# Service Manual

Our energy working for you.™

Cummins Power Generation

## Generator Set

**QSX15-G8 (50 Hz) Engine with the PowerCommand® 2100 Controller**
**QSX15-G9 (60 Hz) Engine with the PowerCommand® 2100 Controller**

DFEG (Spec A-K)
DFEH (Spec A-K)
DFEJ (Spec A-K)
DFEK (Spec A-K)

English
Original Instructions

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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 the equipment .

***DANGER: Warns of a hazard that will result in severe personal injury or death.***

***WARNING: Warns of a hazard that may result in severe personal injury or death.***

*CAUTION: Warns of a hazard or an unsafe practice that can result in product or property damage.*

**NOTE: A short piece of text giving information that augments the current text.**

## 1.2 General Information

This manual should form part of the documentation package supplied by Cummins Power Generation with specific generator sets. In the event that this manual has been supplied in isolation please contact your authorized distributor.

**NOTE: It is in the Operator's interest to read and understand all Warnings and Cautions contained within the documentation relevant to the generator set, its operation and daily maintenance.**

### 1.2.1 General Safety Precautions

***WARNING: Coolants under pressure can cause severe scalding. Do not open a radiator or heat exchanger pressure cap while the engine is running. Let the engine cool down before removing the coolant pressure cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.***

***WARNING: Moving parts can cause severe personal injury or death and hot exhaust parts can cause severe burns. Make sure all protective guards are properly in place before starting the generator set.***

***WARNING: 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.***

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

***WARNING: Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity. Do not breath in or come into contact with exhaust gases.***

***WARNING: Flammable liquids can cause fire or explosion. Do not store fuel, cleaners, oil, etc. near the generator set.***

***WARNING: Wear hearing protection when going near an operating generator set .***

***WARNING: Hot metal parts can cause severe burns. Avoid contact with the radiator, turbo charger, and exhaust system.***

***WARNING: Maintaining or installing a generator set can cause severe personal injury. Wear personal protective equipment such as safety glasses, protective gloves, hard hats, steel-toed boots, and protective clothing when working on equipment.***

***WARNING: Ethylene glycol, used as engine coolant, is toxic to humans and animals. Clean up coolant spills and dispose of used antifreeze in accordance with local environmental regulations.***

***WARNING: Starting fluids, such as ether, can cause explosion and generator set engine damage. Do not use.***

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

*CAUTION: To prevent accidental or remote starting while working on the generator set, disconnect the negative (–) battery cable at the battery using an insulated wrench.*

*CAUTION: Make sure that rags are not left on or near the engine.*

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

*CAUTION: Accumulated grease and oil can cause overheating and engine damage presenting a potential fire hazard. Keep the generator set clean and repair any oil leaks promptly.*

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

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

**NOTE: Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in applicable region.)**

## 1.3 Generator Set Safety Code

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

***WARNING: Improper operation and maintenance can lead to severe personal injury, or loss of life and property, by fire, electrocution, mechanical breakdown, or exhaust gas asphyxiation. Read and follow all Safety Precautions, Warnings, and Cautions throughout this manual and the documentation supplied with your generator set.***

***WARNING: Lifting and repositioning of the generator set must only be carried out using suitable lifting equipment, shackles, and spreader bars, in accordance with local guidelines and legislation, by suitably trained and experienced personnel. Incorrect lifting can result in severe personal injury, death, and/or equipment damage. For more information, contact your authorized distributor.***

### 1.3.1 Moving Parts Can Cause Severe Personal Injury Or Death

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

### 1.3.2 Positioning of Generator Set

The area for positioning the set should be adequate and level and the area immediately around the set must be free of any flammable material.

***WARNING: On an enclosed generator set, the canopy doors must be locked before re-positioning, and they must remain locked during transportation and siting.***

### 1.3.3 Positioning of Generator Set - Open Sets

The area for positioning the set should be adequate and level and the area immediately around the set must be free of any flammable material.

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

***WARNING: Any work with exposed energized circuits with potentials of 50 Volts AC or 75 Volts DC or higher poses a significant risk of electrical shock and electrical arc flash. These silent hazards can cause severe injuries or death. Refer to standard NFPA 70E or equivalent safety standards in corresponding regions for details of the dangers involved and for the safety requirements.***

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

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.

- De-energize and lockout/tagout electrical systems prior to working on them. Lockout/Tagout is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy. Please refer to the lockout/tagout 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:

**NOTE: 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.**

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

In summary:

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

## 1.4.1 AC Supply and Isolation

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 to local electrical codes and regulations. Refer to the wiring diagram supplied with the generator set.

**NOTE: Local electrical codes and regulations (for example BS EN 12601:2001) 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.**

**NOTE: 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).**

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

## 1.4.2 Medium Voltage Equipment (601 V to 15 kV)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and experienced to work on such devices. Improper use or procedures will result in severe personal injury or death.

- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

# 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.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

## 1.5.1 Spillage

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

## 1.5.2 Fluid Containment

If fluid containment is incorporated into the bedframe, it must be inspected at regular intervals. Any liquid present should be drained out and disposed of in line with local health and safety regulations. Failure to perform this action may result in spillage of liquids which could contaminate the surrounding area.

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

**NOTE: Where spillage containment is not part of a Cummins supply, it is the responsibility of the installer to provide the necessary containment to prevent contamination of the environment, especially water courses and sources.**

## 1.5.3 Do Not Operate in Flammable and Explosive Environments

Flammable vapor can cause an engine to overspeed 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 by fuel spill, leak, etc., unless the generator set is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the generator set are solely responsible for operating the generator set safely. Contact your authorized Cummins Power Generation distributor for more information.

# 1.6 Exhaust Gases Are Deadly

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust 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.
- Be sure the unit is well ventilated.

***WARNING: Engine exhaust, and some of its constituents, are known to the state of California to cause cancer, birth defects, and other reproductive harm.***

## 1.6.1 Exhaust Precautions

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

***WARNING: Hot exhaust gas can cause burns resulting in severe personal injury.***

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.

***WARNING: 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: Contaminated insulation is a fire risk which can result in severe personal injury.***

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated by fuel or oil, 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 topping off the oil or draining the fuel filters.
- Clean the exhaust pipe thoroughly.

# 1.7 Earth Ground Connection

The neutral of the generator set may be required to be bonded to earth ground at the generator 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.

**NOTE: The end user is responsible to ensure that the ground connection point surface area is clean and free of rust before making a connection.**

**NOTE: The end user is responsible for ensuring that an earthing arrangement that is compliant with local conditions is established and tested before the equipment is used.**

# 1.8 Distribution Panel Door

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

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# 2 Introduction

***WARNING: Improperly connected generator electrical output connections can cause equipment damage, severe personal injury, or death and therefore must be made by a trained and experienced electrician in accordance with the installation instructions and all applicable codes.***

***WARNING: Improper installations can cause equipment damage, severe personal injury, or death and therefore all installations must be conducted by a trained and experienced person in accordance with the installation instructions and all applicable codes.***

## 2.1 About This Manual

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

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.

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

## 2.2 Test Equipment

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

- True RMS meter for accurate measurement of small AC and DC voltages. Fluke models 87 or 8060A are good choices.
- Grounding wrist strap to prevent circuit board damage due to electrostatic discharge (ESD).
- Battery Hydrometer
- Jumper Leads
- Tachometer or Frequency Meter
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter
- PCC Service Tool Kit (Harness Tool and Sensor Tool)
- InPower Service Tool (PC based Generator Set Service Tool)

- InSite Service Tool (PC based CM570 engine control module service tool)

## 2.3 Schedule of Abbreviations

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

AmpSentry, INSITE, and InPower are trademarks of Cummins Inc. PowerCommand is a registered trademark of Cummins Inc.

| ABBR. | DESCRIPTION | ABBR. | DESCRIPTION |
|---|---|---|---|
| AC | Alternating Current | LCT | Low Coolant Temperature |
| AMP | AMP, Inc., part of Tyco Electronics | LED | Light-emitting Diode |
| ANSI | American National Standards Institute | MFM | Multifunction Monitor |
| ASTM | American Society for Testing and Materials (ASTM International) | Mil Std | Military Standard |
| ATS | Automatic Transfer Switch | NC | Normally Closed |
| AVR | Automatic Voltage Regulator | NC | Not Connected |
| AWG | American Wire Gauge | NFPA | National Fire Protection Agency |
| CAN | Controlled Area Network | NO | Normally Open |
| CB | Circuit Breaker | NWF | Network Failure |
| CE | Conformité Européenne | OEM | Original Equipment Manufacturer |
| CFM | Cubic Feet per Minute | OOR | Out of Range |
| CGT | Cummins Generator Technologies | OORH / ORH | Out of Range High |
| CMM | Cubic Meters per Minute | OORL / ORL | Out of Range Low |
| CT | Current Transformer | PB | Push Button |
| DC | Direct Current | PCC | PowerCommand® Control |
| DPF | Diesel Particulate Filter | PGI | Power Generation Interface |
| ECM | Engine Control Module | PGN | Parameter Group Number |
| ECS | Engine Control System | PI | Proportional/Integral |
| EMI | Electromagnetic interference | PID | Proportional/Integral/Derivative |
| EN | European Standard | PLC | Programmable Logic Controller |
| EPS | Engine Protection System | PMG | Permanent Magnet Generator |
| E-Stop | Emergency Stop | PT | Potential Transformer |
| FAE | Full Authority Electronic | PTC | Power Transfer Control |
| FMI | Failure Mode Identifier | PWM | Pulse-width Modulation |
| FSO | Fuel Shutoff | RFI | Radio Frequency Interference |
| Genset | Generator Set | RH | Relative Humidity |
| GCP | Generator Control Panel | RMS | Root Mean Square |
| GND | Ground | RTU | Remote Terminal Unit |
| HMI | Human-machine Interface | SAE | Society of Automotive Engineers |
| IC | Integrated Circuit | SPN | Suspect Parameter Number |

| ABBR. | DESCRIPTION | ABBR. | DESCRIPTION |
|---|---|---|---|
| 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 |
| LCL | Low Coolant Level | USASI | United States of America Standards Institute former name of ANSI |

# 2.4 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with the warnings and operating procedures.

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

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

- Operator Manual for DFEG, DFEH, DFEJ, and DFEK with PowerCommand® 2100 Controller (A040Z644)
- Installation Manual for DFEG, DFEH, DFEJ, and DFEK with PowerCommand® 2100 Controller (A040Z642)
- Service Manual for DFEG, DFEH, DFEJ, and DFEK with PowerCommand® 2100 Controller (A040Z646)
- Controller Service Manual for PowerCommand® 2100 Controller (A029X163)
- Engine Operation & Maintenance Manual for QSX15 Engine (3666423)
- Alternator Service Manual for HC Alternator (0900-9904)
- *Specification* and *Data Sheet* (For engineering data specific to the generator set)
- Application Manual T-030, *Liquid Cooled Generator Sets* (For application information)
- Parts Manual for DFEG, DFEH, DFEJ, and DFEK with QSX15 Engine, PowerCommand® 2100 Controller or PowerCommand® 3201 Controller (A040G238)
- Standard Repair Times - CH Family (A034H045)
- Warranty Manual (F1117-0005)
- Global Commercial Warranty Statement (A028U870)

# 2.5 After Sales Services

Cummins Power Generation offers a full range of maintenance and warranty services.

## 2.5.1 Maintenance

***WARNING: Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and/or mechanical service.***

For customers who wish to have their generator sets expertly serviced at regular intervals your local distributor offers a complete maintenance contract package. This covers all items subject to routine maintenance and includes a detailed report on the condition of the generator set. In addition, this can be linked to a 24-hour call-out arrangement, providing year-round assistance if necessary. Specialist engineers are available to maintain optimum performance levels from customer's generator sets, and it is recommended that maintenance tasks are only undertaken by trained and experienced technicians provided by your authorized distributor.

## 2.5.2 Warranty

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

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

For further warranty details, contact your authorized distributor.

**NOTE: Damage caused by failure to follow the correct coolant recommendations will not be covered by the warranty. Please contact your authorized distributor.**

### 2.5.2.1 Warranty Limitations

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

# 3 Specifications

## 3.1 Generator Set Specifications

**TABLE 1. DFEG, DFEH, DFEJ, AND DFEK SPECIFICATIONS**

| MODELS | DFEG | DFEH | DFEH | DFEJ | DFEJ | DFEK | DFEK |
|---|---|---|---|---|---|---|---|
| **Engine** | | | | | | | |
| Cummins Diesel Series | QSX15 (60 Hz) | QSX15 (50 Hz) | QSX15 (60 Hz) | QSX15 (50 Hz) | QSX15 (60 Hz) | QSX15 (50 Hz) | QSX15 (60 Hz) |
| Generator kW Rating (Standby) | 350 | 352 | 400 | 400 | 450 | 440 | 500 |
| Generator kW Rating (Prime) | 320 | 320 | 350 | 364 | 410 | 400 | 455 |
| **Engine Fuel Connection** | | | | | | | |
| Inlet/Outlet Thread Size | Refer to generator set outline drawing supplied | | | | | | |
| Maximum Weight (Wet) | 8800 lbs (3992 kgs) | 8800 lbs (3992 kgs) | | 9300 lbs (4218 kgs) | | 9800 lbs (4445 kgs) | |
| **Fuel** | | | | | | | |
| Fuel Pump Flow Rate | 112 Gal/hr (423.9 L/hr) | 100 Gal/hr (378.5 L/hr) | 112 Gal/hr (423.9 L/hr) | 100 Gal/hr (378.5 L/hr) | 112 Gal/hr (423.9 L/hr) | 100 Gal/hr (378.5 L/hr) | 112 Gal/hr (423.9 L/hr) |
| Maximum Fuel Inlet Restriction | 5 in Hg (127 mm Hg) | | | | | | |
| Maximum Fuel Return Restriction | 6.5 in Hg (165.1 mm Hg) | | | | | | |
| **Air** | | | | | | | |
| Maximum Air Cleaner Restriction | 25 cfm (6.2 kPa) | | | | | | |
| **Exhaust** | | | | | | | |
| Outlet Size | 6 in. NPT Male STD (A299)/ASA Flange (A355) or Slip-on (A298) Optional | | | | | | |
| Exhaust Flow at Rated Load (Standby) | 2600 cfm | 2680 cfm | 2875 cfm | 2935 cfm | 3105 cfm | 3130 cfm | 3625 cfm |
| Exhaust Flow at Rated Load (Standby) | 73.6 $m^3$/min | 75.8 $m^3$/min | 81.4 $m^3$/min | 83.1 $m^3$/min | 87.9 $m^3$/min | 88.6 $m^3$/min | 102.6 $m^3$/min |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Exhaust Flow at Rated Load (Prime) | 2505 cfm | 2470 cfm | 2685 cfm | 2720 cfm | 2910 cfm | 2935 cfm | 3135 cfm |
| Exhaust Flow at Rated Load (Prime) | 70.9 $m^3$/min | 69.9 $m^3$/min | 76 $m^3$/min | 77 $m^3$/min | 82.4 $m^3$/min | 83.1 $m^3$/min | 88.7 $m^3$/min |
| Exhaust Temperature (Standby) | 810 °F | 856 °F | 825 °F | 880 °F | 865 °F | 925 °F | 901 °F |
| Exhaust Temperature (Standby) | 432.2 °C | 457.8 °C | 440.6 °C | 471.1 °C | 462.8 °C | 496.1 °C | 482.8 °C |
| Exhaust Temperature (Prime) | 805 °F | 852 °F | 815 °F | 858 °F | 825 °F | 880 °F | 872 °F |
| Exhaust Temperature (Prime) | 429.4 °C | 455.6 °C | 435 °C | 458.9 °C | 440.6 °C | 471.1 °C | 466.7 °C |
| Maximum Allowable Back Pressure | 41 in H2O (10.2 kPa) | | | | | | |
| **Electrical System** | | | | | | | |
| Starting Voltage | 24 Volts DC | | | | | | |
| Battery(s) | Two 12 Volt | | | | | | |
| Battery Group Number | 8D | | | | | | |
| CCA (minimum) Cold Soak @ 0 °F (-18 °C) | 1400A at 0 °F to 32 °F (-18 °C to 0 °C) | | | | | | |
| **Cooling System** | | | | | | | |
| Ambient design | 104 °F (40 °C) | | | | | | |
| Coolant Capacity with Standard Set-mounted Radiator | 15.3 Gal (57.9 L) | | | | | | |
| **Lubricating System** | | | | | | | |
| Oil Capacity with Filters | 88 qt (83.3 L) | | | | | | |

# 3.2 Engine Fuel Consumption

**TABLE 2. FUEL CONSUMPTION (L/HR) AT 1500 RPM (50 HZ)**

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

1. Standby/Full Load
Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.

**TABLE 3. FUEL CONSUMPTION (L/HR) AT 1800 RPM (60 HZ)**

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

1. Standby/Full Load
Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.

**TABLE 4. FUEL CONSUMPTION (GAL/HR) AT 1500 RPM (50 HZ)**

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

1. Standby/Full Load
Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.

**TABLE 5. FUEL CONSUMPTION (GAL/HR) AT 1800 RPM (60 HZ)**

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

1. Standby/Full Load
Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.

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# 4 Periodic Maintenance

The periodic maintenance procedures should be performed at whichever interval occurs first. At each scheduled maintenance interval, perform all previous maintenance checks that are due for scheduled maintenance.

The tabular data that follows give the recommended service intervals for a generator set on Standby service. If the generator set will be subjected to Prime usage or extreme operating conditions, the service intervals should be reduced accordingly. Consult your authorized distributor.

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

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand.

Consult with an authorized distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated, or after the number of operating hours indicated, whichever comes first.

## 4.1 Periodic Maintenance Schedule

**TABLE 6. PERIODIC MAINTENANCE SCHEDULE - ONE DAY TO ONE YEAR**

| Maintenance Items | See Engine Schedule | Daily or After 8 Hrs | Monthly or After 100 Hrs | 6 Months or After 250 Hrs | 1 Year |
|---|---|---|---|---|---|
| **Perform maintenance tasks as specified using Daily or Hourly periods - whichever is sooner** | | | | | |
| General set inspection | X[1] | X[2] | | | |
| Check engine oil level | | X | | | |
| Check coolant level | | X | | | |
| Check coolant heater(s) | | X | | | |
| Check battery charging system | | | X | | |
| Check all hardware (fittings, clamps, fasteners, etc.) | | | X | | |
| Check battery electrolyte level | | | X | | |

| | | | | | |
|---|---|---|---|---|---|
| Check generator air outlet | | | X | | |
| Check radiator hoses for wear and cracks | | | | X | |
| Test rupture basin leak detect switch | | | | | X[3] |
| Check drive belt | X[1] | | | | |
| Check air cleaner (replace as necessary) | X[1] | | | | |
| Drain fuel filter(s) | X[1] | | | | |
| Check anti-freeze and DCA concentration | X[1] | | | | |
| Replace engine oil and filter | X[1] | | | | |
| Replace water coolant filter | X[1] | | | | |
| Clean crankcase breather | X[1] | | | | |
| Replace fuel filter | X[1] | | | | |
| Clean cooling systems | X[1] | | | | |

1. Refer to Cummins QSX15 Series Engine Operation and Maintenance Manual for maintenance interval and/or procedure
2. Check for oil, fuel, coolant, and exhaust system leaks. Check exhaust system audibly and visually with the generator set running.
3. Check leak detect switch in sub-base fuel tank of optional enclosure, once a year or as required by safety code. Contact your authorized service center.

# 5 Troubleshooting

## 5.1 Control System

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

## 5.2 Safety Considerations

***WARNING: Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review the safety precautions in Chapter 1 on page 1.***

***WARNING: Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Keep the output box covers in place during troubleshooting.***

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

***WARNING: Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch a trouble light ON or OFF near the battery. Discharge static electricity from your body before touching the batteries by first touching a grounded metal surface.***

***Ventilate the battery area before working on or near a battery—Wear goggles—Stop the generator set and disconnect the charger before disconnecting the battery cables—Disconnect the negative (−) cable first and reconnect it last using an insulated wrench.***

*CAUTION: 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.*

***WARNING: Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (−) cable from the battery terminal with an insulated wrench.***

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 InPower Service Tool

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

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

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

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

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

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

## 5.4 Network Applications and Customer Inputs

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

## 5.5 Troubleshooting Procedures

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

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

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

This section contains the following information:

- How to troubleshoot a local/remote failure to crank problem when the control panel does not indicate any fault condition.
- How to troubleshoot engine problems that are not within the detectable range of the PC control.

- How to troubleshoot a Check Engine lamp fault for generator sets that contain the low emissions option.
- Descriptions of each status, warning, and shutdown code; warning and shutdown limits where applicable; and basic corrective actions, such as checking fluid levels, control reset functions, battery connections, etc.
- Detailed troubleshooting procedures. In the following list of troubleshooting procedures, the fault codes are arranged in numeric order.

