



# Installation Manual

## **Generator Set**

**QSL9-G2 Engine with PowerCommand® 2100 Control**

DSHAD (Spec D-F)



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# 1 IMPORTANT SAFETY INSTRUCTIONS

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SAVE THESE INSTRUCTIONS. This manual contains important instructions that should be followed during installation and maintenance of the generator set and batteries.


Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

## 1.1 Warning, Caution, and Note Styles Used in This Manual

The following safety styles and symbols found throughout this manual indicate potentially hazardous conditions to the operator, service personnel, or equipment.

 <b>DANGER</b>
<i>Indicates a hazardous situation that, if not avoided, will result in death or serious injury.</i>

 <b>WARNING</b>
<i>Indicates a hazardous situation that, if not avoided, could result in death or serious injury.</i>

 <b>CAUTION</b>
<i>Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.</i>

<b>NOTICE</b>
Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

## 1.2 General Information

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

<b>NOTICE</b>
<b>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.</b>

## 1.2.1 General Safety Precautions

### WARNING

#### **Hot Pressurized Liquid**

**Contact with hot liquid can cause severe burns.**

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

### WARNING

#### **Moving Parts**

**Moving parts can cause severe personal injury.**

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

### WARNING

#### **Toxic Hazard**

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

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

### WARNING

#### **Electrical Generating Equipment**

**Incorrect operation can cause severe personal injury or death.**

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

### WARNING

#### **Toxic Gases**

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

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

### WARNING

#### **Combustible Liquid**

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

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

### WARNING

#### **High Noise Level**

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

**Wear appropriate ear protection at all times.**

**⚠ WARNING****Hot Surfaces**

**Contact with hot surfaces can cause severe burns.**

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

**⚠ WARNING****Electrical Generating Equipment**

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

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

**⚠ WARNING****Toxic Hazard**

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

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

**⚠ WARNING****Combustible Liquid**

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

**Do not use combustible liquids like ether.**

**⚠ WARNING****Automated Machinery**

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

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

**⚠ WARNING****Fire Hazard**

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

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

**⚠ WARNING****Fire Hazard**

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

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

**⚠ WARNING****Fall Hazard**

*Falls can result in severe personal injury or death.*

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

**⚠ WARNING****Fire Hazard**

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

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

**⚠ WARNING****Pressurized System**

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

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

**⚠ WARNING****Confined Areas**

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

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

**⚠ CAUTION****Manual Handling Heavy Objects**

*Handling heavy objects can cause severe personal injury.*

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

**⚠ CAUTION****Power Tools and Hand Tools**

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

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

**⚠ CAUTION****Sharp Edges and Sharp Points**

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

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

**NOTICE**

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

**NOTICE**

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

**NOTICE**

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

**NOTICE**

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

## 1.3 Generator Set Safety Code

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

**⚠ WARNING*****Electrical Generating Equipment***

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

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

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

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

### 1.3.2 Positioning of Generator Set

The generator set should be placed on level ground with adequate open space around it. The immediate area around the generator set should be free of any flammable material.

**NOTICE**

Access or service doors must be closed and locked before repositioning, and they must remain locked during transportation and siting.

**NOTICE**

The generator set is capable of operating at inclines of up to +/- 2.5 degrees.

### 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*****Electric Shock Hazard***

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

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

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

Guidelines to follow when working on energized electrical systems:

**NOTICE**

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

**NOTICE**

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

In summary:

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



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

## 1.4.1 AC Supply and Isolation

### NOTICE

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

### NOTICE

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

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

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

### 1.4.1.1 AmpSentry

Generator sets with PC 3.3 control utilize AmpSentry™ protective relay which includes integral AC protective functions for the alternator and conductors, if conductors are rated for operation at a minimum of 100% of the generator nameplate rating.

## 1.4.2 AC Disconnect Sources

### WARNING

#### *Hazardous Voltage*

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

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

## 1.4.3 Medium Voltage Equipment (601 V to 15 kV - U.S. and Canada)

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

### 1.5.1 Spillage

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

### 1.5.2 Fluid Containment

#### NOTICE

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

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

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

### 1.5.3 Do Not Operate in Flammable and Explosive Environments

Flammable vapor can cause an engine to over speed and become difficult to stop, resulting in possible fire, explosion, severe personal injury, and death. Do not operate a generator set where a flammable vapor environment can be created, unless the generator set is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the generator set are solely responsible for operating the generator set safely. Contact your authorized Cummins distributor for more information.

## 1.6 Exhaust Gases Are Deadly

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

## 1.6.1 Exhaust Precautions

### WARNING

#### **Hot Exhaust Gases**

**Contact with hot exhaust gases can cause severe burns.**

**Wear personal protective equipment when working on equipment.**

### WARNING

#### **Hot Surfaces**

**Contact with hot surfaces can cause severe burns.**

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

### WARNING

#### **Toxic Gases**

**Inhalation of exhaust gases can cause asphyxiation and death.**

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

### WARNING

#### **Fire Hazard**

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

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

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

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

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

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

## 1.7 Earth Ground Connection

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

### **NOTICE**

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

**NOTICE**

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

## 1.8 Decommissioning and Disassembly

**NOTICE**

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

## 2 Introduction

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### WARNING

#### ***Hazardous Voltage***

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

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

### WARNING

#### ***Electrical Generating Equipment***

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

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

## 2.1 About This Manual

The purpose of this manual is to provide the users with accurate, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

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

Users are respectfully advised that, in the interests of good practice and safety, it is their responsibility to employ competent persons to carry out any installation work. Consult your authorized distributor for further installation information. It is essential that the utmost care is taken with the application, installation, and operation of any engine due to their potentially hazardous nature. Careful reference should also be made to other Cummins literature. A generator set must be operated and maintained properly for safe and reliable operation.

For further assistance, contact your authorized distributor.

### 2.1.1 Additional Installation Manual Information

The purpose of this manual is to provide the Installation Engineer with sound, general information for the installation of the generator set. Refer to the Generator Set Operator Manual for additional information which must also be read before operating the set.

This manual provides installation instructions for the generator set models listed on the front cover. This includes the following information:

- **Mounting Recommendations** - for fastening the generator set to a base and space requirements for normal operation and service.
- **Mechanical and Electrical Connections** - covers most aspects of the generator set installation.
- **Prestart** - checklist of items or procedures needed to prepare the generator set for operation.
- **Installation Checklist** - reference checks upon completion of the installation.

This manual **DOES NOT** provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), additional information is required. Review standard installation practices. For engineering data specific to the generator set, refer to the Specification and Data Sheets. For application information, refer to Application Manual T-030, "Liquid Cooled Generator Sets." To find this manual online:

1. Go to [powersuite.cummins.com](http://powersuite.cummins.com)
2. Click on "Login" on the Home page.
3. Click on "Library".
4. Click on "Technical Documents".
5. Click on "Technical information".
6. Click on "Liquid Cooled Genset Application Manual".

## 2.2 Schedule of Abbreviations

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

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
AC	Alternating Current	LED	Light-emitting Diode
AMP	AMP, Inc., part of Tyco Electronics	LTS	Long Term Storage
ANSI	American National Standards Institute	LVRT	Low Voltage Ride Through
ASOV	Automatic Shut Off Valve	MFM	Multifunction Monitor
ASTM	American Society for Testing and Materials (ASTM International)	Mil Std	Military Standard
ATS	Automatic Transfer Switch	MLD	Masterless Load Demand
AVR	Automatic Voltage Regulator	NC	Normally Closed
AWG	American Wire Gauge	NC	Not Connected
CAN	Controlled Area Network	NFPA	National Fire Protection Agency
CB	Circuit Breaker	NO	Normally Open
CE	Conformité Européenne	NWF	Network Failure
CFM	Cubic Feet per Minute	OEM	Original Equipment Manufacturer
CGT	Cummins Generator Technologies	OOR	Out of Range
CMM	Cubic Meters per Minute	OORH / ORH	Out of Range High
CT	Current Transformer	OORL / ORL	Out of Range Low
D-AVR	Digital Automatic Voltage Regulator	PB	Push Button
DC	Direct Current	PCC	PowerCommand® Control
DEF	Diesel Exhaust Fluid	PGI	Power Generation Interface
DPF	Diesel Particulate Filter	PGN	Parameter Group Number

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
ECM	Engine Control Module	PI	Proportional/Integral
ECS	Engine Control System	PID	Proportional / Integral / Derivative
EMI	Electromagnetic interference	PLC	Programmable Logic Controller
EN	European Standard	PMG	Permanent Magnet Generator
EPS	Engine Protection System	PPE	Personal Protective Equipment
E-Stop	Emergency Stop	PT	Potential Transformer
FAE	Full Authority Electronic	PTC	Power Transfer Control
FMI	Failure Mode Identifier	PWM	Pulse-width Modulation
FRT	Fault Ride Through	RFI	Radio Frequency Interference
FSO	Fuel Shutoff	RH	Relative Humidity
Genset	Generator Set	RMS	Root Mean Square
GCP	Generator Control Panel	RTU	Remote Terminal Unit
GND	Ground	SAE	Society of Automotive Engineers
LCT	Low Coolant Temperature	SCR	Selective Catalytic Reduction
HMI	Human-machine Interface	SPN	Suspect Parameter Number
IC	Integrated Circuit	SWL	Safe Working Load
ISO	International Organization for Standardization	SW_B+	Switched B+
LBNG	Lean-burn Natural Gas	UL	Underwriters Laboratories
LCD	Liquid Crystal Display	UPS	Uninterruptible Power Supply
		VPS	Valve Proving System

## 2.3 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 DSHAD Spec D Generator Set with Engine QSL9 and PowerCommand® 2100 (A040X970)
- Installation Manual for DSHAD Spec D with Engine QSL9 and PowerCommand® 2100 (A040Y566)
- Service Manual for DSHAD Spec D with Engine QSL9 and PowerCommand® 2100 (A040Y568)
- Controller Service Manual for PowerCommand® 2100 (A029X163)

- Engine Operation & Maintenance Manual for QSL9 (4021518)
- Alternator Service Manual for UC (0900-9901)
- *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 DSHAD with QSL9 Engine, PowerCommand® 2100 (0961-0208)
- Standard Repair Times - CT Family (A030C157)
- Warranty Administration Manual (4021290)
- Global Commercial Warranty Statement (A028U870)

### 2.3.1 Further Information - Literature

Contact your authorized distributor for more information regarding related literature for this product.

## 2.4 After Sales Services

Cummins offers a full range of maintenance and warranty services.

### 2.4.1 Maintenance

#### WARNING

##### ***Electrical Generating Equipment***

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

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

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

### 2.4.2 Warranty

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

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

Extended warranty coverage is also available.

For further warranty details, contact your authorized service provider.

#### NOTICE

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



### **2.4.2.1 Warranty Limitations**

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

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# 3 System Overview

This section provides an overview of the generator set.

## 3.1 Generator Set Identification

Each generator set is provided with a nameplate similar to that shown below. The nameplate provides information unique to the generator set.

### 3.1.1 Nameplate

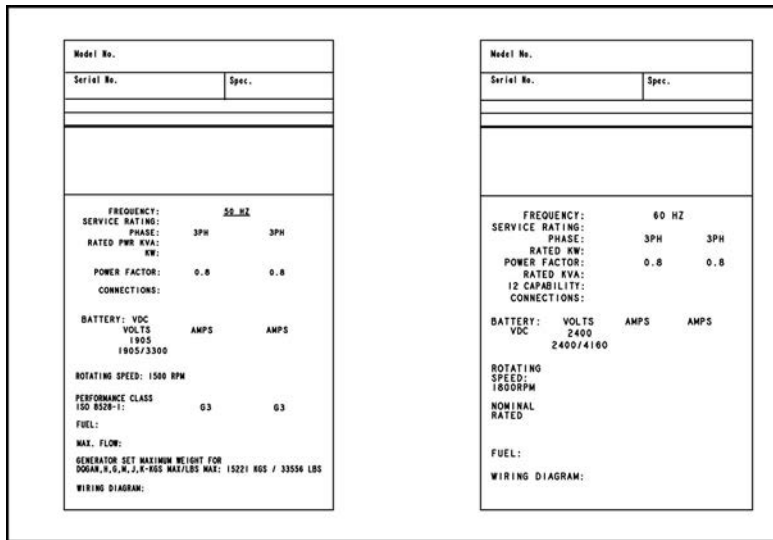
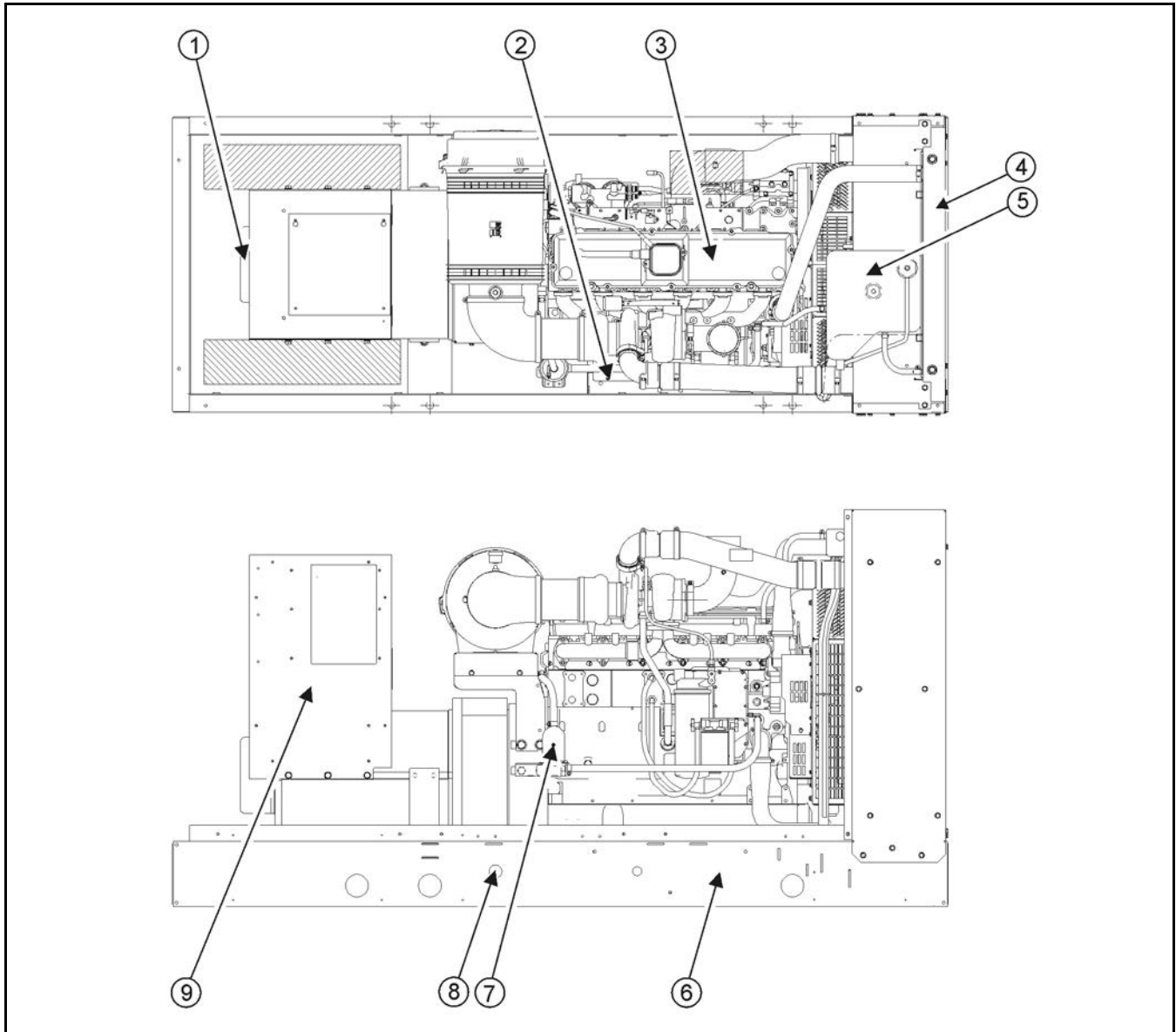


FIGURE 1. TYPICAL GENERATOR SET NAMEPLATE

## 3.2 Generator Set Components

The main components of a DSHAD generator set are shown below, and referred to within this section.

There are various options listed although they may not be available for all models.



No	Description	No	Description
1	Alternator	6	Bed Frame
2	Battery	7	Engine Coolant Heater
3	Engine	8	Oil Drain
4	Radiator	9	Electrical Connection Area (Both Sides)
5	Radiator Expansion Tank		

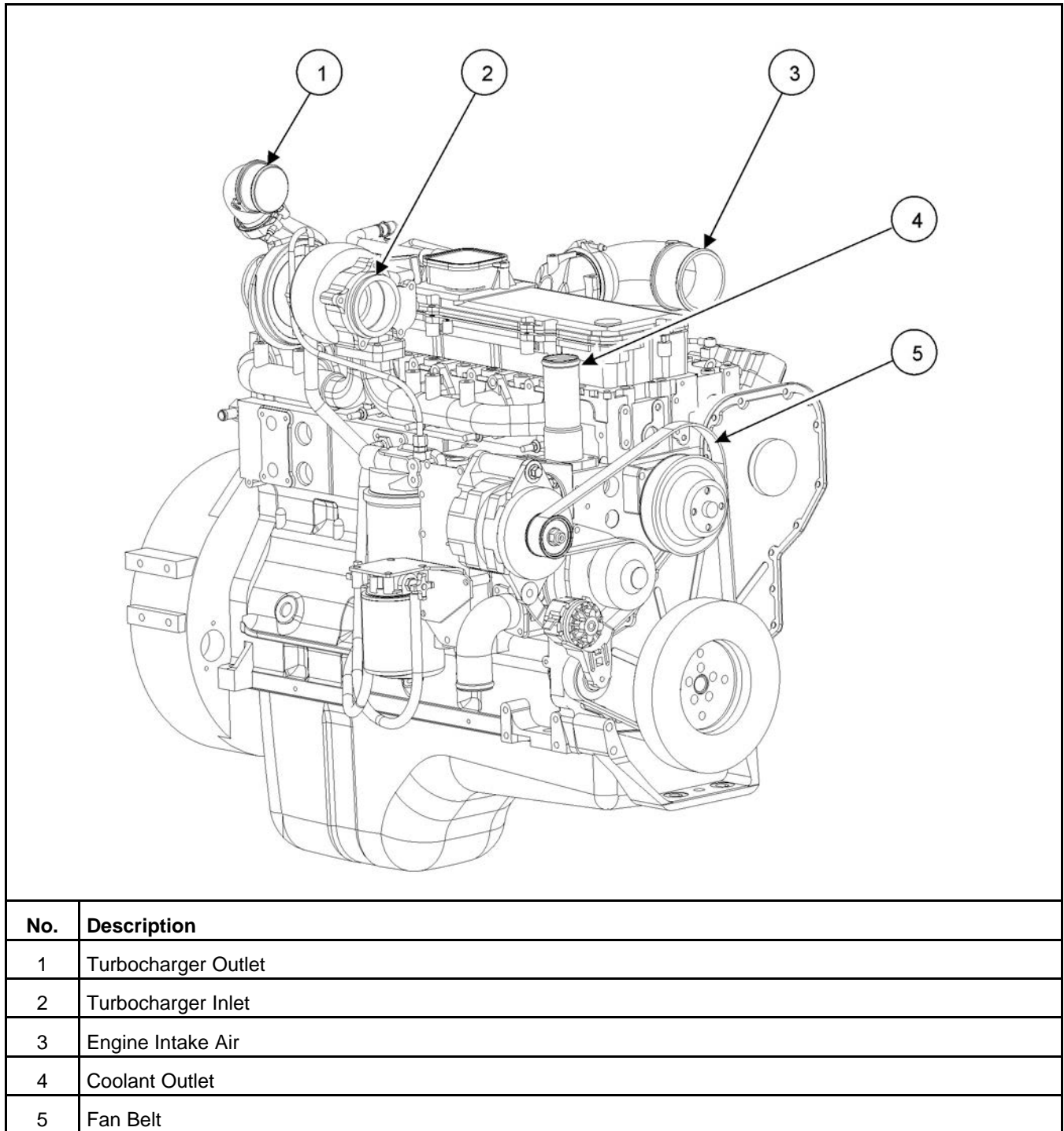
FIGURE 2. TYPICAL DSHAD GENERATOR SET

### 3.3 Generator Set Rating

For details of the generator set rating, refer to the generator set nameplate. For operation at temperatures or altitudes above those stated on the nameplate, a derate may be necessary.

