVE AND SECURE THE ALTERNATOR (WITH DETAIL)**

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.***

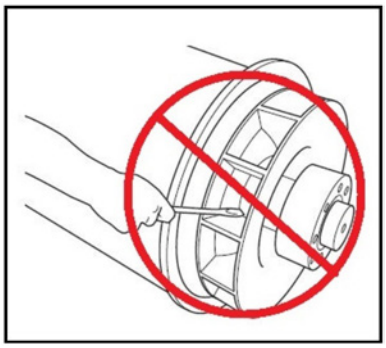


**FIGURE 93. DO NOT ROTATE ROTOR USING FAN**

**⚠ CAUTION**

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

***NOTICE***

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

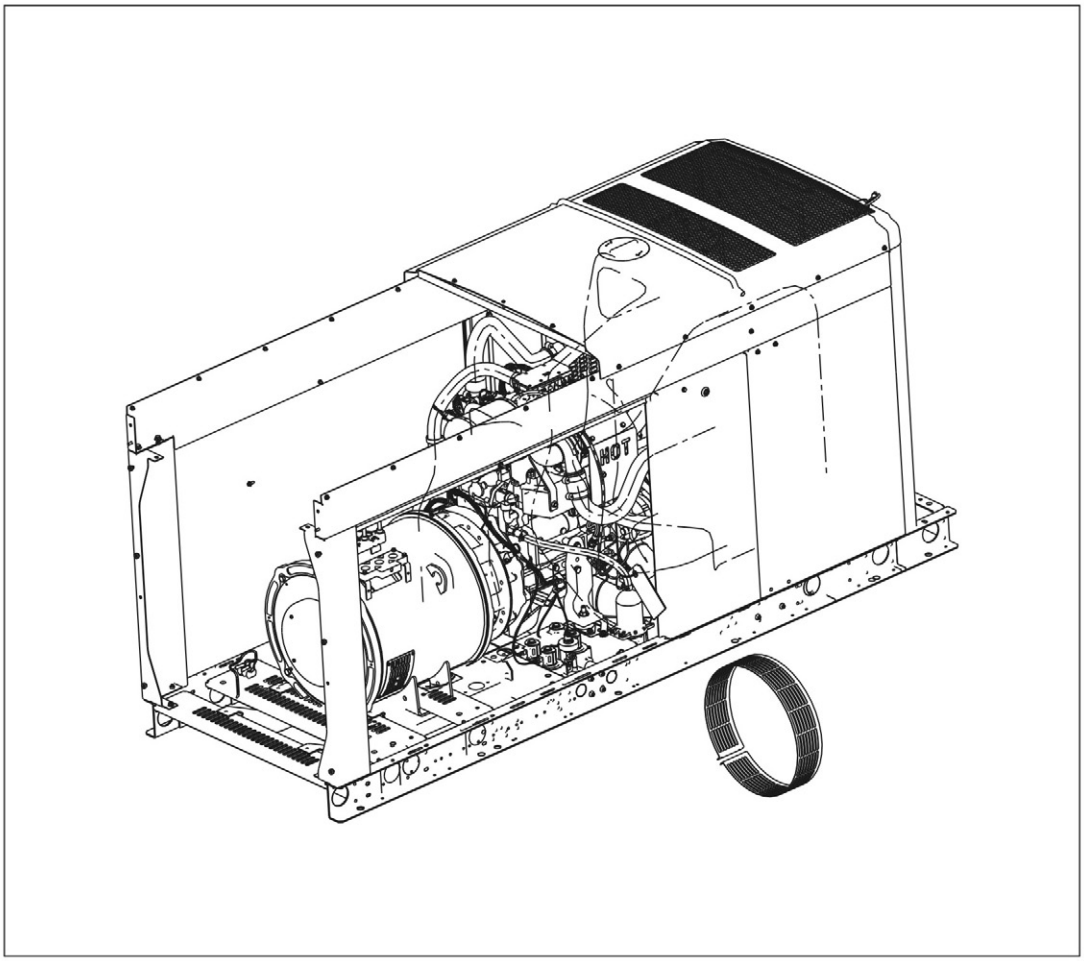



**FIGURE 94. ALTERNATOR FAN GUARD (WITH DETAIL)**

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

| *NOTICE* |
| --- |
| **The alternator weighs up to 600 pounds.** |

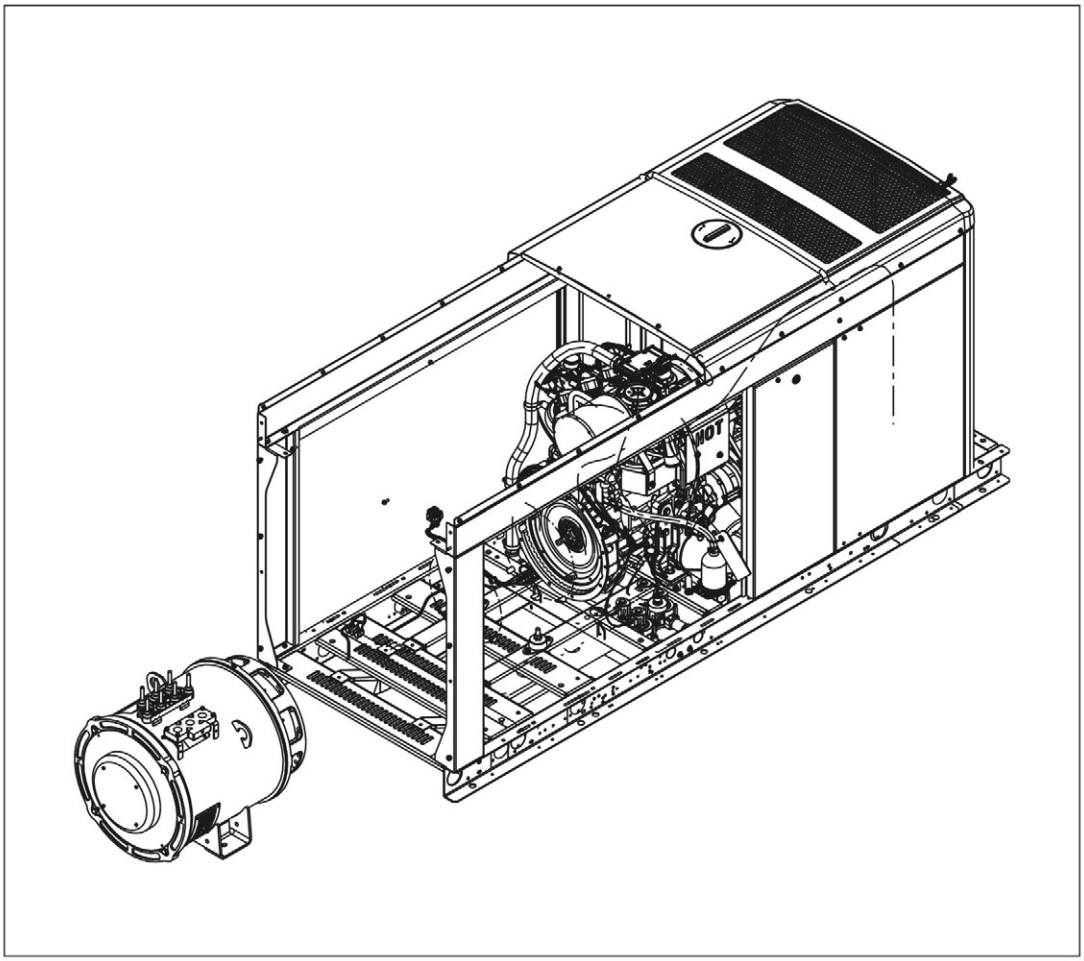


**FIGURE 95. MOVING THE ALTERNATOR**

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

# Bearings

## 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.

## Sealed Bearings

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

## 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.** |

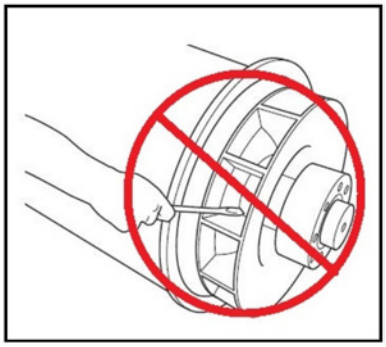
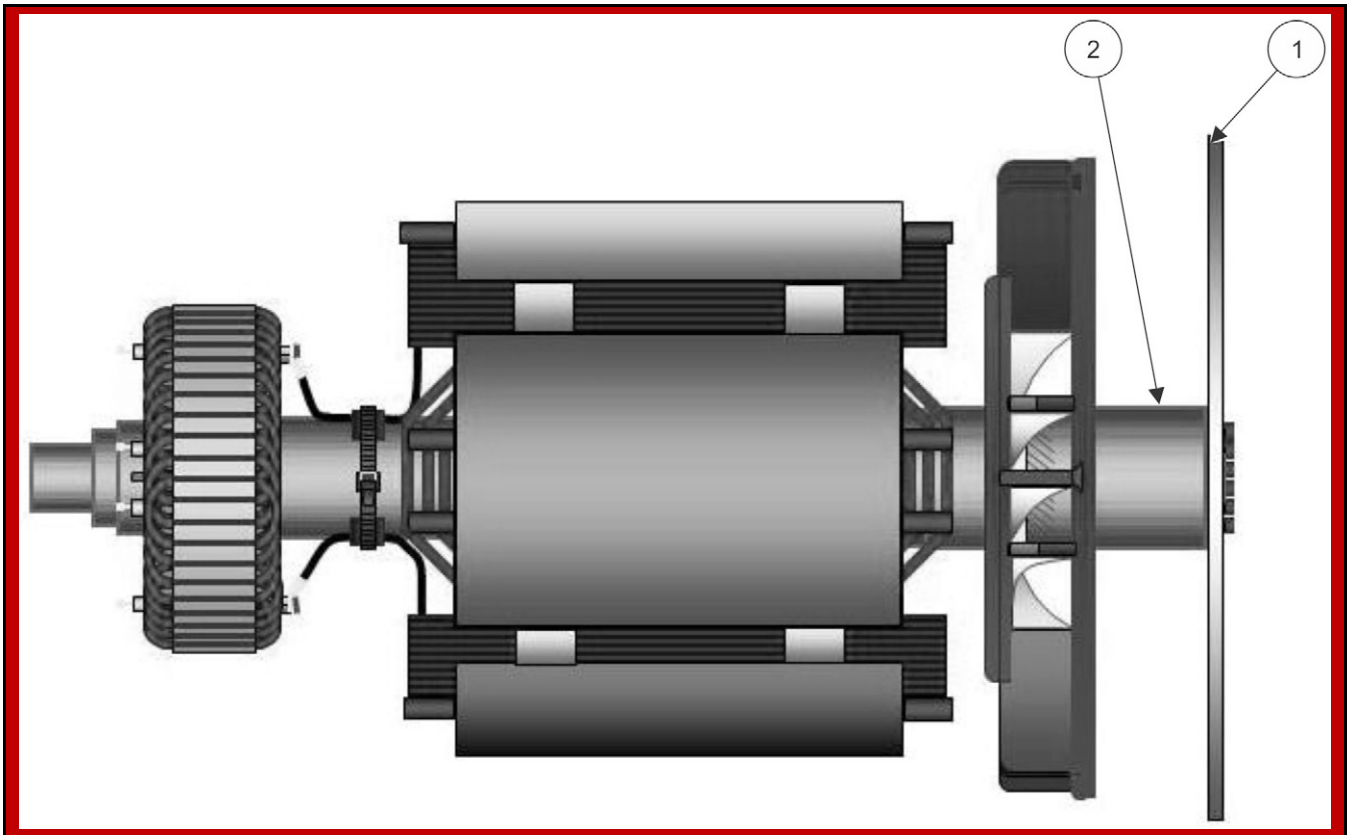


**FIGURE 96. DO NOT ROTATE ROTOR USING FAN**

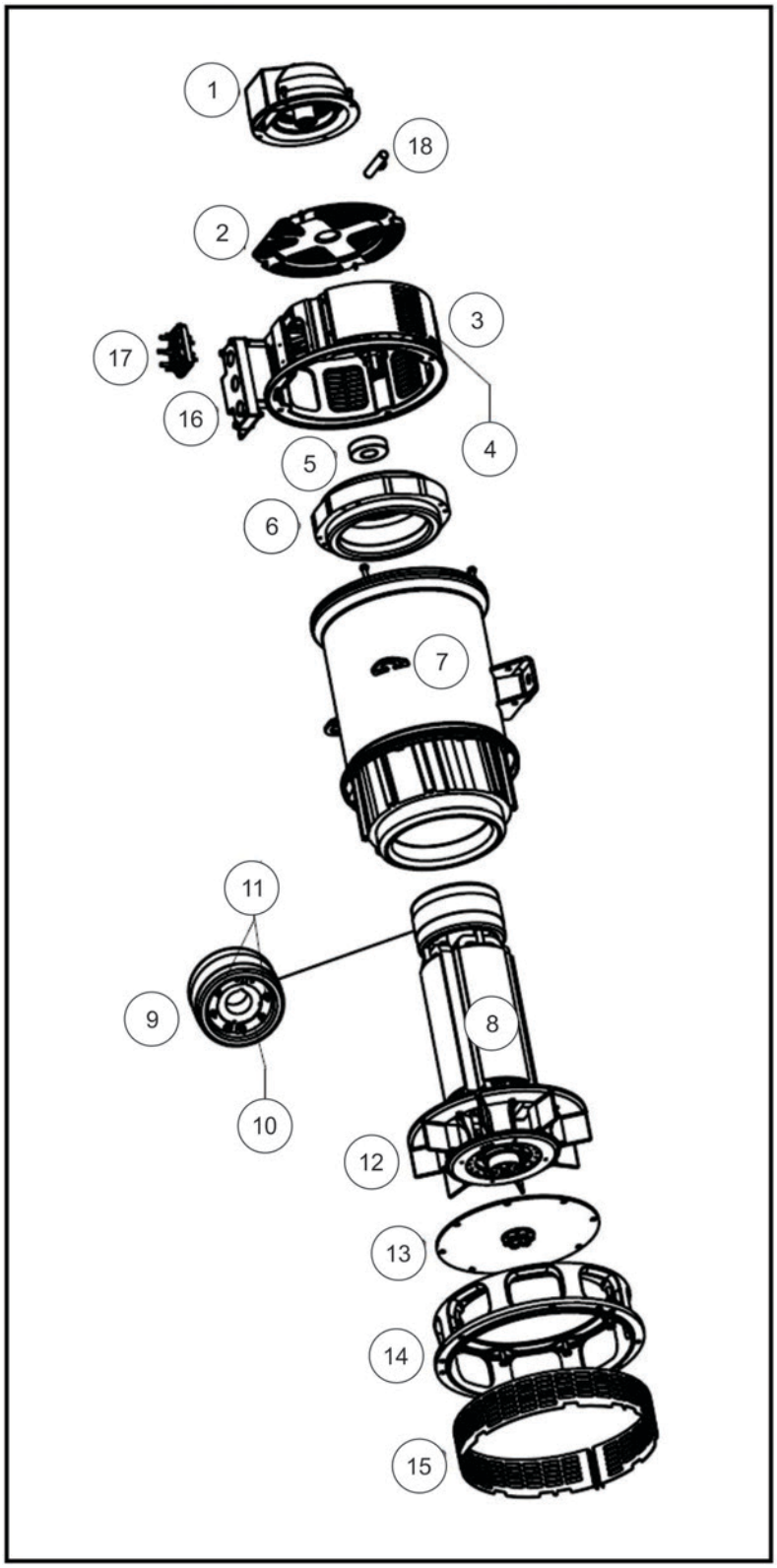



| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Coupling Disc | 2 | Drive End Coupling Hub |