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

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

# 5.6 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 is supplied to the control. (Control Alive indicator on the base board is not flashing).
2. The base board is not properly calibrated or the calibration is corrupt (the Control Alive indicator on the base board is flashing every 0.5 seconds).
3. The Emergency Stop switch or wiring is defective.
4. The Manual input is not getting from the Manual Select Switch (S12) to the base board.
5. The Manual Run/Stop button, harness, or the base board is defective.

## 5.6.1 Engine Does Not Crank in Manual Mode - Diagnosis and Repair

1. No power is supplied to the control. (The Control Alive indicator on the base board is not flashing).
    - Poor battery cable connections. Clean the battery cable terminals and tighten all connections using an insulated wrench.
    - Remove F4 and check continuity. If open, replace the fuse with one of the same type and amp rating (5 Amps).
        - If F4 is OK, remove connector P7 and check for B+ at P7-1 through P7-4 and GND at P7-5 through P7-8.
        - If B+ or ground missing, isolate to the harness and the TB BAT terminal mounted on the engine block.
        - If B+ and ground check OK, the base board may be defective. Cycle power to the base board by reconnecting P7.

2. The base board is not properly calibrated or the calibration is corrupt. (The Control Alive indicator flashes every ½ second.)
    - Confirm that the installed calibration part number matches the serial plate information. Re-enter a calibration file if necessary. (When properly installed, the Control Alive indicator flashes once every second.)
3. The Emergency Stop switch or wiring is defective.
    - With the Emergency Stop push button not activated, remove connector P1 and check for continuity between P1-1 (ESTOP-NC1) and P1-2 (ESTOP-NC2). (If the circuit is open, the control will detect a local E-Stop condition but will not display the E-Stop condition.) If the circuit is open, isolate to the Emergency Stop switch and wiring.
    - If there is continuity, go to the next step.
4. The Manual input is not getting from the Manual select switch (S12) to the base board indicating that S12, the base board, or the harness is defective.
    - With S12 in the Manual position, remove connector P1 from the base board and check for continuity from P1-6 (MAN) to P1-9 (GND). If there is no continuity, isolate the switch and wiring.
    - If there is continuity, go to the next step.
5. The Manual Run/Stop button, harness, or the base board is defective.
    - Remove connector P3 from the base board and check for continuity from P3-9 (MAN RUN/STOP) to P3-10 (GND). If there is no continuity when pressing the Manual Run/Stop button, replace the front membrane panel.

# 5.7 Fault Code 135 - Oil Pressure Sensor High

**Lamp:** Warning

**Logic:** Engine oil pressure sensor is shorted high.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Sensor Connections are defective.
3. Sensor is defective.
4. Harness is defective.

## 5.7.1 Fault Code 135 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor Connections are defective.
    - Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

3. Sensor is defective.
    - Disconnect the oil pressure sensor leads and connect an oil pressure sensor simulator to the harness.

      "**OIL PRESSURE SENSOR H" warning is displayed after the fault condition is sensed for 10 seconds.**

        - If the control responds to the simulator, replace the sensor.
        - If control does not respond, go to next step.
4. Harness is defective.
    - Remove connector P7 from the base board and the connector from the sensor. Check P7-13, 17, and 21 as follows:
        - Check for a short circuit from pin to pin (more than 200k ohms is OK)
        - Check for an open circuit (10 ohms or less is OK)
    - Repair or Replace as necessary.

# 5.8 Fault Code 141 - Oil Pressure Sensor Low

**Lamp:** Warning

**Logic:** Engine oil pressure sensor is shorted low.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Sensor Connections are defective.
3. Sensor is defective.
4. Harness is defective.

## 5.8.1 Fault Code 141 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor Connections are defective.
    - Inspect the sensor and the engine harness connector pins. Repair or replace as necessary.
3. Sensor is defective.
    - Disconnect the oil pressure sensor leads and connect an oil pressure sensor simulator to the harness.

      "**OIL PRESSURE SENSOR L" warning is displayed after the fault condition is sensed for 10 seconds.**

        - If the control responds to the simulator, replace the sensor.
        - If control does not respond, go to next step.

4. Harness is defective.
    - Remove connector P7 from base board and the connector from the sensor. Check P7-13, 17, and 21 as follows:
        - Check for a short circuit from pin to pin (more than 200k ohms is OK)
        - Check for an open circuit (10 ohms or less is OK)
    - Repair or replace as necessary.

## 5.9 Fault Code 143 - Pre-Low Oil Pressure

**Lamp:** Warning

**Logic:** Engine oil pressure has dropped below the warning threshold for the low oil pressure.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Low oil level, clogged lines or filters.
3. Sensor or oil pump is defective. The generator set may be shutting down on another fault.
4. Harness is defective.

### 5.9.1 Fault Code 143 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Low oil level, clogged lines or filters.
    - Check oil level, lines, and filters.
    - If the oil system is OK but oil level is low, replenish.
3. Sensor or oil pump is defective. The generator set may be shutting down on another fault.
    - Disconnect the oil pressure sensor leads and connect an oil pressure sensor simulator to the harness.
        - If the control responds to the simulator, reconnect the sensor, disconnect the ACT – signal wire at the fuel pump actuator, and crank the engine. Check the oil pressure reading on the digital display.
        - If the display shows an acceptable oil pressure, the problem may not be in the oil or the oil sensing system. The generator set may be shutting down on another fault (out of fuel, intermittent connector). Restart the generator set and monitor the PCC display panel for other faults.
        - If the display does not show and acceptable oil pressure, replace the sensor. If the PCC still doesn’t display an oil pressure while cranking, the oil pump may be defective. Refer to the engine service manual.
        - If the control does not respond to the simulator, go to the next step.

4. Harness is defective.
    - If the control does not respond to the simulator, the base board or the harness is defective.
        - Check for +5 VDC at the sensor (lead marked E1-A). If there is no 5 VDC at the sensor:
            - Check for 5 VDC at P7-21.
            - If yes, the harness is defective and must be replaced.
    - If there is 5 VDC at the sensor, use the sensor simulator to generate a signal to P7-13 (OP OUT) and P7-17 (OP COMM). If the pressure signal (.5 to 4.5 VDC) does not get to P7, isolate to the harness. If the pressure signal does go to P7, the base board is defective.

# 5.10 Fault Code 144 - Coolant Temperature Sensor High

**Lamp:** Warning

**Logic:** Coolant temperature sensor signal is shorted high.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Sensor connections are defective.
3. Sensor is defective.
4. Harness is defective.

## 5.10.1 Fault Code 144 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor Connections are defective.
    - Inspect the sensor and engine harness connector pins. Repair or replace as necessary.
3. Sensor is defective.
    - Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault.
    - If the control responds to the simulator, replace the sensor. If the control does not respond, go to the next step.
4. Harness is defective.
    - Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for a short circuit as follows:
        - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
        - Check for a short circuit from pin to pin (more than 200k ohms is OK).

- Repair or replace as necessary.

- Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).
  - If resistance is not the same, the harness is defective and must be replaced.

# 5.11 Fault Code 145 - Coolant Temperature Sensor Low

**Lamp:** Warning

**Logic:** Coolant temperature sensor signal is shorted low.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Sensor connections are defective.
3. Sensor is defective.
4. Harness is defective.

## 5.11.1 Fault Code 145 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
   - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
   - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor connections are defective.
   - Inspect the sensor and engine harness connector pins. Repair or replace as necessary.
3. Sensor is defective.
   - Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault.
   - If the control responds to the simulator, replace the sensor. If control does not respond, go to the next step.
4. Harness is defective.
   - Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for a short circuit as follows:
     - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
     - Check for a short circuit from pin to pin (more than 200k ohms is OK).
     - Repair or replace as necessary.
   - Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).
     - If resistance is not the same, the harness is defective and must be replaced.

# 5.12 Fault Code 146 - Pre-High Coolant Temperature

**Lamp:** Warning

**Logic:** Engine coolant temperature has exceeded the warning threshold for pre-high/high coolant temperature.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Engine or sensor circuitry problem.
3. Sensor is defective.
4. Harness is defective.

## 5.12.1 Fault Code 146 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor connections are defective.
    - Isolate to the engine or sensor circuitry.
    - Check the sensor accuracy with a thermocouple or similar temperature probe.
        - If the PCC ambient coolant temperature reading is accurate, the engine may be overheating. Refer to the engine service manual.
        - If the PCC ambient coolant temperature reading is not accurate go to the next step.
3. Sensor is defective.
    - Disconnect the sensor, and connect a coolant temperature sensor simulator to the harness.
    - If the control responds to the simulator, replace the sensor. If control does not respond, go to the next step.
4. Harness is defective.
    - Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for a short circuit as follows:
        - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
        - Check for a short circuit from pin to pin (more than 200k ohms is OK).
        - Repair or replace as necessary.
    - Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).
        - If resistance is not the same, the harness is defective and must be replaced.

# 5.13 Fault Code 151 - High Coolant Temperature

**Lamp:** Warning

**Logic:** Engine coolant temperature has exceeded the warning threshold for pre-high/high coolant temperature.

**Possible Cause:**

1. Fault simulation has been enabled with InPower.
2. Engine or sensor circuitry problem.
3. Sensor is defective.
4. Harness is defective.

## 5.13.1 Fault Code 151 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the oil pressure sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Sensor connections are defective.
    - Isolate to the engine or sensor circuitry.
    - Check the sensor accuracy with a thermocouple or similar temperature probe.
        - If the PCC ambient coolant temperature reading is accurate, the engine may be overheating. Refer to the engine service manual.
        - If the PCC ambient coolant temperature reading is not accurate go to the next step.
3. Sensor is defective.
    - Disconnect the sensor, and connect a coolant temperature sensor simulator to the harness.
    - If the control responds to the simulator, replace the sensor. If control does not respond, go to the next step.
4. Harness is defective.
    - Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for a short circuit as follows:
        - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
        - Check for a short circuit from pin to pin (more than 200k ohms is OK).
        - Repair or replace as necessary.
    - Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).
        - If resistance is not the same, the harness is defective and must be replaced.

# 5.14 Fault Code 197 - Low Coolant Level

**Lamp:** Warning (Optional)

**Logic:** Engine coolant level has dropped below the warning threshold for low coolant level.

**Possible Cause:**

1. Coolant level is low and needs to be replenished.
2. The sensor or harness is defective.

## 5.14.1 Fault Code 197 - Diagnosis and Repair

1. The coolant level is low and needs to be replenished.
    - Check the level of coolant in the radiator.
    - Add coolant to the radiator if necessary.
2. The sensor or harness is defective.
    - If the coolant level is normal, isolate the source of the low coolant signal (GND signal).
    - Disconnect the signal lead at the sender and reset the control.
        - If the 197/235 message drops out and does not reappear, replace the sender.
        - If the 197/235 message reappears and remains after the control is reset, remove connector P7 from the base board and check for continuity from P7-32 to the ground.
            - If there is continuity, replace the harness.

# 5.15 Fault Code 234 - Overspeed

**Lamp:** Shutdown

**Logic:** Engine speed signal indicates the engine speed is greater than the shutdown threshold.

**Possible Cause:**

1. Cold engine (no heaters).
2. Single step large block load removal.
3. Fault simulation has been enabled with InPower
4. Fault threshold is incorrectly set with InPower.
5. Monitor the engine RPM using InPower.
6. The electronic governor actuator is defective.

## 5.15.1 Fault Code 234 - Diagnosis and Repair

1. Cold engine (no heaters).
    - Overspeed can occur when starting a very cold engine. Clear the fault and restart the generator set.
2. Single step large block load removal.
    - Clear the fault and restart the generator set.

3. Fault simulation has been enabled with InPower.
    - With InPower, verify that the fault simulation is not enabled for the coolant sensor.
    - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
4. Fault threshold is incorrectly set with InPower.
    - Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
5. Monitor the engine RPM using InPower.
    - If the RPM is not correct, refer to Fault Code 121 for corrective action.
6. The electronic governor actuator is defective.
    - Check for binding in the actuator assembly of the injection pump. Disassembly of the injection pump may be required to inspect/repair O-rings, pump, etc.
    - Refer to engine service manual.

# 5.16 Fault Code 235 - Low Coolant Level

**Lamp:** Shutdown

**Logic:** Engine coolant level has dropped below the shutdown threshold for low coolant level.

## 5.16.1 Fault Code 235 - Diagnosis and Repair

Refer to fault code **197.**

# 5.17 Fault Code 359 - Fail to Start (3.3L Electronic Governed Engine)

**Lamp:** Shutdown

**Logic:** Engine failed to start after expiration of the last crank time.

**Possible Cause:**

1. Restricted fuel supply due to:
    - Fuel level below the pickup tube in the tank.
    - Closed shutoff valve in the supply line.
    - Fuel injectors are clogged.
    - Air in the fuel system.
2. Injection pump actuator is not energized because the harness or governor is defective.

## 5.17.1 Fault Code 359 - Diagnosis and Repair

1. Restricted fuel supply.
    - Add fuel if low. Prime the fuel system
    - Open any closed shutoff valve in the fuel line supplying the engine.

- Refer to the engine service manual.
- Bleed air from the fuel system. Refer to the engine service manual.

2. Injection pump actuator not energized because the harness or governor actuator is defective.
   - Isolate to the harness or governor actuator.
     - Display “Governor Duty Cycle” menu. Attempt to start and check for duty cycle (55% is about average). If the percentage of duty cycle is displayed before the shutdown, the harness or actuator is defective; go to next step.
       - The duty cycle displayed indicates the processor is functioning, but the output circuitry of the base board could be defective.
     - Remove connector P7 from the base board and check wiring continuity of the actuator circuit. P7-24 (ACT+) and P7-28 (ACT**–**) to appropriate +/**–** terminals of the governor actuator. Repair as necessary. If continuity is OK, go to next step.
     - Disconnect the two leads attached to the injector pump actuator. Measure the resistance across the two actuator terminals. A reading of 2.3 ohms indicates that the actuator circuit is OK.
       - This test only shows that the actuator circuit is not open or shorted, but not if there is binding. Replace the actuator assembly if an open or short is measured. If the actuator is OK, go to next step.
     - Attempt to start and check for CNTL B+ at terminal lead ACT+ of the governor actuator (use the engine block for meter ground).
       - If CNTL B+ is present, attempt to start and check for GOV PWM (pulse width modulated) signal (measure across the terminals of the actuator).
       - If GOV PWM signal is present, the governor actuator is defective (binding in the actuator assembly of the injection pump). Disassembly of the injection pump may be required to inspect/repair the O-rings, pump, etc. Refer to the engine service manual.

# 5.18 Fault Code 415 - Low Oil Pressure

**Lamp:** Shutdown

**Logic:** Engine oil pressure has dropped below the shutdown threshold for low oil pressure.

## 5.18.1 Fault Code 415 - Diagnosis and Repair

Refer to fault code **143**

# 5.19 Fault Code 441 - Low Battery Voltage

**Lamp:** Warning

**Logic:** Low battery voltage has been detected.

**Possible Cause:**

1. Battery connections are loose or dirty.

2. Low electrolyte level in the battery.
3. Defective or discharged battery.
4. Incorrect battery voltage.
5. Insufficient battery charging voltage.
6. Engine DC alternator is defective.
7. Harness is defective.

## 5.19.1 Fault Code 441 - Diagnosis and Repair

1. Battery connections are loose or dirty.
   - Clean and tighten (with an insulated wrench), the battery cable connectors or replace the battery cable connectors and cables.
2. Low electrolyte level in the battery.
   - Replenish the electrolyte and recharge the battery.
3. Defective or discharged battery.
   - Recharge or replace the battery.

**NOTE: Specific gravity of a fully charged battery is approximately 1.26 at 80 °F (27 °C).**

4. Incorrect battery voltage.
   - Verify that the battery voltage (12 or 24 VDC) matches the calibration.
5. Insufficient battery charging voltage.
   - Adjust the charge rate of the battery charging circuit, according to the manufacturer's instructions.
6. Engine DC alternator is defective.
   - Replace the engine DC alternator if the normal battery charging voltage (12 to 14 or 24 to 26 VDC) is not obtained.
7. The harness is defective.
   - Remove connector P7 from the base board and check the battery voltage at P7-3 (B+) to P7-7 (GND) and P7-4 (B+) to P7-8 (GND).

**NOTE: If the voltage at P7 is not the same as the battery voltage, the harness is defective and must be replaced.**

# 5.20 Fault Code 442 - High Battery Voltage

**Lamp:** Warning

**Logic:** High battery voltage has been detected.

**Possibly Cause:**

1. Excessive battery charging voltage.
2. Engine DC alternator is defective.

3. Incorrect battery voltage.

### 5.20.1 Fault Code 442 - Diagnosis and Repair

1. Excessive battery charging voltage.
   - Adjust the charge rate of the battery charging circuit according to the manufacturer's instructions.
2. Engine DC alternator is defective.
   - Replace the engine DC alternator if the normal battery charging voltage (12 to 14 or 24-26 VDC) is not obtained.
3. Incorrect battery voltage.
   - Verify that the battery voltage (12 or 24 VDC) matches the calibration.

## 5.21 Fault Code 1123 - Shutdown After Battle Short

**Lamp:** Warning

**Corrective Action:** A shutdown fault occurred while Battle Short was enabled and Battle Short transitioned from enabled to disabled. Review the Fault History and perform corrective action.

## 5.22 Fault Code 1124 - Delayed Shutdown

**Logic:** Provides an advanced warning of an impending generator set shutdown to loads which cannot handle sudden losses of power, and fault 1124 (Warning) becomes active.

**Lamp:** Warning

**Possible Causes:**

1. A shutdown fault

## 5.23 Fault Code 1131 - Battle Short Active

**Logic:** If the battle short mode has been activated the fault code 1131 (warning) becomes active.

**Lamp:** Warning

**Possible Causes:**

1. Battle short function enabled

## 5.24 Fault Codes 1311, 1312, 1317, and 1318 - Customer Input

**Lamp:** Nature of the fault is an optional customer selection.

**Possible Cause:**

1. If there is no actual fault, the problem may be an external wiring problem; active input (closed or open) selection is incorrect.

### 5.24.1 Fault Code 1311, 1312, 1317, 1318 - Diagnosis and Repair

1. Disconnect the signal lead from TB1 and reset the control.
   - CUST_IN1 – TB1-4
   - CUST_IN2 – TB1-5
   - CUST_IN3 – TB1-6
   - CUST_IN4 – TB1-7
- If the fault message clears, the external wiring has a short or open circuit, or the active input selection (closed/open) is not correct for the customer input (use the service tool to check the selection).

## 5.25 Fault Code 1313-1316 - Network Fault 1 Through 4

**Lamp:** Warning/ Shutdown or none for status message.

**Corrective Action:** Indicates network input (#1-#4) is in an active state. Each of the fault functions can be programmed (using the service tool), as follows:

- Status, Warning, or Shutdown
- Change display name, using up to 19 characters

## 5.26 Fault Code 1334 - Crit Scaler OR

**Lamp:** Shutdown

**Corrective Action:** An incorrect feature or calibration was entered into the control.

## 5.27 Fault Code 1335 - Non-Crit Scaler OR

**Lamp:** Warning

**Corrective Action:** An incorrect feature or calibration was entered into the control.

## 5.28 Fault Code 1416 - Fail to Shutdown

**Logic:** In order to provide a record in the fault history that the generator set shutdown faults were bypassed while the power command controller was in Battle Short mode the fault code 1416 (warning) becomes active.

**Lamp:** Warning

**Possible Causes:**.

1. A shutdown fault was bypassed while the Battle Short feature was enabled on the power command controller

## 5.29 Fault Code 1417 - Power Down Failure

**Logic:** If the control has failed to go to sleep the fault code 1417 (warning) becomes active.

**Lamp:** Warning

**Possible Causes:**

1. Possibility of the base board fault

# 5.30 Fault Code 1433 - Emergency Stop

**Lamp:** Shutdown

**Corrective Action:** Indicates a local Emergency Stop. To reset the local/remote Emergency Stop button:

1. Pull the Emergency stop button out.
2. Move the O/Manual/Auto switch to O.
3. Press the front panel Fault Acknowledge/Reset button.
4. Select Manual or Auto, as required.

# 5.31 Fault Code 1434 - Remote Emergency Stop

**Logic:** If the Remote Emergency Stop has been activated the fault code 1434 (shutdown) becomes active.

**Lamp:** Shutdown

**Possible Causes:**

1. The Remote Emergency stop button has been activated
2. Faulty connection or faulty emergency stop switch

# 5.32 Fault Code 1435 - Low Coolant Temperature

**Lamp:** Warning

**Logic:** Engine coolant temperature has dropped below the warning threshold for low coolant temperature.

**Possible Cause:**

1. Fault simulation was enabled with InPower.
2. Fault threshold is incorrectly set with InPower.
3. The engine coolant heater is defective. (Radiant heat should be felt with your hand held close to the outlet hose.)
4. Sensor connections are defective.
5. Sensor is defective.
6. Harness is defective.