### 3.4 Engine

For additional engine specific information, refer to the relevant engine manual for your generator set.



**FIGURE 3. DSHAD ENGINE COMPONENTS**

## 3.5 Sensors

Various generator set parameters are measured by sensors, and the resulting signals are processed by the control board.

Engine-mounted sensors monitor a number of different systems, such as:

- Lube Oil Pressure
- Cooling System Temperature

## 3.6 System Options

### 3.6.1 Annunciators

The annunciator's lamps and alarm indicate the operating status and fault conditions of an emergency power system. For more information, see [Section 9.11 on page 88](#).

### 3.6.2 Battery Charger

A battery charger can be wall mounted, bench mounted, or skid mounted.

### 3.6.3 Day Tank

Some generator set installations include a fuel day tank. For more information, refer to [Section 7.1.6 on page 40](#).

#### 3.6.3.1 Fuel Transfer Pump

A fuel transfer pump and control can be installed when a sub-base or an in-skid day tank is provided. For more information, see [Section 7.1.7 on page 41](#) and [Section 9.5.1 on page 82](#).

### 3.6.4 Fuel Filter Kits

Fuel filter kits must be installed during generator set installation. For more information, see the Fuel Filter Kit Installation section.

### 3.6.5 Heaters

#### 3.6.5.1 Heater Supply and Isolation

An external power supply is required for the operation of the generator set heaters.

#### NOTICE

**If not already provided, it is the sole responsibility of the customer to provide the power supply and the means to isolate the AC input to the terminal box. Cummins accepts no responsibility for providing the means of isolation.**

#### 3.6.5.2 Alternator Heaters

Alternator heaters are used to help keep the alternator free of condensation when the generator set is not running. For more information on alternator heater components and specifications, refer to [Section 9.8 on page 84](#).

### 3.6.5.3 Coolant Heater

Coolant heaters heat the coolant to maintain a minimum engine temperature when the generator set is not running. For more information on coolant heater components and specifications, see [Section 9.7 on page 84](#).

### 3.6.5.4 Control Box Heater

A control box heater provides a means of humidity and temperature control of the control box interior. It protects the components when the generator set is subjected to varying ambient air conditions during extended periods of non-use. For more information on heater components and wiring, see [Section 9.9 on page 85](#).

### 3.6.5.5 Oil Heaters

An engine oil heater keeps the oil warm which improves cold weather starting. For more information on oil pan heaters, refer to [Section 9.10 on page 87](#).

## 3.6.6 Remote Radiator Installation

Special requirements apply if your generator set includes a remote radiator. For more information, refer to [Section 7.7 on page 54](#).

## 3.6.7 Relays

### 3.6.7.1 Customer Relays

These relays are used for customer-specific applications. For more information, see [Section 8.3 on page 70](#).

### 3.6.7.2 Ground Fault Relays

Ground fault relays can be used in the following applications:

- Local CT for 4-pole transfer switch
- Remote CT for 3-pole transfer switch

For more information on ground fault relay components and wiring, see [Section 8.5 on page 73](#).

### 3.6.7.3 Paralleling Circuit Breaker Control Relays

Paralleling circuit breaker control relays can be installed on generator sets used in paralleling applications. For more information on relay components and wiring, see [Section 8.4 on page 71](#).

## 3.6.8 Seismic Installation Requirements

Seismically certified generator set installations have special requirements, as defined by IAA-VMC (Independent Approval Agency, the VMC Group).

For special installation requirements, refer to the tabulated and written seismic requirements listed in the Seismic Requirements appendix [Appendix F on page 125](#). The installation of the seismically certified generator set should be overseen by the installation project structural engineer of record.

The "Seismic Certificate of Compliance" should be kept with the Warranty and other generator set documents.

The seismic requirements installation drawing and the Seismic Certificate of Compliance for generator sets are included in the literature package of each seismically certified generator set.

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# 4 Installation Overview

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These installation recommendations apply to typical installations with standard model generator sets. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your nearest authorized distributor for assistance.

## 4.1 Application and Installation

A power system must be carefully planned and correctly installed for proper operation. This involves two essential elements.

- **Application** (as it applies to generator set installations) refers to the design of the complete power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, cooling, exhaust, and fuel systems. Each component must be correctly designed so the complete system will function as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers or other trained specialists are responsible for the design of the complete power system and for selecting the materials and products required.
- **Installation** refers to the actual set-up and assembly of the power system. The installers set up and connect the various components of the system as specified in the system design plan. The complexity of the system normally requires the special skills of qualified electricians, plumbers, sheet-metal workers, etc. to complete the various segments of the installation. This is necessary so that all components are assembled using standard methods and practices.

## 4.2 Safety Considerations

The generator set has been carefully designed to provide safe and efficient service when properly installed, maintained, and operated. However, the overall safety and reliability of the complete system is dependent on many factors outside the control of the generator set manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the generator set exactly as specified in this manual. All systems external to the generator (fuel, exhaust, electrical, etc.) must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

### **WARNING**

#### ***Fall Hazard***

***Falls can result in severe personal injury or death.***

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

## 4.3 Seismic Installations

Seismically certified generator set installations have special requirements, as defined by IAA-VMC (Independent Approval Agency, the VMC Group).

For special installation requirements, refer to the tabulated and written seismic requirements listed in [Appendix F on page 125](#).

The installation of the seismically certified generator set should be overseen by the installation project structural engineer of record.

The "Seismic Certificate of Compliance" should be kept with the Warranty and other generator set documents.

The seismic requirements installation drawing and the Seismic Certificate of Compliance for generator sets are included in the literature package of each seismically certified generator set.

### 4.3.1 Seismic Installation Notes

1. The design of post-installed anchors in concrete used for the component anchorage is pre-qualified for seismic applications in accordance with "ACI 355.2" and documented in a report by a reputable testing agency. (ex. the evaluation service report issued by the International Code Council)
2. Anchors must be installed to an embedment depth as recommended in the pre-qualification test report as defined in Note 1. For "IBC 2000" and "IBC 2003" applications, the minimum embedment must be 8X for the anchor diameter.
3. Anchors must be installed in minimum 4000 PSI compressive strength normal weight concrete. Concrete aggregate must comply with "ASTM C33". Installation in structural lightweight concrete is not permitted unless otherwise approved by the structural engineer of record.
4. Anchors must be installed to the torque specification as recommended by the anchor manufacturer to obtain maximum loading.
5. Anchors must be installed in locations specified in this section.
6. Wide washers must be installed at each anchor location between the anchor head and equipment for tension load distribution. Wide washers must be Series "W" of American National Standard Type "A" plain washers (ANSI B18.22.1-1965, R1975) with the nominal washer size selected to match the specified nominal anchor diameter.
7. Concrete floor slab and concrete housekeeping pads must be designed and rebar reinforced for seismic applications in accordance with "ACI 318". The design loads shall be taken as those specified in this section.
8. All housekeeping pad thicknesses must be designed in accordance with the pre-qualification test report as defined in Note 1 or a minimum of 1.5X the anchor embedment depth, whichever is largest.
9. All housekeeping pads must be dowelled or cast into the building structural floor slab and designed for seismic application per "ACI 318" and as approved by the structural engineer of record.
10. Wall mounted equipment must be installed to a rebar reinforced structural concrete wall that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the wall.
11. Floor mounted equipment (with or without a housekeeping pad) must be installed to a rebar reinforced structural concrete floor that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the floor.
12. When installing to a floor or wall, rebar interference must be considered.
13. Attaching seismic certified equipment to any floor or wall other than those constructed of structural concrete and designed to accept the seismic loads from said equipment is not permitted by this specification and beyond the scope of this certification.
14. Attaching seismic certified equipment to any floor constructed of light weight concrete over steel decking is not permitted by this specification and beyond the scope of this certification.
15. Attaching the seismic certified equipment to any concrete block walls or cinder block walls is not permitted by this specification and beyond the scope of this certification.
16. Installation upon a rooftop steel dunnage shall be coordinated with the structural engineer of record.

17. Installation upon any rooftop curb shall be coordinated with the curb manufacturer and the structural engineer of record. Any curb or concrete pad that supports the generator set unit is beyond the scope of this certification.
18. Connections to the equipment, including but not limited to conduit, wiring from cable trays, other electrical services, ducting, piping such as exhaust, steam, water, coolant, refrigerant, fuel, or other connections, are the responsibility of the installing contractor and beyond the scope of this document. Typical requirements for these connections are stated in the equipment installation manual. Special considerations for seismic applications are as follows; connections to non-isolated components or equipment may be installed as typical for that particular application. Connections to isolated components (ex. breaker box bolted directly to an isolated generator set) or isolated equipment (ex. an enclosed generator set mounted on external isolators) must be flexibly attached. The flexible attachment must provide for enough relative displacement to remain connected to the equipment and functional during and after a seismic event.

## 4.4 Standby Heating Devices

Cummins requires installing standby generator sets (life safety systems) with engine jacket water coolant heaters in order to ensure a 10 second start. Jacket water coolant heaters are also recommended in prime and continuous applications where time and load acceptance is to be minimized.

The jacket water coolant heater provided by Cummins rated to provide the above requirements in ambient temperatures as low as 4 °C (40 °F). Although most Cummins generator sets will start in temperatures down to -32 °C (-25 °F) when equipped with engine jacket water coolant heaters, it might take more than 10 seconds to warm the engine before a load can be applied when ambient temperatures are below 4 °C (40 °F).

On generator sets equipped with a graphic display, the **Low Coolant Temperature** message, in conjunction with illumination of the Warning LED, is provided to meet the current requirements. The engine cold sensing logic initiates a warning when the engine jacket water coolant temperature falls below 21 °C (70 °F). In applications where the ambient temperature falls below 4 °C (40 °F), or there exists a high amount of cold airflow, the jacket water coolant heater may not provide the necessary heating. Under these conditions, although the generator set may start, it may not be able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions may be necessary to warm the engine before applying a load.

## 4.5 Product Modifications

Agency certified products purchased from Cummins comply only with those specific requirements and as noted on company product specification sheets. Subsequent modifications must meet commonly accepted engineering practices and/or local and national codes and standards. Product modifications must be submitted to the local authority having jurisdiction for approval.

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# 5 Specifications

## 5.1 Generator Set Specifications

TABLE 1. DSHAD SPECIFICATIONS

MODELS	DSHAD
<b>Engine</b> Cummins Diesel Series	QSL9-G2, NR3
<b>Generator kW Rating</b>	See generator set nameplate for rating information.
<b>Engine Fuel Connection</b> Inlet/Outlet Thread Size	Refer to generator set outline drawing supplied (A002R623)
<b>Maximum Weight</b>	3442 lb (1561 kg)
<b>Fuel</b>	
Max. Fuel Inlet Restriction	6 inHg (152.4 mmHg)
Max. Fuel Return Restriction	10 inHg (254 mmHg)
Fuel Pump Flow Rate	43 gal/hr (162.8 L/hr)
<b>Exhaust</b>	1800 RPM
Outlet Size	12 in. NB
Max. Allowable Back Pressure	3.02 in. (76.5 mm) Hg
Exhaust Flow at Rated Load	1176 cfm (5.55 L/s at SBY)
Exhaust Temperature	1110 °F (600 °C)
<b>Electrical System</b>	
Starting Voltage	12 Volts DC
Battery	Two, 12 Volt
Battery Group Number	24XL
Cold Soak @ 0 °F (-18 °C)	810 at 0 °F to 32 °F (-18 °C to 0 °C)
<b>Cooling System</b>	
Capacity with Standard Radiator	7.8 US gal (29.5 L)

## 5.2 Engine Fuel Consumption

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

Model	DSHAD
Engine	QSL9-G2
Standby Rating (kVA)	288

Prime Rating (kVA)	<b>261</b>
Engine Performance Data at 60Hz <sup>1</sup> (L/hr)	<b>69</b>
Engine Performance Data at 60Hz <sup>1</sup> (Gal/hr)	<b>18.2</b>
Engine Performance Data at 60Hz <sup>2</sup> (L/hr)	<b>64</b>
Engine Performance Data at 60Hz <sup>2</sup> (Gal/hr)	<b>17</b>
1. Standby/Full Load 2. Prime/Full Load Refer to Data Sheets for other applications. In line with the CPG policy of continuous improvement, these figures are subject to change.	

# 6 Installing the Generator Set

Generator set installations must be engineered so that the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. The complete installation must comply with all local and state building codes, fire regulations, and other applicable regulations.

Requirements to be considered prior to installation are:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of generator set air
- Non-combustible mounting surface
- Discharge of exhaust gases
- Electrical connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation

## NOTICE

*Depending on the location and intended use, ensure that international, national or local laws and regulations regarding Air Quality Emissions have been observed and complied with. Be sure to consult local pollution control or air quality authorities before completing construction plans.*

## 6.1 Location

### WARNING

#### ***Electrical Generating Equipment***

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

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

### WARNING

#### ***Incorrect installation***

***Incorrect installation of the generator set, 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 mechanical component installation.***

**NOTICE**

**Depending on your location and intended use, additional laws and regulations may require for you to obtain an air quality emissions permit before beginning installation of your generator set. Be sure to consult local pollution control or air quality authorities before completing your construction plans.**

Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power service entrance. Exhaust gases must not be able to enter or accumulate around inhabited areas.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions.

Use the following information to locate the generator set for optimal operating conditions:

**Surface:** Concrete or compacted gravel with the generator set resting on solid, poured concrete blocks, or timber blocks spaced at reasonable intervals around the perimeter of the generator set.

**Leveling:** Level the generator set from side-to-side within + 3.5°, and end-to-end within +2.5°.

**Placement:**

- Generator sets should be a minimum of 5 m (16.4 ft) apart to allow for adequate access.
- Make sure that the air inlets are not obstructed by surrounding trees, buildings, or other obstructions.
- Make sure noise distribution (to prevent echoing) is kept to a minimum.
- Consider exhaust for immediate neighbors.
- The prevailing wind direction should be considered so that the engine combustion air inlet is upwind and the exhaust discharge is downwind.
- The immediate area around the proposed location of the mounting surface should be evaluated for proper drainage so that moisture run-off is sufficient to prevent ponding around the unit(s).

## 6.2 Mounting

Generator sets are mounted on a steel skid that provides proper support, which is sited on mechanical spring isolators to provide adequate vibration isolation per application.

**NOTICE**

**The use of unapproved isolators may result in harmful resonances and may void the generator set warranty.**

Mount the generator set on a substantial and level base such as a concrete pad. A non-combustible material must be used for the pad.

The fixing centers for the mounting bolts can be found on the generator set *Outline Drawing* referenced in [Appendix D on page 115](#)

## 6.3 Access to Generator Set

Generally, at least 1 meter (3.3 ft) of clearance should be provided on all sides of the generator set for maintenance and service access. (Increase clearance by width of door if optional housing is used.) A raised foundation or slab of 152 mm (6 inches) or more above floor level will make servicing easier. Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the transfer switch so that it is available at all times.



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## 6.4 Vibration Isolator Installation and Adjustment Procedure

This procedure covers installing the following non-seismic rated isolators (Does not carry IBC/OSHPD certification). Part numbers: 0402-0427, 0402-0234, 0402-0246, 0402-0222, 0402-0427.

1. Place the vibration isolators (see [Figure 4](#)) on the generator set support structure. The isolators should be shimmed or grouted to make sure that all of the isolator bases are within 6 mm (0.25 inches) elevation of each other. The surface that the isolator bases rest on must also be flat and level.
2. Loosen the side snubber lock nuts so that the top plate of the isolator is free to move vertically and horizontally. Be sure that the top plate is correctly aligned with the base and springs.
3. Place the generator set onto the isolators while aligning the skid's mounting with the threaded isolator hole. The top plates will move down and approach the base of the isolator as load is applied.
4. Once the generator set is in position, the isolators may require adjusting so that the set is level. The isolators are adjusted by inserting the leveling bolt through the skid and into the isolator (the leveling bolt's locking nut should be threaded up towards the bolt head).

The leveling bolt will adjust the clearance between the top plate and the isolator base. A nominal clearance of 6 mm (0.25 inches) or greater is desired. This will provide sufficient clearance for the rocking that occurs during startup and shutdown. If the 6 mm (0.25 inches) clearance is not present, turn the leveling bolt until the desired clearance is achieved.

5. If the radiator and engine are mounted on separate skids, make sure the radiator skid and engine/alternator skid are level with each other after adjusting the isolators. If not level, proper fan belt alignment cannot be achieved.
6. If the generator set is not yet level, adjust the leveling bolts until the set is level and sufficient clearance still remains. (Clearance on all isolators should be roughly equal).
7. Once all isolators have been set, lock the leveling bolt in place with the lock nut.
8. The snubber nuts must remain loose to provide better isolation between the generator set and the support structure.