**FIGURE 97. SINGLE BEARING GENERATOR ROTOR SHOWING COUPLING DISC BOLTED TO DRIVE END COUPLING HUB (AT RIGHT)**

# Parts Identification

## CA115 Single Bearing Alternator

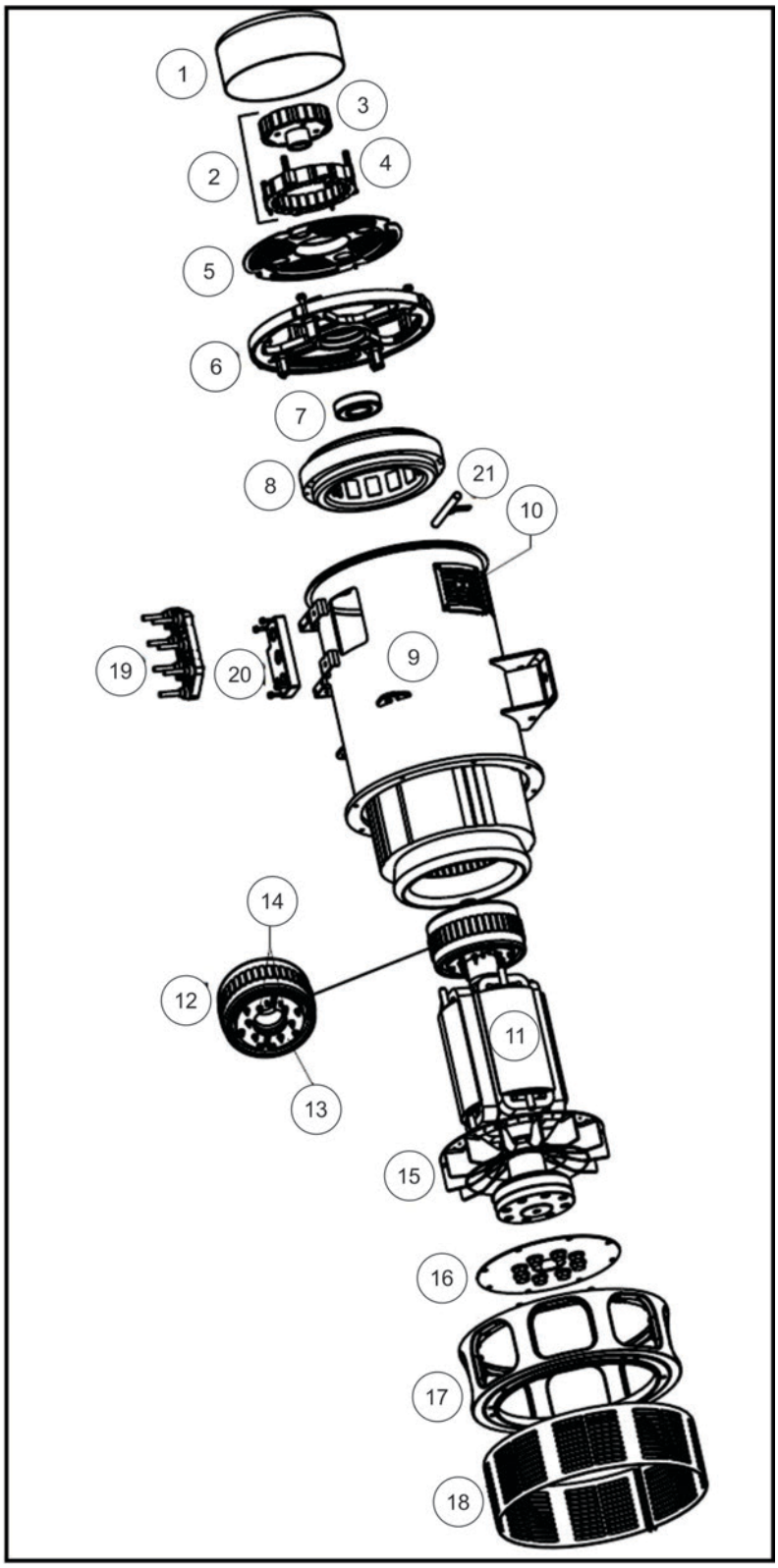


## TABLE 22. CA115 PARTS AND FASTENERS

| 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 |

## CA125 Single Bearing Alternator



## TABLE 23. CA125 PARTS AND FASTENERS

| Reference | Component |
|---|---|
| 1 | PMG Cover |
| 2 | Complete PMG Kit |
| 3 | PMG Rotor Assembly |
| 4 | PMG Stator Assembly |
| 5 | NDE Cover for Use with PMG |
| | NDE Cover for Use without PMG |
| 6 | NDE Bracket |
| 7 | Bearing |
| 8 | Exciter Stator Assembly |
| 9 | Stator Frame Assembly |
| 10 | Bottom Screen |
| 11 | Rotor Shaft Assembly |
| 12 | Exciter Rotor Assembly |
| 13 | Rotating Rectifier Assembly |
| 14 | Diode (Forward/Reverse) & Varistor Assembly |
| 15 | Fan |
| 16 | Coupling Disc (SAE 10) |
| 17 | Adapter Kit (SAE 4) |
| 18 | DE Screen |
| 19 | Terminal Board |
| 21 | Heater |

## CA135 Single Bearing Alternator

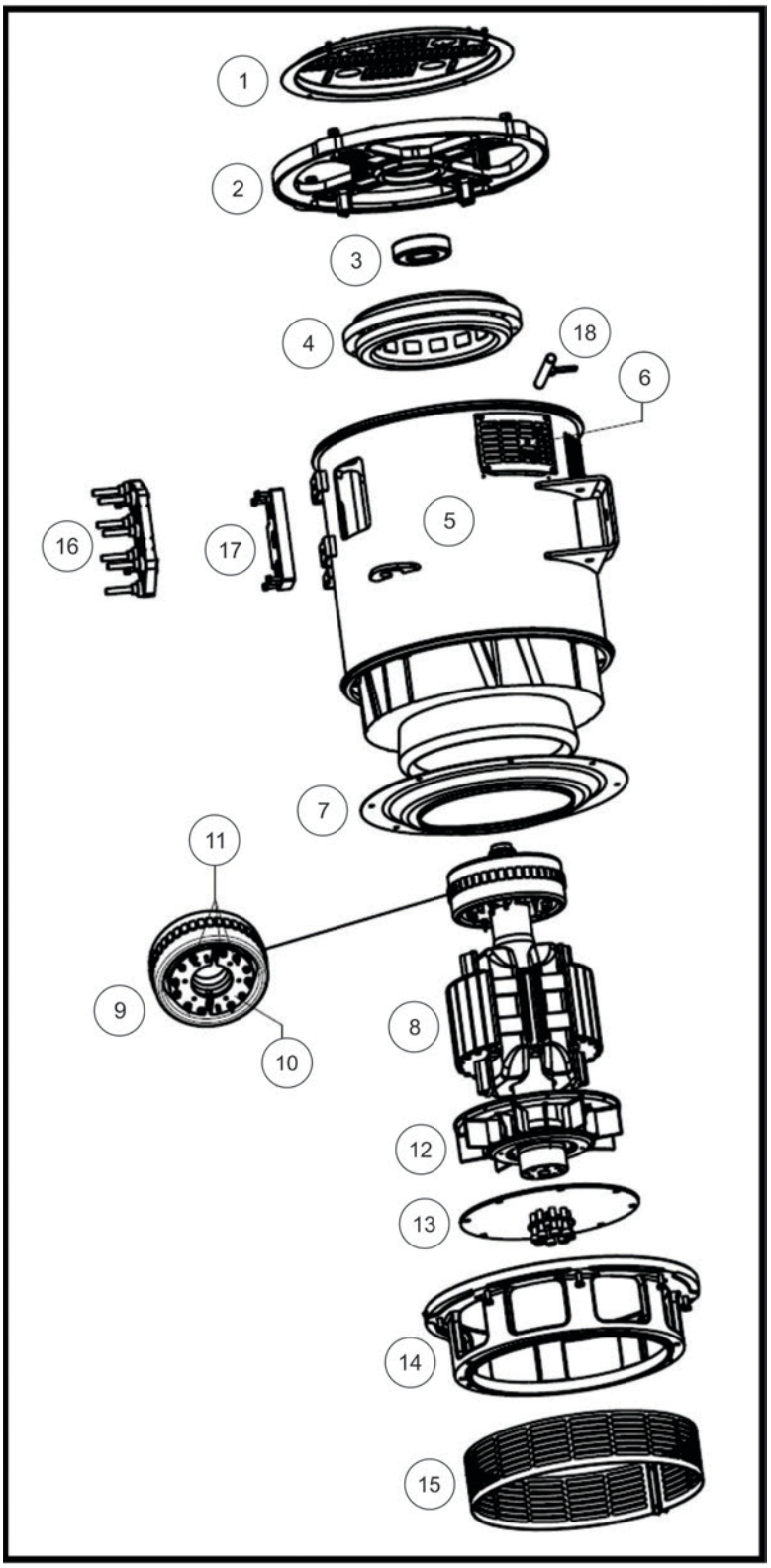


**TABLE 24. CA135 PARTS AND FASTENERS**

| Reference | Component |
|---|---|
| 1 | NDE Cover |
| 2 | NDE Bracket |
| 3 | Bearing |
| 4 | Exciter Stator Assembly |
| 5 | Stator Frame Assembly |
| 6 | Bottom Screen |
| 7 | Baffle |
| 8 | Rotor Shaft Assembly |
| 9 | Exciter Rotor Assembly |
| 10 | Rotating Rectifier Assembly |
| 11 | Diode (Forward/Reverse) & Varistor Assembly |
| 12 | Fan |
| 13 | Coupling Disc (SAE 10) |
| 14 | Adapter Kit (SAE 4) |
| 15 | DE Screen |
| 16 | Terminal Board |
| 18 | Heater |

# 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.***

## Test and Replace Rectifier System Component Requirements

**TABLE 25. RECIFIER SYSTEM TEST AND REPLACE REQUIREMENTS**

| Requirements | Description |
|---|---|
| **Personal Protective Equipment (PPE)** | Wear appropriate PPE |
| **Consumables** | • Loctite 241 thread locking adhesive<br>• 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)<br>• One metal-oxide varistor |
| **Tools** | • Insulation tester<br>• Multimeter<br>• 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.

# 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 26. WINDING TEST REQUIREMENTS**

| Requirement | Description |
|---|---|
| **Personal Protective Equipment (PPE)** | Wear mandatory site PPE. |
| **Consumables** | None |
| **Parts** | None |
| **Tools** | • Insulation test meter<br>• Multimeter<br>• Milliohm meter or microohm meter<br>• Clamp ammeter<br>• Infrared thermometer<br>• 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 27. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

| Component | Test Voltage (V) | Minimum Insulation Resistance at 1 Minute (MΩ) | |
|---|---|---|---|
| | | New | In-Service |
| Main Stator | 500 | 10 | 5 |
| Exciter Stator | 500 | 10 | 5 |
| Exciter Rotor, Rectifier & Main Rotor Combined | 500 | 10 | 5 |

1. Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. For main stators:
   a. Disconnect the neutral to earth conductor (if equipped).
   b. Connect together the three leads of all phase windings (if possible).
   c. Apply the test voltage from the table between any phase lead and earth.
   d. Measure the winding insulation resistance after 1 minute ($IR_{1min}$). Disconnect all control wiring and customer load leads from the alternator winding connections before conducting these tests.
   e. Discharge the test voltage with an earth rod for 5 minutes.
   f. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, and then repeat the method.
   g. If minimum resistance is not above listed, replace the main stator.
   h. Reconnect neutral to earth conductor (if equipped).
3. For exciter stators, and combined exciter and main rotors:
   a. Connect together both ends of the winding (if possible).
   b. Apply the test voltage from the table between the winding and earth.
   c. Measure the winding insulation resistance after 1 minute, $IR_{1min}$. Insulation should be measured with winding temperatures of 20 °C.
   d. Discharge the test voltage with an earth rod for 5 minutes.
   e. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, and then repeat the method.
   f. Repeat the method for each winding.
   g. If minimum resistance is not above listed, replace the exciter stator.
   h. Remove the connections made for testing.

## Remove Main Rotor

**NOTICE**

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

**NOTICE**

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

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

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

## Install Main Rotor

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

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

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

12. Carefully move the crane sling towards the alternator frame, as the extension tube rolls on the V rollers, until the rotor windings are fully inserted.
13. Gently lower the crane sling to put the rotor weight onto the support packing and remove the sling.
14. For a two bearing alternator, refit drive end bracket, see **Assemble Drive End** section.
15. For a one bearing alternator, assemble the drive end as follows:
    a. Refit the DE adapter
    b. Couple the alternator to the prime mover.
    c. Refit the upper and lower air outlet screen covers.
16. Refit the non-drive end bracket, see **Assemble Non-Drive End** section.
17. Remove the rotor shaft extension tube.
18. Remove the rotor shaft extension stub shaft.
19. Remove the V roller support.

# 5 Troubleshooting

## 5.1 Troubleshooting Procedures

This section is a guide to help you evaluate problems with the generator set. You can save time if you read through the entire manual ahead of time and understand the system.

This section contains the following information:

- How to troubleshoot symptom-based problems that are not numbered
- How to troubleshoot numeric fault codes, including descriptions of warning and shutdown code and corrective actions, such as checking fluid levels, control reset functions, battery connections, etc.

Make sure the generator set is shut down and disabled before disconnecting or connecting harness connectors to troubleshoot.

1. Press the generator set's "O" (Off) button to stop the generator set. Allow the generator set to thoroughly cool to the touch.
2. If applicable, 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.

| ***NOTICE*** |
| --- |
| **It is recommended that all changes to settings be recorded at each site to help troubleshoot the generator set.** |

| ***NOTICE*** |
| --- |
| **Electrostatic discharge will damage circuit boards. Always wear a wrist strap when handling circuit boards or when disconnecting or connecting harness connectors.** |

## 5.2 Safety Considerations

| ⚠ **WARNING** |
| --- |
| ***Hazardous Voltage***<br>***Contact with high voltages can cause severe electrical shock, burns, or death.***<br>***Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.*** |

**⚠ WARNING**

***Combustible Gases***

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

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

**⚠ WARNING**

***Automated Machinery***

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

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

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

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

***NOTICE***

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

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

1. Make sure the generator set is in the Off mode.
2. Turn off or remove AC power from the battery charger.
3. Using an insulated wrench, remove the negative (−) battery cable from the generator set starting battery.

# 5.3 GATRR Troubleshooting Approach

Cummins recommends the GATRR (Gather, Analyze, Test, Repair, Retest) troubleshooting approach.

**TABLE 28. 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 tees and symptoms present. |
|  | **R - Repair**: If necessary, perform repair per manufacturing guidelines and document all of the steps taken. |
|   | **R - Re-test**: Re-test the component, verify that the unit operates properly, and ensure that the documentation is complete. |

# 5.4 Service Repair Levels

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

**TABLE 29. SERVICE BILL OF MATERIAL GUIDE**

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

# 5.5 Control System

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

## 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.

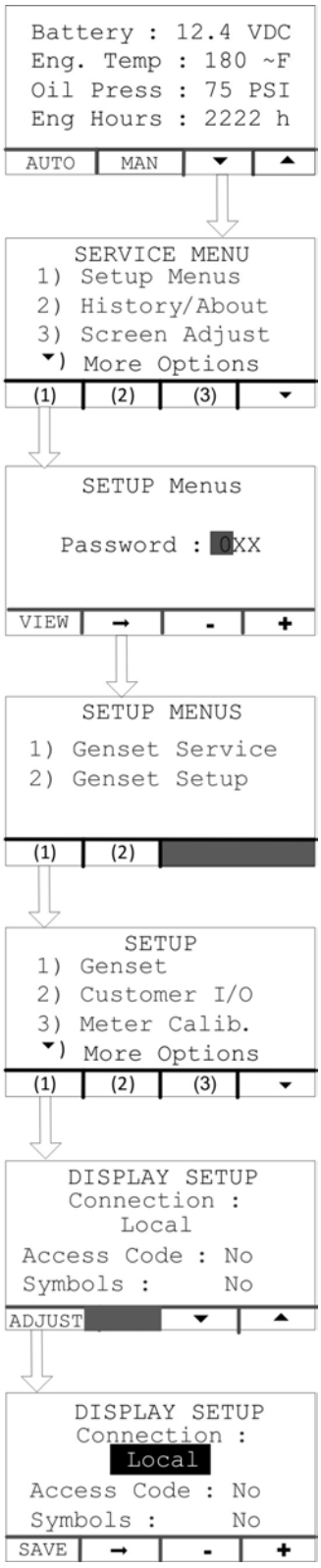



**FIGURE 98. DISPLAY SETUP MENU NAVIGATION**

# 5.6 Fault Finding

**⚠ WARNING**

***Troubleshooting procedures.***

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

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

***Review safety precautions listed in this manual together with the documentation supplied with the generator set.***

For any symptom not listed, contact your authorized dealer for assistance.