## 5.32.1 Fault Code 1435 - Diagnosis and Repair

1. Fault simulation was enabled with InPower.
    - Using InPower, verify that the fault simulation is not enabled for the coolant sensor.

- If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. Fault threshold is incorrectly set with InPower.
    - Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.
3. The engine coolant heater is defective.
    - Coolant heater is not operating due to:
        - Coolant heater is not connected to power.
            - Check for a blown fuse or a disconnected heater cord and correct as required.
        - Low coolant level.
            - Look for possible coolant leakage points and repair as required.
        - Defective heater element/thermostat.
            - With the coolant heater removed and power disconnected, flush with cold tap water for two minutes to close the internal heater thermostat (opens at 100 °F and closes at 80 °F). Check resistance across input power leads.
                - Open – replace the coolant heater.
                - Closed – coolant heater is operational (coil resistance of 10-60 ohms).
4. Sensor connections defective.
    - Inspect the sensor and the engine harness connector pins. Repair or replace as necessary.
5. Sensor defective.
    - Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault.
    - If the control responds to the simulator, replace the sensor.
6. Harness is defective.
    - Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for a short circuit as follows:
        - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
        - Check for a short circuit from pin to pin (more than 200k ohms is OK).
        - Repair or replace as necessary.
    - Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).
        - If resistance is not the same, the harness is defective and must be replaced.

# 5.33 Fault Code 1442 - Weak Battery

**Logic:** If the voltage of the battery as sensed by the alternator control drops below the Weak Battery Voltage threshold for the time period that is registered in the Weak Battery Voltage Set Time, the fault code 1442 (warning) becomes active.

**Lamp:** Warning

**Possible Cause:**

1. Weak Battery Voltage threshold parameter is set too high
2. Weak or discharged battery
3. Battery connection(s) are loose or corroded
4. Insufficient battery charging voltage
5. Faulty engine DC alternator
6. Wiring issue(s)

## 5.33.1 Fault Code 1442 - Diagnosis and Repair

Refer to Fault Code 441.

# 5.34 Fault Code 1443 - Battery Failed

**Lamp:** Shutdown

**Logic:** Dead battery - engine will not start.

**Possible Cause:** See Fault Code 1442.

## 5.34.1 Fault Code 1443 - Diagnosis and Repair

Refer to Fault Code 441.

# 5.35 Fault Code 1444 - kW Overload

**Logic:** If the Overload Warning Threshold has been exceeded for the time that is registered in the Overload Warning Set Time parameter the fault code 1444 (warning) becomes active.

**Lamp:** Warning

**Possible Cause:**

1. The Overload Threshold percentage parameter is configured incorrectly (low)
2. Short in the load or load cable(s)
3. Incorrect current transformer ratio, current transformer(s), or current transformer connection(s)
4. Incorrect potential transformer ratio, potential transformer (s), or potential transformer connection(s)

## 5.35.1 Fault Code 1444 - Diagnosis and Repair

1. Fault threshold is incorrectly set with InPower.
   - Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
2. Short circuit or overload.
   - Check the load and load cables. Repair if necessary.
   - Check the operation by disconnecting the load and restarting the generator set.
3. Incorrect CTs or CT connections.
   - Check CTs and CT connections. Correct if necessary. (Refer to the *Current Transformer Installation* procedure in the controller Service Manual.)
4. Harness connections are defective.
   - Remove connector P7 from the base board. Check continuity from P7 to the CTs.
     - P7-11 (CT1) to P7-12 (CT1-COM)
     - P7-15 (CT2) to P7-16 (CT2-COM)
     - P7-19 (CT3) to P7-20 (CT3-COM)
   - Repair connections as necessary.

# 5.36 Fault Code 1445 - Short Circuit

**Logic:** If the alternator output current has exceeded 175% of rated current the fault code 1445 (shutdown) becomes active.

**Lamp:** Shutdown

**Possible Cause:**

1. Short in the load or load cable( s)
2. Faulty current transformers, Incorrect current transformer ratio, current transformers, current transformer connection(s)

## 5.36.1 Fault Code 1445 - Short Circuit - Diagnosis and Repair

- Short in the load or load cable( s)
  - With the generator set being turned off visually inspect the load and load cables for damage or short circuit. Repair if necessary.
- Faulty current transformers, Incorrect current transformer ratio, current transformers, current transformer connection(s)
  - Verify the current transformer connections are correct from the current transformers to the input terminals, J12-1, J12-2, J12-3, J12-4, J12-5, and J12-6, of the base board.
  - Ensure the power command controller is set up for the correct current transformer ratio. Refer to the event/fault code 2814 for current transformer ratio troubleshooting information.

- With a meter check for the secondary current transformer input (1A or 5A) into the base board and verify that the value corresponds to the current transformer primary current sensing. Example: If the power command controller is setup with a current transformer ratio of 1000:5, then the secondary current input into the base board should not be more than 5A.

# 5.37 Fault Code 1446 - High AC Voltage

**Logic:** If one or more of the phase voltages exceeds the High AC Voltage Threshold percentage value for the time period that is registered in the High AC Voltage Delay the fault code 1446 (shutdown ) becomes active.

**Lamp:** Shutdown

**Possible Cause:**

1. Fault simulation feature is enabled
2. The high AC voltage trip parameter is configured incorrectly for the application
3. The high AC voltage threshold is configured incorrectly (low) for the application
4. Faulty potential transformers, Incorrect potential transformers ratio, potential transformers s, potential transformers connection(s)
5. Faulty automatic voltage regulator
6. Faulty permanent magnet generator
7. Governor preload offset percentage high

## 5.37.1 Fault Code 1446 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
   - Using InPower, verify that the related fault simulation is not enabled.
   - If you do not have InPower, remove battery power from the control to disable fault simulation overrides.
2. Signal step large block load removal.
   - Clear the fault and restart the generator set.
3. Fault threshold is incorrectly set with InPower.
   - Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
4. Generator is defective.
   - Follow the *Generator/Base Board Isolation Procedure* in the alternator Service Manual to determine if the generator is causing the high AC voltage shutdown fault.

# 5.38 Fault Code 1447 - Low AC Voltage

**Logic:** If one or more of phase voltages has decreased below the Low AC Voltage Threshold percentage for the time period that is registered in the Low AC Voltage Delay parameter the fault code 1447 (shutdown ) becomes active.

**Lamp:** Shutdown

**Possible Cause:**

1. Fault simulation is enabled
2. The Low AC Voltage Threshold parameter is configured incorrectly (high)
3. Overload
4. Faulty potential transformers, Incorrect potential transformer ratio, potential transformers, potential transformer connection(s)
5. Faulty automatic voltage regulator or wiring
6. Faulty permanent magnet generator
7. Faulty rotating rectifier assembly

## 5.38.1 Fault Code 1447 - Low AC Voltage - Diagnosis and Repair

- Fault simulation is enabled
  - Connect with the InPower service tool and ensure that the fault simulation for Low AC Voltage percentage override is not enabled. Go to: **Setup > Test > Protection Verification > Alternator Protection > Undervoltage** and set parameter appropriately for the application.
- The Low AC Voltage Threshold parameter is configured incorrectly (high )
  - To access the Low AC Voltage configuration menu on the operator panel, go to: **Setup > OEM Setup > OEM ALT Setup > Low AC Voltage Threshold** and set the Low AC Voltage Threshold Parameter appropriately for the application. Refer to the parameter section to see the default value for Low AC Voltage.
- Overload
  - Ensure that the load is within the proper operating range. Verify for the absence of inrush current or current spikes. Test the operation of the generator set by disconnecting the load and restarting the unit. Correct any overload if found.
- Faulty potential transformers, Incorrect potential transformer ratio, potential transformers, potential transformer connection(s)
  - Visually inspect the connections from the alternator to the potential transformers and from the potential transformers to the base board.
    - Three phase inputs on the base board: L1 = J22-1, L2 = J22-2, L3 = J22-3, and LN = J22-4. Single phase use L1, L2, and LN.
    - If the wires are incorrectly connected, or there is an open circuit, correct the wiring issue.
    - If the voltage input is less than 600 VAC, a potential transformer is not required.
  - Ensure that the power command controller is set up with the correct potential transformer ratio (primary versus secondary).
    - Refer to the event/ fault code 2816 for troubleshooting information on the potential transformer ratio.

- To access the potential transformer Ratio configuration menu on the operator panel, go to: **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the potential transformer ratio appropriately for the application.

- Measure the voltage going into the potential transformer from the alternator.

***WARNING: High voltages are present in this step. Special equipment and training is required to work on or around high-voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures may result in severe personal injury or death.***

- Then measure the voltage output of potential transformer to the base board; three phase inputs on the base board: L1 = J22-1, L2 = J22-2, L3 = J22-3, and LN = J22-4, For Single phase use L1, L2, and LN.
  - The control calibrated potential transformer ratio is potential transformer voltage input to potential transformer voltage output, and should match the voltage input into and output of the potential transformer.
- If the control calibrated potential transformer ratio, matches the voltage input into the potential transformer, but does not match the voltage output; e.g. power command controller calibrated potential transformer ratio is 13,500:480, the voltage input into the potential transformer is 13,500 VAC, but the output of the potential transformer is 589 VAC instead of 480 VAC, replace the potential transformer module.

- Faulty automatic voltage regulator or wiring
  - Check the power supply to the automatic voltage regulator. Ensure that the 10 Amp fuses at J18-1 and J18-2 are not open or blown, replace if found faulty.
    - Verify the automatic voltage regulator has sufficient power at:
      - J18-1 and J18-2 used in a shunt application
      - J18-1, J18-2, and J18-3 used in the permanent magnet generator application
  - Measure the output of the AVR Powerstage (AUX 103) at J17-1 (positive) and J17-2 (negative) while the generator set is running at no load, idle speed.
    - In a three phase configuration, the output voltage at J17-1 and J17-2 should be: 9 to 12 VDC at No Load, or 38 to 41 VDC at Full Load.
    - In a single phase configuration, the output voltage at J17-1 and J17-2 should be: 5.5 to 7.5 VDC at No Load, or 19 to 21 VDC at Full Load.
    - If the voltage output of J17-1 and J17-2 is constantly zero or less than 9 to 12 for a three phase configuration, then the AVR Powerstage (Aux 103) module could be at fault.
    - To verify, disconnect the J17 connector from the AUX 103 AVR output; the AVR module is no longer connected to the field wires, and place a 9 to 12 VDC power supply to the field wires: J17-1 (positive) and J17-2 (negative). If the generator set produces adequate voltage (Nominal Voltage) with the power supply connected to the field wires, the problem has been isolated to the AVR Powerstage (AUX 103) module.

- Visually inspect the wiring on J19 (interconnect) coming from the baseboard and J18 (automatic voltage regulator power) coming from the permanent magnet generator for damage, bad connection, and short or open circuits.

- Faulty permanent magnet generator
  - Start the set and run at rated speed. Measure the voltages at the automatic voltage regulator terminals P2 (J18-1), P3 (J18-2), and P4 (J18-3).
    - These should be balanced and within the following ranges:
      - 50 Hz generators - 170 to 180 volts
      - 60 Hz generators - 200 to 216 volts
    - Should the voltages be unbalanced, stop the generator set, remove the permanent magnet generator cover from the non-drive end bracket and disconnect the multi-pin plug in the permanent magnet generator output leads.
      - Check leads P2, P3, and P4 for continuity.
      - Check the permanent magnet generator stator resistances between output leads. These should be balanced and within +/−10% of 2.3 ohms.
        - If resistances are unbalanced or incorrect the permanent magnet generator stator must be replaced.
        - If the voltages are balanced but low and the permanent magnet generator stator winding resistances are correct the permanent magnet generator rotor must be replaced.
- Faulty rotating rectifier assembly
  - This procedure is carried out with leads J17-1 and J17-2 disconnected at the automatic voltage regulator or transformer control rectifier bridge and apply a 12 VDC supply to leads J17-1 (positive) and J17-2 (negative).
    - Start the generator set and run at rated speed. Measure the voltages at the main output terminals L1, L2, and L3.
    - If voltages are balanced but below the nominal, there is a fault in the rotating diode assembly or the main excitation windings.
    - The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode (CR1 through CR6) should be disconnected at the terminal end, and the forward and reverse resistance checked.
      - A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction.
      - A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.
    - On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.
    - Replace diode(s) if found to be faulty. Refer to the alternator service manual for any additional information.

# 5.39 Fault Code 1448 - Under Frequency

**Logic:** If the frequency has dropped below the Underfrequency Threshold for the time period that is registered in the Underfrequency Delay parameter the fault code 1448 (shutdown) becomes active.

**Lamp:** Shutdown

**Possible Cause:**

1. Fault simulation is enabled
2. Underfrequency Threshold parameter is configured incorrectly
3. Adjustable Freq/Speed Gain parameter is configured incorrectly
4. Incorrect number of poles or the frequency to speed ratio configuration
5. Overload
6. Faulty engine crankshaft or camshaft speed sensor connection( s)
7. Engine crankshaft or camshaft speed sensor(s) are faulty
8. Faulty Engine Harness
9. Air restriction
10. Fuel system restriction or running out of fuel

## 5.39.1 Fault Code 1448 - Diagnosis and Repair

1. Fault simulation has been enabled with InPower.
   - Using InPower, verify that the related fault simulation is not enabled.
   - If you do not have InPower, remove battery power from the the control to disable the fault simulation overrides.
2. Fault threshold is incorrectly set with InPower.
   - Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.
3. Overload.
   - Check the load and correct any overload.
   - Check the generator set operation by disconnecting the load and restarting the generator set.
4. Incorrect fuel or air supply.
   - Refer to the engine service manual.
5. Loose connector.
   - Repair connections (P8).

# 5.40 Fault Code 1449 - Over Frequency

**Logic:** If the frequency has exceeded the Overfrequency Threshold for the time period that is registered in the Overfrequency Delay parameter the fault code 1449 (warning) becomes active.

**Lamp:** Warning

**Possible Cause:**

- Fault simulation is enabled
- Overfrequency Threshold parameter is configured incorrectly
- Adjustable Freq/Speed Gain parameter is configured incorrectly
- Incorrect number of poles or the frequency to speed ratio configuration
- Large cycling load(s)
- Faulty engine crankshaft or camshaft speed sensor connection(s)
- Engine crankshaft or camshaft speed sensor(s) are faulty
- Faulty engine harness
- Air in the fuel system

## 5.40.1 Fault Code 1449 - Over Frequency - Diagnosis and Repair

- Fault simulation is enabled
  - With the InPower service tool ensure that the Overfrequency Enable parameter is not enabled.
    - Go to: **Setup > OEM Setup > OEM Alternator Setup** and set the parameter to disable.
- Overfrequency Threshold parameter is configured incorrectly
  - To access the over frequency configuration menu on the operator panel, go to: **Setup > OEM Setup > OEM ALT Setup > Overfrequency Threshold** and set the Overfrequency Threshold parameter appropriately for the application.
- Adjustable Freq/Speed Gain parameter is configured incorrectly
  - Verify that the conversion factor is being set correctly when the parameter Frequency to Speed Gain Select is configured to Adjustable Freq/Speed Gain.
    - Go to: **Setup > OEM Setup >OEM Engine Setup > Adjustable Freq/Speed Gain** to manually input the desired conversion factor.
    - To calculate the frequency to speed gain ratio use the following equation: 120/Number of poles of the alternator.
- Incorrect number of poles or the frequency to speed ratio configuration
  - Verify via system records whether the unit has had an alternator/stator replacement.
    - Go to **Setup > OEM Setup >OEM Engine Setup > Frequency to Speed Gain Select** and adjust the parameter accordingly to the alternator.
    - To calculate the frequency to speed gain ratio use the following equation: 120/Number of poles of the alternator.

- Large cycling load(s)
  - Verify that the load is within proper operating range (ex. motor starts). Verify for the condition by disconnecting the load and restarting the generator set.
  - Stager large loads.
- Faulty engine crankshaft or camshaft speed sensor connection( s)
  - Check speed/position sensor connections at the plug for an adequate connection or a short circuit at the sensor to harness connector end.
  - Inspect the speed/position sensor(s) and the harness connector pins for:
    - Bent or broken pins, pushed back, or expanded pin(s)
    - Evidence of moisture or corrosion in or on the connector(s)
    - Missing or damaged connector seal(s)
    - Dirt or debris in or on the connector pin(s)
- Engine crankshaft or camshaft speed sensor(s) are faulty
  - Inspect the crankshaft and camshaft tone wheels for any physical damage such as cracked or broken teeth, rough surfaces, debris, rust, and etc.
    - Verify the clearance between the sensor(s) and the tone wheel(s) as appropriate.
  - Verify the speed or position sensor power supplies.
    - Disconnect the engine harness connector from the sensors and measure the supply voltage at pin 16 (crankshaft) and 37 (camshaft) on the 60 pin connector.
    - The reading should be between 4.75 and 5.25 VDC.
    - If not, check for harness open condition, bad connection, or an electronic control module issue.
  - Verify the speed or position sensor signal (sense) voltage.
    - Measure the signal voltage at pin 27 (crankshaft) and 26 (camshaft) on the 60 pin connector.
    - The reading should be between 0.46 and 4.56 VDC.
    - If not, check for harness open condition, bad connection, or an electronic control module issue.
    - Verify the values of the sense voltages with those on the Insite service tool.
- Faulty engine harness
  - Disconnect harness from electronic control module and sensor(s). Measure the resistance in each pin from electronic control module to sensor. Resistance should be 5 ohms or less. Repair or replace harness as necessary.
- Air in the fuel system
  - Fuel lines might have loose connections or air is trapped within the fuel system.
    - To verify for the absence of air in the fuel system connect the mechanical gauge adapter to the fuel system per the engine service manual.
    - Start generator set and monitor for air bubbles in the fuel line.

- Ensure there is steady flow of fuel with no bubbles for about 5 minutes after start.

## 5.41 Fault Code 1461 - Loss of Field

**Lamp:** Shutdown

**Corrective Action:** Indicates loss of field (electric) due to reverse kVAR.

## 5.42 Fault Code 1466 - Modem Failure

**Lamp:** Warning

**Corrective Action:** Indicates that the control can not communicate with the modem. Check for an open short circuit to ground and loose connections to the modem.

## 5.43 Fault Code 1468 - Network Error

**Lamp:** Warning

**Corrective Action:** Indicates a momentary loss of communication from the LonWorks network. Refer to the LonWorks network publications for more specific troubleshooting methods.

## 5.44 Fault Code 1469 - Speed/Hz Match

**Lamp:** Shutdown

**Corrective Action:** Indicates that measured speed and measured AC output frequency do not agree. Check the calibration file.

## 5.45 Fault Code 1471 - Over Current

**Lamp:** Warning

**Logic:** Generator set output has exceeded 110% of rated.

**Possible Cause:** Refer to Fault Code 1444.

### 5.45.1 Fault Code 1471 - Diagnosis and Repair

Refer to Fault Code 1444.

## 5.46 Fault Code 1472 - Over Current

**Lamp:** Shutdown

**Corrective Action:** Indicates that generator output current has exceeded 110% of rated, and that a control time/current calculation has initiated an overcurrent shutdown. Check the load and load lead connections. (The fault may not reset for several minutes.)

## 5.47 Fault Codes 2323−2326 - Network Faults 5 through 8

**Lamp:** Shutdown, Warning, or none for status message

**Corrective Action:** Indicates network inputs (#5−#8) are in an active state. See Fault Codes 1313−1316 for corrective action.

## 5.48 Fault Code 2335 - Excitation Fault

**Logic:** If the control has detected the simultaneous loss of all phase sensing the fault code 2335 (shutdown) becomes active.

**Lamp:** Shutdown

**Possible Causes:**

1. Parameters incorrectly configured
2. Wiring issue( s)

## 5.49 Fault Code 2336 - Memory Error

**Lamp:** Shutdown

**Corrective Action:** Indicates a control memory error, resulting in data corruption of critical operating parameters. Try reloading the calibration file.

## 5.50 Fault Code 2341 - High Control Temperature

**Lamp:** Warning

**Corrective Action:** The control temperature is above normal (158° F [70° C]) for a time greater than the control temperature set time. Check the generator set room air flow.

## 5.51 Fault Code 2342 - Too Long in Idle

**Logic:** If the engine has been running at idle speed for a time that is longer than the time registered in the Maximum Idle Time parameter the fault code 2342 (warning) becomes active. Long periods of engine idling, more than 20 minutes, can eventually affect engine performance and may void engine warranty.