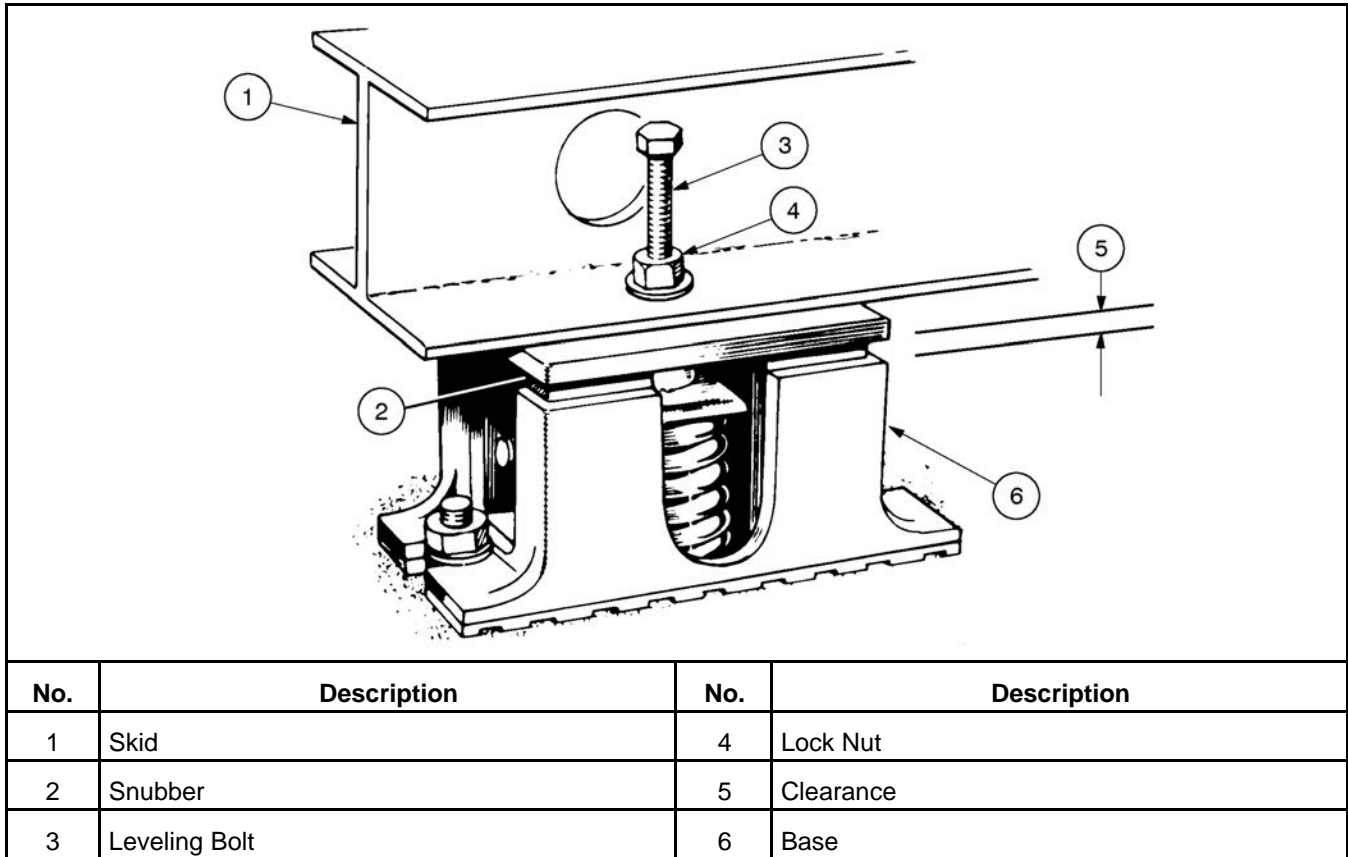


FIGURE 4. VIBRATION ISOLATOR INSTALLATION

## 6.5 Generator Set Long Term Storage

If long term storage of the generator set is required refer to the Long Term Storage section in the generator set service manual. Long term storage procedures must be repeated every 12 months for Modular Common Rail Fuel System (MCRS) fuel equipped engines.

## 6.6 Rigging Instructions

### **⚠ WARNING**

#### **Heavy Load**

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Do not lift the generator set by attaching to the engine or alternator lifting points. Do not stand under or near the generator set when lifting.***

**⚠ WARNING****Heavy Load**

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.***

1. Consult the generator set outline drawing for weight and center-of-gravity information.
2. Attach cables from the lifting lugs to a spreader bar. Never make the spreader bar cable attachment points wider than the attachment points on the skid or the bars. Make sure cables do not touch any other part of the generator set other than the skid.

**NOTICE**

**Spreader bar cable attach points width "Y" must never be wider than skid cable attach points "X." Distance "X" is the narrowest width.**

**NOTICE**

**Angle B must be slightly greater than angle A. Angle B should be as close to 90 degrees as possible to provide a stable lift.**

3. With pedestal box (not shown), the spreader bars (front and back) should be used to clear the pedestal box and the attachment cables must be as vertical as possible.

**NOTICE**

**The lifting angle (angle C) must not exceed 20° from vertical.**

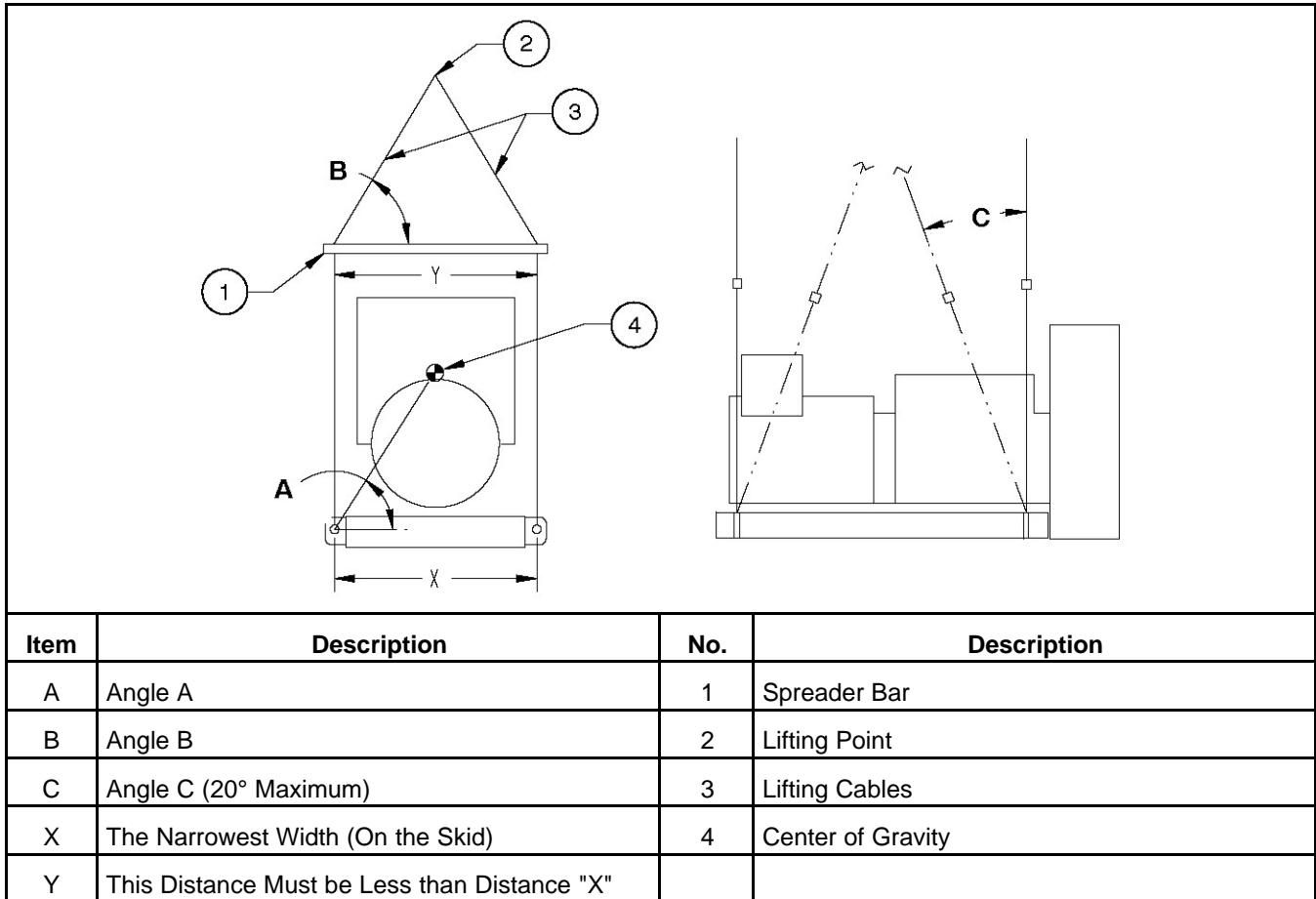


FIGURE 5. RIGGING

## 6.7 Moving the Generator Set

**⚠ WARNING**

**Heavy Load**

*Incorrect lifting or repositioning can cause severe personal injury or death.*

*Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.*

**⚠ WARNING**

**Heavy Load**

*Incorrect lifting or repositioning can cause severe personal injury or death.*

*Do not lift the generator set by attaching to the engine or alternator lifting points. Do not stand under or near the generator set when lifting.*

**⚠ WARNING*****Mechanical Hazard***

***Failed components may be ejected or operate incorrectly which can cause severe personal injury or death.***

***Do not climb the generator set; this may damage critical parts.***

**NOTICE**

**Make sure that any shipping brackets supplied with the generator set are fitted, before moving the generator set. Failure to install the shipping brackets before moving may result in damage to the generator set.**

**NOTICE**

**Access or service doors must be closed and locked before repositioning, and they must remain locked during transportation and siting.**

It is essential that there are sufficient trained and experienced personnel in attendance to make sure the lifting and transportation of the generator set is undertaken in a safe and appropriate manner, and in accordance to local guidelines and legislation.

Before lifting the generator set, lifting points, angle of slings, mass, access to intended site, and the distance of movement should all be taken into account when organizing a suitable crane/hoist. Consult the generator set information supplied with the generator set for details of dimensions and mass.

- Make sure the genset is not having fuel in the fuel tank of the generator set.
- Make sure that the crane operating area is able to support the mass of the crane and the generator set.
- Make sure the equipment used for lifting is adequate to support the weight of the generator set.
- Attach the lifting device to the lifting points only using suitable shackles, chains, and spreader bars.
- Slowly tighten the slings. Inspect the lifting attachments before commencing a full lift to make sure they are attached correctly.
- Hoist the generator set slowly using the indicated lifting points only.
- Guide the generator set with ropes at a safe distance to prevent uncontrolled rotation when positioning the generator set.
- Move the generator set to the desired location and place in position, bringing the set down slowly.
- Loosen the slings; unhook and remove the shackles.

## 6.8 Transportation

**⚠ WARNING*****Heavy Load***

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.***

**⚠ WARNING*****Heavy Load***

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Do not lift the generator set by attaching to the engine or alternator lifting points. Do not stand under or near the generator set when lifting.***

**NOTICE**

**Any panels or doors must be locked before re-positioning and must remain locked during transportation and siting.**

- Ensure the generator set is prepared for transport. If necessary drain fluids and ensure that acid or fumes do not leak from the battery (where applicable).
- If the generator set is transported over long distances, protect it against environmental influences by sealing it in a plastic cover or similar.
- Ensure the generator set is secured to the vehicle with suitable securing straps. Wooden chocks and pallets alongside the securing straps can prevent movement during transportation.
- If required, attached impact indicators to the generator set. Upon delivery, check these impact indicators and contact the transport company immediately if an impact has been detected. Impacts can cause serious damage to the generator set and its components.
- Ensure that the generator set cannot turn over during transportation.
- Do not overload the transport vehicle. Under no circumstances should the generator set be started while inside a truck.
- Lifting eyes, where fitted, are to be checked at regular intervals to ensure they are damage free and tight.

# 7 Mechanical Connections

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The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation, and cooling systems. Before starting any type of fuel installation, all pertinent state and local codes must be complied with and the installation must be inspected before the unit is put in service.

## 7.1 Fuel System

Cummins engines normally use a diesel fuel specified to ASTM D975 grade 2 or BS EN 590:2000 is for automotive diesel, BS 2869:2010+A1:2011 Fuel oils for agricultural, domestic and industrial engines and boilers.

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt, or contaminants of any kind into the fuel system. Clean all fuel system components before installing.

### NOTICE

**A fuel filter/strainer/water separator of 100-120 mesh or equivalent (approximately 150 microns nominal) must be fitted between either the main tank and day tank, or between the main tank and the engine.**

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Buried fuel lines must be protected from corrosion.

### NOTICE

**Never use galvanized or copper fuel lines, fittings, or fuel tanks. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The molecular structure of the copper or galvanized lines or tanks reacts with the acid and contaminates the fuel.**

An electric solenoid valve in the supply line is recommended for all installations and required for indoor automatic or remote starting installations. Connect the solenoid wires to the generator set "Switched B+" circuit to open the valve during generator set operation.

Separate fuel return lines to the day tank or supply tank must be provided for each generator set in a multiple-set installation to prevent the return lines of idle sets from being pressurized. Fuel return lines must not contain a shutoff device. Engine damage will occur if the engine is run with the return fuel lines blocked or restricted.

### NOTICE

**Never install a shutoff device in fuel return line(s). If fuel return line(s) is blocked or exceeds fuel restriction limit, engine damage will occur.**

### NOTICE

**A base mounted fuel tank may be part of the generator set build. An additional external fuel system may be required if the on board fuel capacity is not sufficient for the application.**

## 7.1.1 Fuel Return Restrictions (or Pressure) Limit

Fuel return drain restriction (consisting of friction head and static head) between the engine injector return line connection and the fuel tank must not exceed the limit stated in the model-specific generator set *Specification Sheet*.

## 7.1.2 Fuel Line Connections

### WARNING

#### ***Combustible Liquid***

***Fuel leaks are a fire and explosion hazard which can cause severe personal injury or death.***

***Always use flexible tubing between the engine and fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet all application codes.***

### WARNING

#### ***Combustible Liquid***

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

***Do not route fuel lines near electrical wiring.***

### WARNING

#### ***Hot Surface***

***Hot surfaces can ignite fuel. Ignited fuel is a fire and explosion hazard which can cause severe burns or death.***

***Do not route fuel lines near hot exhaust parts.***

### NOTICE

**Fuel lines must be routed and secured to maintain a 12.7 mm (½ inch) minimum clearance from electrical wiring and a 51 mm (2 inches) minimum clearance from hot exhaust parts.**

Flexible lines for connecting between the engine and the skid mounted fuel tank (if fitted) are supplied as standard equipment.

Flexible lines for connecting between the engine and an external fuel supply must be used between the engine fuel system, and the fuel supply and return lines to protect the fuel system from damage caused by vibration, expansion, and contraction.

For additional information refer to T-030 Application Manual.



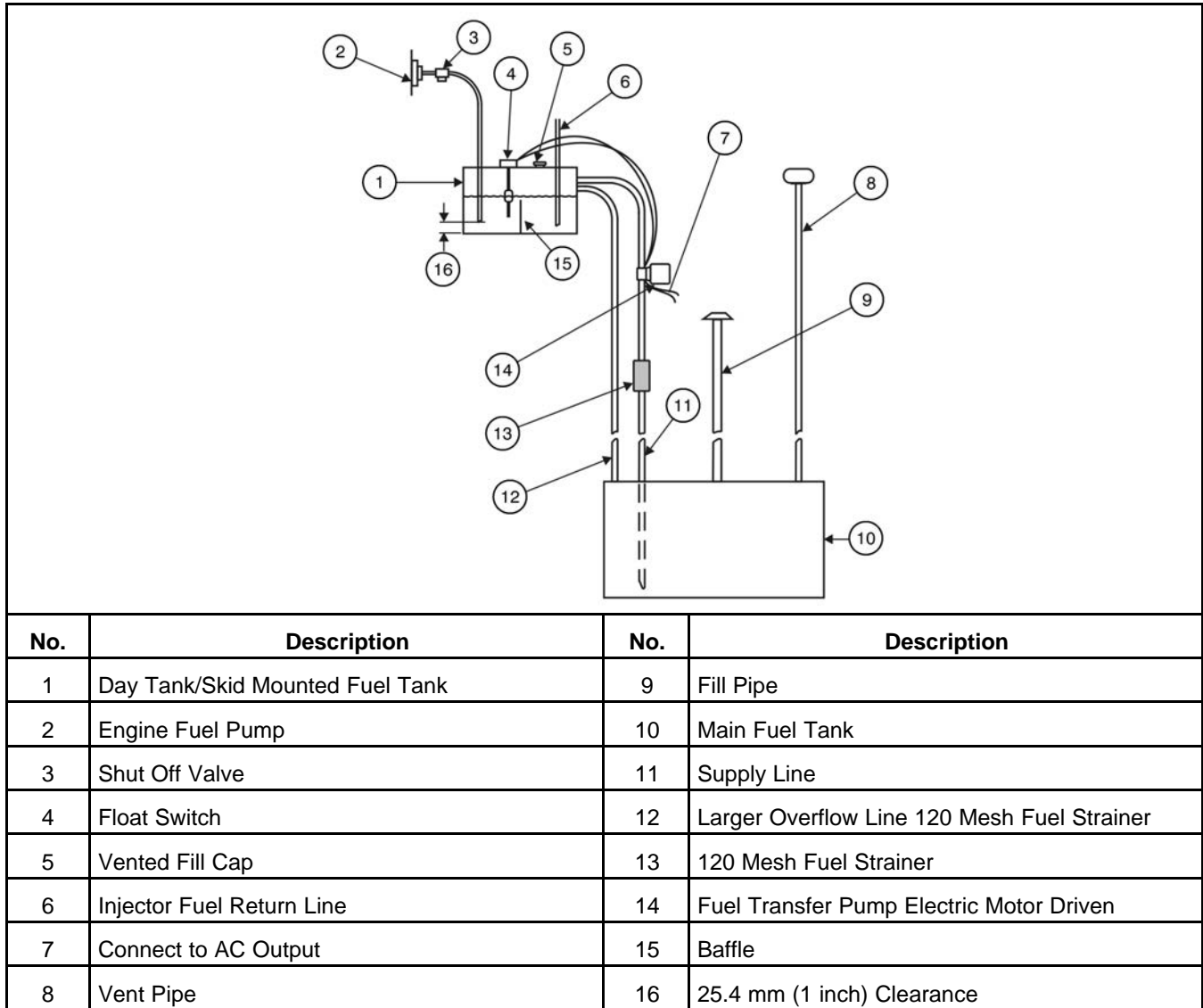


FIGURE 6. TYPICAL FUEL SUPPLY INSTALLATION

### 7.1.3 Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections. All models require a fuel return line from the injectors to the tank.