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

- All switches and controls are in their correct positions
- Fuel system is connected and fuel is available
- The lubricating oil level is correct
- The coolant level is correct
- The radiator cooling air flow is free from obstruction
- The battery charge condition is satisfactory and the connections are secure
- The generator set electrics and alternator connections are secure
- The panel connections are secure
- The protection circuits have been reset
- Blown fuses have been replaced
- Tripped contactors or circuit breakers have been reset

# 5.7 InPower Service Tool

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

## 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.**

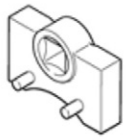
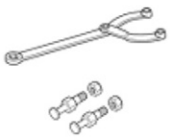
**NOTICE**

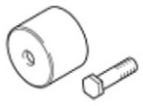
**These steps cannot be performed with the HMI211; they can only be performed with the InPower service tool.**

1. Connect to the PCC 1.1 or PCC 2.3 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.

# 5.8 Mechanical Service Tools List

**TABLE 30. MECHANICAL SERVICE TOOLS LIST**

| Part Number | Description | Image | Required or Recommended | Purpose |
|---|---|---|---|---|
| A044J293 | Tension Pulley Wrench |  | Required | Adjustment of timing belt tension |
| A047V508 | End Yoke Holder |  | Recommended kit | Holding camshaft sprocket when loosening or torquing bolt |

| Part Number | Description | Image | Required or Recommended | Purpose |
|---|---|---|---|---|
| A044J295 | Camshaft Oil Seal Installer |  | Recommended | Installation of camshaft oil seal |
| A044J297 | Crankshaft Front Oil Seal Guide |  | Recommended | Installation of crankshaft front oil seal |
| A044J299 | Crankshaft Front Oil Seal Installer |  | Recommended | Installation of crankshaft front oil seal |
| A044J303 | Crankshaft Rear Oil Seal Installer |  | Recommended | Installation of crankshaft rear oil seal |
| A044J025 | Handle |  | Recommended | Installation of crankshaft rear oil seal |

# 5.9 Network Applications and Customer Inputs

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

# 5.10 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 31. SYMBOLS**

| Symbol | Text |
|---|---|
|  | Generator Warning Fault |
|  | Generator Shutdown Fault |

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

# 5.11 Troubleshooting by Symptom

## 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:

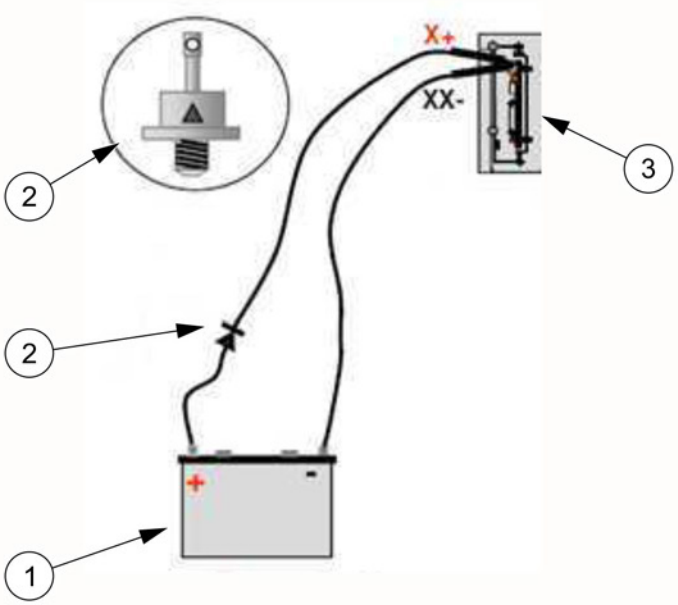
   - Extended storage
   - Reversed magnetic field by flashing with wrong battery polarity
   - Exciter stator rewind

- 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.** |




| No. | Description | No. | Description |
| --- | --- | --- | --- |
| 1 | 12V Battery | 3 | AVR/PC1.1 control |
| 2 | Blocking Diode | | |

**FIGURE 99. 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.

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

***Possible Causes:***

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

***Diagnosis and Repair:***

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

## 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.

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

## 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 32. 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 µΩ meter to measure resistance from the leads to ground. | Resistance is less than 1 MΩ. | Clean the main stator, allow it to dry, and repeat the test. If the same result is achieved, replace the alternator/main stator. |
| | | Resistance is greater than 1 MΩ. | Proceed to Test 2. |
| 2 | Use a multimeter to measure the exciter stator resistance across the leads X+ (F1) and XX- (F2). | Resistance is not with 10% of the relevant value in 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. |

| Test | | Result | Action |
|---|---|---|---|
| 3 | Use an insulation tester to megger from the XX- (F2) to ground. | Resistance value is less than 1 MΩ. | Clean the exciter stator, allow it to dry, and repeat the test. If the same result is achieved, replace the exciter stator. |
| | | Resistance value is greater than 1 MΩ. | Exciter stator is good. Proceed to Test 4. |
| 4 | Connect a 12V battery to the exciter stator windings, positive terminal to X+ (F1), negative terminal to XX- (F2). Disconnect all loads. Run the generator at nominal speed. Measure AC output voltage. | Voltage is balanced between phases within 1%, and within 10% of nominal. | Main stator, main rotor, exciter stator, exciter rotor, and rectifier are functioning properly. Proceed to Test 10. |
| | | Voltage is balanced between phases within 1%, but greater than 10% below nominal. | Main stator is functioning properly. Proceed to Test 6. If Tests 6 and 7 already completed, proceed to Test 8. |
| | | Voltage is unbalanced by greater than 1%. | Main stator windings are faulty. Proceed to Test 5. |
| 5 | At the terminal block, disconnect all leads. Use a μΩ meter/kelvin bridge to measure each winding resistance. | Resistances are not within 10% of the relevant value from 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. |

| Test | | Result | Action |
|---|---|---|---|
| 8 | Disconnect the 6 exciter rotor leads from the rotating rectifier. Use a μΩ meter to measure the resistance across all of the leads connected to the same polarity diodes. | Resistance is within 10% of the relevant value in 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. |
| 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. |

| Test | | Result | Action |
|---|---|---|---|
| 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. |

# Engine Performance Troubleshooting

## Engine Is Difficult to Start or Does Not Start

**Possible Causes:**

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

**Diagnosis and Repair:**

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

iii. Repair if necessary

f. The throttle plate and shaft are binding.

i. Check for fault codes using the E-Controls tool. Troubleshoot those as specified in the E-Controls manual.

ii. Inspect the bore of the throttle body.

iii. Clean if necessary, or replace if worn.

g. Inspect the pressure regulator and EPR assembly for damage.

i. The valve located inside the assembly should move freely.

ii. Clean or replace if necessary.

3. Air intake or exhaust issues

a. The air intake system restriction is above specification.

i. Check the air intake system restriction.

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

b. The exhaust system restriction is above specification.

i. Check the exhaust system restrictions.

ii. Correct or replace if necessary. Refer to the Exhaust section.

4. Sensor issues

a. The intake manifold pressure sensor is malfunctioning.

i. Check the intake manifold pressure sensor.

ii. Correct or replace if necessary.

b. The temperature manifold absolute pressure (TMAP) sensor is malfunctioning.

i. Refer to the Sensors section.

c. The crankshaft and/or camshaft speed/position sensors are reading incorrectly.

i. Refer to the Control System section and/or the Sensors section.

5. Base engine problem

a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.

b. Correct or replace if necessary.

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

***Possible Causes:***

1. Excessive load
2. Fuel system issues

3. Engine air intake system or engine exhaust system issues
4. Other issues

***Diagnosis and Repair:***

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
        i. Verify actual load applied to the generator set.
        ii. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual for proper generator set sizing and application.
2. Fuel system issues
    a. Verify that the proper fuel type is selected in the PCC.
    b. Inspect fuel lines and fuel connections for leaks.
        i. Repair if leaks are found.
    c. Verify fuel pressure at the generator set when applying load.
    d. Verify coils are on the right plugs.
3. Engine air intake system or engine exhaust system issues
    a. The engine air intake system restriction is above specification.
        i. Check the air intake system restriction.
        ii. Clean or replace the air filter and inlet piping if necessary.
    b. There are air intake system or exhaust system leaks.
        i. Repair if necessary.
    c. The turbocharger is malfunctioning (if used).
        i. Monitor the turbocharger boost pressure.
    d. Exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Replace exhaust system if necessary.
4. Other issues
    a. The engine is operating above the recommended altitude.
        i. Generator set power decreases above recommended altitude.
            A. Verify product capability at altitude against installed load.
            B. Refer to altitude and temperature derates to calculate expected power.

b. There is a base engine problem.

i. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.

ii. Correct or replace if necessary.

## Engine Runs Rough or Misfires

***Possible Cause:***

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

***Diagnosis and Repair:***

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

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

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

ii. If there is a variation in the command versus the actual, add a regulator right at the generator set

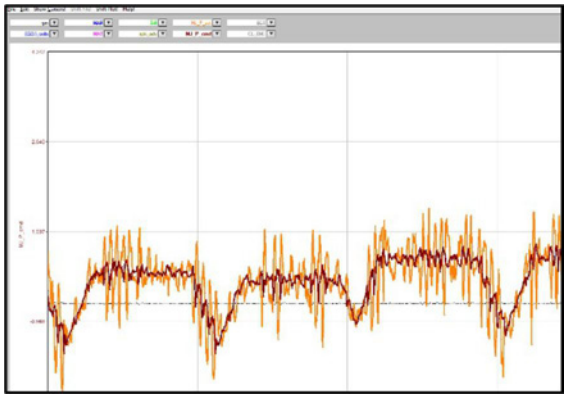


**FIGURE 100. POOR FUEL CONTROL EXAMPLE**

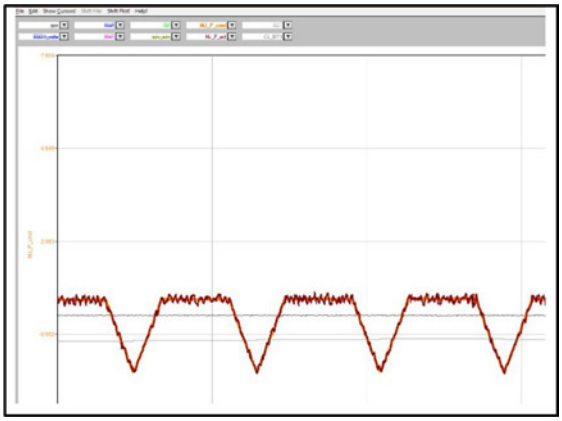


**FIGURE 101. GOOD FUEL CONTROL EXAMPLE**

3. Engine air intake system or engine exhaust system issues
   a. Engine air intake system restriction is above specification.
      i. Check the air intake system for restriction.
      ii. Clean or replace the air filter and inlet piping as necessary.
   b. There are air intake system or exhaust system leaks.
      i. Repair if necessary.
   c. Exhaust system back pressure is above specification.
      i. Check the exhaust system back pressure.
      ii. Replace the exhaust system if necessary.
4. Sensor issues
   a. Crankshaft and/or camshaft speed/position sensors reading incorrectly.
      i. Check for fault codes at the PCC.
      ii. Check for fault codes at the Engine Control Module (ECM).

iii. Correct or replace if necessary.

5. Other issues
   - Verify that the proper fuel type is selected.
   - There is a base engine problem.
     a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
     b. Correct or replace if necessary.

## Engine Shuts Off Unexpectedly or Dies during Deceleration

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Emergency Stop (if used)
   a. The Emergency Stop circuit is energized.
      i. Make sure that the Emergency Stop circuit is not energized.
2. Fuel system issues
   a. Check the fuel supply for appropriate pressure and flow.
   b. The manual fuel shutoff (FSO) valve is closed.
      i. Open the valves.
   c. The FSO valve solenoids or circuit are malfunctioning.
      i. Check the FSO valve solenoids and circuit.
      ii. Repair if necessary.
3. Wiring to the throttle body has failed (shorted or open)
   a. Verify that the wiring is intact.
   b. Repair if necessary.
4. Engine Control Module (ECM) related issues
   a. The battery voltage supply to the ECM has been lost.
      i. Check the battery connections.
      ii. Check all components in the un-switched battery supply circuit to the ECM.

b. The ECM is not grounded correctly.

i. Check the grounding and verify the correct placement of the star washer on the engine block ground cable.

c. There is a problem between the ECM and the PCC.

i. Check connections, wiring and components (i.e., relays).

d. The ECM is malfunctioning.

i. Correct or replace if necessary.

5. Base engine problem

a. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.

b. Correct or replace if necessary.

## Engine Speed Surges Under Load or in Operating Range

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Ignition system issues

a. Replace the spark plugs.

i. Spark plug defects on gaseous engines are very hard to detect. Microscopic carbon tracing can be very hard to see. Replace the spark plugs with Cummins approved spark plugs to ensure this is not an issue.

b. Check the spark plug wires.

i. Inspect connection points and wires for breaks or damage.

c. Test the ignition coils.

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

i. Use a coil on a plug tester (or in-line spark tester) to isolate the faulty coil.

ii. Replace the faulty coil if necessary.

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

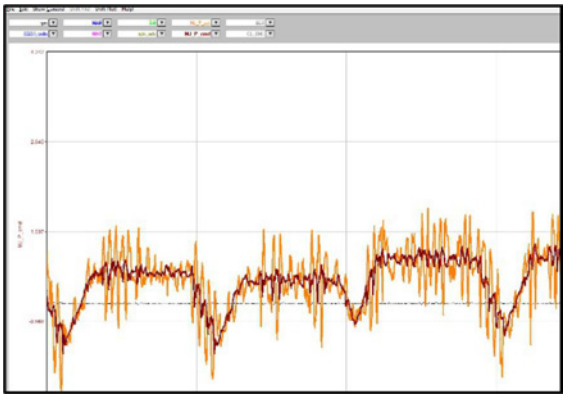


**FIGURE 102. POOR FUEL CONTROL EXAMPLE**

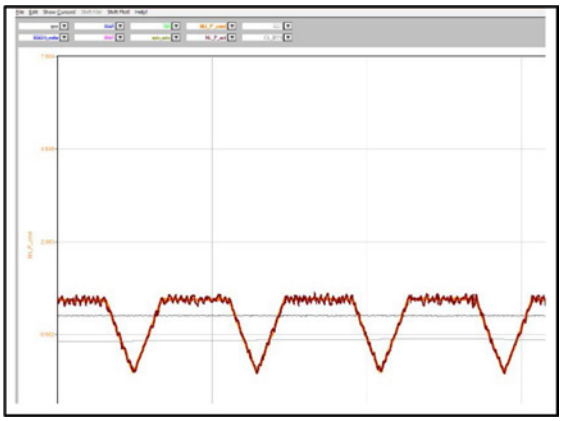


**FIGURE 103. GOOD FUEL CONTROL EXAMPLE**

3. Engine air intake system or engine exhaust system issues
    a. Engine air intake system restriction is above specification.
        i. Check the air intake system for restriction.
        ii. Clean or replace the air filter and inlet piping as necessary.
    b. There are air intake system or exhaust system leaks.
        i. Repair if necessary.
    c. Exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.

ii. Replace the exhaust system if necessary.

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

## Poor Engine Transient Response

***Possible Cause:***

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

***Diagnosis and Repair:***

1. Excessive loads
   a. Make sure that the load on the generator set does not exceed the generator set KW rating.
      i. Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual for proper generator set sizing and application.
2. Fuel system issues
   a. Verify fuel pressure at the generator set.

b. Inspect fuel lines and connections for leaks. Spray soapy water along the lines and at connection. Bubbling indicates a likely leak location.
    i. Repair or replace leaks, if found.
c. The throttle plate and shaft are binding.
    i. Check for fault codes using the E-Controls tool. Troubleshoot those as specified in the E-Controls manual.
    ii. Inspect the bore of the throttle body.
    iii. Clean if necessary, or replace if worn.
d. Inspect the pressure regulator and EPR assembly for damage.
    i. The valve located inside the assembly should move freely.
    ii. Clean or replace if necessary.