**Lamp:** Warning

**Possible Causes:**

1. Maximum Idle Time parameters configured incorrectly
2. Faulty coolant heater( s)

## 5.52 Fault Code 2967 - Governor Fault

**Lamp:** Warning

**Corrective Action:** Governor hardware drive circuitry contains a fault condition.

## 5.53 Fault Code 2968 - AVR Fault

**Lamp:** Warning

**Corrective Action:** Indicates AVR hardware contains a fault condition.

## 5.54 Fault Code 2969 - LON Failure

**Lamp:** Warning

**Corrective Action:** Indicates no communications with the LonWorks board.

## 5.55 Fault Code 2972 - Field Overload

**Logic:**

If the Field AVR Duty Cycle is operating at a maximum output for a period of time that is longer than the time registered in the Max Field Time parameter the fault code 2972 ( shutdown) becomes active.

**Lamp:** Shutdown

**Possible Causes:**

***WARNING: High voltages are present in this step. Special equipment and training is required to work on or around high-voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures may result in severe personal injury or death.***

1. Max Field Time Delay parameter configured incorrectly
2. Voltage sensing into the base board is too low or an open or short circuit
3. Alternator or application issue

## 5.56 Battery Charger Troubleshooting

### 5.56.1 Fault Code 379 - Over Current

**Logic:**

Charger output current is too high

**Possible Causes:**

1. Output current is excessive. Charger control may be failing.

#### 5.56.1.1 Fault Code 379 - Diagnosis and Repair

1. Cycle through the Setup menus to try and clear the fault.

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

##### 5.56.1.1.1 Clearing the Fault Code

**NOTE: Fault code can only be cleared by:**

- **Disconnect the charger harness plug,**

- **Cycle completely through the setup menus,**

**Or**

- **Recycling the power.**

## 5.56.2 Fault Code 441 - Low Battery Voltage

**Logic:**

Battery voltage is low

**Possible Causes:**

1. No battery connected.
2. Output breaker is in the “Off” (down) position.
3. A 12 V battery is connected but the charger is set for 24 V charging.
4. Battery can no longer maintain charge.
5. The wire between the charger and the battery is loose or broken

### 5.56.2.1 Fault Code 441 - Diagnosis and Repair

1. No battery connected.
    - Connect the battery.
2. Output breaker is in the “Off” (down) position.
    - Verify the output breaker is in “On” (up) position.
3. A 12V battery is connected but the charger is set for 24V charging.
    - Attach a 24V battery or set the charger for 12V charging.
4. Battery can no longer maintain charge.
    - Replace the battery.
5. The wire between the charger and the battery is loose or broken.
    - Check the wire.

## 5.56.3 Fault Code 442 - High Battery Voltage

**Logic:**

Battery voltage is high.

**Possible Causes:**

1. A 24 V battery is connected but the charger is set for 12 V charging.
2. Large load dump may have caused momentary voltage rise.

### 5.56.3.1 Fault Code 442 - Diagnosis and Repair

1. 24V battery is connected but the charger is set for 12 V charging.
    - Attach a 12 V battery or set the charger for 24 V charging.
2. Large load dump may have caused momentary voltage rise.
    - Cycle through the Setup menus to clear the fault and restart charging.

#### 5.56.3.1.1 Clearing the Fault Code

**NOTE:** **Fault code can only be cleared by:**

- **Disconnect the charger harness plug,**
- **Cycle completely through the setup menus,**

**Or**

- **Recycling the power.**

## 5.56.4 Fault Code 2331 - Low AC Voltage

**Logic:**

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

**Possible Causes:**

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

### 5.56.4.1 Fault Code 2331 - Diagnosis and Repair

1. AC input voltage is more than 10% below nominal rated voltage.
   - Check level of input voltage.

     Charger will not operate with voltage 10% or more below nominal.

## 5.56.5 Fault Code 2358 - High AC Voltage

**Logic:**

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

**Possible Causes:**

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

### 5.56.5.1 Fault Code 2358 - Diagnosis and Repair

1. AC input voltage is more than 10% above nominal rated voltage.
   - Check level of input voltage.

     Charger will not operate with voltage 10% or more above nominal.

## 5.56.6 No DC Output (No Fault Message)

**Logic:**

Charger cannot sense any DC output.

**Possible Cause:**

1. Tripped DC circuit breaker.
2. Blown AC fuse(s) (on 277, 380, 416 and 600 VAC battery chargers).
3. Tripped AC circuit breaker(s) (on 120, 208 and 240 VAC battery chargers).

### 5.56.6.1 No DC Output (No Fault Message) - Diagnosis and Repair

1. Tripped DC circuit breaker.
   - Correct the possible overload and reset the circuit breaker.
2. Blown AC fuse(s) (on 277, 380, 416 and 600 VAC battery chargers).
   - Correct the possible overload and replace the fuse(s).
3. Tripped AC circuit breaker(s) (on 120, 208 and 240 VAC battery chargers).
   - Correct the possible overload and reset the circuit breaker.

## 5.56.7 Low DC Output (No Fault Message)

**Logic:**

Charger senses low DC output.

**Possible Cause:**

1. Faulty battery.
2. Charger failure.

### 5.56.7.1 Low DC Output (No Fault Message) - Diagnosis and Repair

1. Faulty battery
   - Replace the battery.
2. Charger failure.
   - Arrange for a replacement charger.

## 5.56.8 High DC Output (No Fault Message)

**Logic:**

Charger senses high DC Output.

**Possible Cause:**

1. Charger failure.

### 5.56.8.1 High DC Output (No Fault Message) - Diagnosis and Repair

1. Arrange for a replacement charger.

# 5.57 CAN Datalink Troubleshooting

## 5.57.1 Fault Code 427 - CAN Datalink Lost Message

**Logic:**

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

**Possible Cause:**

1. Power removed from ECM (keyswitch) during genset operation.
    - O pressed on control during genset operation.
2. Defective Datalink harness assembly.

### 5.57.1.1 Fault Code 427 - Diagnosis and Repair

1. Power removed from ECM (keyswitch) during genset operation.
    - O pressed on control during genset operation.

    Reset control by pressing Fault Reset buttion with O/Manual/Auto switch in O (off) position.
2. Defective Datalink harness assembly.
    - Inspect the Datalink harness between P10 and P41 connector pins.
        - Repair or Replace as necessary.
    - Check for resistive circuit in lead P10-1 to P41-N and P10-2 to P41-P (10ohms or less = ok).
    - Check terminating resistors. With connectors P10 and P41 removed, measure resistance between pins P10-1 and P10-2 (60 ohms = ok).

## 5.57.2 Fault Code 781 - CAN Datalink Lost Messages

**Logic:**

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

### 5.57.2.1 Fault Code 781 - Diagnosis and Repair

Refer to fault code **427**

## 5.57.3 Fault Code 1245 - CAN - Engine Shutdown

**Logic:**

The PCC received a shutdown message from the ECM

**Possible Cause:**

1. ECM/Engine fault

### 5.57.3.1 Fault Code 1245 - Diagnosis and Repair

1. ECM/Engine fault.
    - Refer to the E-Controls service tool and the engine service manual.

## 5.57.4 Fault Code 1246 - CAN - Unknown Engine Fault

**Logic:**

The PCC received an unknown message from the ECM

**Possible Cause:**

1. ECM/Engine fault

### 5.57.4.1 Fault Code 1246 - Diagnosis and Repair

1. ECM/Engine fault.
    - Refer to the E-Controls service tool and the engine service manual.

## 5.57.5 Fault Code 1247 - CAN - Engine Unannounced Fault

**Logic:**

The PCC received an unknown message from the ECM.

**Possible Cause:**

1. ECM/Engine fault

### 5.57.5.1 Fault Code 1247 - Diagnosis and Repair

1. ECM/Engine fault.
    - Refer to the E-Controls service tool and the engine service manual.

## 5.57.6 Fault Code 1248 - CAN - Engine Warning Fault

**Logic:**

The PCC received an unknown message from the ECM.

**Possible Cause:**

1. ECM/Engine fault

### 5.57.6.1 Fault Code 1248 - Diagnosis and Repair

1. ECM/Engine fault.
    - Refer to the E-Controls service tool and the engine service manual.

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# 6 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 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 InSite service tool.

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

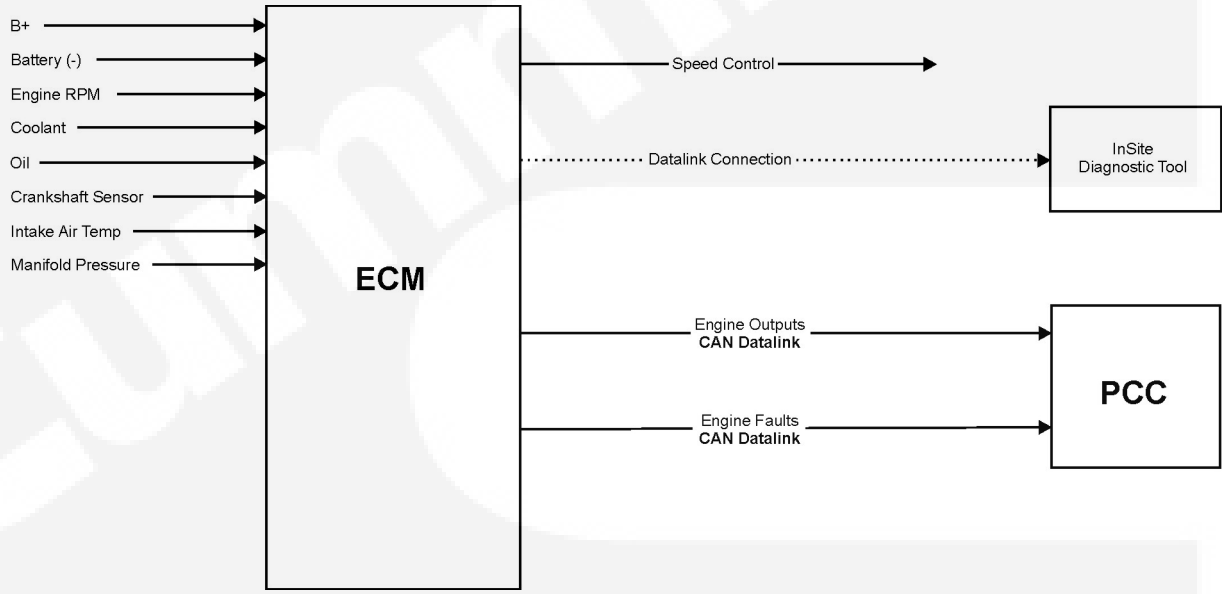



**FIGURE 1. ECM INPUT AND OUTPUT**

## 6.1 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 .

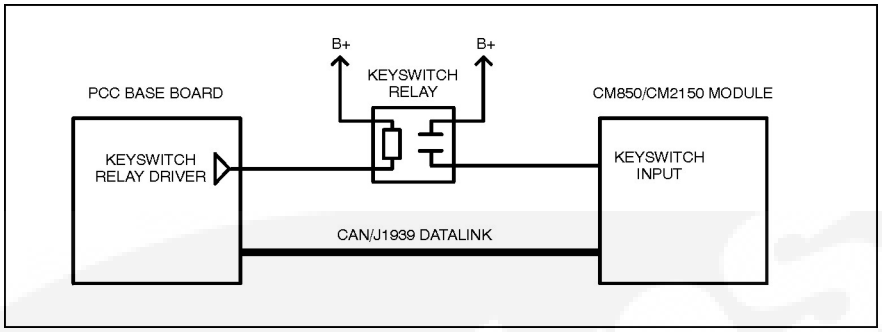



**FIGURE 2. CONTROL SYSTEM BLOCK DIAGRAM**

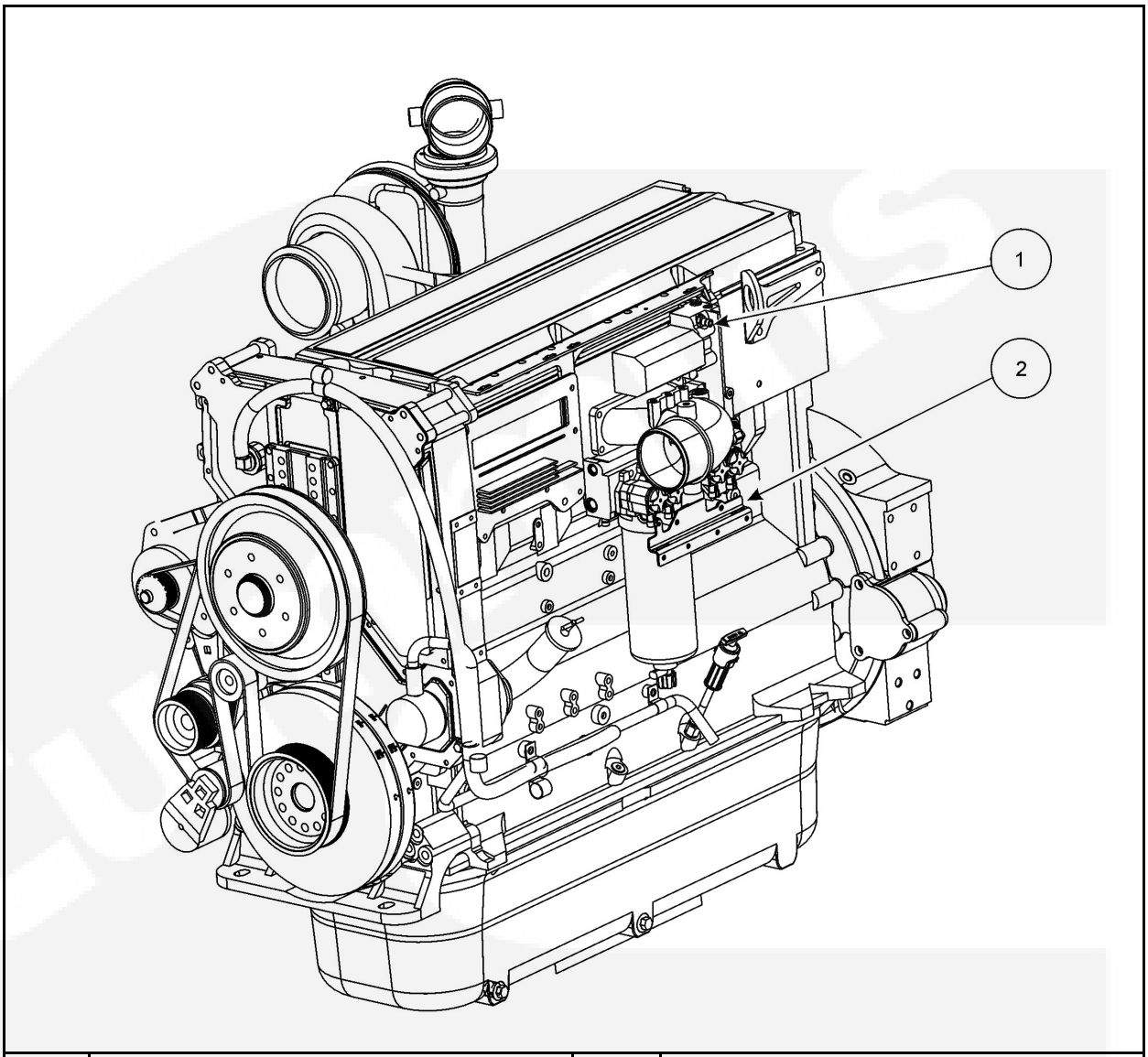
# 7 Engine Sensors

Figure 3 shows the locations of the coolant temperature and oil pressure senders to which the PCC responds for the engine.

The coolant temperature sender functions by varying the resistance with the coolant temperature. With 5 VDC supplied to the sensors, the output signal (which varies with temperature) is supplied to the base board. The coolant sender enables the base board to detect low, pre-high and high coolant temperatures.

The oil pressure sender functions by converting the sensed oil pressure to voltage which varies the supplied 5 VDC to the sender. The output signal of the sender is approximately 0.5 VDC at 0 psi (0 kPa) and 4.5 VDC at 100 psi (689.5 kPa).

The low coolant level switch functions by closing the circuit to the engine chassis ground (battery negative [**–**]). The low coolant level switch is not shown in Figure 3; this switch is located near the top of the radiator.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Temperature Sensor | 2 | Oil Pressure Sender (on engine block behind bracket) |

**FIGURE 3. ENGINE SENSOR LOCATIONS**

# 7.1 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.

## 7.2 Cylinder Head Temperature Sensor (CHT)

The cylinder head temperature (CHT) sensor is a thermistor device, which uses changes in resistance dependant on the temperature. The sensor is installed in the aluminum cylinder head and measures the temperature of the metal. The CHT can provide complete engine temperature and is used to infer coolant temp.

## 7.3 Crankshaft Position Sensor (CKP)

The crankshaft position sensor (CKP) is used to determine engine RPM and crankshaft position. The CKP functions similar to a traditional magnetic pickup sensor. The CKP is located next to the trigger wheel mounted on the end of the crankshaft. The trigger wheel contains 39 teeth spaced 9 degrees apart with one tooth missing. By magnetically locating the empty space on each revolution, the ECM can determine the position of the crankshaft and engine speed.

## 7.4 Camshaft Position Sensor (CMP)

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

## 7.5 Heated Exhaust Gas Oxygen Sensor (HEGO)

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 volts. In the event of a lean mixture, the voltage drops to between 0.1 to 0.3 volts. 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 volts.

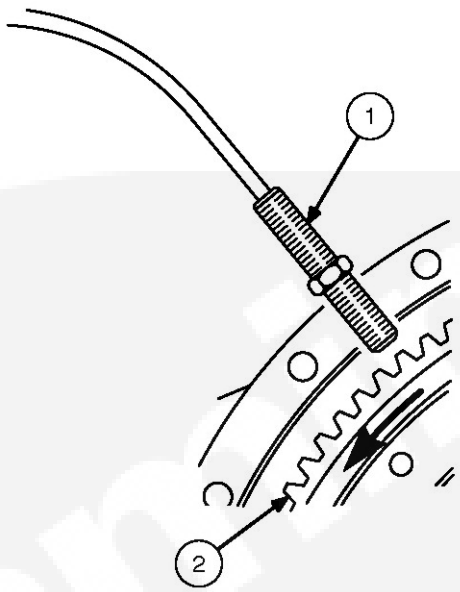
## 7.6 Magnetic Speed Pickup Unit (MPU) Installation

Measure the resistance of the magnetic speed pickup (MPU). Replace the MPU if the resistance is not between 1,000 ohms and 1,050 ohms.

With the MPU removed from the generator set, bar the engine until a gear tooth on the flywheel lines up in the center of the mounting hole. Thread the sensor in gently by hand until it just touches the gear tooth. Back it out 1/4 turn and set the locknut.

⚠ *CAUTION: Do not use fan blade to bar over the engine. That can damage blades and cause property damage and personal injury.*

After adjustment, make sure output voltage of the MPU is correct. Replace the MPU if output voltage at cranking speed is less than 1.5 VAC.



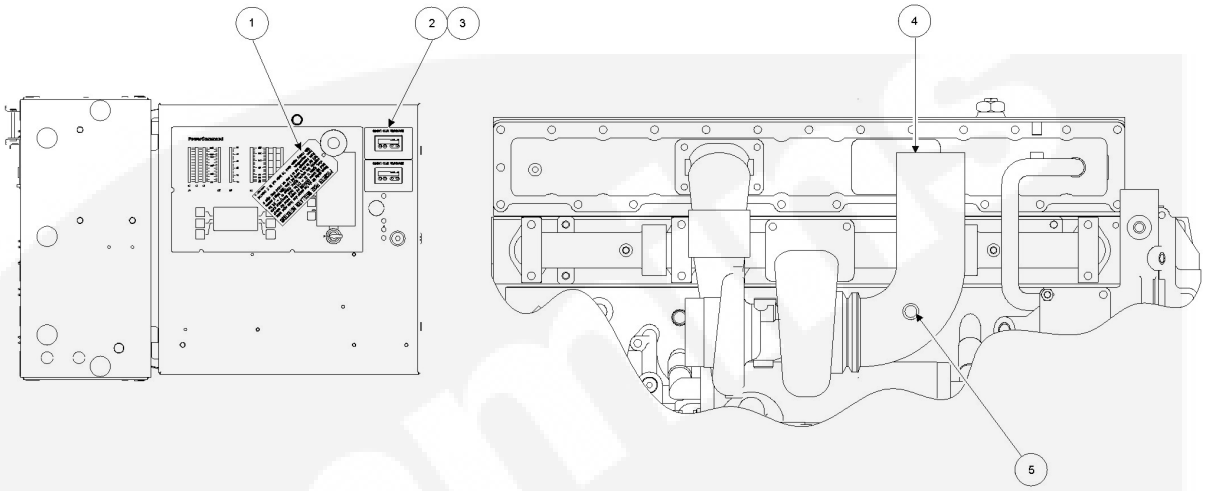

| No. | Description | No. | Description |
|---|---|---|---|
| 1 | MPU Sensor | 2 | Engine Flywheel Ring Gear |

**FIGURE 4. MPU SENSOR**

# 7.7 Pyrometers - Engine Exhaust

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

## 7.7.1 Pyrometer Position




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

**FIGURE 5. PYROMETER LOCATION AND METER(S)**

# 7.8 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.

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# 8 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 40 meters long and 30 devices) that is terminated by a 120 ohm resistor at each end. Stubs (no longer than 1 meter) extend from the main trunk to each module in the bus.