### 7.1.4 Supply Tank

The fuel supply tank, day tank, or other reservoir must be arranged so that the highest fuel level does not exceed the maximum height above the fuel injectors specified for the engine. The lowest level must not fall below the specified lift height of the engine fuel lift pump. In critical start applications, the lowest level should not be less than 150 mm (6 inches) above the engine fuel pump inlet to make sure there is no air in the fuel line during startup. Provisions must be made for draining or pumping out water.

For critical start applications, where generator sets are paralleled or must satisfy emergency start-time requirements, it is recommended that a fuel tank or reservoir be located such that the lowest possible fuel level is not less than 150 mm (6 in) above the fuel pump inlet. This will prevent air from accumulating in the fuel line while the generator set is in standby, eliminating the period during startup when it has to be purged.

Locate the fuel tank as close as possible to the generator set and within the restriction limitations of the fuel pump.

Install a fuel tank that has sufficient capacity to supply the generator set depending on its application:

- Continuous power
- Prime power
- Standby power

Refer to the Engine Fuel Consumption section for fuel consumption data.

If the fuel inlet restriction exceeds the defined limit due to the distance/customer-supplied plumbing between the generator set and the main fuel tank, a transfer tank (sometimes referred to as a day tank) and auxiliary pump will also be required. If an overhead main fuel tank is installed, a transfer tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components.

For additional information on the size and installation of a supply tank for the application, consult your local authorized Cummins distributor or dealer.

## 7.1.5 Fuel Inlet Pressure/Restriction Limit

Engine performance and fuel system durability is compromised if the fuel inlet pressure or restriction limits are not adhered to. Fuel inlet pressure or restriction must not exceed the limits stated in the model-specific generator set *Specification Sheet*.

## 7.1.6 Day Tank

Some generator set installations may include a fuel day tank. They are used when fuel inlet restriction limits cannot be met, or the supply tank is overhead and presents problems of high fuel head pressure for the fuel inlet and return lines.

### 7.1.6.1 Supply Tank Lower Than Engine

#### **WARNING**

##### ***Combustible Liquid***

***Spilled fuel is a fire and explosion hazard which can cause severe personal injury or death.***

***Provide an overflow line to the supply tank from the day tank.***

#### **NOTICE**

***The supply tank top must be below the day tank top to prevent siphoning from the fuel supply to the day tank.***

With this installation, the day tank is installed near the generator set, below the fuel injection system and within the fuel inlet restriction limit. Install a fuel transfer pump, to pump fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.

Provide a return line from the engine injection system return connection to the day tank. Plumb the return line to the bottom of day tank as shown in [Figure 6 on page 39](#). Provide a day tank overflow line to the supply tank in case the float switch fails to shut off the fuel transfer pump.

## 7.1.6.2 Supply Tank Higher Than Engine

With this installation, the day tank is installed near the generator set, above the fuel injection system and within the fuel return restriction limit. Include an automatic fuel shutoff valve in the fuel line between the fuel supply tank and the day tank to stop fuel flow when the generator set is off.

Provide a return line from the engine injection system return connection to the day tank. Plumb the return line to the bottom of day tank as shown in [Figure 6 on page 39](#).

### NOTICE

**Spilled fuel can create environmental hazards. Check local requirements for containment and prevention of draining to sewer and ground water.**

## 7.1.7 Fuel Transfer Pump

### 7.1.7.1 Fuel Transfer Pump Installation

### WARNING

#### ***Combustible Liquid***

***Fuel leaks are a fire and explosion hazard which can cause severe personal injury or death.***

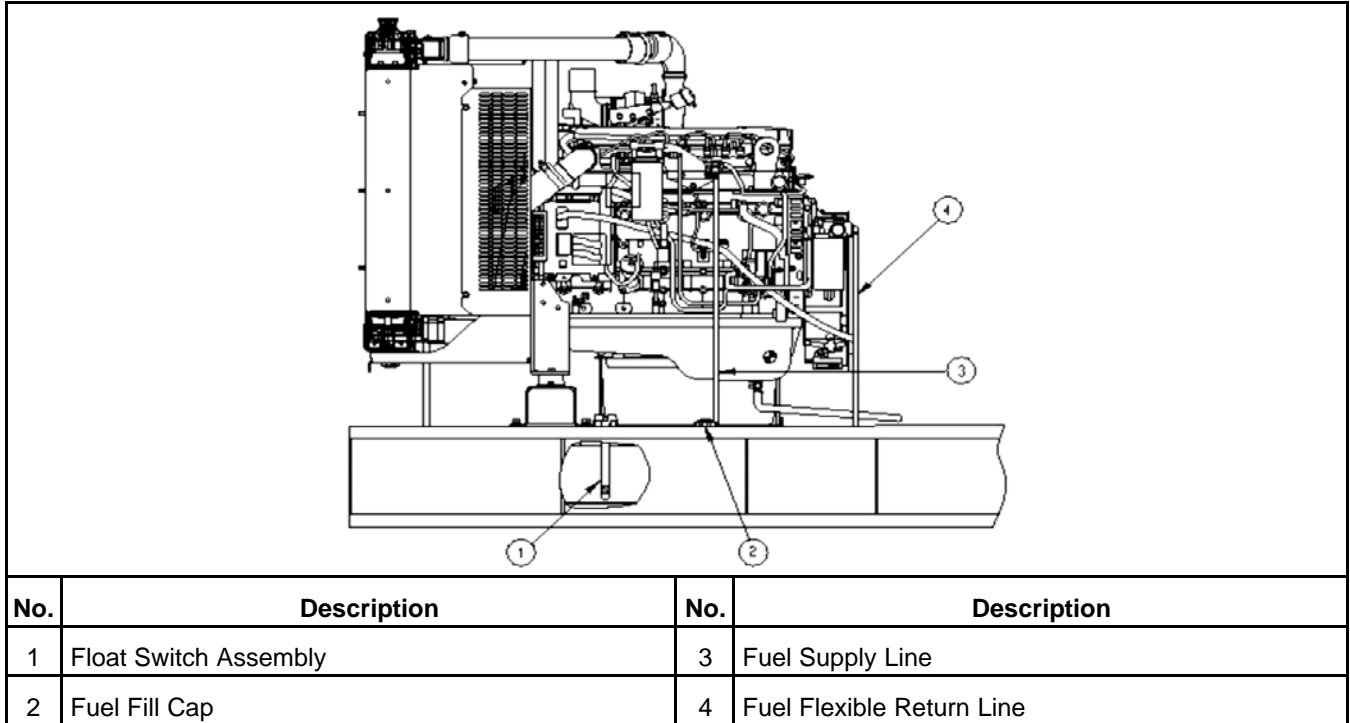
***Make sure that only trained and experienced personnel install and service the generator set in accordance with applicable codes.***

### NOTICE

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

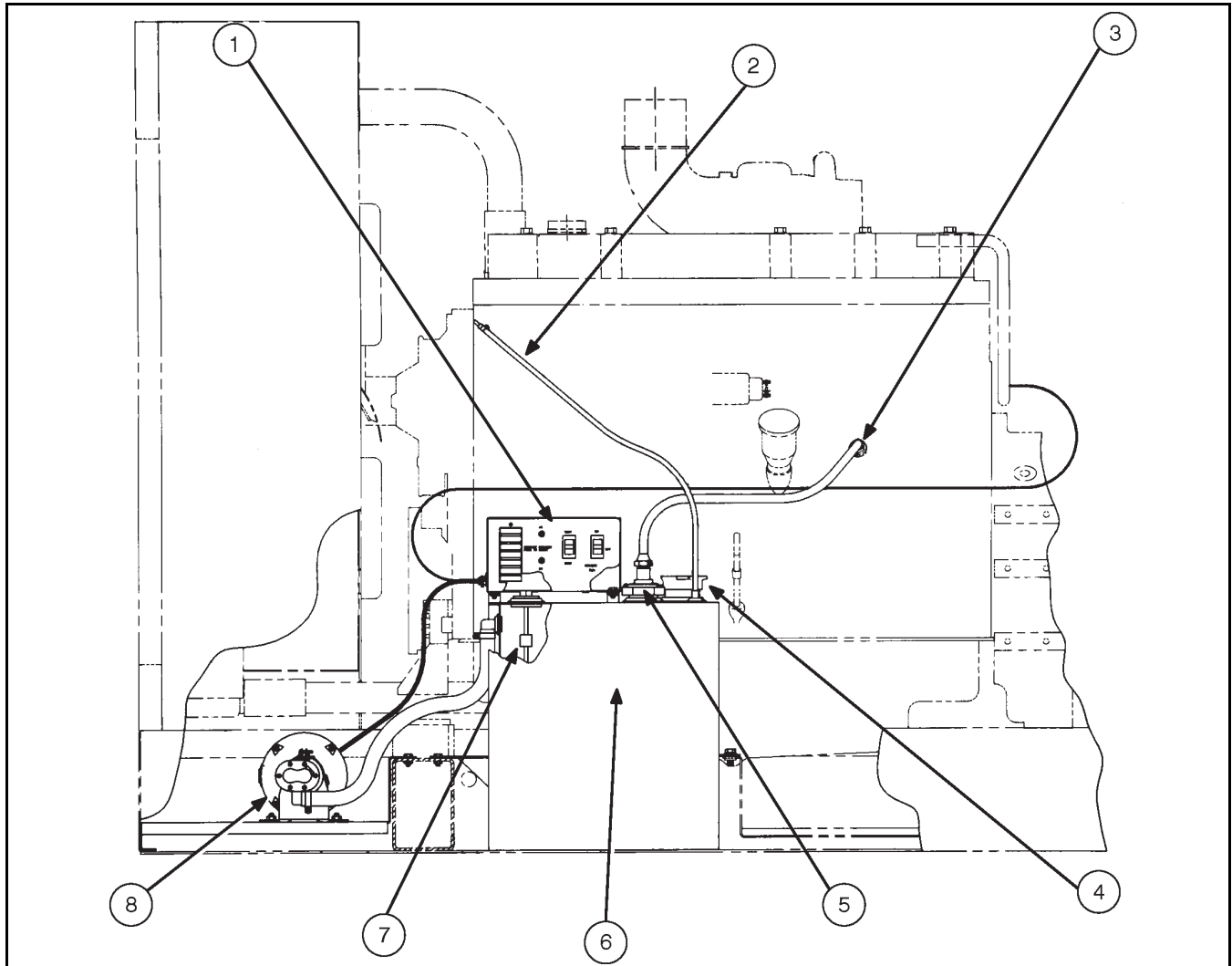
A fuel transfer pump and control are available as an option when a sub-base or an in-skid day tank is provided. The automatic control operates the fuel pump to maintain a reservoir of fuel in the day tank.

**7.1.7.1.1 Sub-Base Installation**



**FIGURE 7. TYPICAL SUB-BASE INSTALLATION**

**7.1.7.1.2 In-Skid Installation**



No.	Description	No.	Description
1	Control	5	Fuel gauge
2	Flexible fuel return line	6	Day tank
3	Flexible fuel supply line	7	Float switch assembly
4	Fuel fill cap	8	Fuel pump and motor

**FIGURE 8. TYPICAL IN-SKID DAY TANK INSTALLATION**

**7.1.8 Fuel Filters**

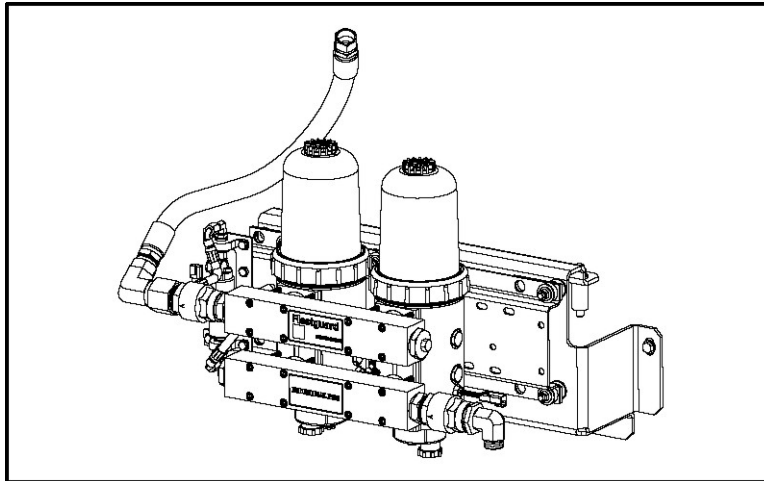
Some generator sets require the installation of a fuel filter kit as part of the installation of the generator set.

**7.1.8.1 Fuel Filter Installation**

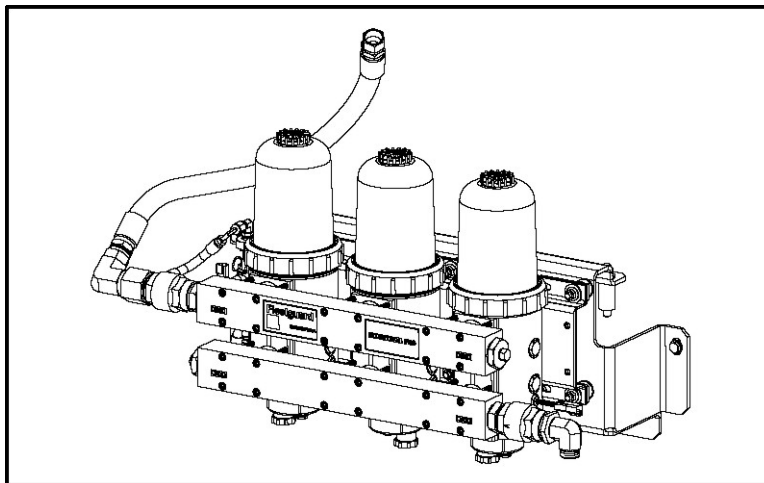
The fuel filter and pump assembly is shipped with the engine. It includes thread sealant, isolator rings, isolators, and the hardware (flange nuts, flat washers, and head head screws) necessary to install the kit.

The fuel filter mounting kit is shipped secured to the skid. It includes the fuel filter mounting bracket, a fuel line, and a stock box that contains elbows and a reducer.

The three types of fuel filter kits that are available are shown below.



**FIGURE 9. DUAL FUEL FILTER**



**FIGURE 10. TRIPLE FUEL FILTER**

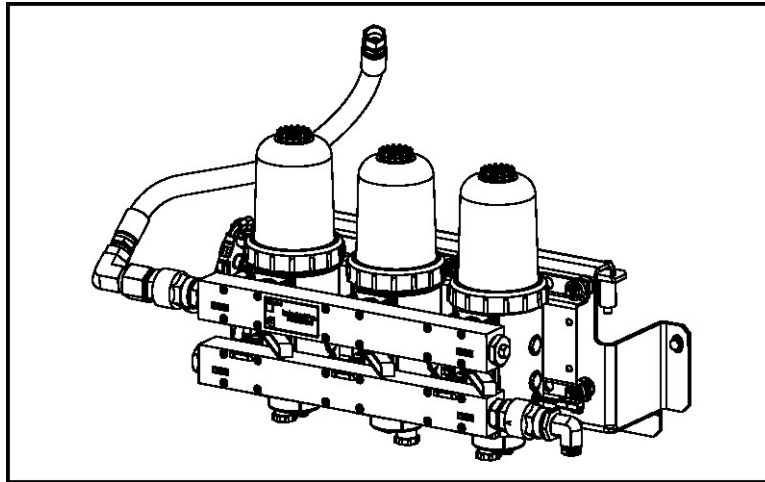
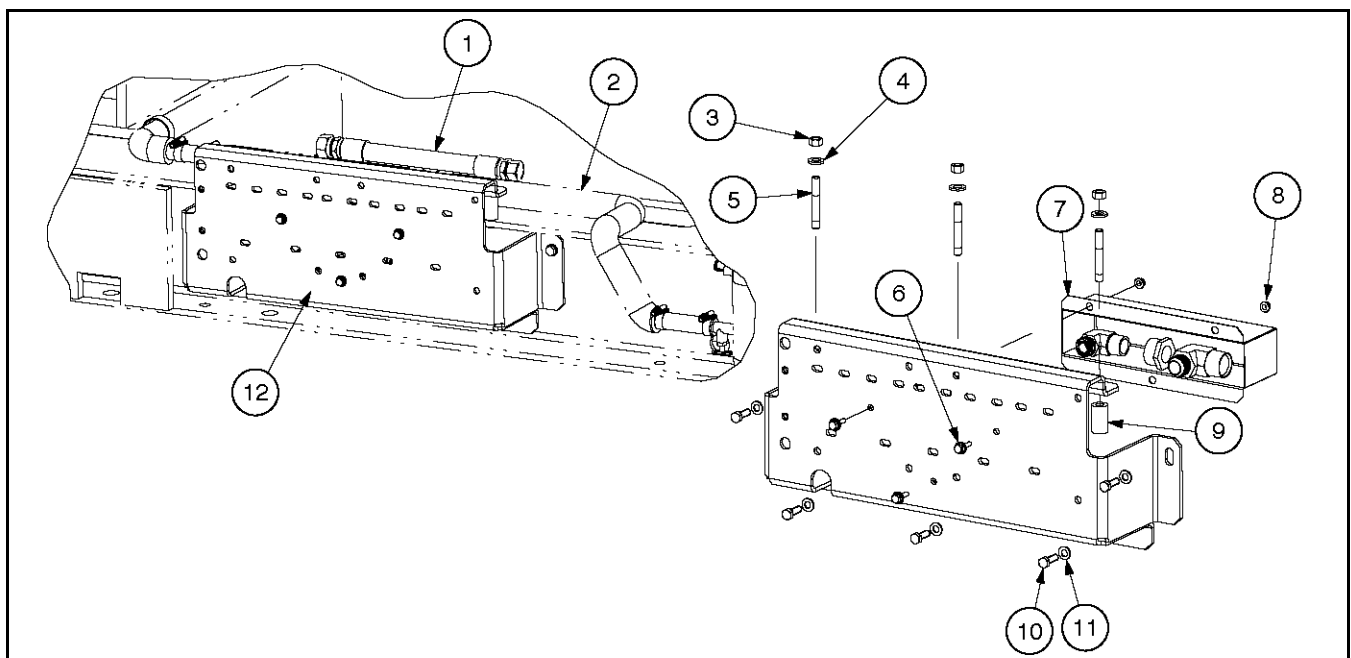


FIGURE 11. TRIPLEX FUEL FILTER

### 7.1.8.1.1 Fuel Filter Mounting Kit Removal

When shipped from the factory, the fuel filter mounting kit is secured to the skid (see [Figure 12](#)).