3. Air intake or exhaust issues
    a. There are air intake or exhaust leaks.
        i. Inspect the air intake and exhaust systems for air leaks.
        ii. Correct or replace if necessary.
    b. The air intake system restriction is above specification.
        i. Check the air intake system restriction.
        ii. Clean or replace the air filter and inlet piping as necessary.
    c. The exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Replace the exhaust system if necessary.
    d. The turbocharger is malfunctioning.
        i. Monitor the turbocharger boost pressure.
        ii. Correct or replace if necessary.
4. Other issues
    a. The engine is operating above the recommended altitude.
        i. Verify product capability at altitude against installed load.
    b. There is a base engine problem.
        i. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
        ii. Correct or replace if necessary.

## Engine Will Not Reach Rated Speed (RPM)

***Possible Causes:***

1. Excessive loads
2. Air intake or exhaust issues

3. Other issues

***Diagnosis and Repair:***

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set KW rating.
        i. Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual for proper generator set sizing and application.
2. Air intake or exhaust issues
    a. The air intake system restriction is above specification.
        i. Check the air intake system restriction.
        ii. Clean or replace the air filter and inlet piping if necessary.
    b. The exhaust system back pressure is above specification.
        i. Check the exhaust system back pressure.
        ii. Clean or replace if necessary.
3. Other issues
    a. The engine is operating above the recommended altitude.
        i. Verify the product capability at altitude against the installed load.
        ii. Refer to altitude and temperature derates to calculate expected power.
    b. There is a base engine problem.
        i. Check the engine for high crankcase pressure and low compression, as well as damaged pistons, camshaft, and other parts.
        ii. Correct or replace if necessary.

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

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

**Possible Causes:**

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

**Diagnosis and Repair:**

1. No power supplied to the control (green "Heartbeat" LED on the baseboard not flashing)
   a. There are poor battery cable connections.
      i. Clean the battery cable terminals and tighten all connections.
   b. There is a continuity problem.
      i. Remove Fuse F3 and check continuity. If open, replace the fuse with one of the same type and amp rating (20 Amps).
      ii. If Fuse F3 is OK, remove connector PCC-P20 and check for B+ at pins 9, 10, 20, and 21; and ground at pins 2, 4, 7, and 12.
      iii. If B+ and ground are OK, the baseboard may be defective. Cycle power to the baseboard by reconnecting PCC-P20.
      iv. Replace the baseboard if necessary.
2. Baseboard not properly calibrated or corrupt calibration (green "Heartbeat" LED on baseboard flashes every 0.5 seconds)
   a. Confirm that the installed calibration part number matches the serial plate information.
   b. Re-enter a calibration file if necessary.

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

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

## Engine Starts but Will Not Keep Running

***Possible Causes:***

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

***Diagnosis and Repair:***

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

g. Inspect the pressure regulator and EPR assembly for damage.
    i. The valve located inside the assembly should move freely.
    ii. Clean or replace if necessary.

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

## Engine Will Not Shut Off

**Possible Cause:**

1. Run/Stop circuit issue

**Diagnosis and Repair:**

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

## Fuel Consumption Is Excessive

**Possible Causes:**

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

**Diagnosis and Repair:**

1. Excessive loads
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
        i. Re-visit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual for proper generator set sizing and application.

2. Maintenance, repair or environmental effects
    a. Fuel consumption has increased after an engine repair.
        i. Evaluate the engine repair to determine its effect on fuel consumption.
            A. Correct if necessary.
        ii. Check part numbers to make sure the correct parts were used.
            A. Replace incorrect parts.
    b. Lubricating oil level is above specification.
        i. Check the oil level.
        ii. Verify the dipstick calibration and oil pan capacity.
        iii. Fill the system to the specified level.
    c. Environmental factors are affecting fuel consumption.
        i. Consider altitude and ambient air temperature when evaluating fuel consumption. Refer to the specific Engine Data Sheets for altitude derate information.
3. Air intake or exhaust issues
    a. There are air intake or exhaust leaks.
        i. Inspect the air intake and exhaust systems for air leaks. Refer to the Air Intake System section.
    b. The air intake system restriction is above specification.
        i. Check the air intake system for a restriction.
        ii. Clean or replace the air filter and inlet piping if necessary. Refer to the Air Intake System section.
4. Fuel system issues
    a. There are leaks in fuel lines and/or fuel connections.
        i. Repair the leaks. Refer to the Fuel System section.
    b. The fuel system pressure sensors (fueling/timing) are malfunctioning.
        i. Check the fuel system pressure sensors (fueling/timing), including: the camshaft sensor, fuel pressure sensors, throttle positions sensors, crankshaft sensor, O2 sensor, and TMAP sensors for proper operation. Refer to the E-Controls manual for test methods for each device.
5. Crankshaft and/or camshaft speed/position sensors are reading incorrectly
    a. Check the sensors.
    b. Check for ECM fault codes related to these sensors. Refer to the Engine Control Module (ECM) section.
    c. Correct or replace if necessary.

6. Other issues
    a. Engine parasitics are excessive.
        i. Check engine-driven units for correct operation. Refer to the operator manual.
        ii. Check the cooling fan for correct operation. With fan belt removed, the fan should spin freely by hand in both directions.
            A. Correct or replace if necessary.
    b. There is a base engine problem.
        i. Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts. Listen for unusual noises, and inspect possible causes. Analyze the oil and inspect the filters to locate an area of probable damage.
        ii. Correct or replace if necessary.

## Engine Noise Is Excessive

***Possible Cause:***

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

***Diagnosis and Repair:***

1. Air intake or exhaust leaks
    a. There are air intake or exhaust leaks.
        i. Inspect the air intake and exhaust systems for air leaks. Refer to the Air Intake System section and/or Exhaust System section.
    b. There is a faulty muffler.
        i. Replace the muffler if necessary. Refer to the Exhaust System section.
2. Turbocharger noise
    a. Inspect the turbochargers for excessive mechanical noise.
        i. Replace them if necessary.
3. Mechanical or internal component wear or damage
    a. There is internal engine damage.
        i. Analyze the oil and inspect the filters to locate an area of probable damage.
        ii. Inspect and further investigate area of probable damage.
    b. Valvetrain components are damaged.
        i. Replace damaged components.

c. The vibration damper is damaged.
    i. Replace the vibration damper.
d. There is main bearing or connecting rod bearing noise.
    i. The engine is damaged, and needs repair or replacement.
e. Flywheel or flexplate cap screws are loose or broken.
    i. Check the flywheel or flexplate and the mounting cap screws.
    ii. Tighten any loose screws; replace any broken screws.
f. Piston, piston rings, or cylinder liner is/are worn or damaged.
    i. Replace worn or damaged components.

# 5.12 Troubleshooting with Fault Codes

## Fault Code Introduction

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

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

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

## Code 135 - Oil Pressure Sensor OOR - High

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Faulty oil pressure sensor and/or circuit
    a. Connect the GCP service tool.
    b. Start the generator set.
    c. Check the oil pressure voltage. If the value is *greater than* that the limit defined in calibration, stop the engine and disconnect the oil pressure sensor from the wire harness.

d. Re-check the oil pressure voltage. If the value *is greater than or equal to* 4.9 VDC, jumper the oil pressure sensor circuit to 5V Analog Return.

e. Re-check the oil pressure voltage.

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

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

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

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

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

2. Faulty ECM connection or harness

a. Connect the GCP service tool.

b. Start the generator set.

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

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

3. Faulty ECM

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

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

## Code 141 - Oil Pressure Sensor OOR Low

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

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

## Code 143 - Engine Oil Pressure Low (Warning)

***Logic:*** Engine oil pressure is below the low oil pressure warning threshold (<25 psig for more than 20 seconds).

| *NOTICE* |
| --- |
| **This is an ECM driven fault. The corresponding DTC is 524.** |

| *NOTICE* |
| --- |
| **The generator set uses either a normally open switch type (two wire) or a sensor type (three wire) pressure sensor. See Appendix A for pressure sensor connections.** |

***Possible Cause:***

1. Low lubricating oil level
2. External leak
3. Fault simulation enabled or threshold set too high
4. Coolant temperature above specification
5. Lubricating oil does not meet specifications

6. Lubricating oil contaminated with coolant or fuel
7. Oil pressure sensor inaccurate or blocked
8. Engine angularity during operation exceeds specification
9. Incorrect lubricating oil cooler installed
10. Plugged lubricating oil cooler
11. Faulty main oil pressure regulator
12. Loose or broken lubricating oil suction or transfer tube
13. Damaged or incorrectly installed piston cooling nozzles
14. Lubricating oil filter plumbing routed incorrectly

***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 capscrews, pipe plugs, and fittings.
    c. Replace gaskets that show signs of oil leaks.
3. Fault simulation is enabled or the threshold set too high
    a. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
    b. Using the electronic service tool, verify that the fault threshold is not within the normal operating range for the oil pressure sensor (>25 psig).
4. Coolant temperature above specification
    a. On the display or using the InPower service tool, read the engine coolant temperature.
    b. Compare the coolant temperature against the expected coolant temperature for that engine model. (Should be <105 °C.)
    c. If the coolant temperature is outside of the expected range, refer to DTC 217 in the E-controls manual.
5. Lubricating oil does not meet specifications
    a. Verify lubricating oil meets the specifications (5W-30 API SM or newer).
    b. Verify alternative oil and additives were not added during the oil life.
    c. Verify the age of the lubricating oil.
    d. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.
6. Lubricating oil contaminated with coolant or fuel
    a. Damaged head gasket.

b. Damaged intake gasket.

7. Inaccurate or blocked oil pressure sensor
   a. Connect a mechanical oil pressure gauge of known good quality and calibration to the engine at one of the plugs on top of the oil filter head.
   b. Connect InPower.
   c. While engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
   d. Only proceed if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
   e. Start the generator set.
   f. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
   g. Oil pressure should be greater than 25 psig.
8. Engine angularity during operation above specification
   a. Verify container is level or near level.
9. Incorrect lubricating oil cooler installed
   a. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.
10. Plugged lubricating oil cooler
    a. Visually inspect the oil cooler for cleanliness.
    b. If the fins are clogged, or show excessive dirt build up, follow the procedures detailed in **Section 4.8**.
    c. If the plug is in the oil circuit, add an oil system cleaner or detergent as per the instructions, drain the oil, and refill using 5W-30 API SM or newer motor oil.
    d. If the plug is still not removed, replace radiator and oil cooler assembly.
11. Faulty lubricating oil pump
    a. Ensure that oil pump turns freely.
       i. Mark the angle of the oil pump shaft.
       ii. Remove timing belt A, and turn the oil pump shaft, it should spin freely. Repair or replace as necessary.
       iii. Re-align the oil pump shaft with the mark made earlier, and re-install timing belt A.
    b. Inspect the lubricating oil pump gears for chips, cracks, or excessive wear.
    c. Check side clearances on the oil pump gears.
       i. Drive gear side clearance: .08-.14 mm (.0031-.005 in.)
       ii. Driven/idler gear side clearance: .06 - .12 mm (.0024-.0047 in.)

d. If debris is suspected of having gone through the pump, drain the oil, and inspect the pump. Replace as necessary.

e. Inspect the rear cover plate for scoring and grooves.

f. Inspect the pump housing for damage and excessive wear.

12. Faulty main oil pressure regulator

a. Inspect the plunger and plunger bore for nicks or scratches.

b. Verify the plunger moves freely in the bore.

c. Repair or replace as necessary.

13. Loose or broken lubricating oil suction or transfer tube

a. Inspect lubricating oil suction tube or transfer tube for leaks. Visually inspect for cracks, kinks, or tears.

b. Inspect the capscrews for signs of leaks.

c. Inspect the gaskets and o-rings for signs of damage, excessive wear or pinching.

14. Damaged or incorrectly installed piston cooling nozzles

a. Inspect capscrew and piston cooling nozzle for damage.

b. Check for leaks and improper seating.

15. Lubricating oil filter plumbing routed incorrectly

a. Inspect the lubricating oil filter plumbing.

b. Compare plumbing to appropriate parts manual, repair or replace as necessary.

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

***Logic:***

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

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

***Diagnosis and Repair:***

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

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

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

***Diagnosis and Repair:***

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

## Code 151 - Engine Coolant Temperature High (Shutdown)

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

***Diagnosis and Repair***

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

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

***Logic:***

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

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

**Diagnosis and Repair:**

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

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

***Logic:***

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

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

***Diagnosis and Repair:***

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

## Code 155 - Intake Manifold Temperature High (Shutdown)

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

***Diagnosis and Repair:***

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

## Code 234 - Engine Speed High (Shutdown)

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Faulty HE sensor connections and wiring
    a. Inspect the HE sensor and the main harness connector pins.
        i. Disconnect the main harness connector from the HE sensor.
        ii. Inspect for corroded, bent, broken, pushed back, expanded, or loose pins.
        iii. Inspect for evidence of moisture in or on the connector.
            A. Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
        iv. Inspect for missing or damaged connector seals.
        v. Inspect for dirt or debris in or on the connector pins.
        vi. Inspect the wiring for any damage or shorting.
    b. Check for 5V at the 5V supply pin of the harness, and ground at the ground pin.
        i. If one or both are not present, repair or replace the harness.
    c. Check continuity from the signal lead of the sensor to the ECM (see wiring diagrams for ECM pin-outs).
        i. If there is not continuity, repair or replace the harness.

2. Faulty HE sensor
    a. Disconnect the main harness connector from the HE sensor.
    b. Remove the sensor from the flywheel housing, clean and inspect it for damage. If damaged, replace the HE sensor, as well as inspect the flywheel and starter.
    c. Check for continuity across all three of the pins. If one or more pins are open, replace the HE Sensor.
    d. If an oscilloscope is available, with sensor connected to the wiring harness, measure the voltage across the ground and output lead (ground and signal) while cranking the engine. A clean square wave should appear. If not, replace the HE sensor.
3. Fault simulation feature is enabled
    a. Connect the InPower service tool.
    b. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC.
4. Incorrect threshold setting
    a. Use the service tool to connect to the PCC and verify fault threshold settings; then compare them to the specifications. The threshold setting values are:
        - Overspeed Trip Level (60 Hz) = 2250
        - Secondary Overspeed Trip Speed (60 Hz) = 2250
    b. Recalibrate the PCC to reset the threshold settings.
5. Incorrect settings on the ECM
    a. Check that the max allowed governed speed is consistent with the PCC.
    b. Verify that the HE sensor is communicating with the ECM with the E-Controls service tool.
6. Incorrect calibrations in the PowerCommand control (PCC)
    a. Using the display or the InPower service tool, verify the calibration in the PCC.
        i. If the calibration in the PCC matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
        ii. Verify that the HE sensor feature is enabled in calibration.
7. Flywheel teeth number is incorrectly set in the PCC or E-Controls
    a. Make sure that the correct number of flywheel teeth is set in the PCC and E-Controls.
        i. Use InPower and the E-controls GCP to ensure that both the PCC and E-controls have the correct number of teeth. These generator sets have 60 evenly spaced teeth, with 2 removed.

8. Engine speed is higher than shutdown threshold
    a. The engine speed governor is not operating correctly. Verify that the throttle plate can move freely. Clean or repair as required.

## Code 286 - CAN Address Conflict Failure (Warning)

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

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

***Diagnosis and Repair:***

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

## Code 359 - Fail to Start

***Logic:***

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

***Possible Causes:***

1. Fuel system issues
2. Incorrect flywheel teeth setting
3. Incorrect starter disconnect speed

***Diagnosis and Repair:***

1. Fuel system issues
    a. Inspect fuel lines and fuel connections for leaks.
        i. Repair if leaks are found. Refer to the Fuel System section.
    b. The manual fuel shutoff (FSO) valve is closed.
        i. Open the valve.
    c. The FSO valve solenoids or circuit are malfunctioning.
        i. Check the FSO valve solenoids and circuit.
        ii. Correct or replace as necessary.
2. Incorrect flywheel teeth setting
    a. Connect to the control via the InPower service tool. Make sure Teeth Pulses Per Revolution matches the specified number (110) of flywheel ring gear teeth.

3. Incorrect starter disconnect speed
    a. Connect to the control via the InPower service tool. Make sure Starter Disconnect Speed is set to 400 RPM.

## Code 415 - Engine Oil Pressure Low (Shutdown)

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

| *NOTICE* |
| --- |
| **This is an ECM driven fault. The corresponding DTC is 524.** |

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Lubricating oil level is low
    a. Check the oil level. Add or drain oil, if necessary.
2. External leak
    a. Inspect the engine and surrounding area for external oil leaks.
    b. Tighten the capscrews, pipe plugs, and fittings.
    c. Replace gaskets that show signs of oil leaks.