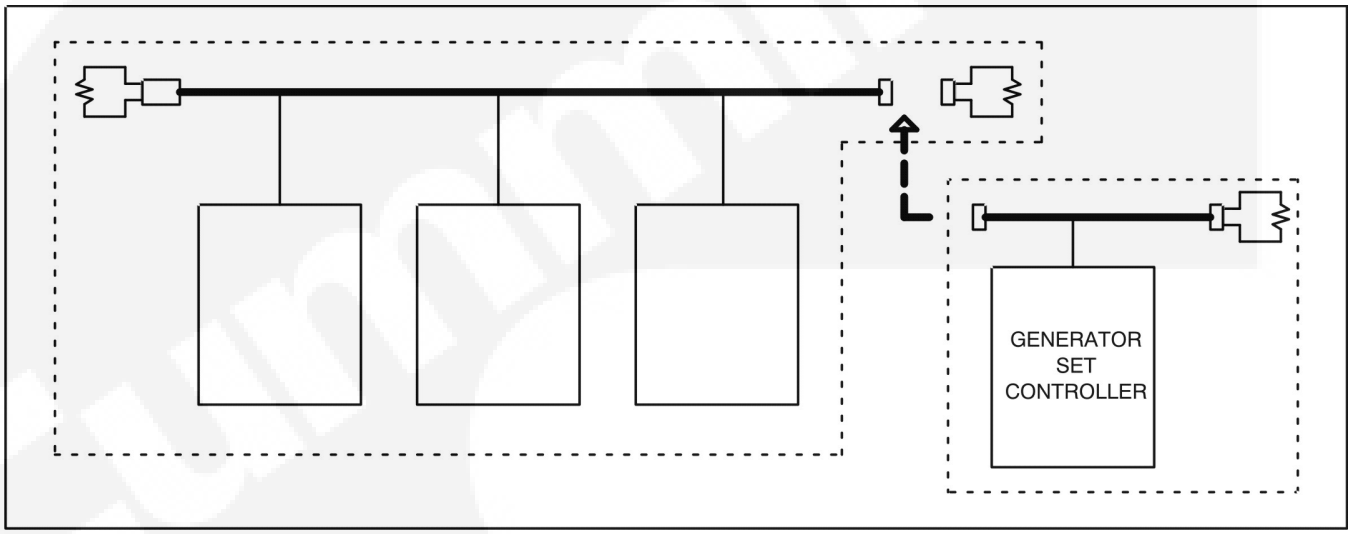


**FIGURE 6. CAN DATALINK**

## 8.1 CAN Datalink Signals

The CAN datalink carries the binary signal between the ECM (Engine Control Module) and the PCC controller. The binary signal is expressed by a change in voltage. Table 7 shows how the generator set controller distinguishes between the voltage signals.

**TABLE 7. 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.

Figure 7 on page 64 and Figure 8 on page 64 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).

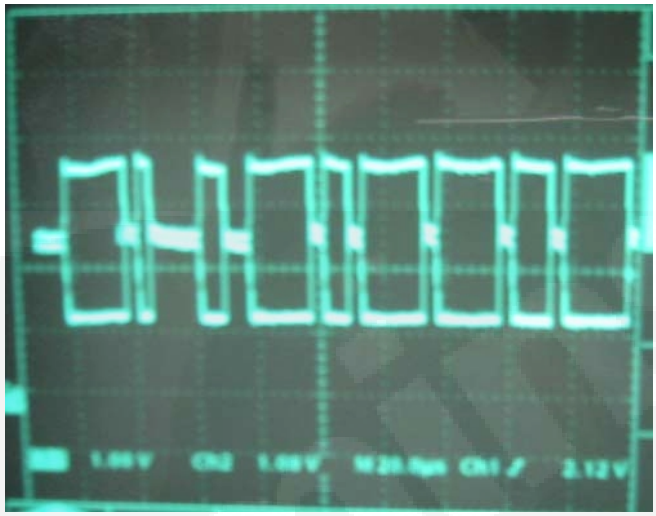

**FIGURE 7. CAN DATALINK: GOOD SIGNAL**

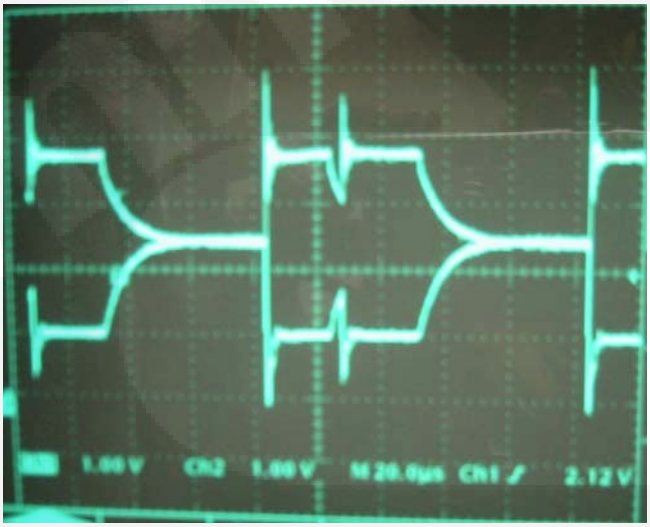

**FIGURE 8. CAN DATALINK: BAD SIGNAL**

## 8.2 Connections

The CAN datalink connects to the PCC baseboard via connector J10. J10 pin connections are identified in **Table 8**

**TABLE 8. CONNECTOR J10**

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

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

## 8.3 Connections

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

**TABLE 9. CONNECTOR J11**

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

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

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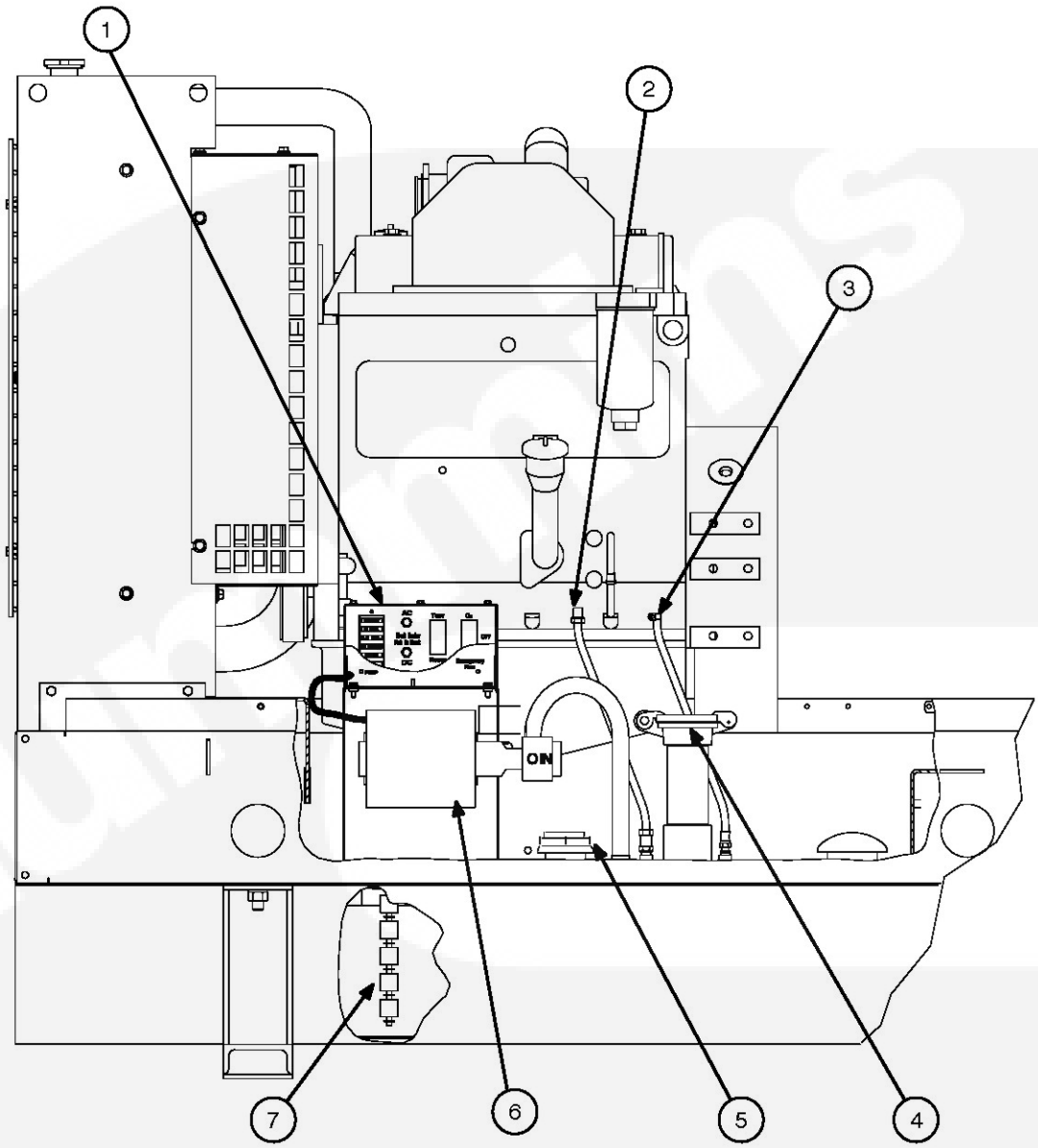
# 9 Fuel Transfer Pump and Control

A fuel transfer pump and control are available when a sub-base or in-skid day tank are provided. The automatic control operates the fuel pump to maintain a reservoir of fuel in the sub-base or in-side day tank.

***WARNING: Diesel fuel is highly combustible. Improper installation of the fuel transfer pump can lead to spillage of large quantities of fuel and loss of life and property if the fuel is accidentally ignited. Installation and service must be performed by trained and experienced personnel in accordance with the applicable codes.***

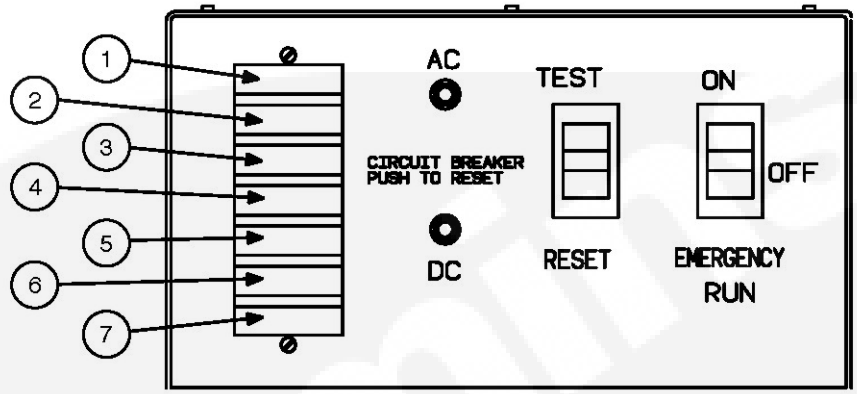
***Do not smoke near fuel and keep flames, pilot lights, sparks, arcing switches, or equipment and other sources of ignition well away.***




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Control | 5 | Fuel Gauge |
| 2 | Flexible Fuel Return Line | 6 | Fuel Pump and Motor |
| 3 | Flexible Fuel Supply Line | 7 | Float Switch Assembly |
| 4 | Fuel Fill Cap | | |

**FIGURE 9. TYPICAL SUB-BASE INSTALLATION**

# 9.1 Fuel Pump Control Panel Operation




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | System Ready (Green) | 5 | Basin (Red) |
| 2 | Hi Fuel (Red) | 6 | Blank (Red) |
| 3 | Lo Fuel (Red) | 7 | Pump On (Green) |
| 4 | Lo Shutdown (Red) | | |

**FIGURE 10. FUEL PUMP CONTROL PANEL**

1. Push the control switch to the **ON** position for automatic operation . The green **SYSTEM READY** light will come on, and the pump will fill the tank if AC power is available for pumping and DC power is available for the internal logic circuits. The level of fuel in the tank will be automatically kept between a set of pump-on and pump-off float switches.

**NOTE: When filling an empty tank, the red LO SHUTDOWN and LO FUEL lights will come on when the control switch is pushed to the ON position. This is normal. Push the panel RESET switch to turn off the red lights after the tank has been filled.**

**If the SYSTEM READY light does not come on, check for correct AC and DC power connections.**

2. The green **PUMP ON** light indicates when the pump is running. It will come on and go off as fuel is pumped to maintain the proper level in the tank.
3. Push the control switch to the **EMERGENCY RUN** position (momentary contact) to pump fuel into the tank if the control fails to operate the pump automatically. (The pump may continue to run after enabling the Emergency Run Switch to complete the filling cycle of the tank.)

**NOTE: The green PUMP ON light does not come on when the switch is in the EMERGENCY RUN position.**

4. The red lights indicate fault conditions and the need for service. The control panel includes the following lights:

   a. **HI FUEL**: The fuel in the tank has reached an abnormally high level, indicating possible failure of the pump-off float switch. The high-fuel float switch takes over as the automatic pump-off switch. The **HI FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level drops to normal but will come back on again during the next pumping cycle if the fault remains.

***WARNING: Continued operation with a HI FUEL fault present can lead to spillage of large quantities of fuel if the high-fuel float switch fails. Spilled fuel can cause loss of life and property if it is accidentally ignited, or environmental damage.***

   b. **LO FUEL**: The fuel in the tank has dropped to an abnormally low level, indicating possible failure of the pump-on float switch. The lo-fuel float switch takes over as the automatic pump-on switch. The **LO FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level rises to normal but will come back on again during the next pumping cycle if the fault remains.

*CAUTION: Continued operation with a **LO FUEL** fault present can lead to low-fuel shutdown if the low-fuel float switch fails.*

   c. **LO SHUTDOWN**: The fuel has dropped to a level near the bottom of the tank, indicating an empty main fuel tank, pump failure or possible failure of both the pump-on and low-fuel level float switches. Further operation will allow air to enter the engine fuel unit, causing shutdown and the necessity to bleed the fuel unit to start up the engine again. If the light comes on, check the fuel level in the main fuel tank and fill it if necessary. As the day tank is refilling, **RESET** the light with the panel switch.

**NOTE: To restore engine operation following this fault, both the pump control and the engine control have to be RESET.**

   d. **BASIN**: Fuel has overflowed into the rupture basin (if provided), indicating possible failure of both the pump-off and hi-fuel level float switches, or a leak in the day tank. **RESET** the control after the fuel in the basin has been safely disposed of and the cause of the overflow corrected.

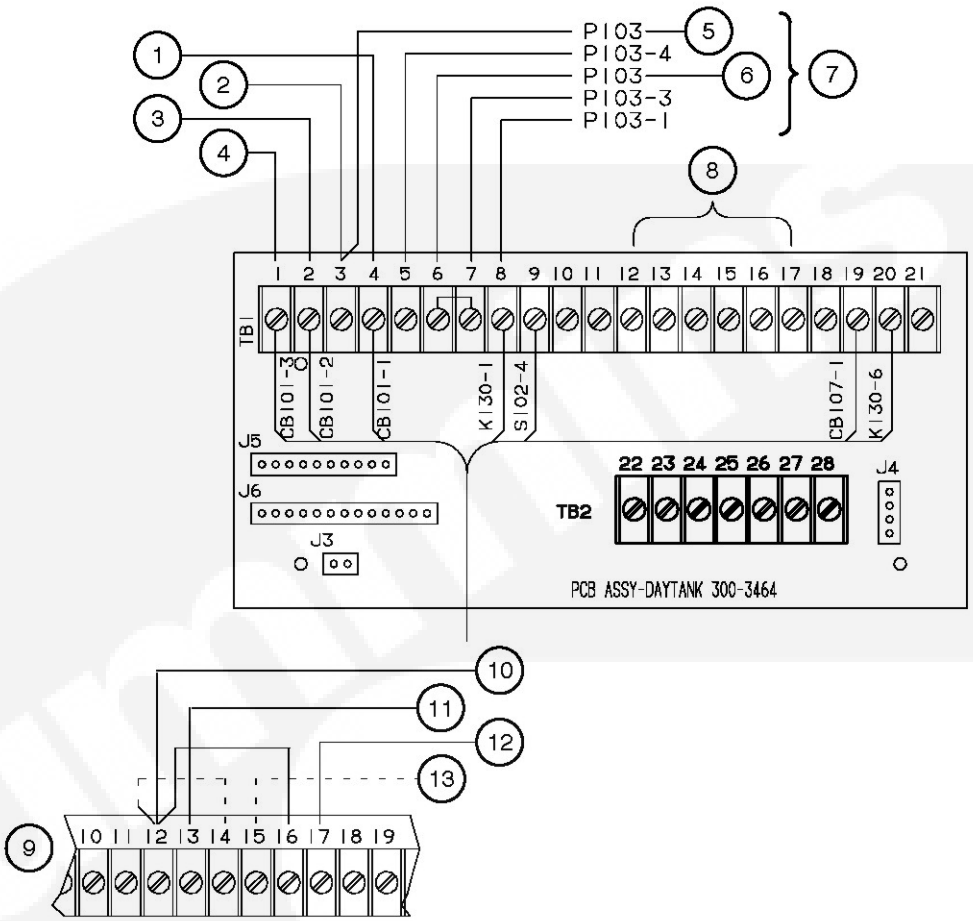
   e. **BLANK**: For customer use.

**NOTE: The control fault circuits will trip and latch, requiring RESET, even if AC power is lost.**

5. Press the **TEST** switch to test the indicator lights and pump operating circuits. Replace any light that does not come on. The pump will stop automatically after it has filled the tank to the normal pump-off fuel level.
6. Press the reset button of the AC or DC circuit breaker if either has tripped.

## 9.2 Fuel Pump Control Terminal Board

See the wiring diagrams provided with your generator set when making connections at the control box terminal board.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | AC (240V) | 8 | Use with PCC (See Detail A) |
| 2 | Earth Ground | 9 | Detail A |
| 3 | Neutral (120V) | 10 | GND TB!-20, -21, or -22 |
| 4 | AC (120/240V) | 11 | To engine harness lead S8 (Low Fuel Warning) |
| 5 | Ground | 12 | To engine harness lead S9 (Rupture Basin Warning). |
| 6 | White | 13 | For low fuel shutdown, connect to Customer Fault 1, 2, 3, or 4 on customer terminal block TB1-4, -5, -6, or -7. |
| 7 | Pump Designation (Ref) | | |

**FIGURE 11. FUEL PUMP CONTROL TERMINAL BOARD**

The following should be noted.