No.	Description	No.	Description
1	Fuel Line	7	Stock Box
2	Heater Tube	8	Hex Head Nut
3	Nut	9	Spacer
4	Flat Washer	10	Hex Head Screw
5	Stud	11	Flat Washer
6	Hex Head Screw	12	Fuel Filter Mounting Bracket

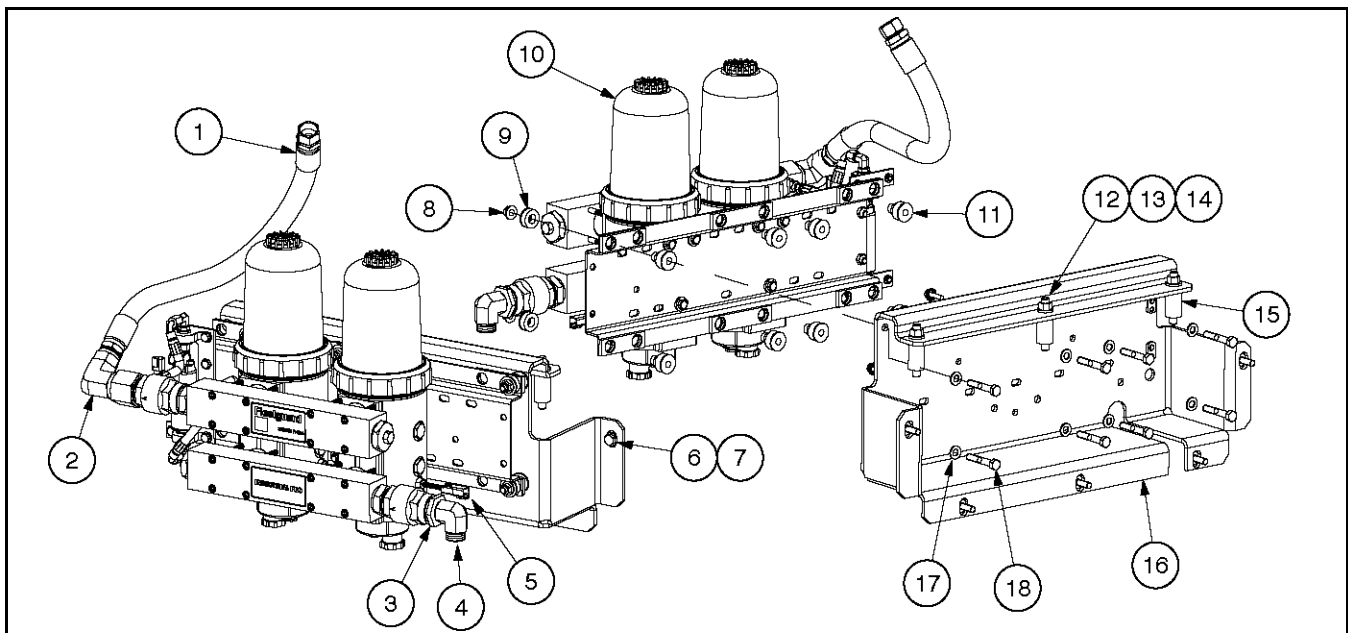
FIGURE 12. PRE-INSTALLED FUEL FILTER MOUNTING KIT

To remove the fuel filter mounting kit from the skid,

1. Remove the cable ties securing the fuel line (item 1) to the heater tube (item 2).
2. Remove the five hex head screws and washers (items 10 and 11) securing the fuel filter mounting bracket (item 12) to the side of the skid.
3. Remove the three screws and nuts (items 6 and 8) securing the stock box (item 7) to the inside of the fuel filter mounting bracket.
4. Remove the contents of the stock box (elbows and reducer).
5. Discard the stock box and its mounting hardware.

### 7.1.8.1.2 Fuel Filter Kit Assembly

[Figure 13](#) shows the installation of the fuel filter kit.



No.	Description	No.	Description
1	Fuel Line	10	Fuel Filter and Pump Assembly
2	Tube Elbow (1 5/16-12 x 1 1/4 NPT)	11	Isolator
3	Reducer (1 1/4 x 1 NPT)	12	Hex Head Nut (M12)
4	Tube Elbow (1 NPT x 1 3/16 ORFS)	13	Flat Washer (M12)
5	Fuel Filter Harness Connector	14	Stud
6	Hex Head Screw (M10 x 30mm)	15	Spacer
7	Flat Washer (M10)	16	Fuel Filter Bracket
8	Flange Nut (M10 x 1.5)	17	Flat Washer (3/8 inch)
9	Isolator Ring	18	Hex Head Screw (3/8-16 x 1 inch)

**FIGURE 13. FUEL FILTER KIT INSTALLATION (DUAL FILTER SHOWN)**



To install the fuel filter assembly on the skid,

1. Make sure the generator set is disabled.
  - a. Press the STOP button on the operator panel to make sure the control is in the OFF mode.
  - b. Activate the E-Stop button.

**⚠ WARNING**

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

- c. If equipped, disconnect the batter charger. Remove any other electrical supply sources.

**⚠ WARNING**

***Ignition of explosive battery gasses can cause severe personal injury or death. ARching at battery terminals, a 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 a battery. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface. Ventiate the battery area before working on or near a battery. Wear goggle. Stop the generator set and disconnect the charger before disconnecting battery cables. Disconnect the negative (-) cable first and reconnect it last.***

**⚠ WARNING**

***Accidental starting of the generator set can cause sever personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.***

- d. Disconnect the generator set negative (–) battery cable.
2. Remove the cap from the fuel inlet port of the engine.
3. Use five M10 screws and flat washers (items 6 and 7) to secure the fuel filter bracket to the side of the skid. Torque the screws to 52 ±5 N·m.
4. Secure the fuel filter and pump assembly (item 10) to the fuel filter bracket (item 16) using the provided eight flange nuts, isolator rings, isolator, flat washers, and hex head screws (items 8, 9, 11, 17, and 18). Torque the M10 flange nuts to 52 ±5 N·m.
5. Apply thread sealant and install the 1-5/16 inch elbow (item 2) on the upper part of the fuel filter pump.
6. Install the fuel line to the elbow installed above.
7. Apply thread sealant and install the 1-1/4 to 1-inch reducer (item 3) on the lower part of the fuel filter pump.
8. Apply thread sealant and install the 1-inch elbow (item 4) on the reducer.
9. Connect the fuel line (item 1) to the fuel inlet connector, as shown in [Figure 14](#).
10. Connect the engine harness to the fuel filter harness connector (item 5).
11. Reconnect the negative (–) cable to the starting battery.
12. Reconnect the battery charger (if equipped).
13. Open the fuel shutoff valve (if equipped).

14. Prime the fuel system. Start the generator set and check for fuel leaks. If any fuel leaks are discovered, make sure they are fixed before placing the generator set in service.

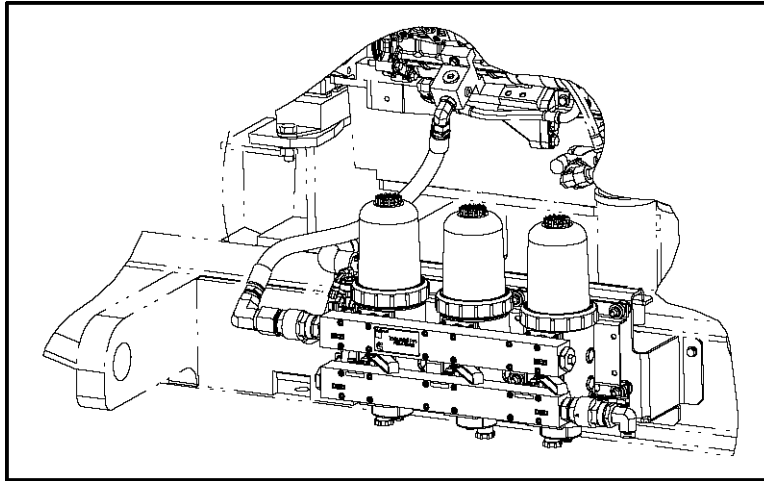


FIGURE 14. INSTALLED FUEL FILTER ASSEMBLY (TRIPLEX FILTER SHOWN)

## 7.2 Exhaust System

### ⚠ WARNING

#### *Toxic Gases*

*Inhalation of exhaust gases can cause asphyxiation and death.*

*Use extreme care during installation to provide a tight exhaust system. Terminate exhaust pipes away from enclosed or sheltered areas, windows, doors, and vents. Do not use exhaust heat to warm a room, compartment, or storage area.*

### ⚠ WARNING

#### *Hot Surface*

*Hot surfaces can start a fire which can cause severe burns or death.*

*Use an approved thimble where exhaust pipes pass through wall or partitions.*

### NOTICE

Weight applied to the engine manifold can result in turbocharger damage. Support the silencer and exhaust piping so no weight or stress is applied to the engine exhaust elbow.

### NOTICE

Gaseous fuels are susceptible to high condensation levels in the exhaust. It is important to have properly routed/sized exhaust systems to prevent harm to turbochargers and Oxygen sensors (HEGO).

### NOTICE

Liability for injury, death, damage, and warranty expense due to use of unapproved silencers or modifications to the exhaust system becomes the responsibility of the person installing the unapproved silencer or performing the modification. Contact your authorized distributor for approved exhaust system parts.

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlets away from any air inlets to avoid gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, and light loads. Regularly inspect the exhaust system both visually and audibly to see that the entire system remains fume tight and safe for operation.

**NOTICE**

**Enclosed generator sets are not generally designed to be used in a building. If the generator set is to be used in a building, additional requirements must be applied.**

Where an enclosed generator set is used in a building, the exhaust system should be extended to vent the exhaust gases. Use sealed joint type fittings where possible to provide a tight exhaust system. Use of slip type fittings (secured with a clamp) may allow leakage of exhaust gases into the building if not fitted correctly. Check to make sure there are no exhaust leaks.

When a unit is provided with a partially installed or incomplete exhaust system, exhaust piping and chimneys shall be designed, constructed, and installed in accordance with the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37, or applicable local standards. Build according to the code requirements in effect at the installation site.

For indoor installation, the exhaust system should use sealed joint type fittings where possible to provide a tight exhaust system. Use of slip type fittings (secured with a clamp) may allow leakage of exhaust gases into the building if not fitted correctly. Check to make sure there are no exhaust leaks.

Use an approved thimble (see [Figure 15 on page 50](#)) where exhaust pipes pass through a wall or partition. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This includes structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a non-combustible wall or roof, such as concrete. When a unit is provided with a partially installed or incomplete exhaust system, exhaust piping and chimneys shall be designed, constructed, and installed in accordance with the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37, or applicable local standards. Build according to the code requirements in effect at the installation site.

Rain caps are available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

Use a section of flexible exhaust pipe between the engine and remainder of exhaust system. Support the exhaust system to prevent weight from being applied to engine exhaust outlet elbow/turbocharger connection.

The exhaust system design should meet local code requirements.

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for the silencer and tailpipe. Pitch a horizontal run of exhaust pipe downward (away from engine) to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins (see [Figure 16 on page 51](#)).

Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 305 mm (12 inches) of clearance if the pipes pass close to a combustible wall or partition. Before installing insulation on exhaust system components, check the exhaust system for leaks while operating the generator set under full load and correct all leaks.

Refer to T-030, *Liquid Cooled Generator Set Application Manual* for more detailed information about sizes of exhaust system pipes and fittings.

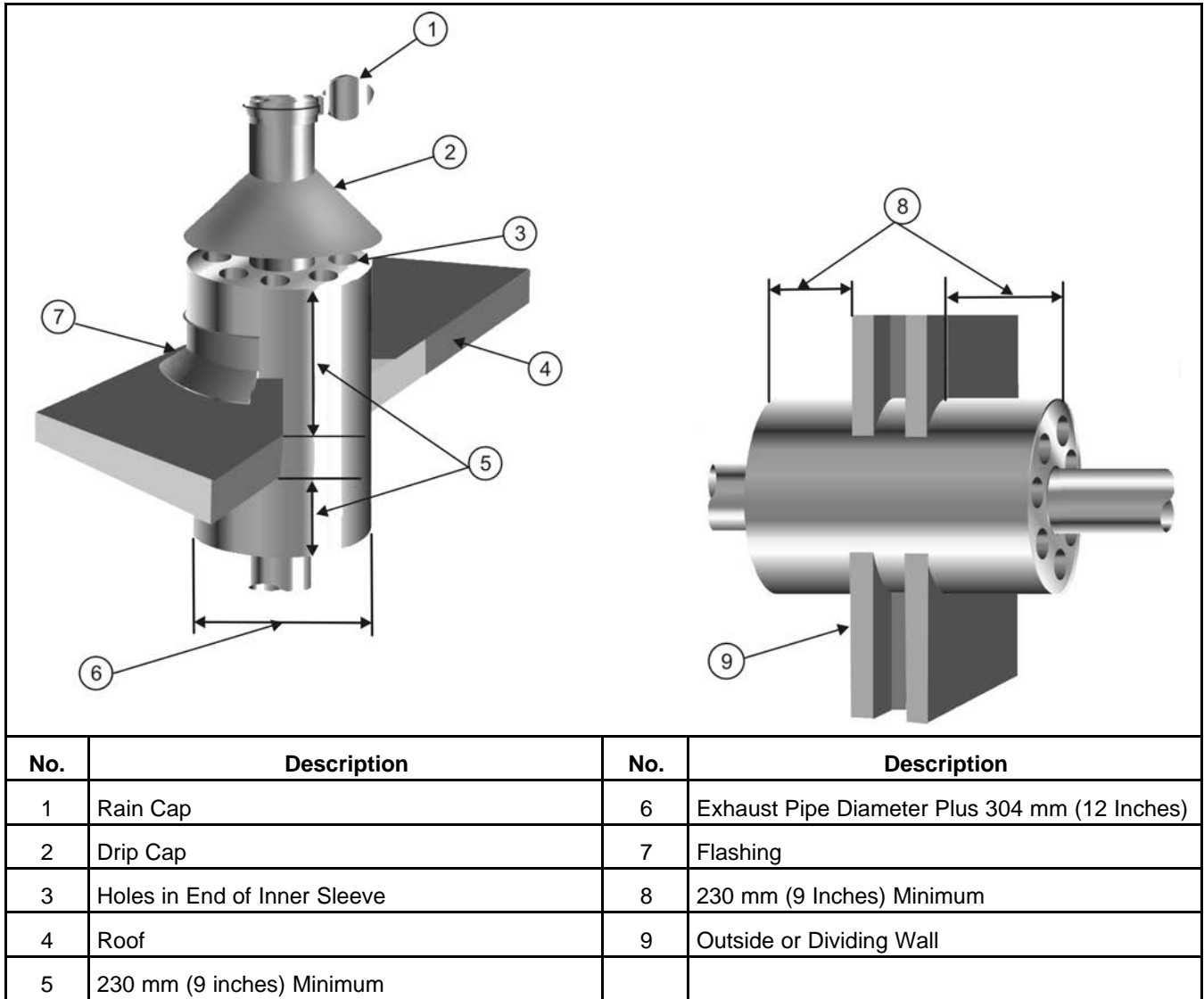
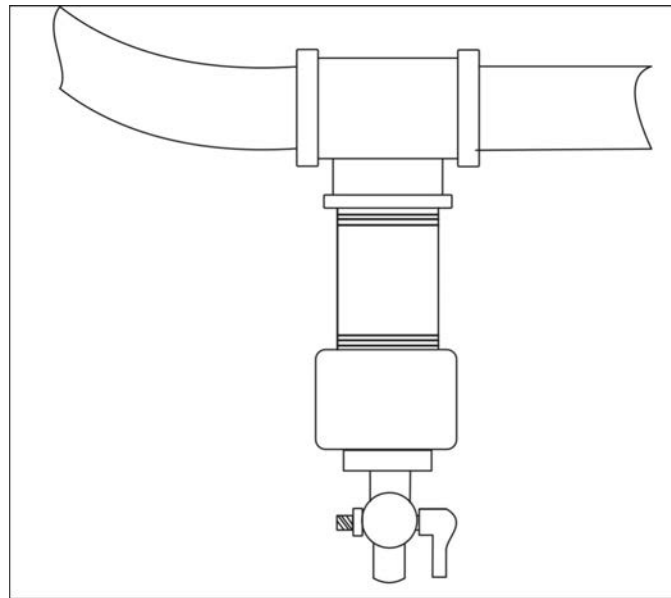
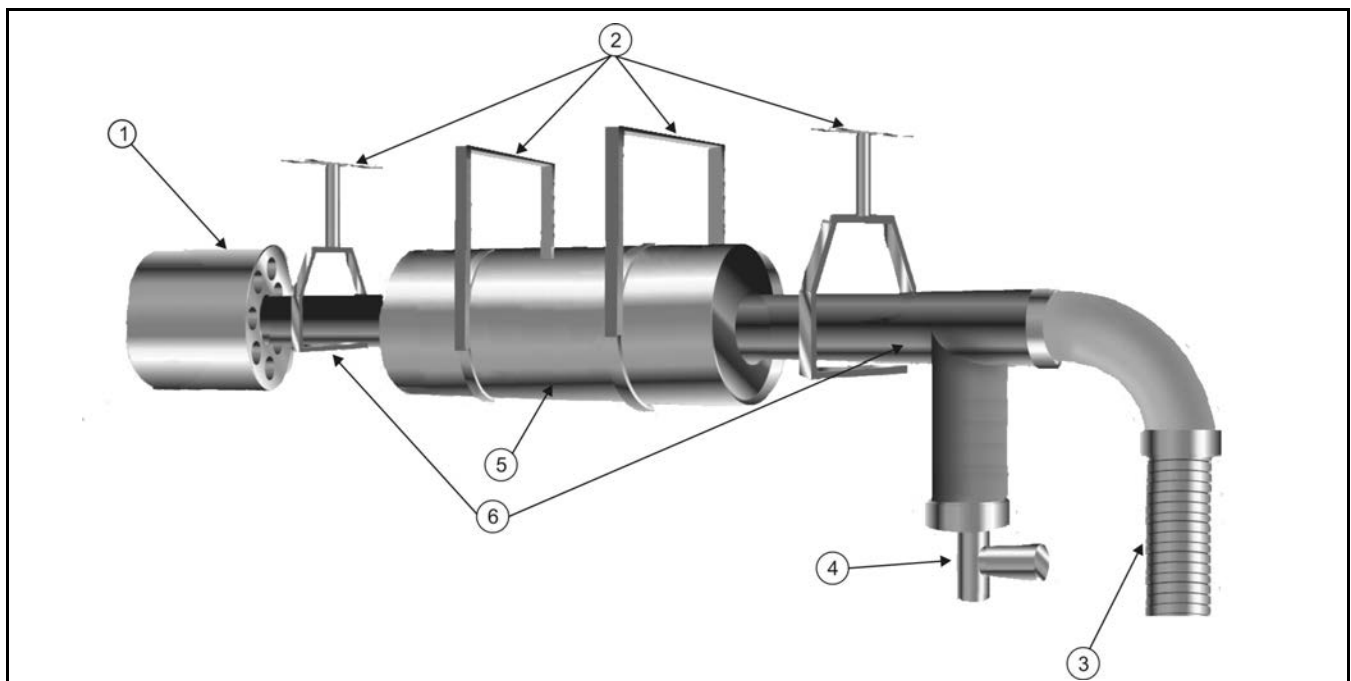


FIGURE 15. EXHAUST THIMBLE



**FIGURE 16. CONDENSATION TRAP**



No.	Description	No.	Description
1	Exhaust Thimble	4	Water Trap with Drain
2	Support Brackets	5	Muffler
3	Flexible Bellows	6	Exhaust Pipe

**FIGURE 17. TYPICAL SUSPENDED EXHAUST SYSTEM**

## 7.3 Ventilation and Cooling

### WARNING

#### **Toxic Gases**

**Engine and radiator cooling air may carry carbon monoxide gas, which can cause asphyxiation and death.**

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

Generator sets create considerable heat that must be removed by proper ventilation.