3. Fault simulation is enabled or the threshold is set too high
    a. Connect to the control with InPower and ensure that the fault simulation for LOP (Low Oil Pressure) is not enabled.
    b. Using the electronic service tool, verify that the fault threshold is not within the normal operating range for the oil pressure sensor (greater than 20 - 65 psig).
4. Coolant temperature is above specification
    a. On the display or using the InPower service tool, read the engine coolant temperature.
    b. Compare the coolant temperature against the expected coolant temperature for that engine model (less than 221 °F [105 °C]).
    c. If the coolant temperature is outside of the expected range, refer to DTC 217 in the E-Controls manual.
5. Lubricating oil does not meet specifications
    a. Verify lubricating oil meets the specifications as described in the Model Specifications section.
    b. Verify alternative oil and additives were not added during the oil life.
    c. Verify the age of the lubricating oil.
    d. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.
6. Lubricating oil is contaminated with coolant or fuel
    a. Damaged head gasket
    b. Damaged intake gasket
7. Oil pressure sensor is inaccurate or blocked
    a. Connect a mechanical oil pressure gauge of known good quality and calibration to the engine at one of the plugs on top of the oil filter head.
    b. Connect InPower.
    c. While engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
    d. Only proceed if engine troubleshooting has been completed. Do not attempt to start the engine if there is doubt about oil pressure.
    e. Start the generator set.
    f. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge. Oil pressure should be greater than 15 psig (low oil pressure warning level).
8. Engine angularity during operation exceeds specification
    a. Verify container is level or near level.

9. Incorrect lubricating oil cooler is installed
    a. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.
10. Lubricating oil pump is faulty
    a. Ensure that oil pump turns freely.
        i. Mark the angle of the oil pump shaft.
        ii. Remove the front gear cover. The oil pump should spin freely. Repair or replace as necessary.
        iii. Re-align the oil pump shaft with the mark made earlier.
    b. Inspect the lubricating oil pump gears for chips, cracks, or excessive wear.
    c. Check side clearances on the oil pump gears. Refer to the Engine Operation & Maintenance Manual for QSJ5.9G.
    d. If debris is suspected of having gone through the pump, drain the oil, and inspect the pump. Replace as necessary.
    e. Inspect the rear cover plate for scoring and grooves.
    f. Inspect the pump housing for damage and excessive wear.
11. Main oil pressure regulator is faulty
    a. Inspect the plunger and plunger bore for nicks or scratches.
    b. Verify the plunger moves freely in the bore.
    c. Repair or replace as necessary.
12. Lubricating oil suction or transfer tube is loose or broken
    a. Inspect lubricating oil suction tube or transfer tube for leaks. Visually inspect for cracks, kinks, or tears.
    b. Inspect the capscrews for signs of leaks.
    c. Inspect the gaskets and o-rings for signs of damage, excessive wear or pinching.
13. Piston cooling nozzles are damaged or are not installed correctly
    a. Inspect capscrew and piston cooling nozzle for damage.
    b. Check for leaks and improper seating.
14. Lubricating oil filter plumbing is not routed correctly
    a. Inspect the lubricating oil filter plumbing.
    b. Compare plumbing to appropriate parts manual, repair or replace as necessary.

## Code 427 - CAN Data Link Degraded

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

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

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

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

    b. Make sure that the E-Stop button is functioning correctly:
        i. Measure the outputs of the E-Stop (Normally Open and Normally Closed contacts).
        ii. Make sure that the outputs switch state correctly when engaged and disengaged.
        iii. Replace the switch if faulty.
    c. Check the wiring from the baseboard.
    d. The keyswitch control relay is a normally open relay. Make sure that B+ is available at the relay input, then measure the voltage output.
        - If there is a B+ at both the input and output of the keyswitch control relay, the relay is not faulty.
        - If B+ is noted at the input but not at the output of the keyswitch control relay, replace the relay.
    e. Connect to the engine ECM with E-Controls GCP Display or 4G Display to verify that the ECM is functioning properly and is communicating with the CAN-LINK network.
        i. Refer to the Engine Control Module (ECM) section. If the ECM is faulty, replace it.
2. The CAN datalink has failed
    a. There is a defective datalink harness connection, or open circuit.
        i. Inspect the datalink harness and connector pins from J11-20 to J1939+ and from J11-19 to J1939-.

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

b. Check the terminating resistors.

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

ii. If resistance is not 60 Ohms, check the terminating resistors. Each of the two terminating resistors should be 120 Ohms; replace them if they are not 120 Ohms.

## Code 441 - Low Battery Voltage

***Logic:***

Battery voltage is low.

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Damaged battery cable connections
    a. Inspect the battery cable connections for loose connections and/or corrosion, and repair if necessary.
2. Low battery voltage
    a. Using DVM, measure the battery voltage from the positive (+) terminal to the negative (-) terminal.
    b. If it is not within 11.0 to 14.2 V recharge the battery.
3. Discharged or defective battery
    a. Check the electrolyte level (if possible).
    b. Replenish the electrolyte level if low and recharge the battery (if possible). The specific gravity of a fully charged lead acid battery is approximately 1.26 at 80 °F (27 °C).
    c. If the battery is not able to hold adequate voltage, replace the battery.
4. Bad battery ground connection
    a. Inspect the battery ground connection.
        i. Disconnect the engine harness.

ii. Measure the resistance from the negative (-) battery terminal to the engine block ground.

iii. If the resistance is more than 1 Ohm, repair the battery ground connection.

5. Damaged accessory wiring at B+

a. Check for add-on or accessory wiring at the positive (+) terminal of the battery.

i. Starting at the positive (+) terminal, follow any add-on or accessory wiring and examine the wire(s) for damaged insulation or an installation error that can cause supply wire to be shorted to the engine block.

6. Faulty engine DC alternator

a. Check the engine DC alternator.

b. If the normal charging voltage is not 12-14 VDC then troubleshoot the DC alternator.

i. Inspect alternator for signs of damage or excessive heat. If damaged, replace the DC alternator.

ii. Check belt tension, and adjust the position of the DC alternator to ensure that the belt is properly tensioned and not slipping on the pulley.

iii. If belt is properly tensioned, but still slips on the DC alternator pulley, remove the fan belt from the pulley, and spin the DC alternator by hand. It should spin freely and easily. If not, replace the DC alternator.

iv. If the alternator still does not produce 12-14 VDC, replace the alternator.

7. Battery voltage (12 VDC) does not match calibration

a. Verify the battery voltage in the calibration.

b. Verify the DC voltage selection in the control calibration matches the generator set system DC voltage (12 VDC).

8. Battery charger (if equipped) is not adjusted and/or is not functioning properly

a. Verify that the battery charger is adjusted properly.

b. Verify that the battery charger is functioning properly.

## Code 442 - High Battery Voltage

***Logic:***

Battery voltage is high.

***Possible Causes:***

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

3. Fault threshold is incorrect

***Diagnosis and Repair:***

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

## Code 781 - ECM CAN Datalink Has Failed

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. The ECM has lost power or failed
    a. The Emergency Stop (E-Stop) button, if installed, is a closed relay when it is pulled out (not active), and open relay when pressed (active). The E-Stop button disables power to the keyswitch input on the ECM when it is pressed (active), and CAN-LINK communication will stop. Make sure that the E-Stop is not active on the control:
        i. Pull out (inactivate) the Emergency Stop button.
        ii. Reset the Emergency Stop button.

iii. Press the Off button on the operator panel.

iv. Press the Reset button.

v. Select Manual or Auto as required.

b. Make sure that the Emergency Stop button is functioning correctly.

i. Measure the outputs of the E-Stop (Normally Open and Normally Closed contacts).

ii. Make sure that the outputs switch state correctly when engaged and disengaged.

iii. Replace the switch if faulty.

c. Check the wiring from the baseboard.

d. The keyswitch control relay is a normally open relay. Make sure that B+ is available at the relay input, then measure the voltage output.

- If there is a B+ at both the input and output of the keyswitch control relay, the relay is not faulty.
- If B+ is noted at the input but not at the output of the keyswitch control relay, replace the relay.

e. Connect to the ECM with E-Controls GCP, to verify that the ECM is functioning properly and is communicating with the CAN-LINK network.

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

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

iii. Ensure that connectors are securely connected.

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

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

2. The CAN datalink has failed

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

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

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

b. Check the terminating resistors.

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

ii. If the resistance is not 60 Ohms, check the terminating resistors. Each of the two terminating resistors should be 120 Ohms; replace if not 120 Ohms.

## Code 1117 - ECM Power Lost

***Logic:***

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

***Possible Causes:***

1. ECM power lost

***Diagnosis and Repair:***

1. ECM power lost
    a. To reset, press the Off button, press the Emergency Stop button, and wait 30 seconds.

## Code 1244 - Engine Normal Shutdown

***Logic:***

The engine has received a normal shutdown request.

***Possible Causes:***

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

***Diagnosis and Repair:***

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

## Code 1245 - Engine Shutdown Fault

***Logic:***

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

***Possible Cause:***

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

***Diagnosis and Repair:***

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

## Code 1246 - CAN Unknown Engine Fault

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

**Possible Cause:**

1. ECM/engine fault

**Diagnosis and Repair:**

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

## Code 1248 - Engine Warning

***Logic:***

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

***Possible Cause:***

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

***Diagnosis and Repair:***

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

## 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.

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

***Logic:*** This fault is used when an optional coolant level sensor is installed. The nature of the fault is an optional customer selection. The fault function can be programmed (using the InPower service tool), as follows:

- Enable/disable input (default: enable)
- Status, Warning, or Shutdown (default: #1-None, #2 and #3-Warning)
- Active closed or open (default: closed [ground])
- Change the display name using up to 19 characters (default: #1- Customer Fault 1, #2-Ground Fault, #3-Low Fuel).

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Low coolant
    a. Stop the engine and allow the engine to cool down.
    b. Visually inspect and verify that the engine coolant is at the appropriate level.
    c. If the coolant level is too low, add coolant per specifications.
2. Faulty coolant level sensor connections
    a. Inspect the coolant level sensor and the main harness connector pins.
        i. Disconnect the main harness connector from the coolant level sensor.

ii. Inspect for:

A. Corroded, bent, broken, pushed back, or expanded pins

B. Evidence of moisture in or on the connector

C. Missing or damaged connector seals

D. Dirt or debris in or on the connector pins

E. Wiring for any damage or shorting

3. Faulty coolant level sensor

a. Check sender operation.

i. Remove the connector from the sensor.

ii. Verify battery power at pin C of the sensor harness plug (Sig P-9 lead into connector). If B+ is not present, check Fuse F1; repair or replace the harness.

iii. Verify ground at pin B of the sensor harness plug (Sig P-11 lead into connector). If ground is not present, repair or replace the harness.

iv. Verify continuity of pin D of sensor harness plug (Sig P-10 lead into connector) and the J20-17 connector. If continuity is not present, repair or replace the harness.

v. With the sensor out of coolant:

A. Provide power to sensor pin C, and ground at pin B.

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

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

vi. With the sensor in coolant:

A. Provide power to sensor pin C, and ground at pin B.

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

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

4. Incorrect calibration settings for the Low Coolant fault in the control

- Verify calibration setting for Configurable Input #3 as "Fault Active State Selection = Active Closed".

5. Faulty control board

- If the sender, harness and control settings are acceptable, replace the baseboard.

## Code 1318 - Low Fuel (Warning or Shutdown)

***Logic:*** This fault is used when an optional low fuel level switch is installed. The nature of the fault is an optional customer selection. The fault function can be programmed using the InPower service tool, as follows:

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

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

***Possible Causes:***

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

***Diagnosis and Repair:***

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

## 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.

## 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.

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

| *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. Coolant heater(s) is/are not operating properly
    a. Make sure that the coolant heater(s) is/are connected properly to a power supply.
        i. Check for open circuits in the wiring.
        ii. Make sure that the power supply of the coolant heater is working properly.
    b. Measure the temperature of the coolant. If the coolant temperature is close to the ambient temperature when the ambient air temperature is below the coolant heater thermostat setting, replace the coolant heater(s).
2. 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.
3. Threshold is set too high
    a. Verify that the LCT Warning Threshold is set to 50 °F (10 °C).

## 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
6. No CAM sense (bad or damaged CAM sensor, harness issue)
7. No Crank sense (bad or damaged Crank sense/MPU, harness issue)

***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. No CAM Sense
    a. Check CAM sensor for damage
    b. Check for continuity/polarity of harness
    c. Check flywheel (fly wheel gear for damage teeth)
7. No Crank Sense
    a. Check MPU for damage or alignment
    b. Check for continuity/polarity of harness
    c. Check magnetic pin on crank wheel for damage or polarity

## 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).

## 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.

## Code 1447 - Low AC Voltage (Shutdown)

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Incorrect threshold setting or AVR settings
    a. Verify factory settings have not changed. Contact factory service support for original settings.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. If the generator set is producing correct voltage with no load, but shutting down on under voltage when the generator set picks up certain loads, the undervoltage shutdowns are being caused by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set.
    c. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual.
3. Improper connections at generator output terminals
    a. Check connections.
        i. Compare connections in generator to wiring schematic.
        ii. Correct according to the appropriate schematic as needed.
4. Incorrect voltage sense or setup wiring connection
    a. Verify that the voltage sensing inputs J22-1, J22-2, J22-3, and J22-4 are connected to L1, L2, L3, and L0 respectively.
    b. Verify that excitation inputs J18-1 and J18-2 are connected to the correct generator terminals.
5. Faulty PCC board (AVR circuit)
    a. Connect the InPower service tool.

b. Start the generator set.

c. Using the InPower service tool, verify that the AC voltage output is greater than residual.

d. If the AC voltage output is residual, using the InPower service tool, verify that the AVR is enabled.

e. Inspect the generator control harness connector pins for voltage sense and field connections.

f. Turn off the generator set.

g. Visually inspect harness for corroded pins, bent or broken pins, pushed back or expanded pins.

6. Faulty rotating rectifier assembly (diodes CR1 through CR6)
   a. Check each diode. Refer to the Alternator Performance Troubleshooting section.
7. Low residual magnetism in excitation coil
   a. The excitation coil may need to be flashed:
      i. Remove the Field Coil+ and Field Coil- leads from the alternator.
      ii. Using a 12 VDC supply:
         A. Touch the positive supply terminal to Field Coil+ and the negative supply terminal to Field Coil-.
         B. Remove after brief contact.
         C. Repeat three times.
      iii. Reconnect the Field Coil+ and Field Coil- leads to the alternator.
      iv. Reset the control.
      v. Restart the generator set.

## Code 1448 - Underfrequency

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Overrides are enabled
   a. Connect with the InPower service tool.

b. Make sure that the Alternator LX-N overrides are not enabled. If required, disable the Alternator LX-N overrides.

2. Underfrequency threshold is set too high
   a. Verify the Underfrequency Threshold and Underfrequency Time Delay set values.
3. Overload
   a. Make sure that the load on the generator set does not exceed the generator set kW rating.
   b. If the generator set is producing correct voltage with no load, but is shutting down on under voltage when the generator set picks up certain loads, the under voltage shutdowns are being caused by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps, and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set. Refer to the T-030 manual.
   c. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
4. Engine governor problem
   a. Verify that the wiring to the throttle body actuator works correctly. Correct if faulty.
   b. Verify that the throttle shaft and plate are free to move. Clean or repair if necessary.

## Code 1449 - Overfrequency

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Overfrequency threshold is set too low
   a. To access the Overfrequency configuration menu on the operator panel, go to **Setup > Genset Setup > Volt Protection**.
   b. Verify that the Overfrequency Threshold and Overfrequency Time Delay are per specification. Refer to the list to see the default value for Overfrequency.

2. Engine governor problem
    a. Verify that the wiring to the throttle body actuator works correctly. Correct if faulty.
    b. Verify that the throttle shaft and plate are free to move. Clean or repair if necessary.

## Code 1471 - High AC Current (Warning)

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Short
    a. Inspect the load cables and the AC harness connections.
    b. Disconnect the AC harness from the load cables.
    c. Inspect the AC harness and board connector pins.
    d. Visually inspect for corroded pins, bent or broken pins, and/or pushed back or expanded pins.
    e. Check for a short circuit of the harness to engine block ground.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. If the generator set is producing correct frequency with no load, but shutting down on underfrequency when the generator set picks up certain loads, the underfrequency shutdowns are being cause by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps, and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set.

c. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual.