1. The control can be powered by 120 VAC or 240 VAC. The control is set up at the factory for connection to 240 VAC.

**NOTE: To convert the day tank controller from 240 VAC to 120 VAC, perform the following steps.**

a. **Remove the two jumpers between terminals TB1-6 and TB1-7 in the control box, and connect one jumper between terminals TB1-5 and TB1-6 and the other jumper between terminals TB1-7 and TB1-8.**

b. **Move selector switch S103 on the control PCB to the up position for 120 V.**

c. **On the control transformer, remove the two jumpers between terminals H2 and H3, and connect one jumper between H1 and H3 and the other jumper between H2 and H4.**

**NOTE: To convert the day tank controller from 120 VAC to 240 VAC, perform the following steps.**

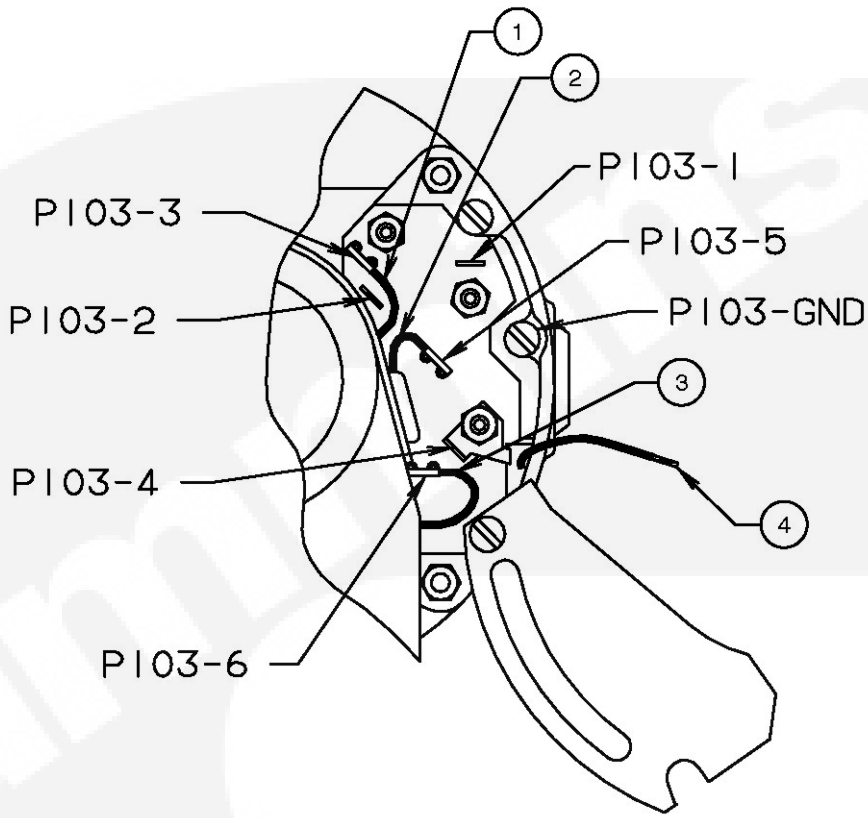
a. **Remove the jumpers between terminals TB1-5 and TB1-6 and TB1-7 and TB1-8 in the control box, and connect the two jumpers between terminals TB1-6 and TB1-7.**

b. **Move selector switch S103 on the control PCB to the down position for 240 VAC.**

c. **On the control transformer, remove the jumpers between terminals H1 and H3 and H2 and H4, and connect the two jumpers between H2 and H3.**

2. Attach a tag to the control box indicating the supply voltage.
3. To immediately shut down the engine when the **LO SHUTDOWN** light comes on, jumper TB1-14 to GND at TB1-12, and connect TB1-15 to one of the programmable PCC customer fault inputs (Fault 1, 2, 3, or 4) at the Customer Terminal Block TB1-16, 17, 18, or 19. Program this fault for a shutdown.
4. Terminals TB1-10 through TB1-17 and TB2-23 through TB2-27 are available for connections to remote annunciators.
5. Terminals TB1-8 and TB1-5 are available for connection of a 120- or 240-VAC electric fuel shutoff valve rated not more than 0.5 amps. The voltage rating of the valve must correspond with the voltage utilized for the pump.

# 9.3 Fuel Transfer Pump Motor Connections




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Red | 3 | Brown |
| 2 | Black | 4 | White |

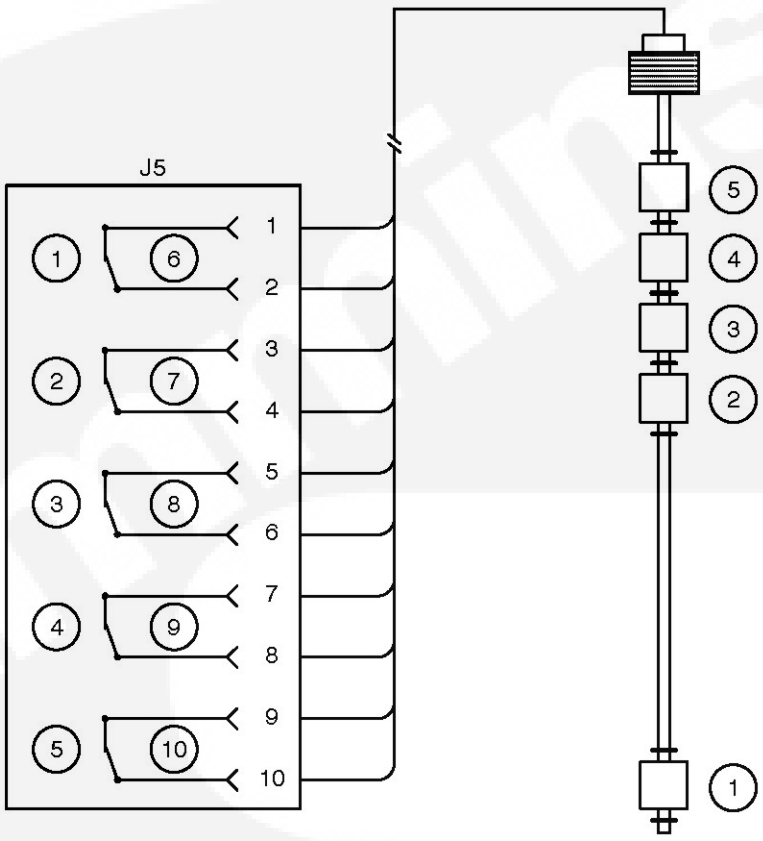
**FIGURE 12. FUEL TRANSFER PUMP MOTOR CONNECTIONS**

Connect a replacement fuel transfer pump motor as follows.

1. Remove the end bell cover for access to the motor wiring terminals.
2. Disconnect the brown lead from motor terminal P103-3, and connect it to terminal P103-6. (Terminal P103-6 is an insulated receptacle for securing the end of the lead so that it cannot move and touch the motor frame or a live terminal and cause a short circuit.)
3. Disconnect the red lead from motor terminal P103-2. It will be connected to the piggy-back terminal on the lead connected at motor terminal P103-3.
4. Cut the white lead from its ring connector at motor terminal P103-4. Strip 1/2-inch (12 mm) of insulation from the end of the white motor lead for splicing to the wire harness lead marked P103-WHITE.
5. Connect each lead of the five-lead wiring harness to the motor terminal or lead marked on it.
6. Connect the red motor lead to the piggy-back terminal at motor terminal P103-3.
7. Secure the end bell cover.

# 9.4 Testing the Float Switch Assembly

The float switch assembly consists of five switches. Each switch has a pair of color-coded leads connected to a common jack.




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Switch 1 - Shutdown | 6 | Red |
| 2 | Switch 2 - Low Fuel | 7 | Yellow |
| 3 | Switch 3 - Pump On | 8 | Blue |
| 4 | Switch 4 - Pump Off | 9 | Brown |
| 5 | Switch 5 - Hi Fuel | 10 | Orange |

**FIGURE 13. FUEL SWITCH ASSEMBLY**

To test the float switches, remove the fuel pump control cover, disconnect the wiring jack, and unscrew the assembly from the top of the day tank. Test as follows:

1. With an ohmmeter, test for electrical continuity (switch closed) between each pair of colored leads, while holding the assembly vertical. Replace the assembly if any switch is open. (All the readings should be zero.)
2. Lift each float, in turn, to 1/8 inch (3 mm) below the C-clip stop above it (use a feeler gauge), and test for electrical continuity. Replace the assembly if any switch does not open. (All the readings should be infinity.)
3. Use pipe thread sealant when replacing the assembly.

# 10 Air Intake System

## 10.1 Air Cleaner Service Indicator

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

***WARNING:*** ***Exhaust components become very hot when the generator set is in use and remain hot for a period of time after the generator set has been shut down. These components can cause severe personal injury or death from contact. Allow these components to cool completely before performing any maintenance tasks.***

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

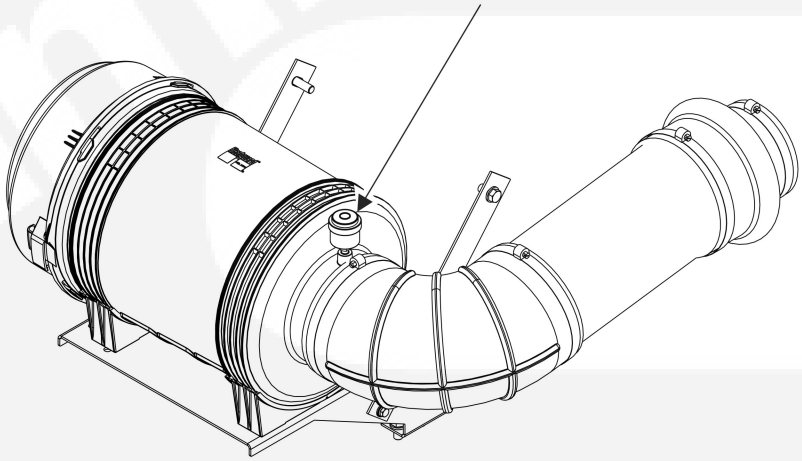


**FIGURE 14. AIR CLEANER SERVICE INDICATOR**

## 10.2 Normal Duty Air Cleaner

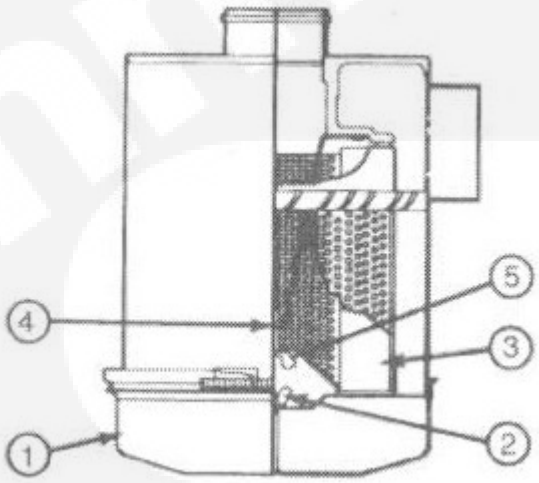
### 10.2.1 Air Cleaner Element Removal

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

*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.*

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

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

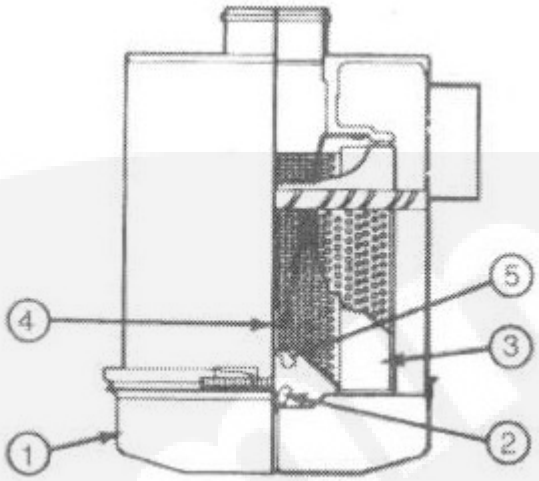



| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Dust Pan | 4 | Air Cleaner Element |
| 2 | Wing Bolt | 5 | Wing Nut |
| 3 | Dust Shield | | |

**FIGURE 15. NORMAL DUTY AIR CLEANER**

## 10.2.2 Air Cleaner Element Installation

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




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

**FIGURE 16. NORMAL DUTY AIR CLEANER**

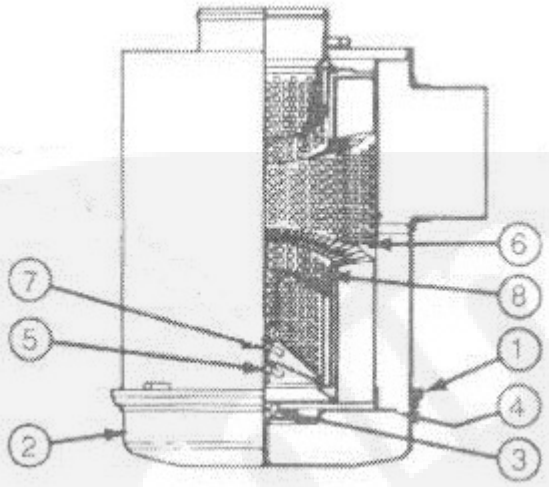
# 10.3 Heavy Duty Air Cleaner

## 10.3.1 Air Cleaner Element Removal

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

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

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

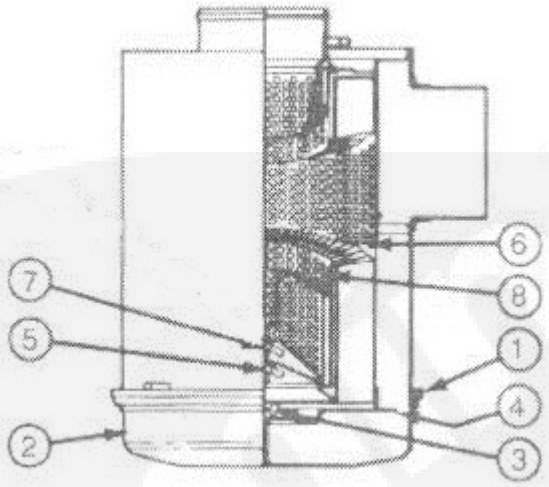



| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Wing Bolt | 5 | Wing Nut |
| 2 | Dust Pan | 6 | Air Cleaner Primary Element |
| 3 | Wing Nut | 7 | Wing Nut |
| 4 | Dust Shield | 8 | Air Cleaner Inner Safety Element |

**FIGURE 17. HEAVY DUTY AIR CLEANER**

## 10.3.2 Air Cleaner Element Installation

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




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

**FIGURE 18. HEAVY DUTY AIR CLEANER**

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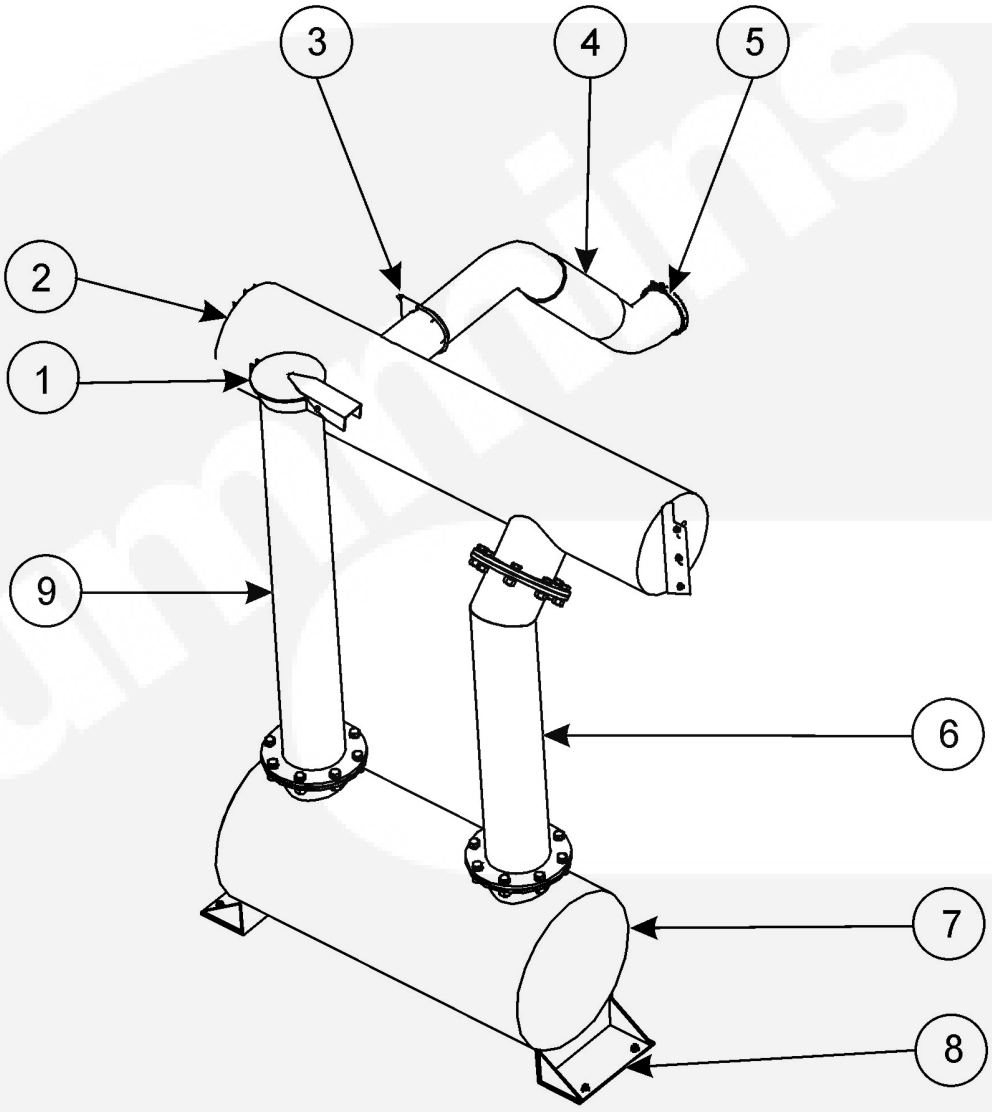
# 11 Exhaust System

## 11.1 Overview

**NOTE: 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.

# 11.2 Exhaust System Graphic

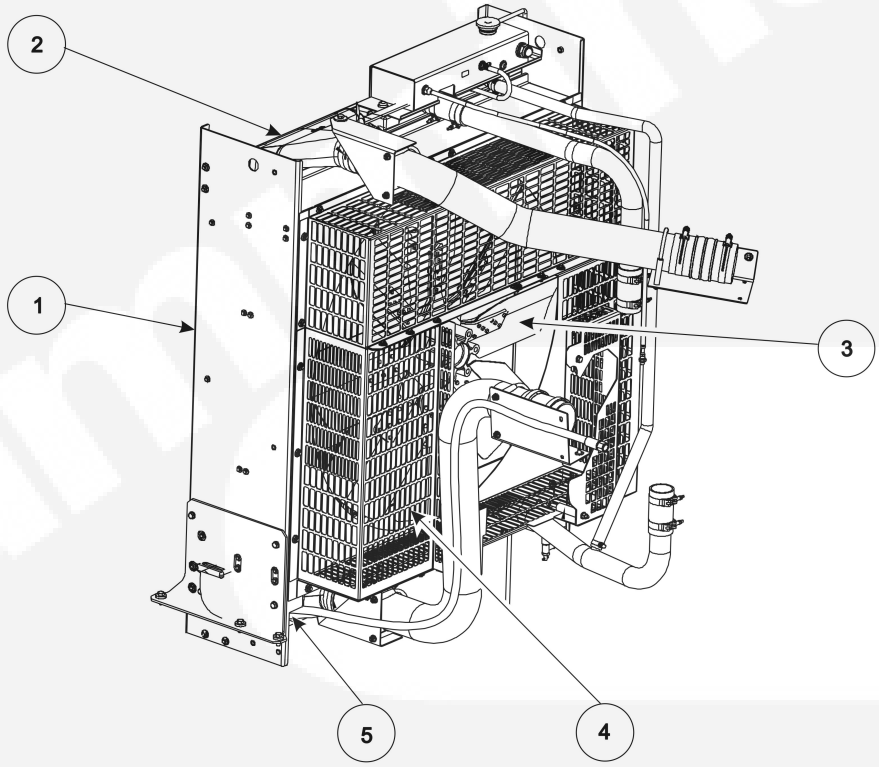



| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Rain Cap | 6 | Exhaust Pipe |
| 2 | Muffler In | 7 | Muffler Out |
| 3 | Exhaust Clamp | 8 | Bracket |
| 4 | Exhaust Pipe | 9 | Tailpipe |
| 5 | Hose Clamp | | |

**FIGURE 19. EXHAUST SYSTEM**

# 12 Cooling System

## 12.1 Cooling System Components




| No. | Description | No. | Description |
|---|---|---|---|
| 1 | Radiator | 4 | Fan Guard |
| 2 | Radiator Guard (on back) | 5 | Coolant Drain |
| 3 | Fan | | |

**FIGURE 20. COOLING SYSTEM FOR DFEG, DFEH, DFEJ, AND DFEK GENERATOR SET**

## 12.2 Radiator Information

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

**NOTE: 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.**

# 12.2.1 Hose Clamp Installation

This section provides general installation guidelines for the correct positioning, orientation and torque figures required when fitting hose clamps. Recommended hose and clamp combinations are also included.

## 12.2.1.1 Choosing the Right Hose Size

The recommended fit for hose to pipe is a 0.5 mm interference fit, i.e. the inner diameter of the hose should be 0.5 mm smaller than the overall diameter of the pipe.