Generator sets in factory-mounted housings for outdoor installation are designed for proper cooling and ventilation.

Indoor installations require careful design with respect to cooling and ventilation. In an indoor installation, all radiator cooling air must be discharged to the out-of-doors. Duct adapter kits are available.

Outdoor installations normally rely on natural air circulation but indoor installations need properly sized and positioned vents for required airflow.

Transfer the stray voltage from the cooling system to the ground through the skid.

## 7.4 Vents and Ducts

1. For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement.
2. Size the vents and ducts so they are large enough to allow the required flow rate of air.
3. Wind will restrict free airflow if it blows directly into the air outlet vent. Locate the outlet vent so the effects of wind are eliminated, or if the outlet vent cannot be located as mentioned, install a wind barrier. See [Figure 18](#).

### NOTICE

**The "free area" of ducts must be as large as the exposed area of the radiator. Refer to the generator set Specification Sheet for the airflow requirements and allowed airflow restriction.**

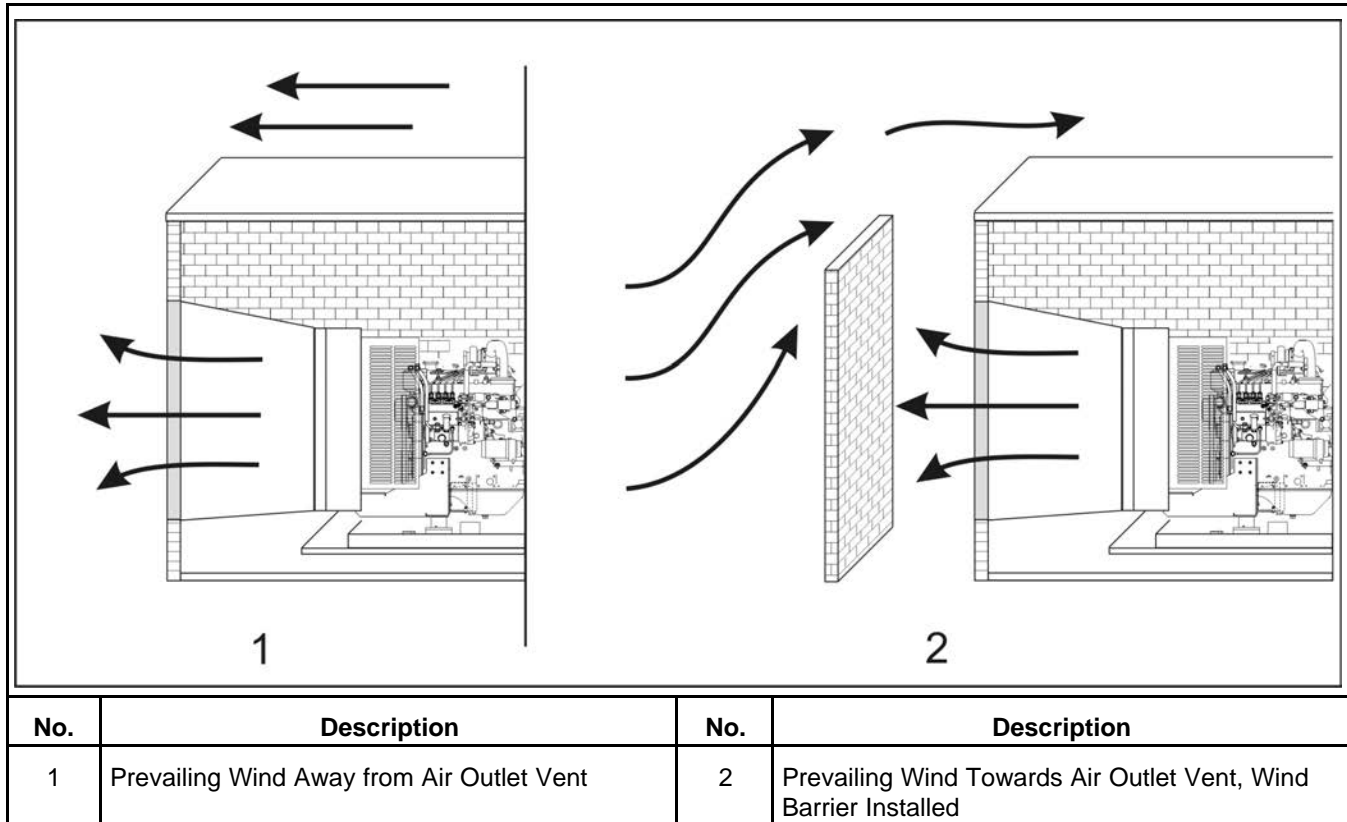


FIGURE 18. WIND BARRIER

## 7.5 Dampers

Dampers or louvers protect the generator set and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the generator set.

In cold climates, the radiator exhaust air can be recirculated to modulate the ambient air temperature in the generator set room. This will help the generator set warm up faster, and help to keep fuel temperatures higher than the cloud point of the fuel. If recirculation dampers are used, they should be designed to 'fail closed', with the main exhaust dampers open, so that the generator set can continue to operate when required. Designers should be aware that the generator set room operating temperature will be very close to the outdoor temperature, and either not route water piping through the generator set room, or protect it from freezing.

## 7.6 Air Inlet and Outlet Openings

Louvers and screens over air inlet and outlet openings restrict air flow and vary widely in performance.

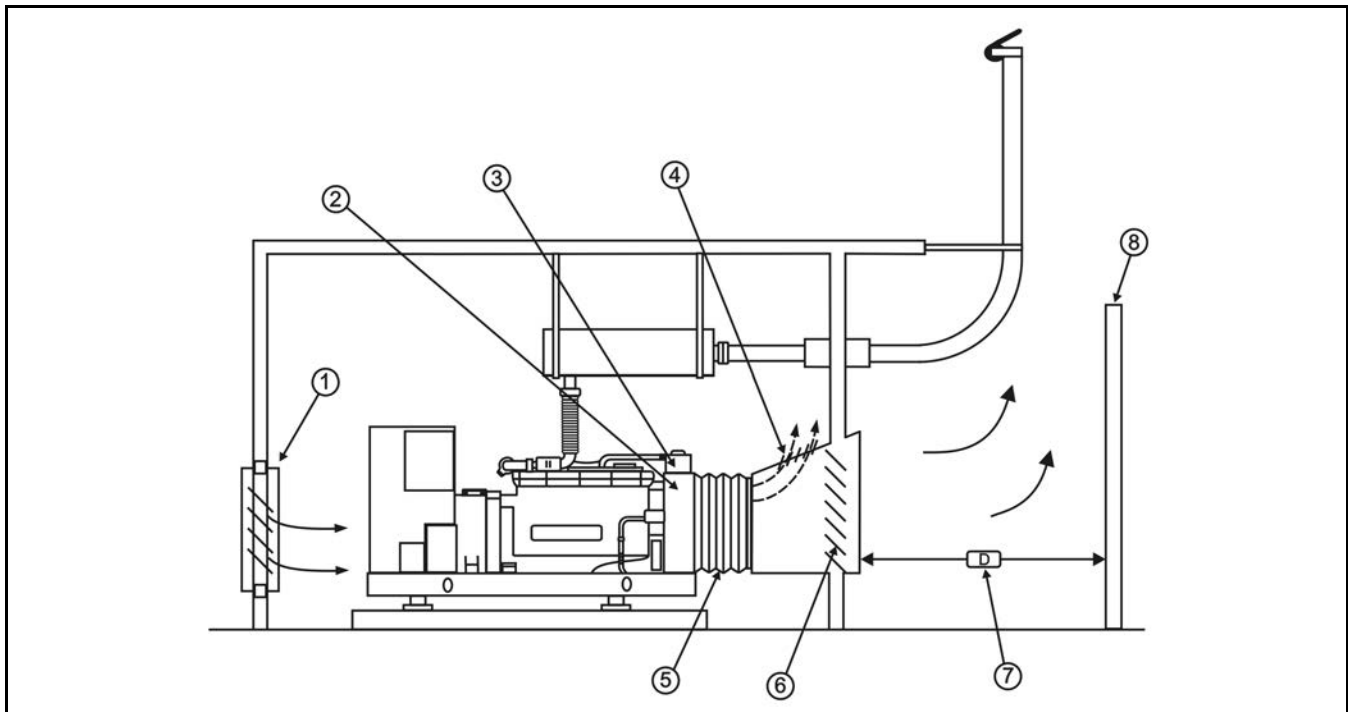
A louver assembly with narrow vanes, for example, tends to be more restrictive than one with wide vanes. The effective open area specified by the louver or screen manufacturer should be used.

Radiator set cooling air is drawn past the control end of the set by a pusher fan that blows air through the radiator. Locate the air inlet to the rear of the set. Make the inlet vent opening 1.5 times larger than the radiator area.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

A flexible duct connector must be provided at the radiator to prevent exhaust air recirculation around the radiator, to take up generator set movement and vibration, and to prevent transmission of noise. Attach the flexible duct using screws and nuts so that the duct can be removed for maintenance purposes. Before installing the duct, remove the radiator core guard.

Enclosed generator sets are primarily designed to work in an open environment. When considering installing an enclosed generator set in an enclosed environment specific application factors must be considered (air flow, exhaust gas extraction, fuel supply and storage, etc.). For advice, contact the Application Engineering Group at Cummins.



No.	Description	No.	Description
1	Cool Air Inlet Damper	5	Flexible Duct Connector
2	Engine Driven Fan	6	Hot Air Outlet Damper
3	Radiator	7	Distance Should Not be Less Than Height of Radiator
4	Thermostat Controlled Re-Circulating Damper	8	Wind/Noise Barrier

FIGURE 19. TYPICAL OPEN GENERATOR SET INSTALLATION

## 7.7 Remote Radiator Cooling

The remote radiator cooling substitutes a remote mounted radiator and an electrically driven fan in place of generator set mounted components. Removal of the radiator and the fan from the generator set reduces noise levels without forcing dependence on a continuous cooling water supply (necessary with heat exchanger cooling). The remote radiator installation must be completely protected against freezing.



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Remote radiator plumbing will vary with installation. Follow recommendations given in Application Manual T-030. See product for friction head and static head limits.

**NOTICE**

**Before filling the cooling system, make sure all hardware is tight. This includes hose clamps, cap screws, fittings, and connections. Use flexible coolant lines with heat exchanger or remote mounted radiator.**

**NOTICE**

**All customer connections must be fully supported where they interface with flexible coolant flange. The support must be located within 100 mm from the flexible flange connection.**

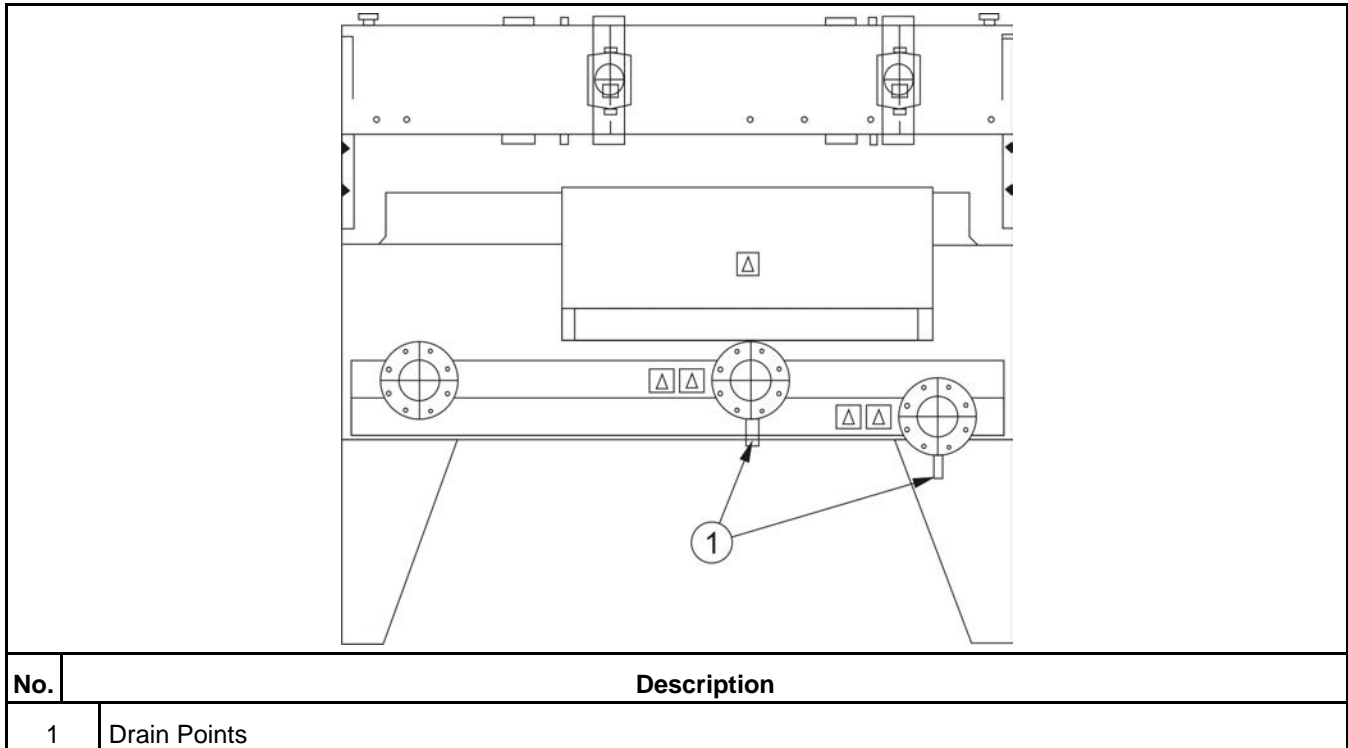
## 7.7.1 Flatbed Radiator Installation

### 7.7.1.1 Flatbed Radiator Siting

The flatbed radiator should be positioned a maximum of 15 meters (49.2 feet) vertically above the engine coolant circuit connection points, and a maximum of 10 meters horizontally from the engine coolant circuit connection points. It should be positioned a minimum of 0.5 meters (19-11/16 inches) vertically above the crank centerline.

It should be positioned on a level surface using a spirit level, such that the make-up draw-off points in the header tanks are always covered. The supporting feet must all be in contact with the supporting surfaces. Refer to [Figure 20 on page 56](#).

The accessory legs should be fitted to the flatbed to enable a minimum underside clearance of 1.5 meters (5 feet) to be achieved.



**FIGURE 20. FLATBED RADIATOR DRAIN POINTS**

The flatbed should be a minimum of 1.5 meters (5 feet) from any vertical partition. Any intake of polluted or warm air must be avoided to ensure efficient operation.

If several units are placed together, they should be spaced at a minimum of 100 mm clearance, and raised to achieve the necessary air inlet area. Anchor bolts should be sized taking account of all masses and wind loadings.

All flanges should be cleaned and rinsed before connecting pipework. To allow for expansion of pipework, it's recommended to use flanged expansion bellows of suitable temperature ratings. The flanges of such bellows will require the fitting of a bridge to the site earth.

### 7.7.1.2 Handling

#### **⚠ WARNING**

##### ***Heavy Load***

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.***

#### **⚠ WARNING**

##### ***Mechanical Hazard***

***Failed components may be ejected or operate incorrectly which can cause severe personal injury or death.***

***Do not climb the generator set; this may damage critical parts.***

The unit should be handled using the four lifting rings on the upper side. It should be performed using a crane by suitably trained and experienced personnel only. The following sling angles should be used :

90° on length

50° - 70° on width.

If necessary use a lifting beam to ensure safe positioning.

### 7.7.1.3 Pipework

Pipework is preferred to align with the sizes of the flatbed HT and LT branches:

HT = minimum of DN125 medium wall pipe - BSEN10255:2004

LT = minimum of DN100 medium wall pipe - BSEN10255:2004

Pipework should be seamless rolled steel tube with a smooth bore.

The number of bends should be kept to a minimum, and any bends should be long radius smooth bore. All transitions should have the slowest gradient practically achievable to enable frictional losses to be minimized. All pipework should be on a continuous rise from engine to radiator (including vents) to prevent proliferation of air pockets.

### 7.7.1.4 Pump Duty

Pumps need to maintain HT and LT flow rates between upper and lower limits as indicated below:

**TABLE 3. PUMP DUTY FLOW RATES**

	USL	LSL
HT	37.3 l/s	36.1 l/s
LT	14.3 l/s	13.8 l/s

To enable these flow rates, the delivery head at each pump exit should conform to:

**TABLE 4. PUMP PRESSURE**

	USL	LSL
HT	7 lb/in <sup>2</sup> (0.48 Bar)	4 lb/in <sup>2</sup> (0.28 Bar)
LT	5 lb/in <sup>2</sup> (0.35 Bar)	2.5 lb/in <sup>2</sup> (0.18 Bar)

### 7.7.1.5 Coolant Fluid

All coolant should be a mixture of 50% pure water and 50% Ethylene Glycol. For more information, consult your authorized distributor.

### 7.7.1.6 Gaskets

All flange gaskets must conform to CPG specifications. Use Klingersill C4430. For more information, consult your authorized distributor.