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

7. Parameter set incorrectly
    a. Verify fault threshold values in calibration.

## Code 1472 - High AC Current (Shutdown)

***Logic:***

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Short or overload
    a. Inspect the load cables and the AC harness connections.
    b. Disconnect the AC harness from the load cables.
    c. Inspect the AC harness and board connector pins.
    d. Visually inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
    e. Check for a short circuit of the harness to engine block ground.
2. Overload
    a. Make sure that the load on the generator set does not exceed the generator set kW rating.
    b. If the generator set is producing correct frequency with no load, but shutting down on underfrequency when the generator set picks up certain loads, the underfrequency shutdowns are being cause by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps**,** and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set.
    c. Revisit the generator set sizing process to make sure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system. Refer to the T-030 manual.
3. Incorrect CTs, CT connections, or CT setup
    a. Check that correct CTs have been installed.

b. Check that CT connections are secure.

c. Check that CTs are installed correctly.

d. Connect the InPower service tools.

e. Verify the correct CT ratio has been used. Adjust the setting if necessary.

f. Check and correct connections for any bent pins, sockets, dirt, etc.

4. Incorrect CT harness connections

a. Measure the resistance of the CT harness on each pin.

b. Disconnect connector P12 from the control board and CTs.

c. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.

d. Verify the CT harness plug wiring is correct**.** Verify that continuity between pins pairs is as follows:

- P12-1 (CT1) to P12-4 (CT1-COM)
- P12-2 (CT2) to P12-5 (CT2-COM)
- P12-3 (CT3) to P12-6 (CT3-COM)

e. Re-terminate connections if necessary.

5. Incorrect rating setup

a. Connect the InPower service tool and make sure that the fault is not enabled.

b. Verify the generator set rating is set correctly.

c. Verify CT ratings in the control are set correctly. Adjust settings if necessary.

6. Fault override enabled

a. Connect with the InPower service tool and make sure that the fault is not enabled.

b. If InPower is not available, cycle power to the control:

i. Press the Emergency Stop (E-Stop) button (if installed) and wait 30 seconds.

ii. Disconnect and disable the stand alone battery charger (if installed).

iii. Disconnect the battery (disconnect the negative first).

iv. Leave the controller without power for 1 minute.

v. In the following order: Reconnect the battery, enable the stand alone battery charger, pull out the E-Stop button, and reset the control.

7. Parameter set incorrectly

a. Verify the fault threshold values in the calibration.

# 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.

## 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.

## 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.

## 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.

## Code 2118 - Fuel Pressure Low

***Logic:***

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

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

***Possible Causes:***

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

***Diagnosis and Repair:***

1. Low fuel pressure
    a. Check fuel supply and change as required.
2. Faulty fuel pressure switch connections
    a. Inspect the fuel pressure switch and the harness connectors.
    b. Disconnect the harness connector from the fuel pressure switch.
    c. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
    d. Inspect for evidence of moisture in or on the connector.
    e. Inspect for dirt or debris in or on the connector pins.
    f. Inspect the wiring for any damage or shorting.
3. Faulty fuel pressure switch
    a. Check switch operation.
    b. Turn off the fuel supply to the unit, and vent fuel in the line. Check for continuity across the two leads of the switch. The circuit should be open.
    c. Turn fuel supply to the unit on, and check for continuity across the two leads of the switch. The circuit should be closed
4. Incorrect fuel system selected in control
    a. Verify fuel system selection in control menu. Refer to the Converting the Fuel System Type section.
5. Faulty control board
    a. If the sender, harness and control settings are acceptable, the baseboard is defective. Replace it.

# 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.

## Code 2676 - Alternator Frequency Conflict (Shutdown)

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

***Possible Causes:***

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

***Diagnosis and Repair:***

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

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

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

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

## Code 2677 - Fail to Stop (Shutdown)

***Logic:***

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

***Possible Causes:***

1. Stuck fuel shutoff (FSO) valve

***Diagnosis and Repair:***

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

## 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.

## 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.

## 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.

## 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.

## 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.

## 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.

## Code 2964 - Intake Air Temperature Higher than Expected

***Logic:*** The manifold air temperature exceeds 94 °C (200 °F) for more than 60 seconds, while the engine is running (DTC 111 active).

***Possible Causes:***

1. Exhaust air entering intake
2. TMAP sensor failure

***Diagnosis and Repair:***

1. Exhaust air entering intake
   a. Inspect the exhaust system for leaks. Check the exhaust manifold gaskets, turbo gasket (if equipped), and exhaust tubing for holes or escaping exhaust. Replace the faulty component(s) if necessary.
   b. The unit is not properly ventilated. Make sure that the unit is greater than 5 feet from any obstruction.
      - For units located inside of a structure, make sure that exhaust gases do not exit within 5 feet of the intake for the structure or generator set.
      - For enclosed sets, make sure that there are no objects blocking the exhaust opening on the top of the enclosure, or objects that may redirect exiting airflow towards the intake end of the unit.
2. TMAP sensor failure
   a. Remove TMAP sensor from the intake manifold, and expose it to ambient air.
   b. Make sure that the tip is well away from the engine or other heat/cold sources.
   c. Connect using the E-controls service tool, and monitor the manifold air temperature. Compare that to the known ambient air temperature.
   d. Check for continuity across leads 1 and 2 of the TMAP sensor. If the circuit is open, replace the TMAP sensor.

## 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.).

## Code 5134 - Unknown Shutdown at Idle

***Logic:***

Engine is not getting a proper fuel supply.

***Possible Causes:***

1. Fuel supply issue

***Diagnosis and Repair:***

1. Fuel supply issue
    a. Check that there is a proper supply of fuel to the engine.

## Code 5365 - Fault Code on Secondary Source (Information that the Fueling Has Been Shifted to Secondary Source)

***Logic:***

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

- *Low Fuel Pressure Switch Active State Selection:* Active Closed
- *Function:* Low Fuel Pressure Switch (default: Disabled)
- *Fault Level Response:* Warning (default: #1-None, #2-Warning and #3-Warning)
- *Fault Active State Selection:* Active Closed (default: Active Closed)
- *Gas Fuel Type:* Dual

**Possible Causes:**

1. Low primary fuel pressure
2. Faulty fuel pressure switch connections
3. Faulty fuel pressure switch
4. Incorrect calibration settings for the Low Fuel Pressure fault in the control
5. Faulty control board

**Diagnosis and Repair:**

1. Low primary fuel pressure
    a. Check fuel supply. Diagnose and fix as required.
    b. Check fuel valve connections and operation. Diagnose and fix as required.
2. Faulty fuel pressure switch connections
    a. Inspect the fuel pressure switch and the harness connectors.
        i. Disconnect the harness connector from the fuel pressure switch.
        ii. Inspect for corroded, bent or broken tabs on the fuel pressure switch.
        iii. Inspect for evidence of moisture in or on the harness connectors.
        iv. Inspect for dirt or debris in or on the harness connectors.
        v. Inspect the wiring for any damage or shorting.
3. Faulty fuel pressure switch
    a. Check switch operation.
        i. Remove the connector from the fuel pressure switch.
        ii. Verify battery power on the sensor harness connector that plugs into tab NO on the fuel pressure switch. If B+ not present, repair or replace the harness.
        iii. Verify ground on the sensor harness connector that plugs into tab C on the fuel pressure switch. If ground is not present, repair or replace the harness.

4. Incorrect calibration settings for the Low Fuel Pressure fault in the control
    a. Verify calibration setting for Low Fuel Pressure Switch Active State Selection = Active Closed.
    b. Verify calibration setting for Configurable Input #3 Function = Low Fuel Pressure Switch.
    c. Verify calibration setting for Configurable Input #3 Fault Active State Selection = Active Closed.
5. Faulty control board
    a. If the sender, harness and control settings are acceptable, the baseboard is defective. Swap the control board.

## Code 5669 - Engine Combustion (Shutdown)

***Logic:***

Rapid rate of increase of intake manifold temperature detected.

***Possible Causes:***

1. Intake manifold over-pressurization event
2. Faulty TMAP sensor
3. Faulty engine harness

***Diagnosis and Repair:***

1. Intake manifold overpressurization event
    a. Inspect the hose couplings between the compressor outlet and intake manifold.
        i. Inspect the hose couplings for damage.
        ii. Inspect the clamps for damage.
    b. Inspect the turbocharger (if used).
        i. Externally inspect the turbocharger for damage.
        ii. Inspect for loose or missing bolts on the compressor housing.
    c. Inspect the mixer.
        i. Remove the air cleaner and confirm there are no loose pieces within the mixer.
2. Faulty TMAP sensor
    a. For the troubleshooting procedure, refer to DTC 127 in the E-Controls manual.
3. Faulty engine harness
    a. Inspect the engine harness and the connector pins.
        i. Disconnect the engine harness connector from the extension harness.
        ii. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

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

iv. Inspect for missing or damaged connector seals.

v. Inspect for dirt or debris in or on the connector pin.

vi. Disconnect the harness from the ECM and sensor.

vii. Measure the resistance in each pin from ECM to sensor. Resistance should be 5 Ohms or less.

viii. Repair or replace the harness as necessary.

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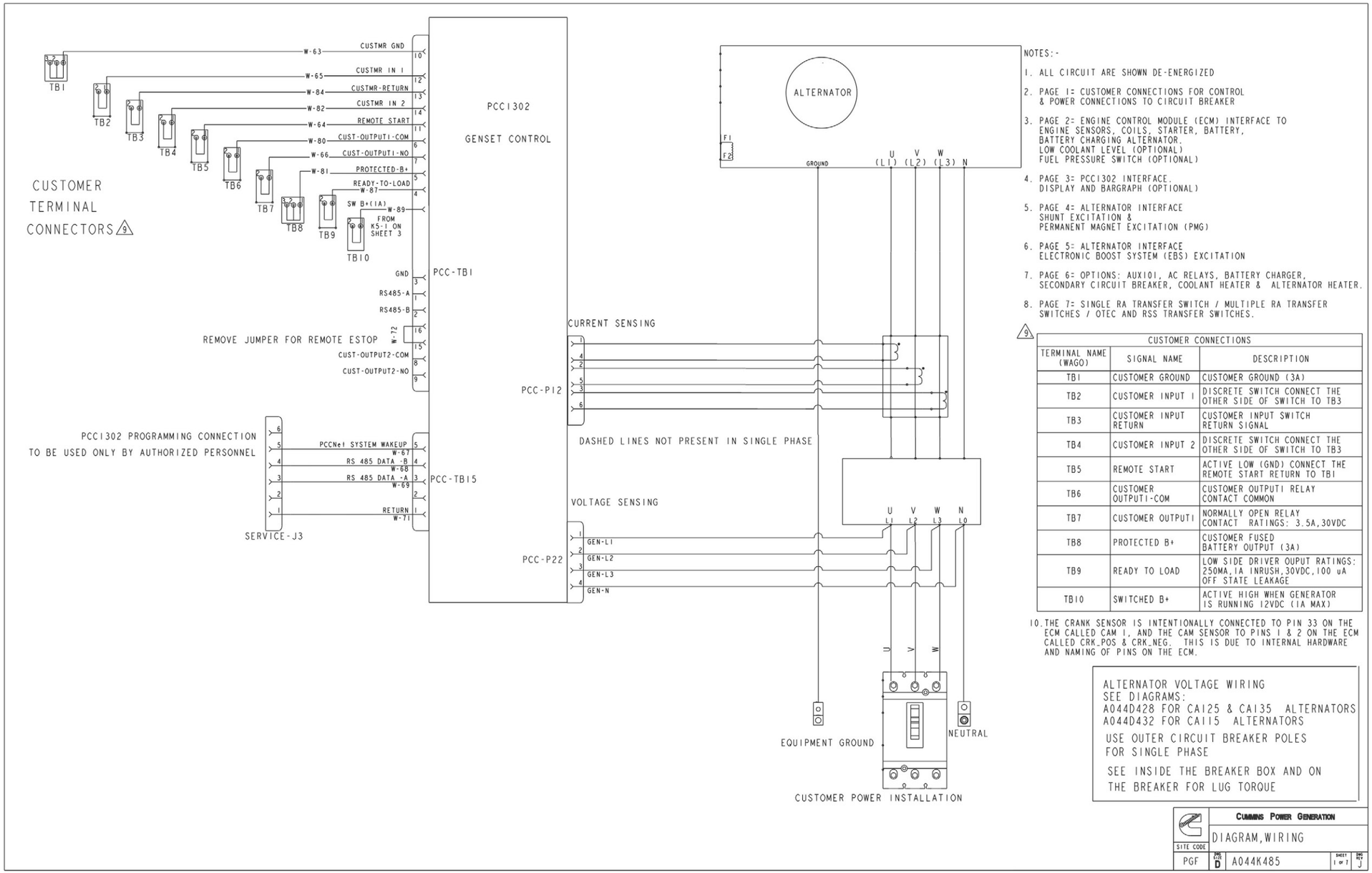
# Appendix A. Wiring Diagrams

## Table of Contents



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




NOTES:-

1. ALL CIRCUIT ARE SHOWN DE-ENERGIZED
2. PAGE 1= CUSTOMER CONNECTIONS FOR CONTROL & POWER CONNECTIONS TO CIRCUIT BREAKER
3. PAGE 2= ENGINE CONTROL MODULE (ECM) INTERFACE TO ENGINE SENSORS, COILS, STARTER, BATTERY, BATTERY CHARGING ALTERNATOR. LOW COOLANT LEVEL (OPTIONAL) FUEL PRESSURE SWITCH (OPTIONAL)
4. PAGE 3= PCC1302 INTERFACE. DISPLAY AND BARGRAPH (OPTIONAL)
5. PAGE 4= ALTERNATOR INTERFACE SHUNT EXCITATION & PERMANENT MAGNET EXCITATION (PMG)
6. PAGE 5= ALTERNATOR INTERFACE ELECTRONIC BOOST SYSTEM (EBS) EXCITATION
7. PAGE 6= OPTIONS: AUX101, AC RELAYS, BATTERY CHARGER, SECONDARY CIRCUIT BREAKER, COOLANT HEATER & ALTERNATOR HEATER.
8. PAGE 7= SINGLE RA TRANSFER SWITCH / MULTIPLE RA TRANSFER SWITCHES / OTEC AND RSS TRANSFER SWITCHES.

9

| CUSTOMER CONNECTIONS | | |
|---|---|---|
| TERMINAL NAME (WAGO) | SIGNAL NAME | DESCRIPTION |
| TB1 | CUSTOMER GROUND | CUSTOMER GROUND (3A) |
| TB2 | CUSTOMER INPUT 1 | DISCRETE SWITCH CONNECT THE OTHER SIDE OF SWITCH TO TB3 |
| TB3 | CUSTOMER INPUT RETURN | CUSTOMER INPUT SWITCH RETURN SIGNAL |
| TB4 | CUSTOMER INPUT 2 | DISCRETE SWITCH CONNECT THE OTHER SIDE OF SWITCH TO TB3 |
| TB5 | REMOTE START | ACTIVE LOW (GND) CONNECT THE REMOTE START RETURN TO TB1 |
| TB6 | CUSTOMER OUTPUT1-COM | CUSTOMER OUTPUT1 RELAY CONTACT COMMON |
| TB7 | CUSTOMER OUTPUT1 | NORMALLY OPEN RELAY CONTACT RATINGS: 3.5A,30VDC |
| TB8 | PROTECTED B+ | CUSTOMER FUSED BATTERY OUTPUT (3A) |
| TB9 | READY TO LOAD | LOW SIDE DRIVER OUPUT RATINGS: 250MA,1A INRUSH,30VDC,100 uA OFF STATE LEAKAGE |
| TB10 | SWITCHED B+ | ACTIVE HIGH WHEN GENERATOR IS RUNNING 12VDC (1A MAX) |

10. THE CRANK SENSOR IS INTENTIONALLY CONNECTED TO PIN 33 ON THE ECM CALLED CAM 1, AND THE CAM SENSOR TO PINS 1 & 2 ON THE ECM CALLED CRK_POS & CRK_NEG. THIS IS DUE TO INTERNAL HARDWARE AND NAMING OF PINS ON THE ECM.