## 12.2.1.2 Types of Hose Clamps

There are three main types of hose clamps:

- Constant Torque Clamps
- T-Clamps
- Worm Drive Clamps

### 12.2.1.2.1 Constant Torque Clamps

| DIA. RANGE (mm) | BOLT SIZE | PIPE DIA. (mm) | HOSE TYPE | INSTALLATION TORQUE |
|---|---|---|---|---|
| 25.4 – 44.4 | 3/8” | 25.4 | EPDM RUBBER | 8 Nm |
| 31.7 – 54.1 | 3/8” | 38.1 | APT THICK WALL | 14 Nm |
| 31.7 – 54.1 | 3/8” | 38.1 | EPDM RUBBER | 14 Nm |
| 31.7 – 54.1 | 3/8” | 38.1 | SILICONE NOMEX | 14 Nm |
| 57.1 – 79.5 | 3/8” | 57.1 | EPDM RUBBER | 14 Nm |
| 57.1 – 79.5 | 3/8” | 57.1 | APT THICK WALL | 14 Nm |
| 69.8 – 92.2 | 3/8” | 76.2 | APT THICK WALL | 14 Nm |
| 69.8 – 92.2 | 3/8” | 76.2 | SILICONE NOMEX | 14 Nm |
| 69.8 – 92.2 | 3/8” | 76.2 | EPDM RUBBER | 14 Nm |
| 82.5 – 104.9 | 3/8” | 88.9 | APT THICK WALL | 14 Nm |
| 95.2 – 117.65 | 3/8” | 101.6 | APT THICK WALL | 14 Nm |
| 95.2 – 117.65 | 3/8” | 101.6 | SILICONE NOMEX | 14 Nm |
| 95.2 – 117.65 | 3/8” | 101.6 | EPDM RUBBER | 14 Nm |
| 133.3 – 155.7 | 3/8” | 127 | APT THICK WALL | 14 Nm |

### 12.2.1.2.2 T-Clamps

| DIA. RANGE (mm) | BOLT SIZE | PIPE DIA. (mm) | HOSE TYPE | INSTALLATION TORQUE |
|---|---|---|---|---|
| 43 – 47 | M6 X 50 | 38.1 | SILICONE NOMEX | 4 Nm |
| 63 – 68 | M7 X 60 | 57.1 | EPDM RUBBER | 4 Nm |
| 68 – 73 | M8 X 80 | 63.5 | EPDM RUBBER | 12 Nm |
| 97 -104 | M8 X 80 | 88.9 | SILICONE NOMEX | 12 Nm |
| 121 – 130 | M8 X 80 | 114.3 | EPDM RUBBER | 12 Nm |
| 121 – 130 | M8 X 80 | 114.3 | SILICONE NOMEX | 12 Nm |
| 130 – 140 | M8 X 80 | 127 | EPDM RUBBER | 12 Nm |
| 130 – 140 | M8 X 80 | 127 | SILICONE NOMEX | 12 Nm |
| 162 - 174 | M10 X 110 | 152.4 | SILICONE NOMEX | 30 Nm |

### 12.2.1.2.3 Worm Drive Clamps

| DIA. RANGE (mm) | INSTALLATION TORQUE | SOCKET REQUIRED | HOSE TYPE |
|---|---|---|---|
| 8 - 16 | 3 Nm | 7 mm | EPDM Rubber |
| 12 - 20 | 3 Nm | 7 mm | EPDM Rubber |
| 16 - 25 | 4.5 Nm | 7 mm | EPDM Rubber |
| 25 - 40 | 4.5 Nm | 7 mm | EPDM Rubber |
| 20 - 32 | 4.5 Nm | 7 mm | EPDM Rubber |
| 32 - 50 | 4.5 Nm | 7 mm | EPDM Rubber |
| 40 - 60 | 4.5 Nm | 7 mm | EPDM Rubber |

| | | | |
|---|---|---|---|
| 50 - 70 | 4.5 Nm | 7 mm | EPDM Rubber |
| 60 - 80 | 4.5 Nm | 7 mm | EPDM Rubber |
| 70 - 90 | 4.5 Nm | 7 mm | EPDM Rubber |
| 80 - 100 | 4.5 Nm | 7 mm | EPDM Rubber |
| 90 - 110 | 4.5 Nm | 7 mm | EPDM Rubber |
| 100 - 120 | 4.5 Nm | 7 mm | EPDM Rubber |
| 120 - 140 | 4.5 Nm | 7 mm | EPDM Rubber |

## 12.2.2 Cleaning

### 12.2.2.1 General Cleaning

**The Cleaning Of Radiator Cores Using Pressurized Water Equipment:**

**NOTE:** ***In specific dust laden environments, this procedure should not be used as the initial cleaning operation; it should follow Cleaning - Dust Laden Environments.***

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

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

For thorough cleaning, pressure wash in the opposite direction to the airflow. A suitable proprietary degreasing additive (as recommended by the manufacturer of the pressure washer) should be applied via the pressure washer but this must not contain ammonia as it will corrode the core.

The recommended equipment for cleaning a radiator core is an industrial pressure washer, but it must be used in the correct manner as misuse can reduce the performance of the core. Protect the generator set from any over spray during this procedure.

To be effective, it is recommended that a hot water washer be used.

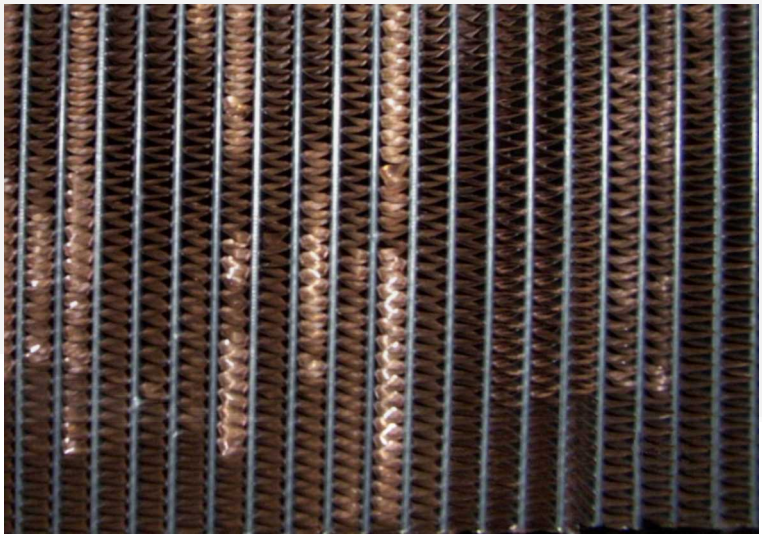


**FIGURE 21. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE**

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

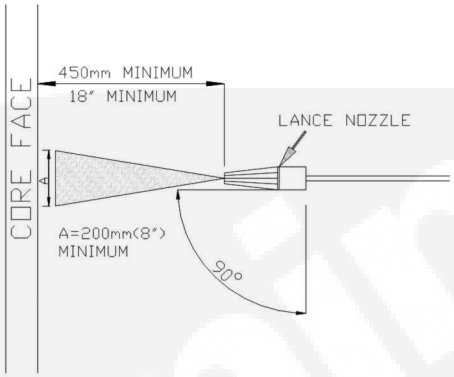



**FIGURE 22. PRESSURE WASHER NOZZLE POSITIONING**

*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 must be kept at a right angle to the core*

*CAUTION: If your pressure washer works above 3000 psi, then the gap between the nozzle and the core face must be increased or fin damage will occur.*

**NOTE:** ***Always follow pressure washer Manufacturer's Health and Safety Guidelines.***

Replace the end panel(s) where necessary.

## 12.2.2.2 Dust Laden Environments

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

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

Inspect the exterior of the radiator for obstructions. During the service life of a radiator a build up of foreign matter can obstruct the flow of air through the radiator cores, reducing the cooling capability. To continue 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 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.

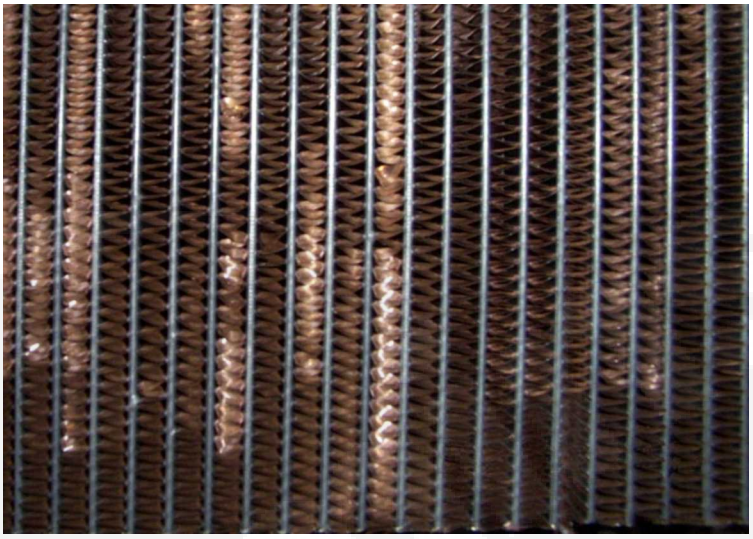


**FIGURE 23. FINS DAMAGED BY COMPRESSED AIR AT ACUTE ANGLES TO CORE FACE**

Immediately after this procedure has been effectively carried out with only the lightest of dust remaining, if deemed essential, it may be followed by cleaning the radiator cores using pressurized water equipment.

Replace the end panel(s) where necessary.

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

# 13 Manufacturing Facilities

| NORTH AMERICA | EMEA, CIS | ASIA PACIFIC |
|---|---|---|
| Cummins Power Generation Limited<br>1400 73rd Ave. NE<br>Minneapolis, MN 55432 USA | Cummins Power Generation Limited<br>Columbus Avenue<br>Manston Park<br>Manston, Ramsgate<br>Kent CT12 5BF<br>United Kingdom | Cummins Power Generation Limited<br>10 Toh Guan Road #07-01<br>TT International Tradepark<br>Singapore 608838 |
| Phone +1 763 574 5000<br>Toll Free +1 800 888 6626<br>Fax +1 763 574 5298 | Phone +44 1843 255000<br>Fax +44 1843 255902 | Phone +65 6417 2388<br>Fax +65 6417 2399 |
| | | |
| **BRAZIL** | **CHINA** | **INDIA** |
| Rua Jati, 310, Cumbica<br>Guarulhos, SP 07180-900<br>Brazil | Cummins Power Generation<br>2 Rongchang East Street,<br>Beijing Economic – Technological Development Area<br>Beijing 100176, P.R.China | 35A/1/2, Erandawana<br>Pune 411 038<br>India |
| Phone +55 11 2186 4195<br>Fax +55 11 2186 4729 | Phone +86 10 5902 3000<br>Fax +86 10 5902 3199 | Phone +91 020 6602 7525<br>Fax +91 020 6602 8090 |
| | | |
| **LATIN AMERICA** | **MEXICO** | |
| 3350 Southwest 148th Ave.<br>Suite 205<br>Miramar, FL 33027<br>USA | Eje 122 No. 200 Zona Industrial<br>San Luis Potosi, S.L.P. 78395<br>Mexico | |
| Phone +1 954 431 551<br>Fax +1 954 433 5797 | Phone +52 444 870 6700<br>Fax +52 444 824 0082 | |

## 13.1 How to Obtain Service

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

### 13.1.1 Locating Your Distributor

**In North America**

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

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

GENERATORS – ELECTRIC or

ENGINES – GASOLINE OR DIESEL

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

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

**Outside North America**

If you are outside North America, telephone Cummins Power Generation at +1 763 574 5000 from 7:30 am to 4:00 pm, Central Standard Time, Monday through Friday, or fax +1 763 528 7229.

## 13.1.2 Fuel Information Needed for Service Issue

When servicing is needed on a failed fuel tank, the following questions must be answered and conveyed via the submission of a Service Issue in the Issues Tracking System (ITS).

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

***WARNING: Do not exceed 2 psig when testing a tank or basin, excessive pressurization may pose a hazard. There must be no fuel or other liquid in the tank or basin during pressure testing.***

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

### 13.1.2.1 Helpful Information to Aid in Obtaining Information Needed For Fuel Tank Service Issues

***WARNING: Do not exceed 2 psig when testing a tank or basin, excessive pressurization may pose a hazard. There must be no fuel or other liquid in the tank or basin during pressure testing.***

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

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

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

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

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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.