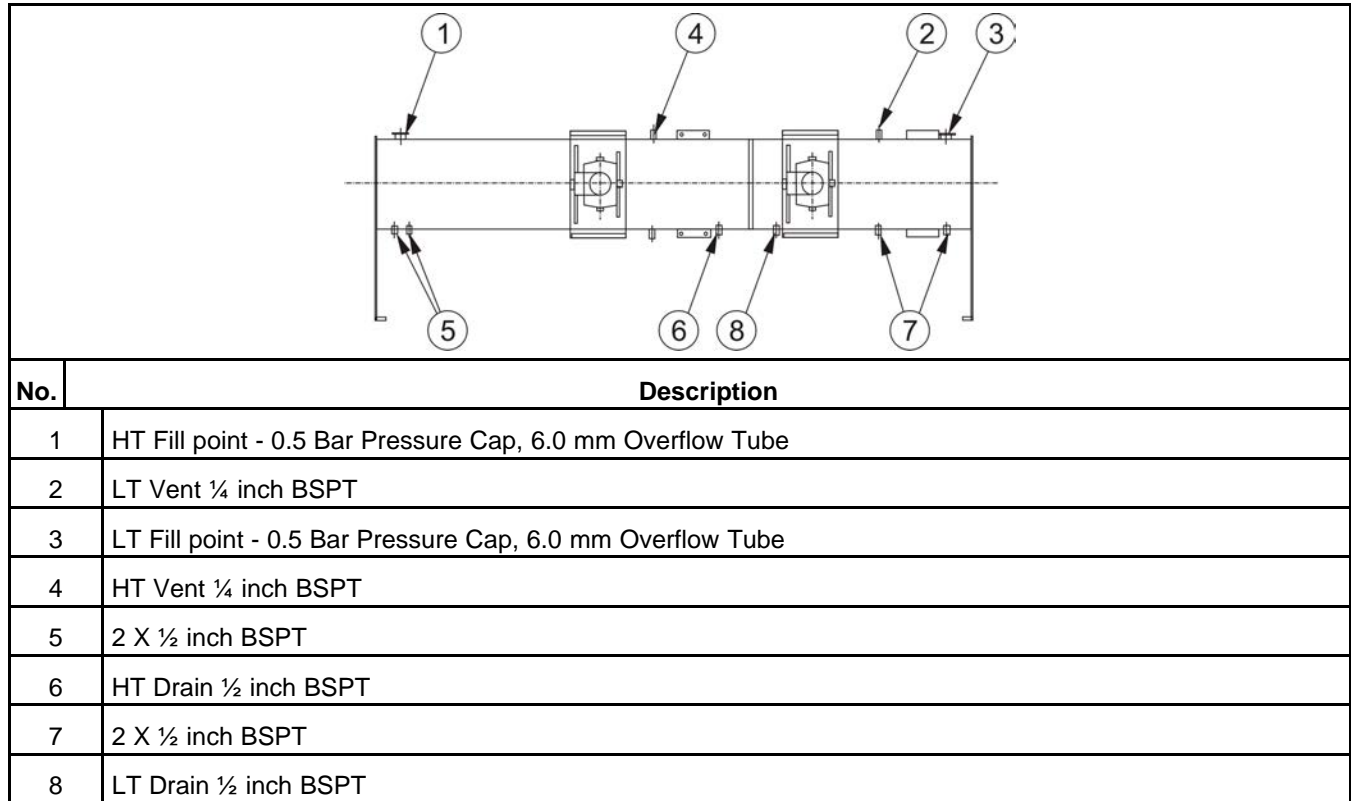
### 7.7.1.7 Venting

Vents for both HT and LT circuits of at least ½" NB should be fitted between :

HT thermostat housing and free air space of HT header tank.

LT thermostat housing and free air space of LT header tank.

The vents should be on a continuous rise from the engine connection points to the flatbed header tank connection points. Refer to [Figure 21 on page 58](#).



**FIGURE 21. VENTING CONNECTIONS**

Flexible vent line materials should conform to AEB24.20.

### 7.7.1.8 Make-up Lines

Make-up lines for both HT and LT of at least 1/2" NB should be fitted between the appropriate HT and LT draw-off points on the header tanks, and the lowest point of each coolant circuit. They should enter the coolant circuit on the delivery side of each pump.

### 7.7.1.9 Drains

#### NOTICE

**Drained fluid disposal must comply with local guidelines and legislation for disposal/recycling of components and fluids. This procedure must only be carried out by suitably trained and experienced service personnel. For more information, contact your authorized distributor.**

Both HT and LT drain sockets must be provided in the lowest part of each coolant circuit.

All hose and connection types and material should conform to AEB 24:20.

Header tank drains are shown in [Figure 21 on page 58](#).

### 7.7.1.10 References

*For further information on generating set operation, refer to AEB10:112.*

*For further information on 2-Pump 2-Loop cooling systems, refer to AEB24:26.*

*For further information on generating set installations, refer to Genset Installation Manual L030.*

## 7.8 Breakerless Conductor Connections

### 7.8.1 Overload and Short Circuit Protection of Generator

NFPA 70: National Electrical Code compliant generator sets are required to be protected from an overload. Cummins generator sets with UL Listed AmpSentry Protective Relay as a standard feature do not require a circuit breaker or other protective device for NEC compliance or UL 2200 Listing.

CEC: Each conductor between the generator terminal and the point where load receives supply of generator current must be protected by an overcurrent device in accordance with the requirement of CEC 14-100: Overcurrent Protection of Conductor.

UL label indicates to the Authority Having Jurisdiction (AHJ) that the generator set incorporates a UL Listed Protective Relay that provides overload and short circuit protection for the generator and its conductors. The generator set does not require use of a circuit breaker or other protective device for NFPA 70: National Electrical Code compliance or UL 2200 Listing.

### 7.8.2 AmpSentry Labels

These are typical labels for compliant generator sets produced after January 2012.

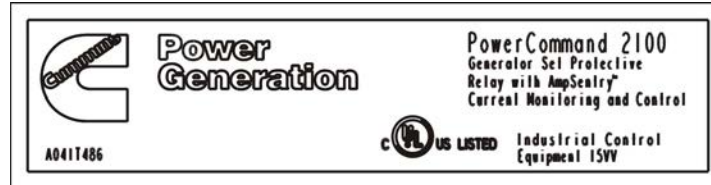


FIGURE 22. POWER COMMAND 2100 LABEL

**PowerCommand Generator Set Protective Relay with AmpSentry™  
Current Monitoring and Control**

PowerCommand Protective Relay with AmpSentry current monitoring and control provides overload and overcurrent protection of generator and feeder conductors at generator terminals in accordance with the requirements of 2011 NFPA 70: National Electrical Code, Articles 240.15(A), 240.21(G), 445.12(A), 445.13 and Canadian Electrical Code, Part I, C22.1-09, Section 28-902 without the use of an additional protective device.

A disconnect for the generator set is required per 2011 NFPA 70: National Electrical Code, Articles 225.31, 225.32, and 445.18 and Canadian Electrical Code, Part I, C22.1-09, Section 28-900 unless the driving means for the generator set can be readily shutdown and the generator is not arranged to operate in parallel with another generator or source of voltage. This engine-generator includes an emergency stop switch with lockout/tagout capability that meets this requirement.

PowerCommand Protective Relay with AmpSentry current monitoring and control allows selective coordination of generator with a downstream instantaneous trip overcurrent protective device in accordance with the requirements of 2011 NFPA 70: National Electrical Code, Articles 700.27, 701.27, 708.54 and Canadian Electrical Code, Part I, C22.1-09, Section 46-206. Verification of generator set electrical system coordination must be achieved by a coordination study.

**Relais de protection de groupe électrogène PowerCommand avec  
fonction de mesurage et contrôle AmpSentry™**

Le relais de protection PowerCommand avec fonction de mesurage et contrôle Ampsentry fournit une protection contre les surintensités à l'alternateur du groupe électrogène ainsi qu'aux conducteurs y étant raccordés conformément aux conditions énumérées dans le Code Canadien de l'Électricité Partie I, CSA C22.2-09 Section 28-902 et ce, sans l'usage d'appareils de protection supplémentaires.

Un sectionneur permettant de déconnecter l'alternateur du groupe électrogène est exigé par le Code Canadien de l'Électricité Partie I, CSA C22.2-09 Section 28-900 à moins que les moyens d'entraînement du groupe électrogène puisse être facilement mis à l'arrêt et que le groupe électrogène ne puisse pas fonctionner en parallèle avec un autre groupe électrogène ou une autre alimentation électrique (réseau du distributeur d'électricité). Ce groupe électrogène inclut un arrêt d'urgence avec provision de cadenassage d'étiquetage (lockout/tagout) qui rencontre cette condition.

Le relais de protection PowerCommand avec fonction de mesurage et contrôle Ampsentry permet la coordination sélective de l'alternateur de ce groupe électrogène et les appareils de protection contre les surintensités de courant instantanées et temporisées situés en aval en conformité avec le Code Canadien de l'Électricité Partie I, CSA C22.2-09 Section 46-206. La vérification de la coordination sélective doit être vérifiée par une étude de coordination.

A041T769

FIGURE 23. TYPICAL INFORMATION LABEL

PowerCommand 2100, 3201	
DC Supply Rating:	<input type="checkbox"/> 12V <input type="checkbox"/> 24V 22A Maximum
Voltage Sensing:	347/600VAC Maximum, 50/60 Hz
Current Sensing:	0.5A
Heater Voltage (opt):	<input type="checkbox"/> 120V <input type="checkbox"/> 240V
AVR Supply:	<input type="checkbox"/> 210V <input type="checkbox"/> 240V , 4 Amps
Field Output:	300V Peak, 4 Amps
Remote Input and Sensor Circuits -	30VDC Max, 10mA Max
Output Relay Contacts:	240VAC - Make and Carry 30A for 0.2 Seconds, Resistive Circuit
Operating Ambient:	70°C Maximum Surrounding Air
Environmental:	Type 3R - 2100 Only Type 1 - 3201 Only

Trip Current Setting	110% of the Generator Nameplate Rating
Percent Current Setting	Trip Time
100%	Will Not Trip
135%	100 Seconds
200%	25 Seconds

A041V081

FIGURE 24. POWER COMMAND 2100 AND 3201 SPECIFIC CHECK LABEL

### 7.8.3 AmpSentry Protective Relay Time-Over Current Characteristic Curve

The protection provided is shown in the figure below, which shows the time-current characteristic of the supplied protection. This protection curve is specifically designed to protect the generator supplied, so adjustments to the operation points for this curve are not allowed.

**NOTICE**

The values shown on the current scale are shown based on the value of 1.0 being equal to the nameplate rated current of the generator set for the specific operating voltage.



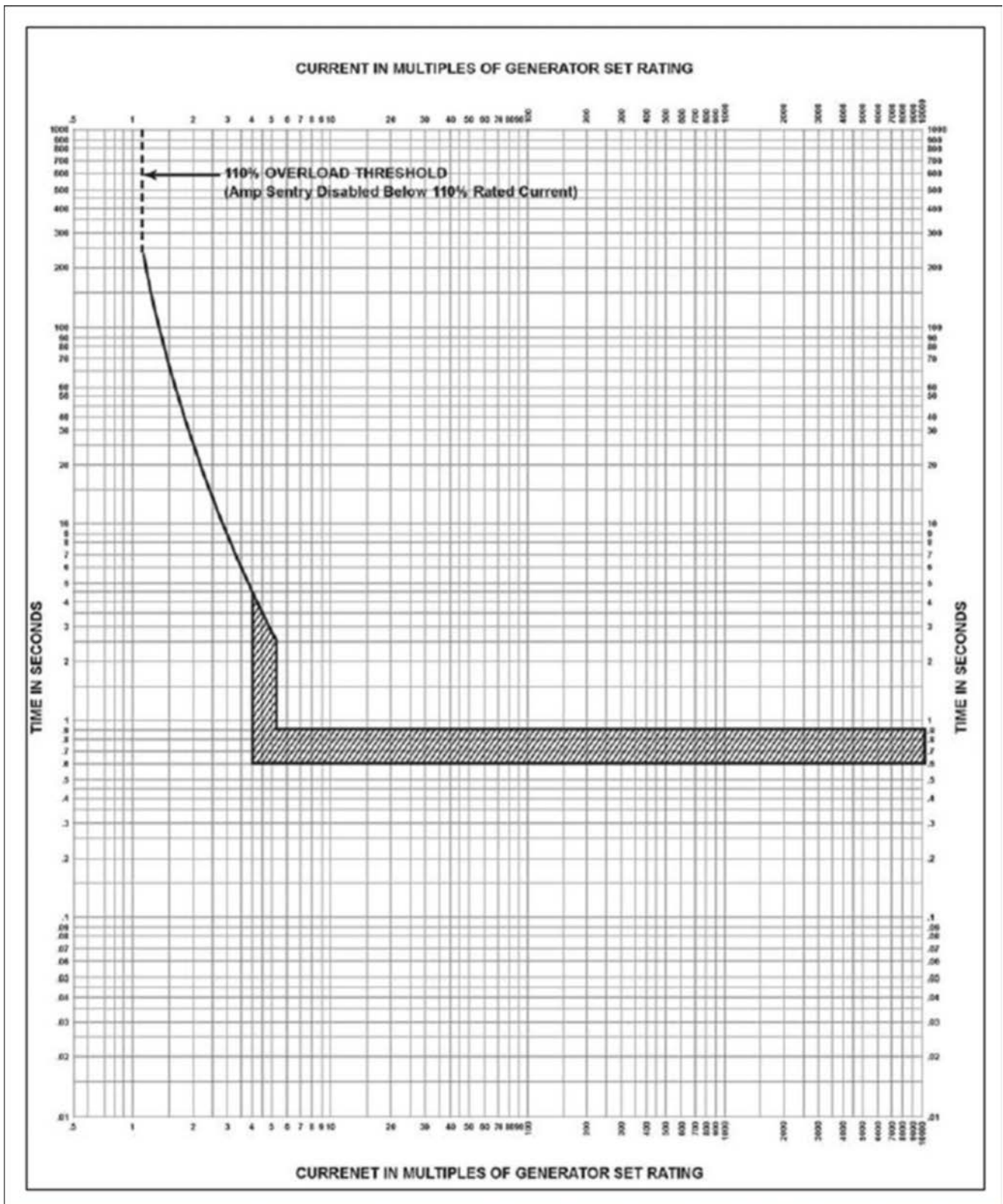


FIGURE 25. AMPSENTRY PROTECTIVE RELAY TIME OVER-CURRENT CHARACTERISTIC CURVE



## 7.8.4 Coordination of Protective Devices

Conduct a selective coordination (discrimination) study on the distribution system that incorporates the generator set when choosing a generator set. Visit [power.cummins.com](http://power.cummins.com) for a copy of document R-1053, or it can be found using SKM Power Tools for Windows library or from your distributor.

## 7.8.5 Additional AmpSentry Protective Relay Information

TABLE 5. ADDITIONAL AMPSENTRY PROTECTIVE RELAY INFORMATION FOR POWERCOMMAND 2100 CONTROL

	Voltage	No. of Phases	Frequency (Hz)	Current (Max)	Connection
Battery Supply	8-30 V		DC	22 A	TB1 (17-22)
Voltage Sense Input	347/600 V	3	50/60	10 mA	J8 (4, 7, 12, 20)
Current Sense Input		3	50/60	5 A	J7 (11, 12, 15, 16, 19, 20)
AVR Shunt Supply	240 V	1	50/60	100 mA	J8 (21-23)
AVR PMG Supply	210 V	1	50/60	100 mA	
AVR Output (Continuous)	300 V (Peak)	1	PWM	4 A	J8 (5,13)
AVR Output (Max/10 seconds)	300 V (Peak)	1	PWM	6 A	
Run Relay Output	30 V		DC	8 A; 1.44 A Pilot Duty	TB1 (17-22)
Customer Relay Output	30 V		DC	5 A	TB1 (8-15)
	250 V	1	AC	5 A; C300 Pilot Duty	
Indicator Supply	5 V		DC	50 mA	J2
Engine Sensors	5 V		DC	3 mA	J7 (13, 17, 21, 22, 25, 26, 29-35)
Governor Drive	5-30 V		DC	100 mA	J7 (14, 24, 28, 36)
Power Out	8-30 V		DC	100 mA	J7 (1-8, 18)
Solenoid Driver Signal	5-30 V		DC	100 mA	J7 (9, 10, 23, 27)
Switch Input	8-30 V		DC	1 mA	J1
Membrane Switch Input	5 V		DC	1 mA	J3
Customer Inputs	8-30 V		DC	1 mA	TB1 (1-6)

	Voltage	No. of Phases	Frequency (Hz)	Current (Max)	Connection
<b>Power Transfer Status</b>	5-30 V		DC	1 mA	TB2 (5)
<b>Power Transfer Signal Supply</b>	5-30 V		DC	100 mA	TB2 (3, 4, 6)
<b>Interface</b>	5 V		DC	1 mA	J50, J51, J4, J6
<b>Communication</b>	RS485				TB2 (1, 2)
	RS232				J9 (1-5, 9)
	CAN (Optional)				J10 (1-5)
<b>Trip Current</b>	110% generator nameplate FLA				
<b>Percentage of Trip Current</b>	100		300		600
<b>Trip Times</b>	500 seconds		10 seconds		1 second
<b>Temperature</b>	70 °C Maximum Surrounding Air Ambient				

# 8 DC Control Wiring

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**⚠ WARNING**

***Electric Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. Avoid contact with the voltage sense and bus sense leads; voltages of up to 600 VAC may still be present. These voltages could be live even when the generator set is switched off.***

**⚠ WARNING**

***Electric Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. Make sure all power is off before performing control wire installation.***

**⚠ WARNING**

***Electric Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. To prevent accidental electrocution, stand on a clean dry wooden platform or clean rubber insulating mat, make sure your clothing and shoes are dry, remove all jewelry, and use tools with insulated handles.***

The generator set control box contains connection points for remote control and monitor options.

**NOTICE**

**Always run control circuit wiring in a separate metal conduit from the AC power cables to avoid inducing currents that could cause problems within the control.**

Use cable ties to keep control wiring away from sharp edges and AC power cables within the control housing.

**NOTICE**

**Stranded copper wire must be used for all customer connections to the control panel. Solid copper wire may break due to the generator set vibration.**

Use flexible conduit for all wiring connections to the generator set.