ALTERNATOR VOLTAGE WIRING
SEE DIAGRAMS:
A044D428 FOR CA125 & CA135 ALTERNATORS
A044D432 FOR CA115 ALTERNATORS
USE OUTER CIRCUIT BREAKER POLES FOR SINGLE PHASE
SEE INSIDE THE BREAKER BOX AND ON THE BREAKER FOR LUG TORQUE

CUMMINS POWER GENERATION
DIAGRAM,WIRING
SITE CODE PGF
DWG CTR D A044K485
SHEET 1 OF 7
DWG REV J

**FIGURE 104. WIRING DIAGRAM (SHEET 1 OF 7)**

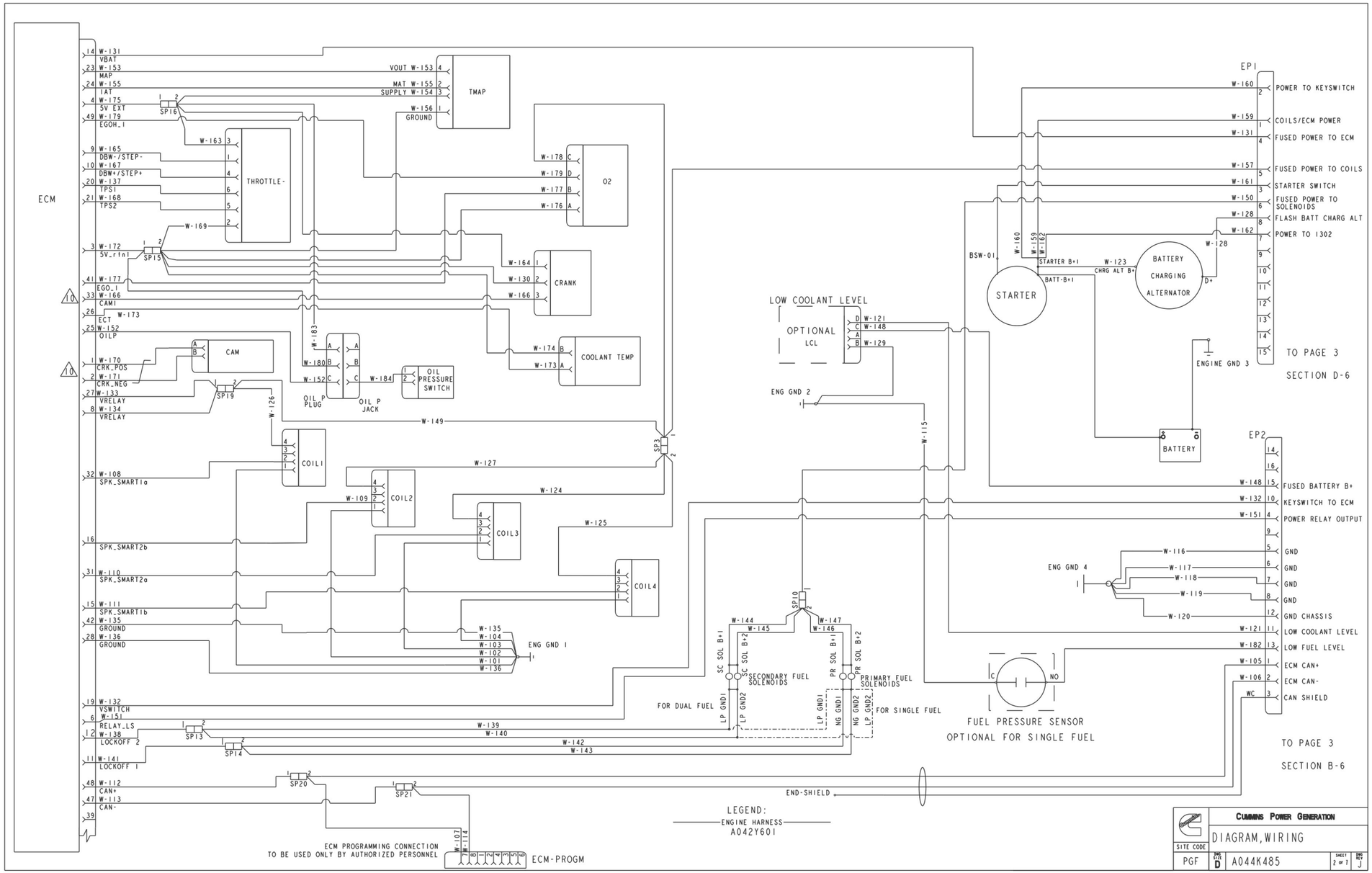



**FIGURE 105. WIRING DIAGRAM (SHEET 2 OF 7)**

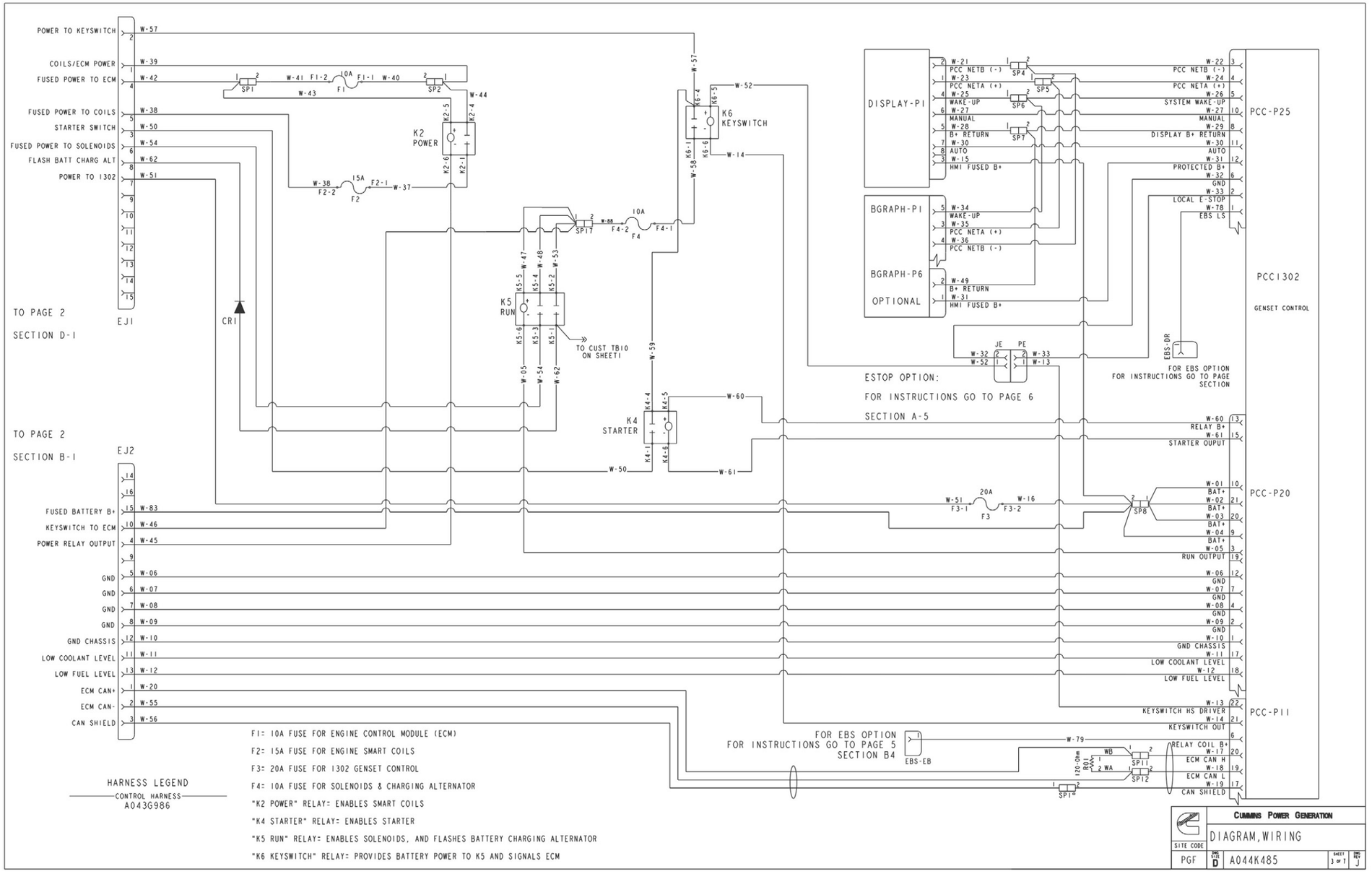



**FIGURE 106. WIRING DIAGRAM (SHEET 3 OF 7)**

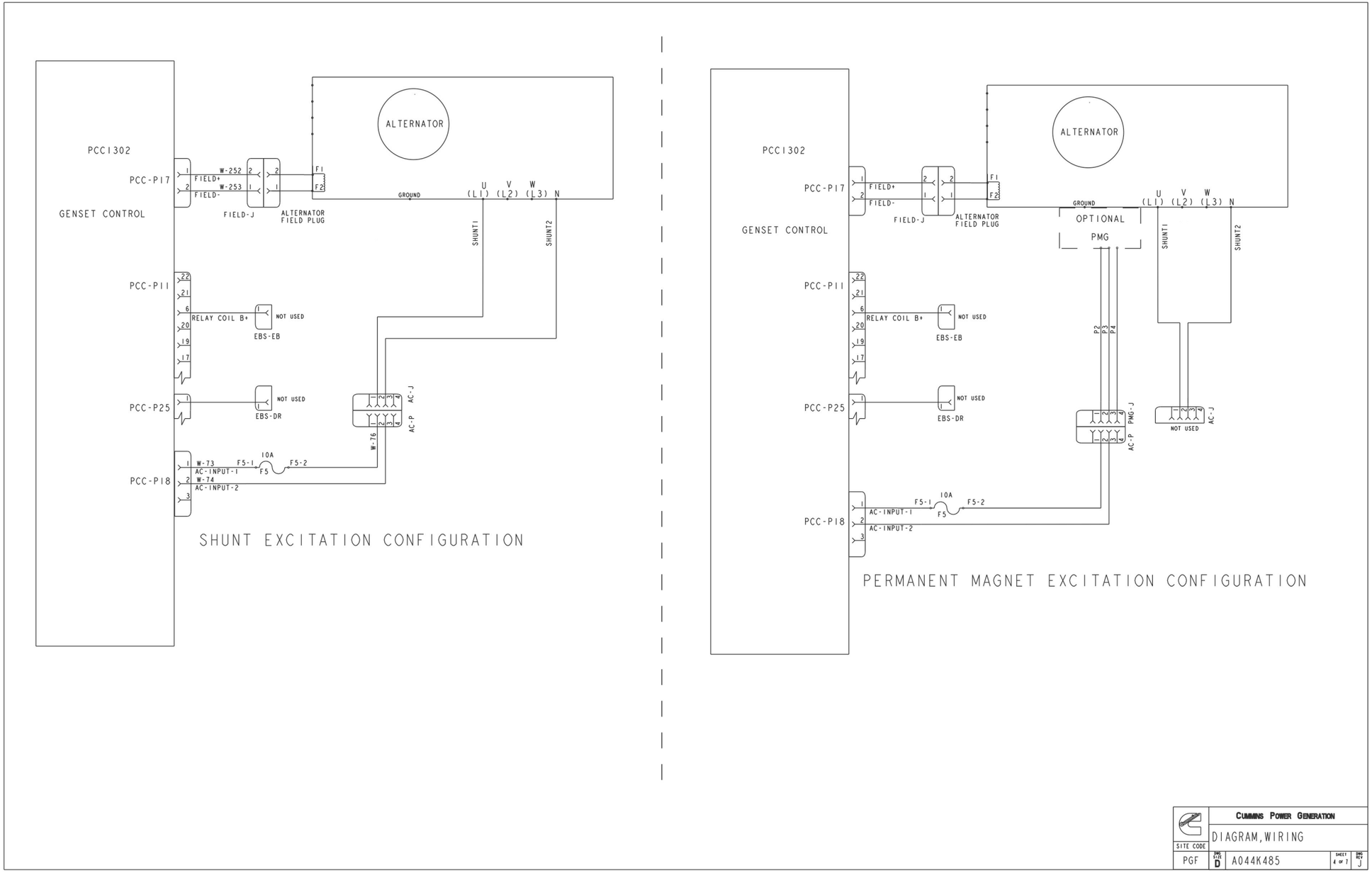



**FIGURE 107. WIRING DIAGRAM (SHEET 4 OF 7)**

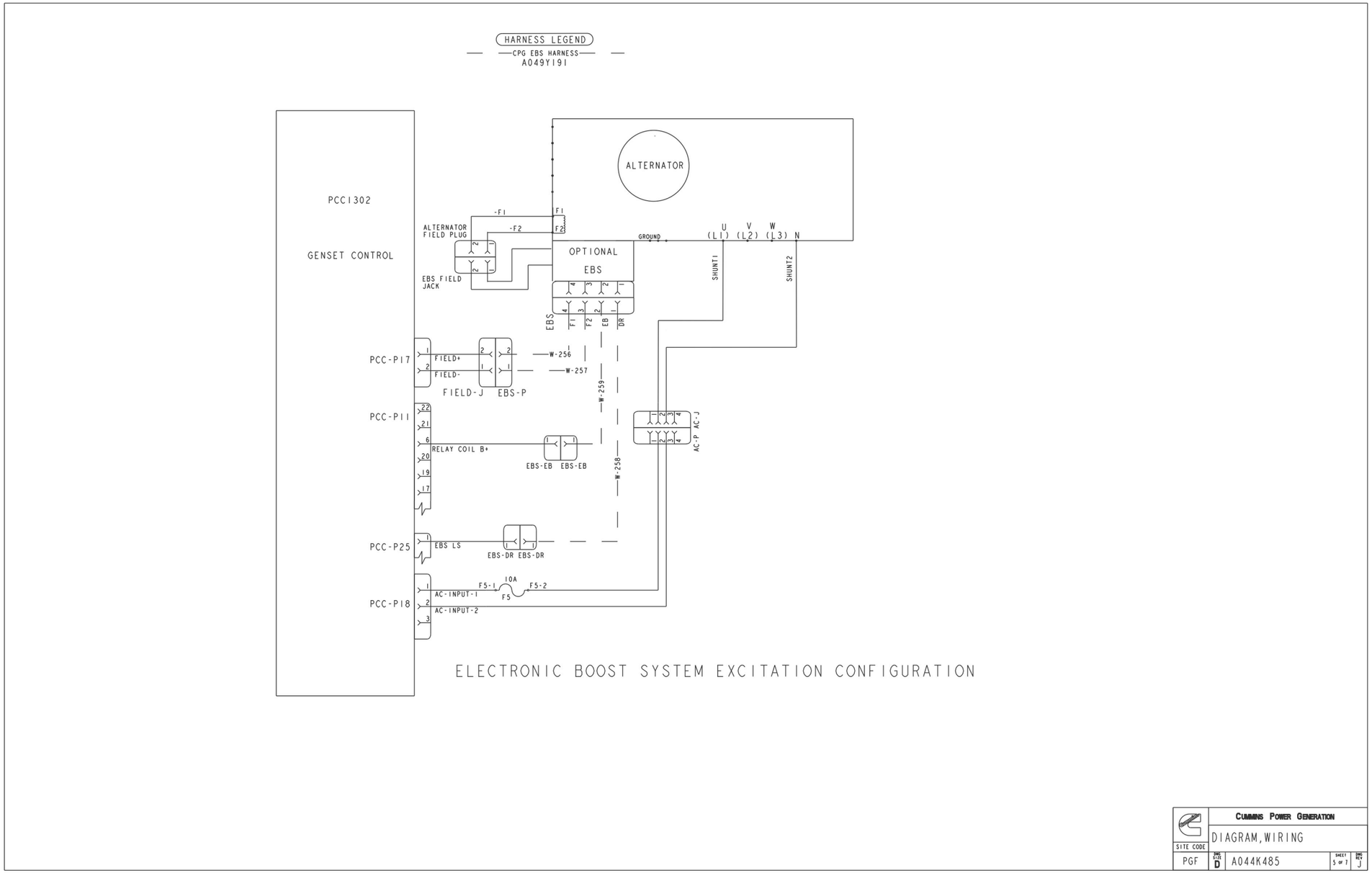



**FIGURE 108. WIRING DIAGRAM (SHEET 5 OF 7)**

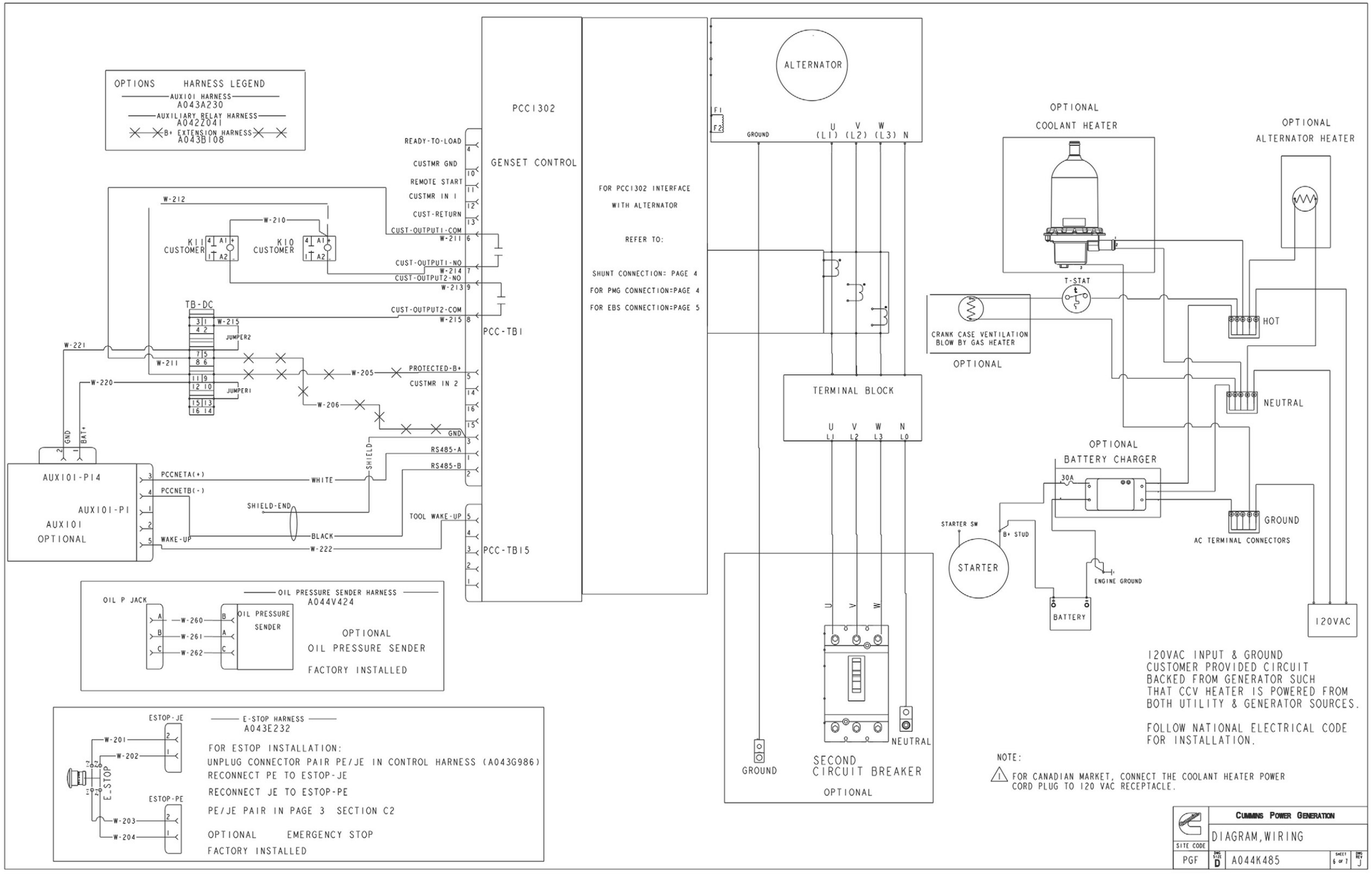
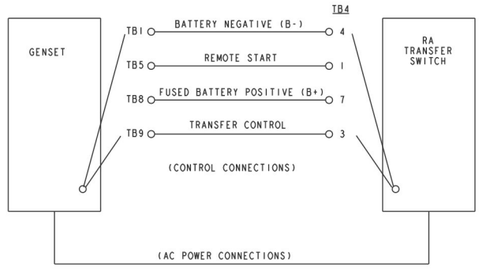



**FIGURE 109. WIRING DIAGRAM (SHEET 6 OF 7)**

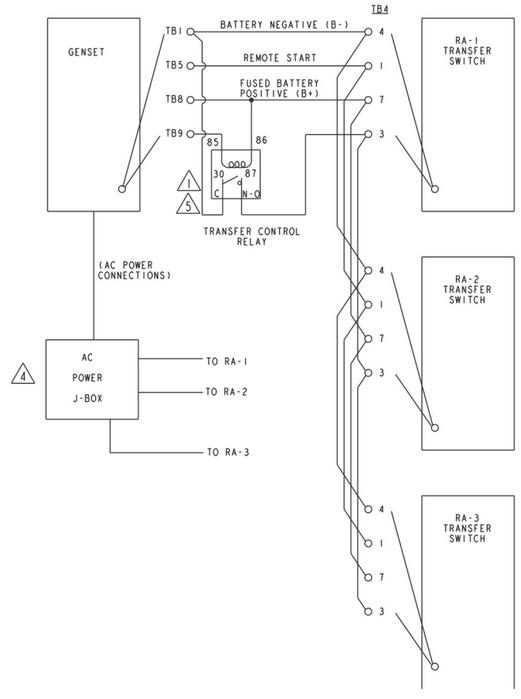
## QUIET CONNECT WITH SINGLE RA TRANSFER SWITCH




NOTES:

1. ALWAYS USE SEPARATE CONDUITS FOR POWER AND CONTROL WIRING.
2. TB9 IN GENSET IS ALSO LABELLED "READY TO LOAD" AND TB1-4.
3. CONTROL WIRES TO BE 14 GA OR 16 GA STRANDED COPPER, MAXIMUM RUN IS 200 FEET ONE WAY.

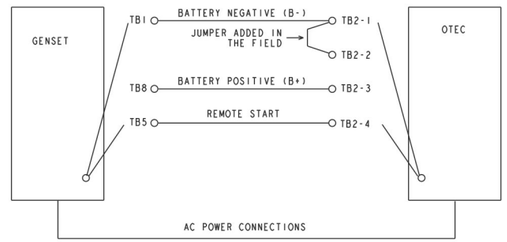
## QUIET CONNECT WITH MULTIPLE RA TRANSFER SWITCHES (UPTO 3)




NOTES:

1. INSTALL INTERPOSING RELAY 0307-2817-01 OR EQUIVALENT FOR MORE THAN 1 SWITCH
2. USE FASTON CONNECTORS 0332-1993 OR EQUIVALENT FOR RELAY CONNECTIONS.