# A.2 DFEG, DFEH, DFEJ, and DFEK Generator Set Wiring Diagram with PowerCommand 2100 Control

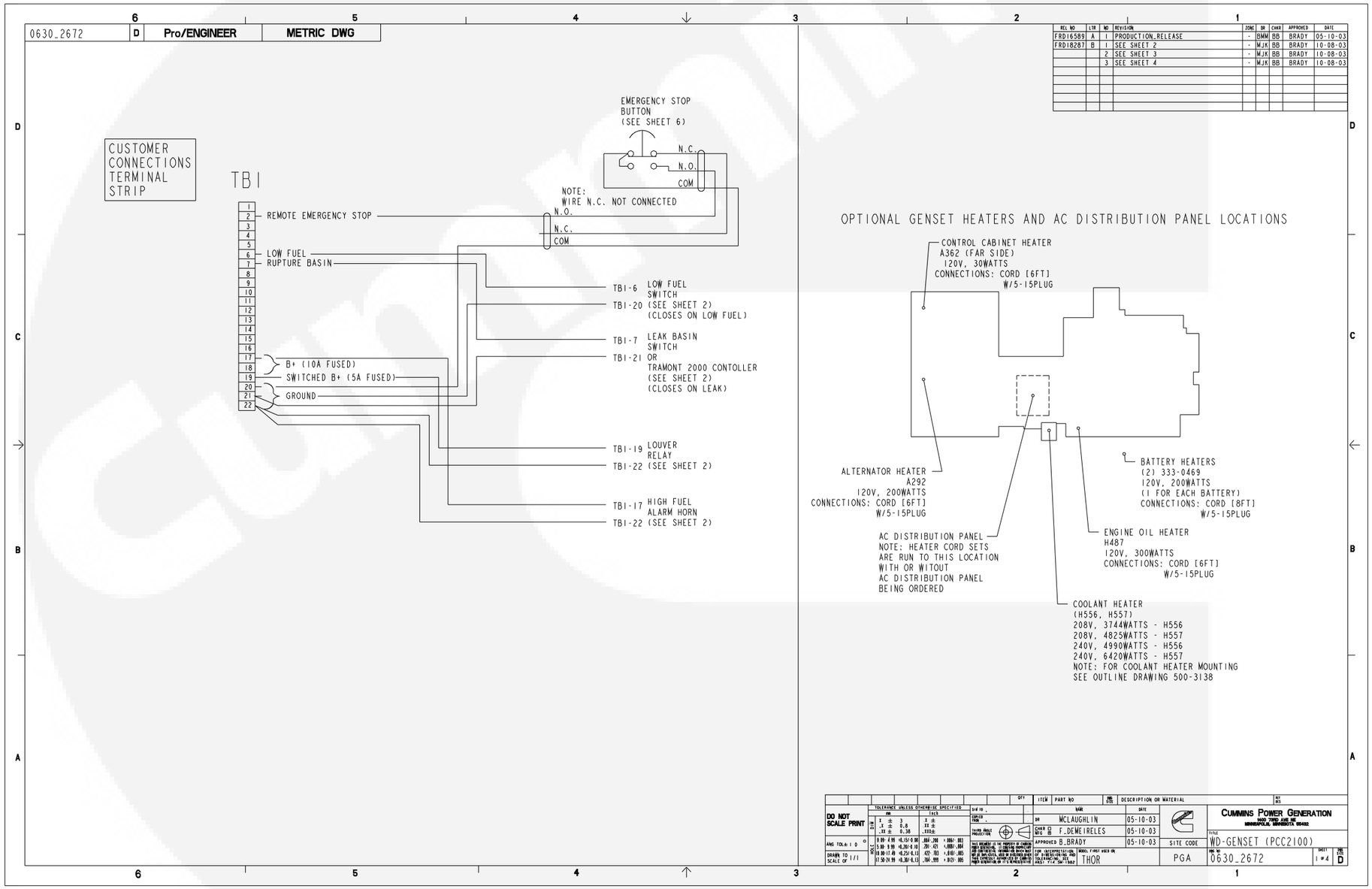



**FIGURE 24. 0630_2672 SHEET 1**

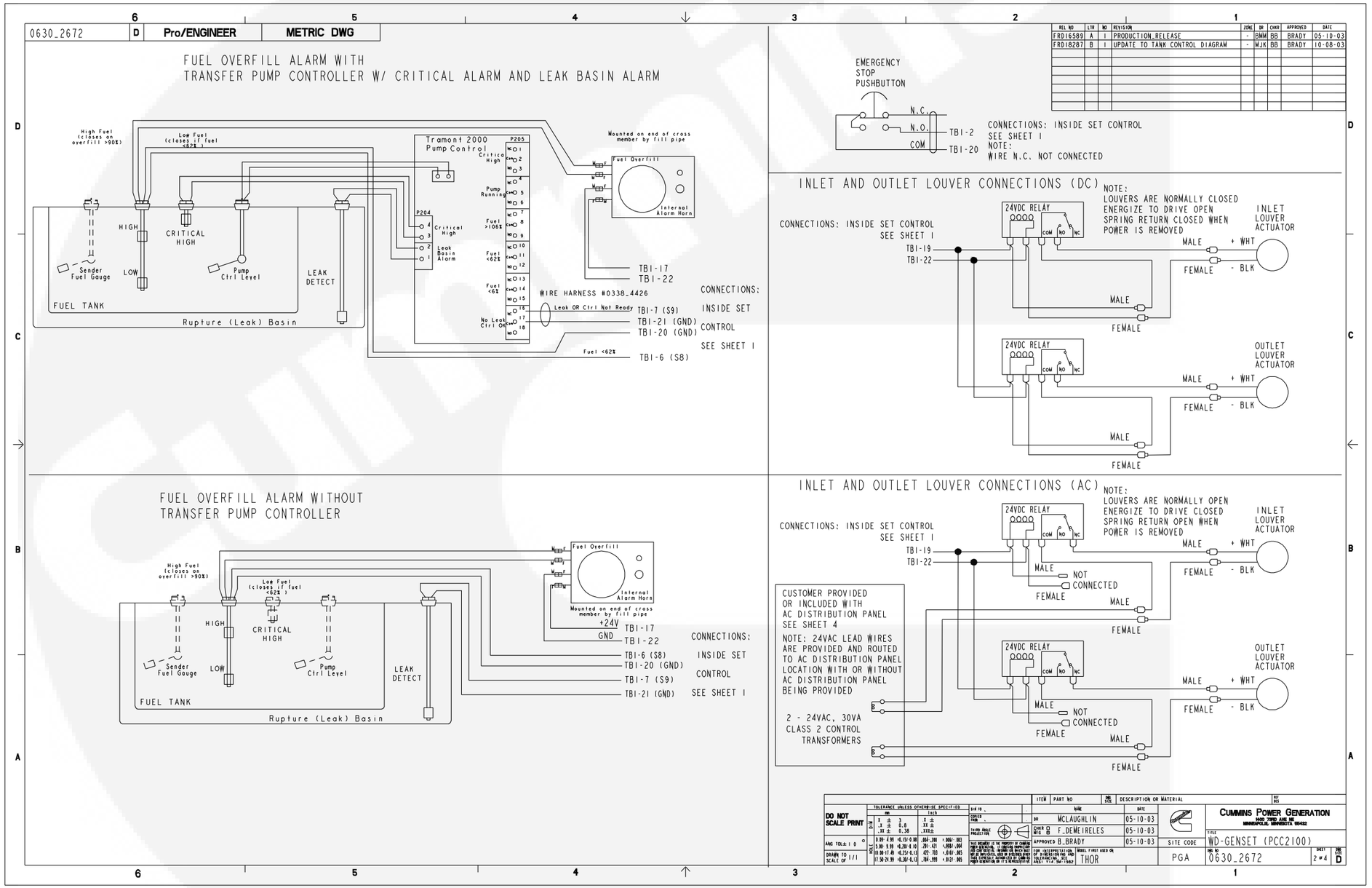



**FIGURE 25. 0630_2672 SHEET 2**

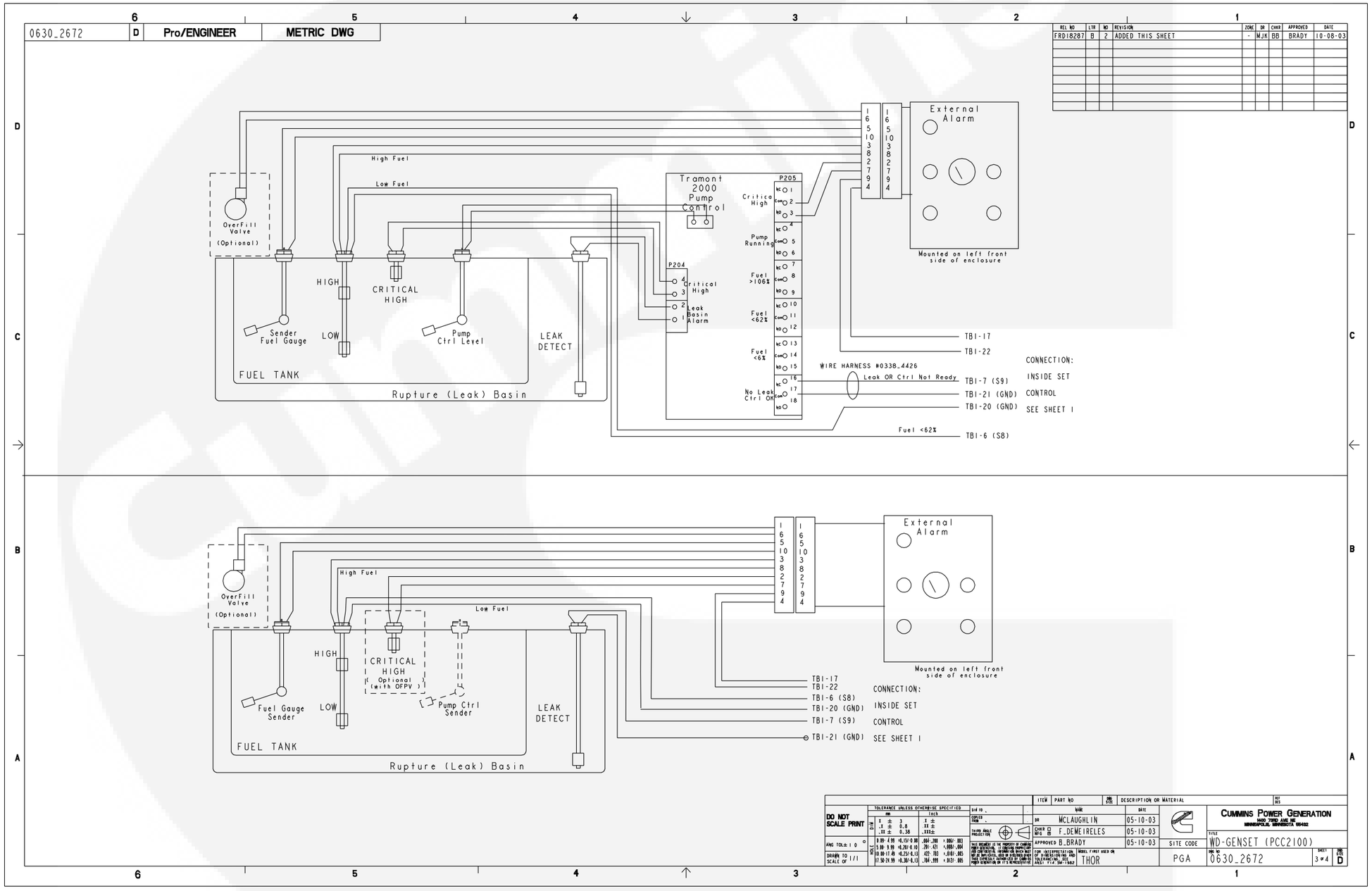



**FIGURE 26. 0630_2672 SHEET 3**

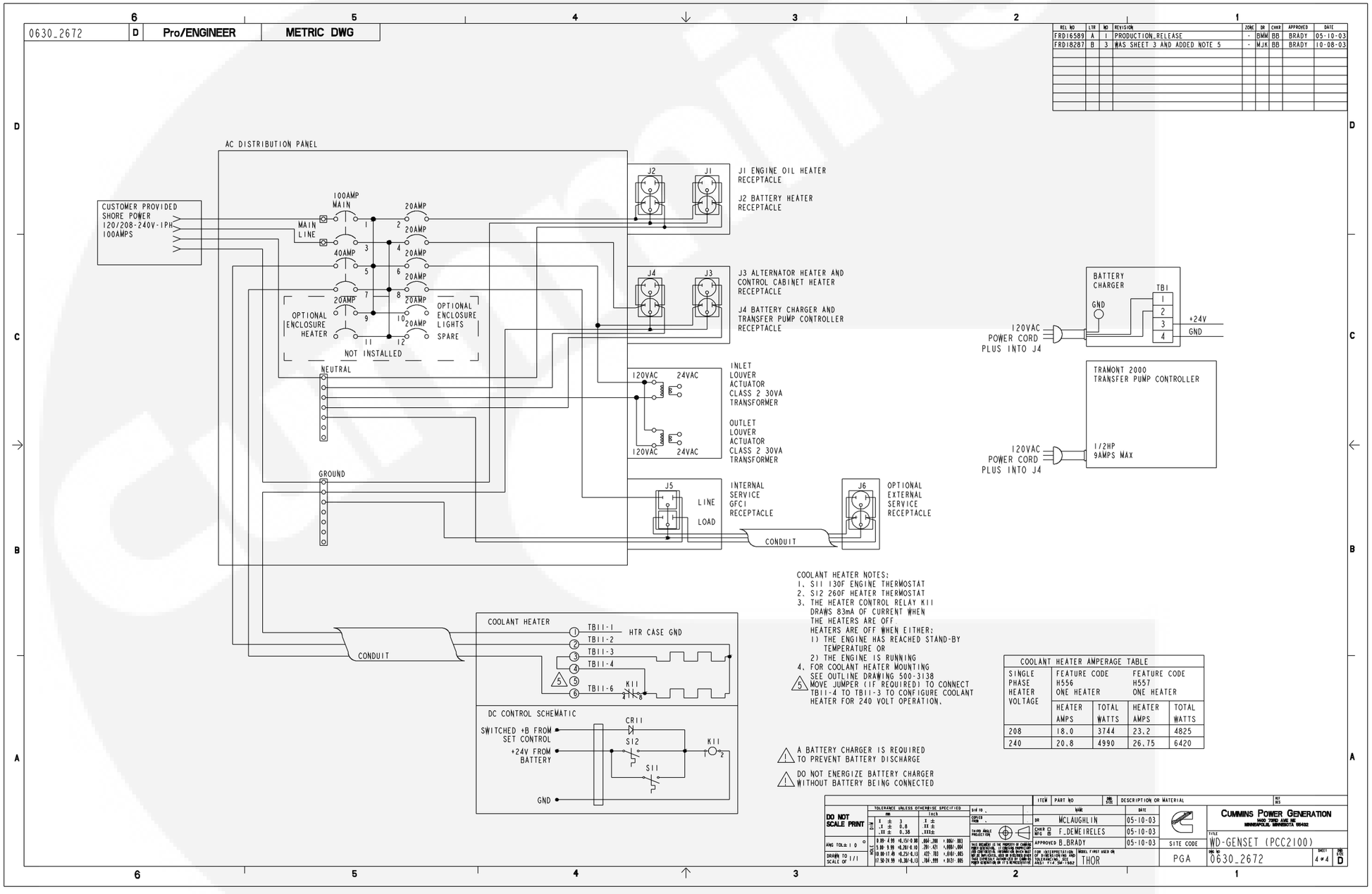



**FIGURE 27. 0630_2672 SHEET 4**

# Appendix B. Customer Connections

## Table of Contents

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

## B.2 DFEG/DFEH/DFEJ/DFEK Genset Customer Connections with PowerCommand 2100 Control

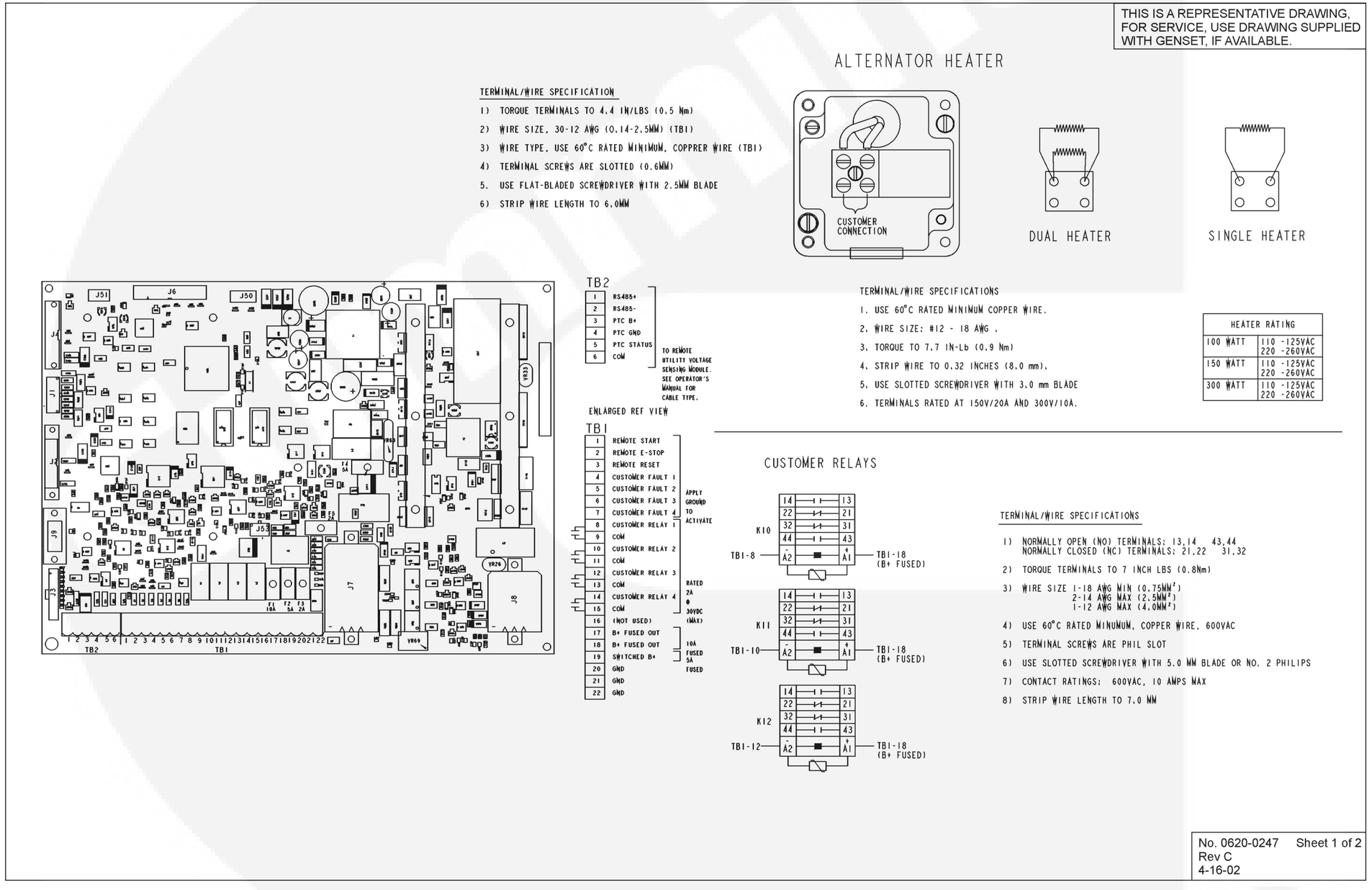
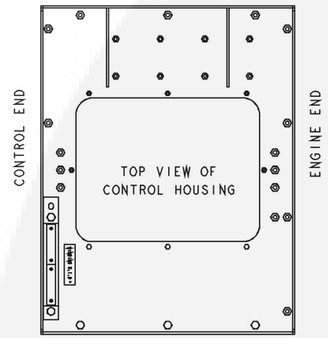


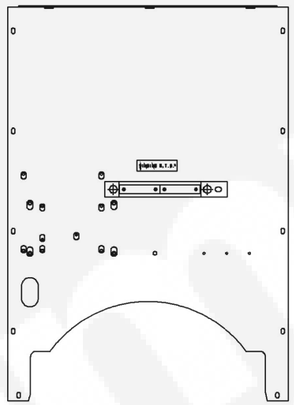

**FIGURE 28. 0620_0247 SHEET 1**

THIS IS A REPRESENTATIVE DRAWING, FOR SERVICE, USE DRAWING SUPPLIED WITH GENSET, IF AVAILABLE.

## RTD CUSTOMER CONNECTIONS




HC6 & 7 ONLY

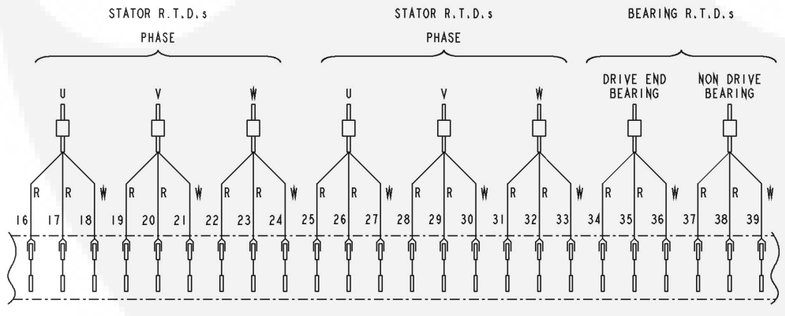


HC4 & 5 ONLY

RTD TERMINAL BLOCK CONNECTIONS:

1. USE 60°C RATED MINIMUM COPPER WIRE.
2. USE WIRE SIZES 22 TO 12 AWG.
3. TORQUE TO 7.7 LBS-IN (0.9 N-M)
4. STRIP WIRE TO 0.32 INCHES (8.0 MM).
5. USE SLOTTED SCREWDRIVER WITH A 3.0 MM BLADE.
6. TERMINALS RATED AT 150V/20A AND 300V/10A.

## R.T.D. (Resistance Temperature Detector)




NOTES:
(1) R = RED W = WHITE

C2

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**FIGURE 29. 0620_0247 SHEET 2**

# Appendix C. Alternator Reconnect Drawing

## Table of Contents

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

## C.2 Reconnect Drawing for Alternator for DFEG, DFEH, DFEJ, and DFEK

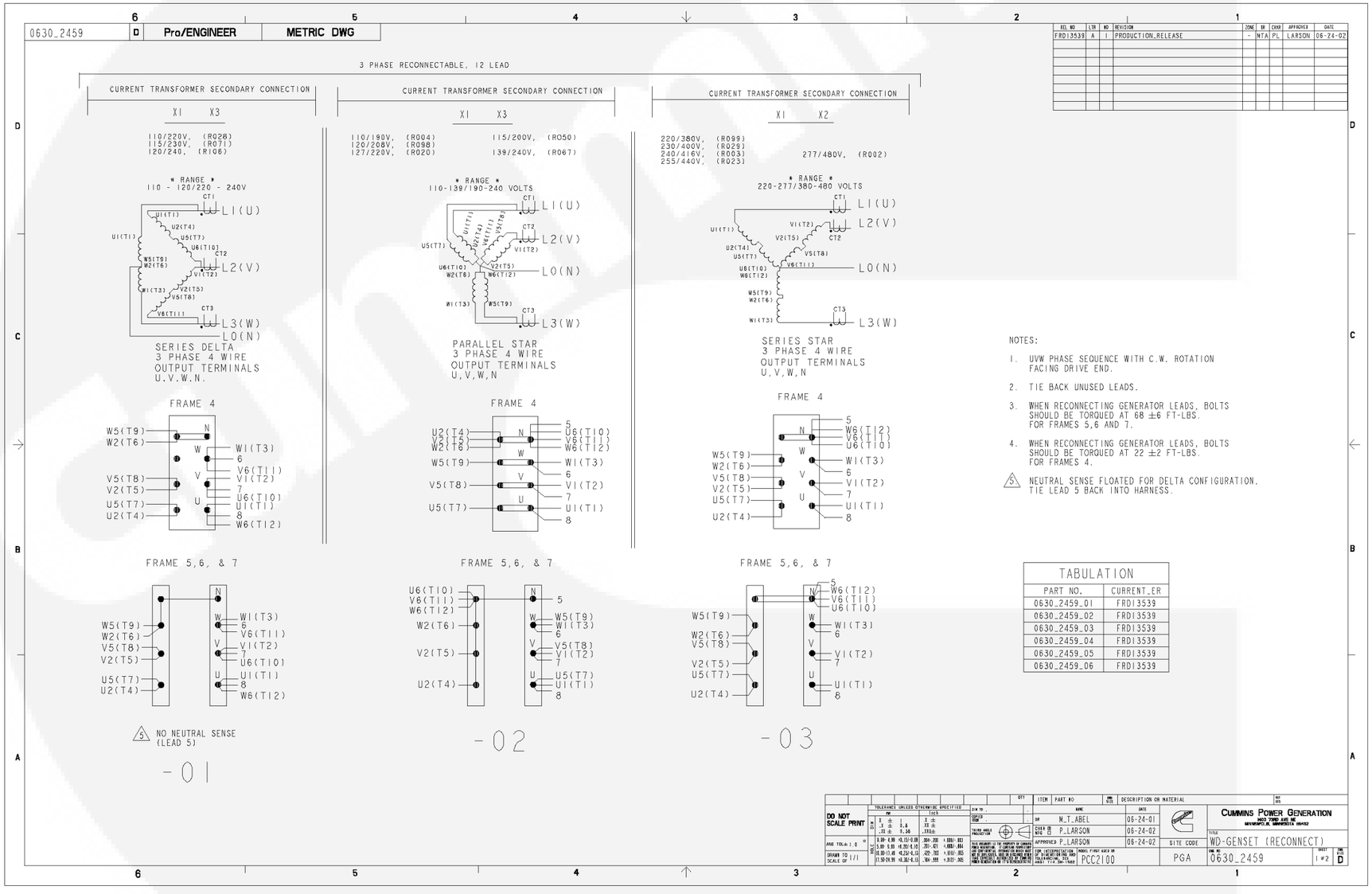


**FIGURE 30. 0630-2459 REVISION A SHEET 1**

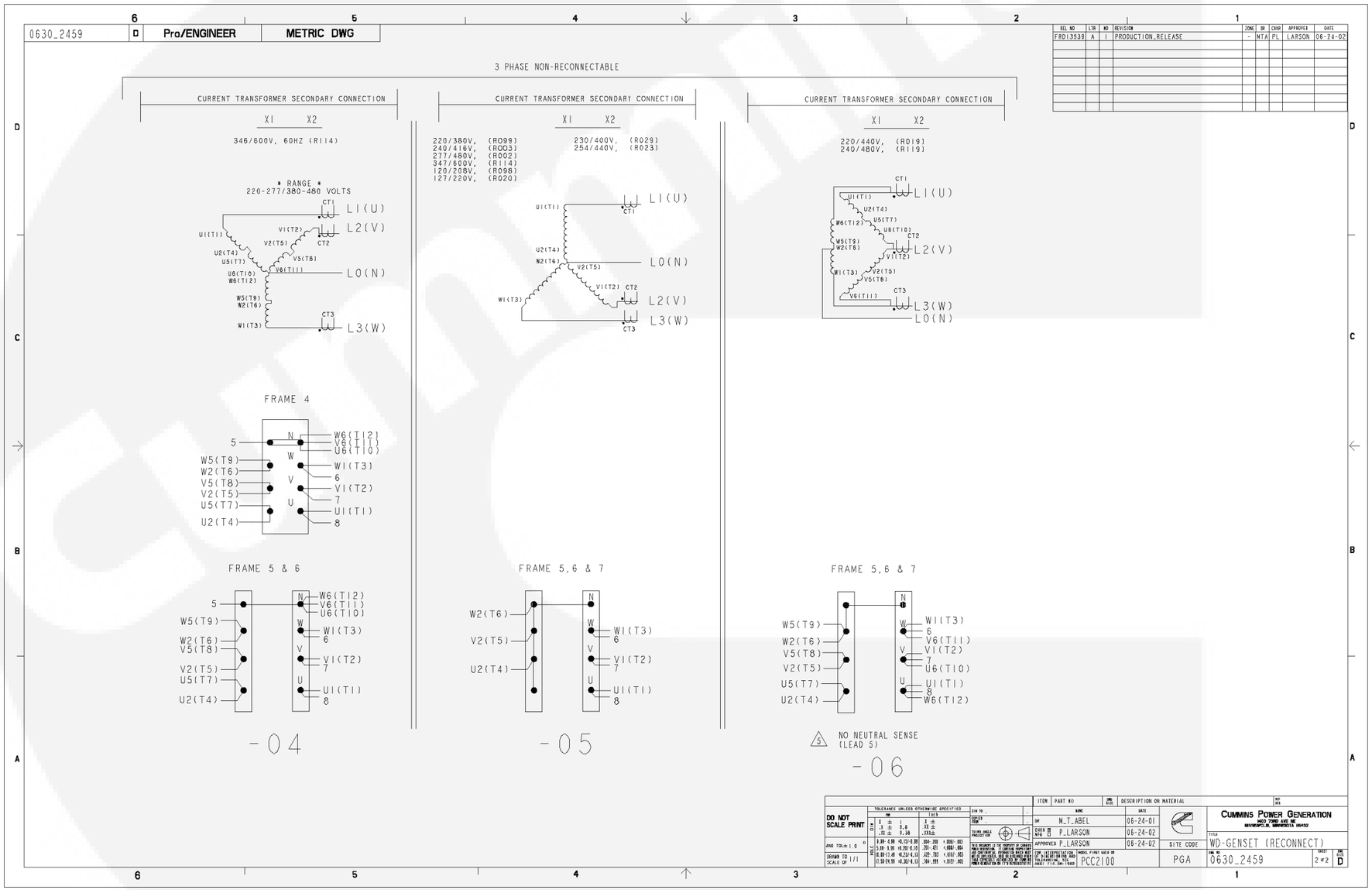


**FIGURE 31. 0630-2459 REVISION A SHEET 2**

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