3. DAISY CHAIN FROM SWITCH TO SWITCH.
4. USE APPROPRIATELY SIZED TERMINAL BOX FOR POWER CONDUCTORS. LUGS ARE RATED FOR 1 CONDUCTOR ONLY.
5. INTERPOSING RELAY CAN BE INSTALLED IN GENSET OR RA-1.
6. ALWAYS USE SEPARATE CONDUITS FOR POWER AND CONTROL WIRING.
7. CONTROL WIRES TO BE 14 GA OR 16 GA STRANDED COPPER, MAXIMUM RUN IS 200 FEET ONE WAY.

## 3 QUIET CONNECT WITH OTEC AND RSS TRANSFER SWITCHES




NOTES:

1. ALWAYS USE SEPARATE CONDUITS FOR POWER AND CONTROL WIRING.
2. CONTROL WIRES TO BE 14 GA OR 16 GA STRANDED COPPER, MAXIMUM RUN IS 200 FEET ONE WAY.
3. ONLY APPLIES TO RSS TRANSFER SWITCHES WITH CONTROL.

RSS100-6866
RSS200-6867
RSS100-6634
RSS200-6655
RSS100-6992
RSS200-6993
RSS100-7040
RSS200-7041

| CUMMINS POWER GENERATION | | | |
|---|---|---|---|
| DIAGRAM, WIRING | | | |
| SITE CODE | SIZE | | SHEET |
| PGF | D | A044K485 | 7 OF 7 |

**FIGURE 110. WIRING DIAGRAM (SHEET 7 OF 7)**

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# Appendix B. Alternator Reconnect Drawing

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# B.0 Alternator Reconnect Wiring Diagrams

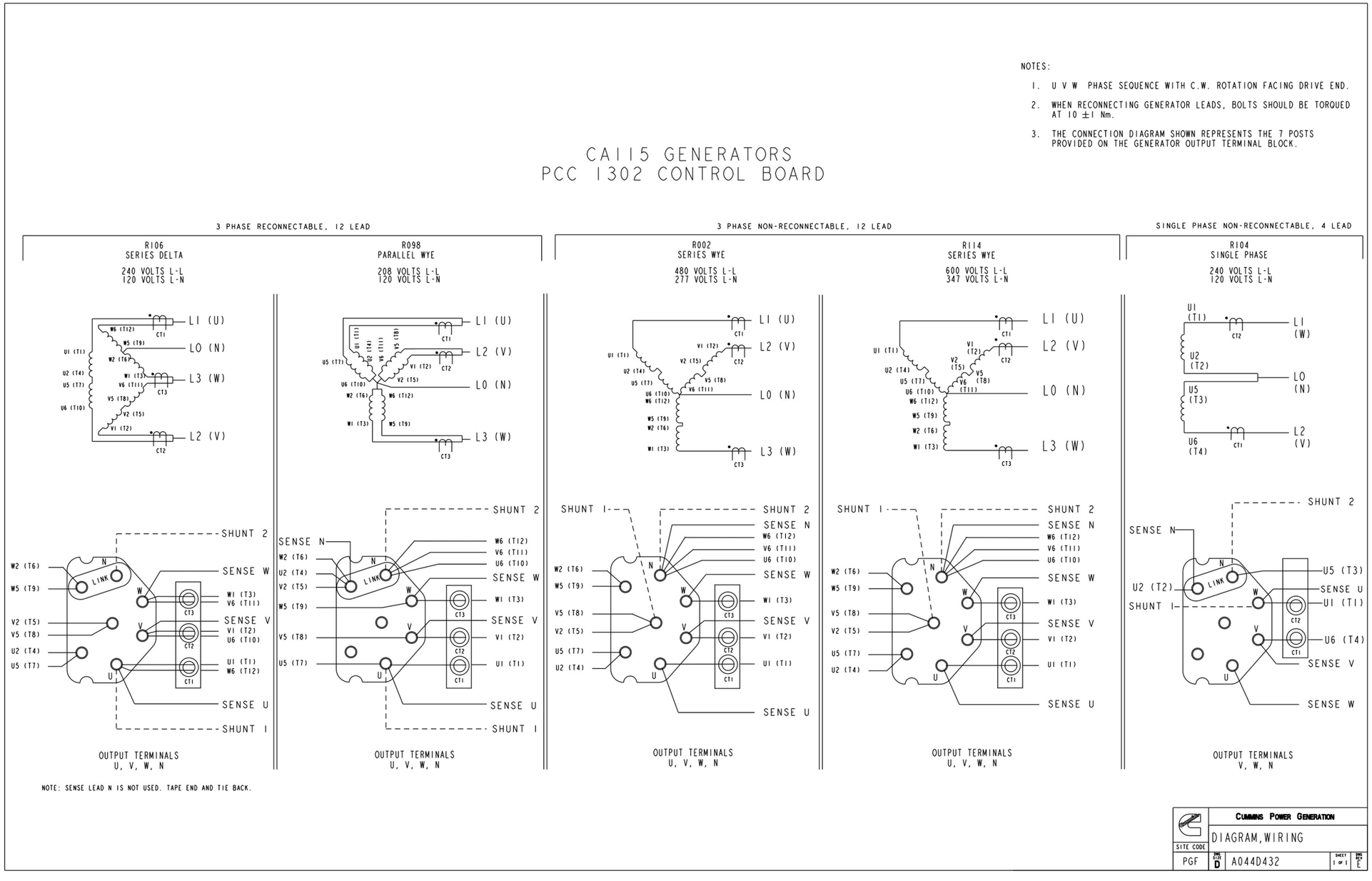


**FIGURE 111. ALTERNATOR RECONNECT, WIRING DIAGRAM FOR AW1 (SHEET 1 OF 1)**

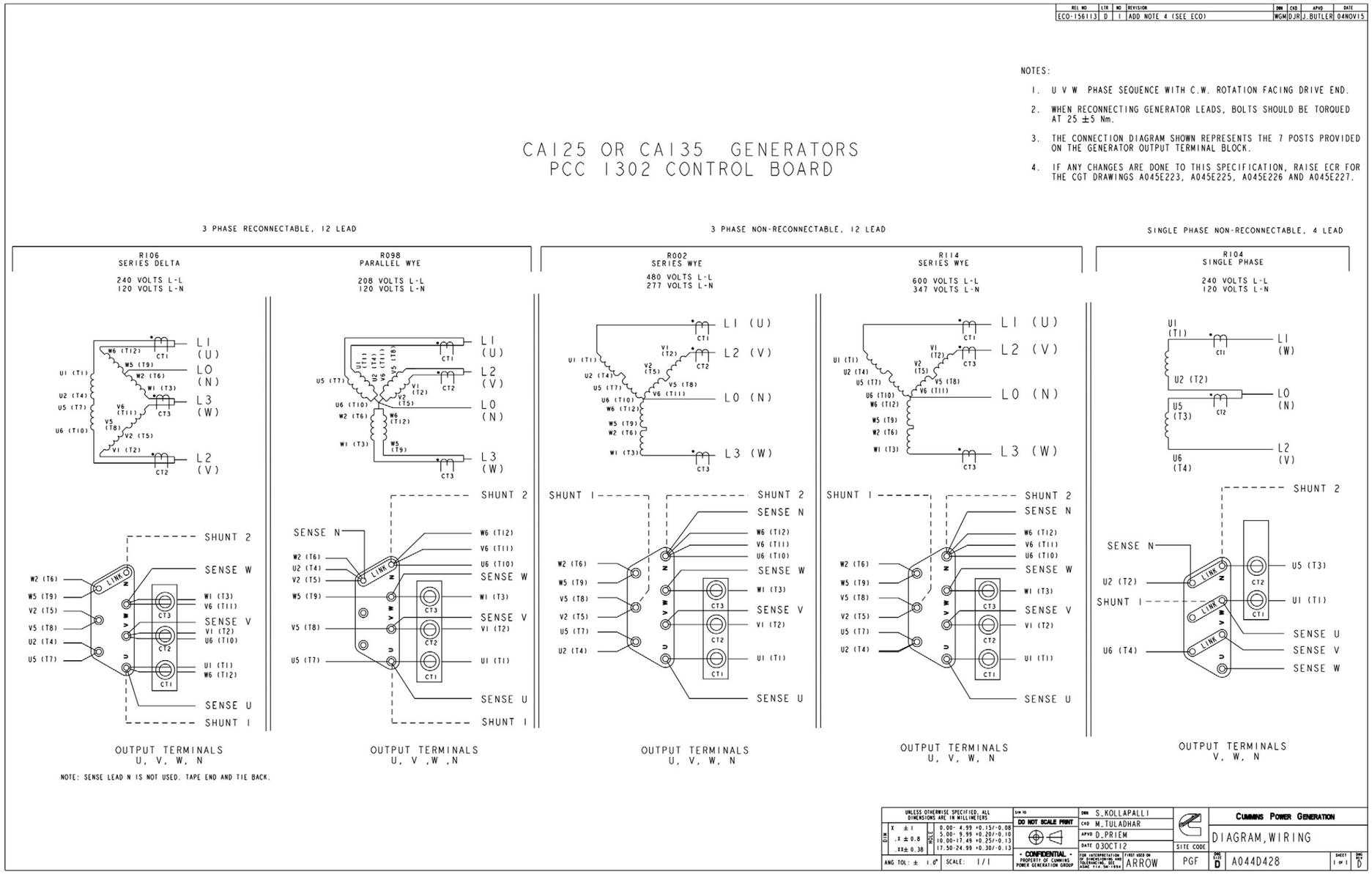


**FIGURE 112. ALTERNATOR RECONNECT, WIRING DIAGRAM FOR AW2 AND AW3 (SHEET 1 OF 1)**

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