## 8.1 Guidelines for Customer Connections to the Control System

- Torque terminals to 0.5 Nm (4.4 in-lb)
- Wire type: Use 60 C rated minimum copper wire
- Terminal screws (if fitted) are slotted 0.6 mm
- Use flat bladed screwdriver with 2.5 mm blade

- 
- Strip wire length to 6.0 mm (0.236 in) for screw type terminals and 10 mm (0.75 in) for push type terminals

### **8.1.1 Digital Connections**

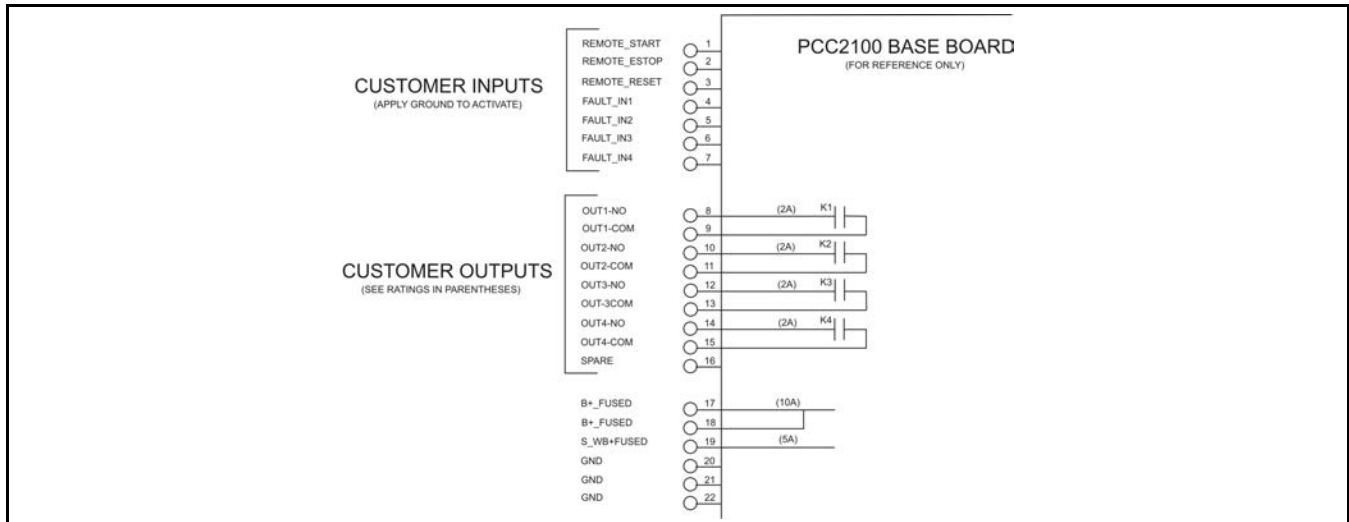
Connection points, other than relayed outputs and network are considered digital connections. The type/gauge wire to use for these connections are:

- Less than 305 m (1000 ft), use 0.5 mm<sup>2</sup> (20 gauge) stranded copper wire.
- 305 m to 610 m (1000 ft to 2000 ft), use 0.75 mm<sup>2</sup> (18 gauge) stranded copper wire.

### **8.1.2 Relay Connections**

Due to the wide variety of devices that can be attached to the relay outputs, the electrical contractor must determine the gauge of the stranded copper wire that is used.

## 8.2 PCC 2100 TB1 Customer Connections



No.	Description	No.	Description
1	Remote start	12	Configurable output 3
2	Remote emergency stop	13	Configurable output 3 (common)
3	Remote fault reset	14	Configurable output 4
4	Configurable input 1	15	Configurable output 4 (common)
5	Configurable input 2	16	Not used
6	Configurable input 3	17	B+
7	Configurable input 4	18	B+
8	Configurable output 1	19	Switched B+
9	Configurable output 1 (common)	20	Ground
10	Configurable output 2	21	Ground
11	Configurable output 2 (common)	22	Ground

FIGURE 26. PCC 2100 TB1 CUSTOMER CONNECTIONS

### 8.2.1 Remote Start

**⚠ WARNING**

**Automated Machinery**  
*Accidental or remote starting of the generator set can cause severe personal injury or death. Make sure that the generator set cannot be started accidentally or remotely before starting work on the generator.*

**NOTICE**

Remote start terminals should only be used for a remote application. Remote start terminals are not to be shorted if the remote start function is not intended to be used.

When the control is in Auto/Remote mode, grounding this input initiates the engine cranking and start sequence. This circuit must be opened to permit resetting a shutdown condition with the Reset input. (The remote stop is actually the removal of the remote start signal to the control.)

## 8.2.2 Remote Emergency Stop

Opening this input causes an immediate shutdown. Emergency stop must be reset at the remote panel, then at the front panel.

## 8.2.3 Remote Fault Reset

Ground this input to acknowledge faults after they have been corrected. The control must be in Auto mode.

### NOTICE

**Faults are re-announced if they are detected again after being acknowledged.**

### NOTICE

**Using the InPower service tool or accessing the Setup submenus is required to modify the customer outputs. Contact an authorized distributor for assistance.**

## 8.2.4 Configurable Inputs

Grounding any one of these inputs activates the corresponding warning or shutdown sequence.

External sensing equipment must be connected to the designated digital input.

The nature of the fault is an optional customer selection. Example inputs: Low Coolant Level, Low Fuel Level, Ground Fault, etc.

### NOTICE

**The InPower service tool or access to the Setup submenus is required to modify the customer fault inputs. Contact your authorized distributor for assistance.**

## 8.2.5 Configurable Outputs

Each output has normally-open contacts. The contacts can be used to control small devices, indicator lamps, or relays.

The contacts are programmed to energize by entering a code number for the desired event.

### NOTICE

**Using the InPower service tool or accessing the Setup submenus is required to modify the customer outputs. Contact an authorized distributor for assistance.**

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### 8.2.5.1 Contact Ratings for Configurable Outputs

TABLE 6. CONTACT RATINGS FOR CONFIGURABLE OUTPUTS

Description	Value
Maximum voltage	30 VDC
Maximum current	2 Amps

### 8.2.6 Switched B+

This output is active when the control receives a run command, for example, a remote start signal in Auto mode or the Start button in Manual mode.

## 8.3 Customer Relays

### 8.3.1 Location of Customer Relays

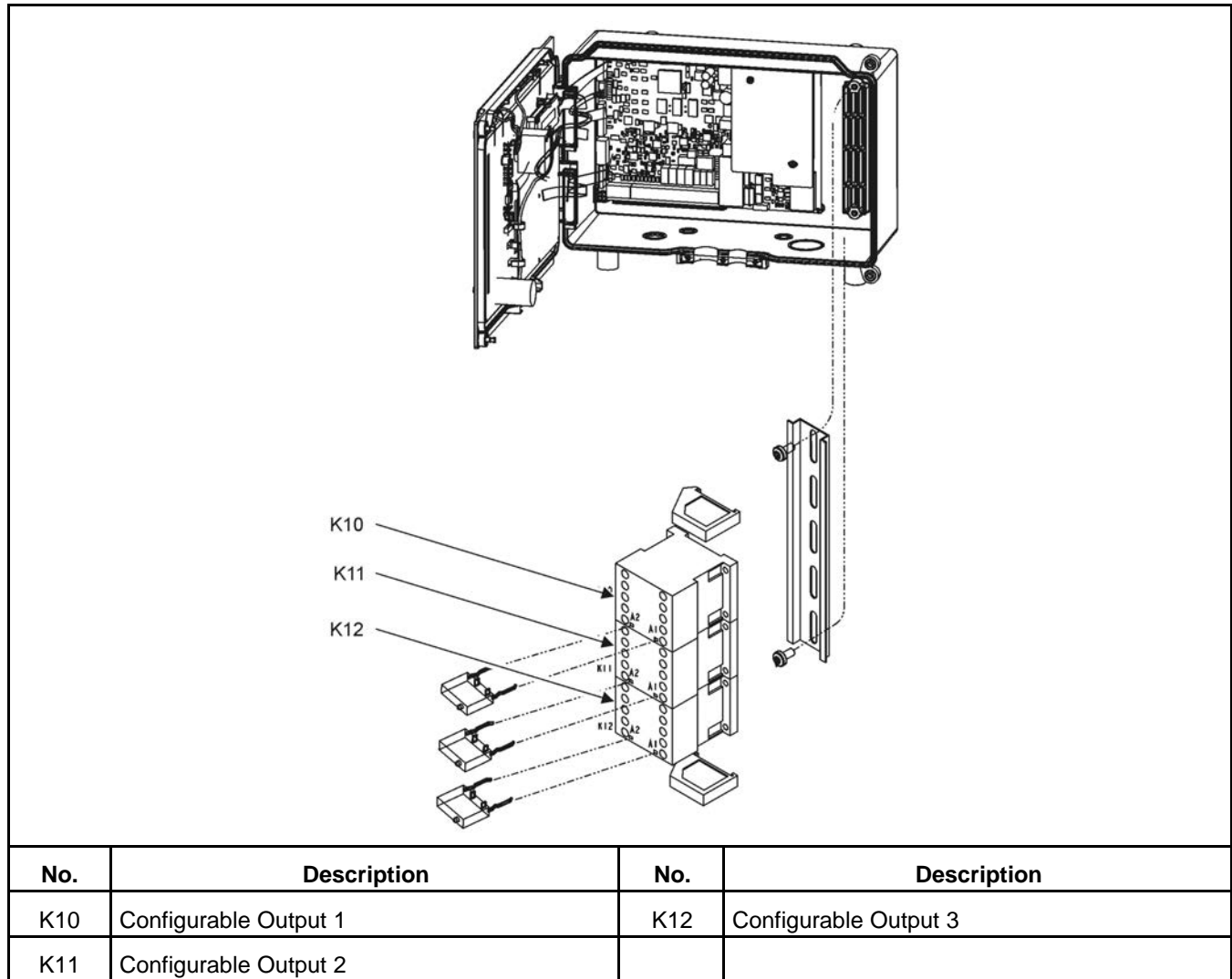


FIGURE 27. LOCATION OF CUSTOMER RELAYS

#### 8.3.1.1 Configurable Outputs

This relay is connected to the corresponding configurable output on the control. If the configurable output is active, the relay is active. If the configurable output is inactive, the relay is inactive.

This relay allows the configurable output to control larger devices, and it isolates the control from these devices.

#### 8.3.1.2 Contact Specifications

The contacts are rated at 10 A at 600 VAC.



### 8.3.1.3 Schematic

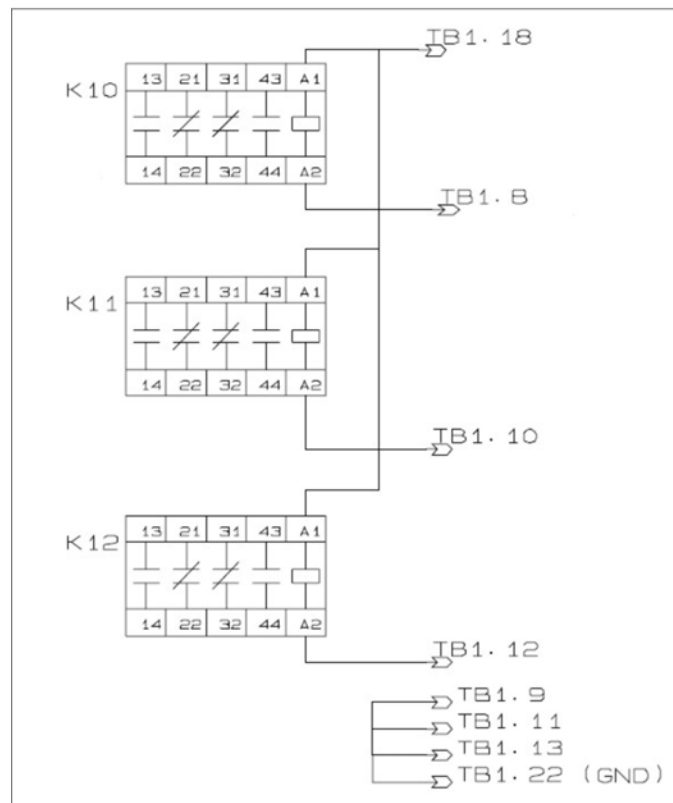


FIGURE 28. SCHEMATIC

## 8.4 Paralleling Circuit Breaker Control Relays

### 8.4.1 Paralleling Circuit Breaker Control Relays Installation

The circuit breaker control and monitor function manages opening and closing the genset breaker. It also manages sensing/determining both genset and utility breaker positions. The genset breaker is controlled with two separate relays -one for closing and one for opening.

The control logic instructs the genset breaker to always (except for a short delay) close or always open the breaker. Opening the breaker always takes priority over any close.

Only two functions can close the breaker -- either a dead bus close or the permissive close (sync check).

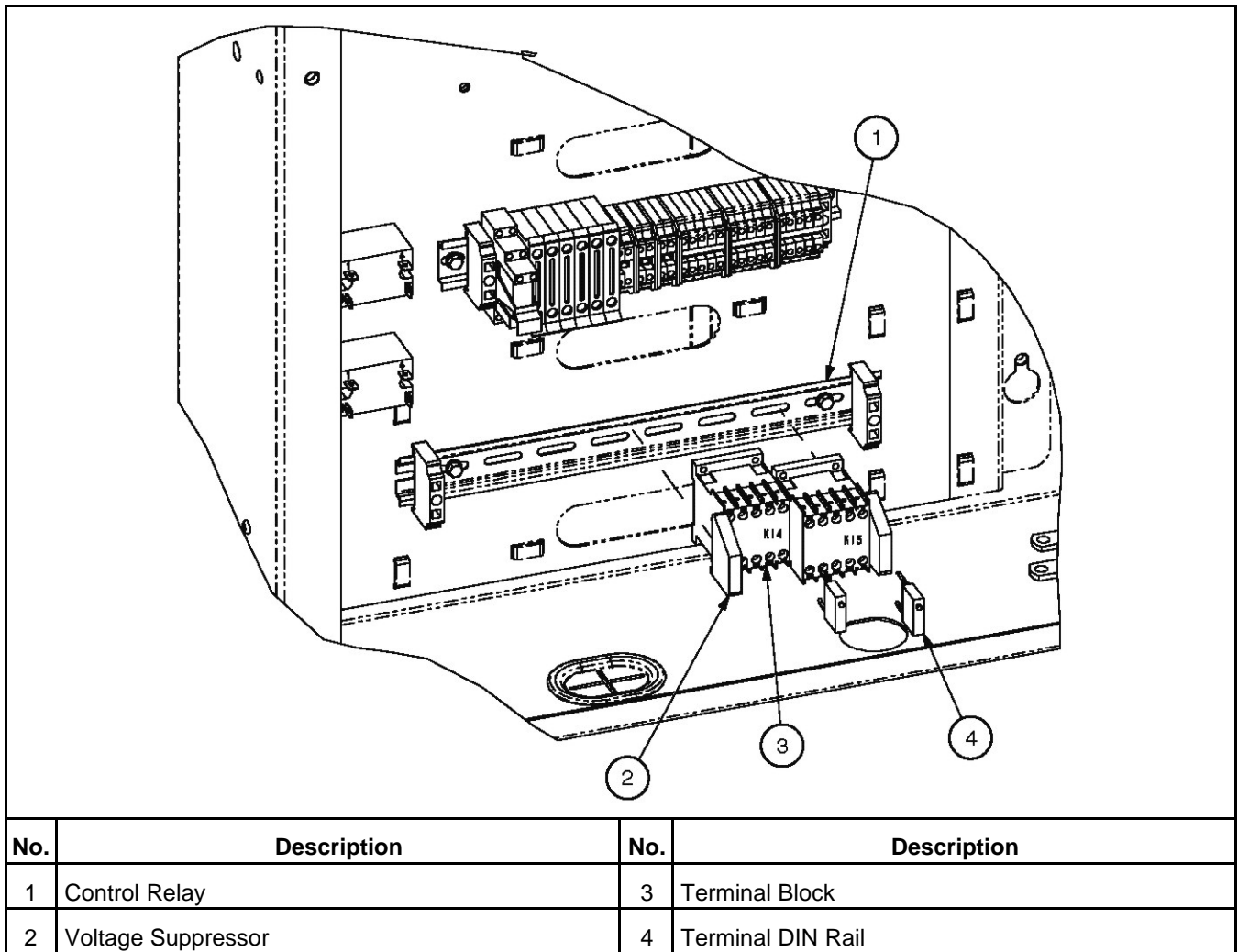
In single genset applications, the relay contact used for breaker closing is capable of being set up to trip the breaker on fault shutdowns only and the breaker position is not sensed.

TABLE 7. BREAKER CONTROL FUNCTIONS

Connector Pin	Signal Name	Signal Type	Description of Default Function
TB5-1	Genset CB Close Status	Relay Output	Contact for closing genset breaker, ratings 5A 30 VDC inductive L/R = 7 msec
TB5-2			

TB5-3	Genset CB Open Status	Relay Output	Contact for opening genset breaker, ratings 5A 30 VDC inductive L/R = 7 msec
TP5-4			
TP5-5			
TB5-6	Utility CB Close Status	Relay Output	Contact for closing utility breaker, ratings 5A 30 VDC inductive L/R = 7 msec
TB5-7			
TP5-8	Utility CB Open Status	Relay Output	Contact for opening utility breaker, ratings 5A 30 VDC inductive L/R = 7 msec
TP5-9			

Paralleling circuit breaker control relays are located in the control pedestal.



**FIGURE 29. PARALLELING CIRCUIT BREAKER CONTROL RELAYS**

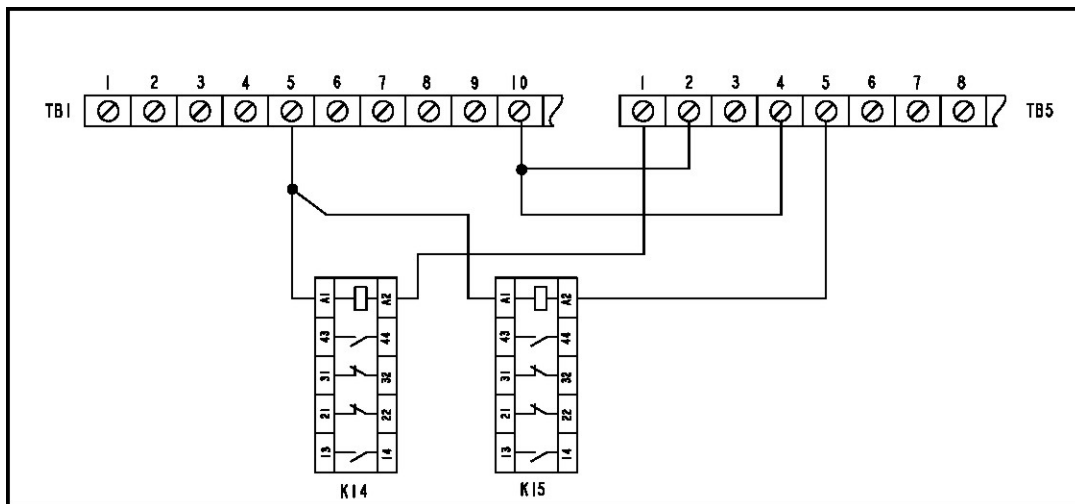


FIGURE 30. WIRING DIAGRAM OF PARALLELING CIRCUIT BREAKER CONTROL RELAYS

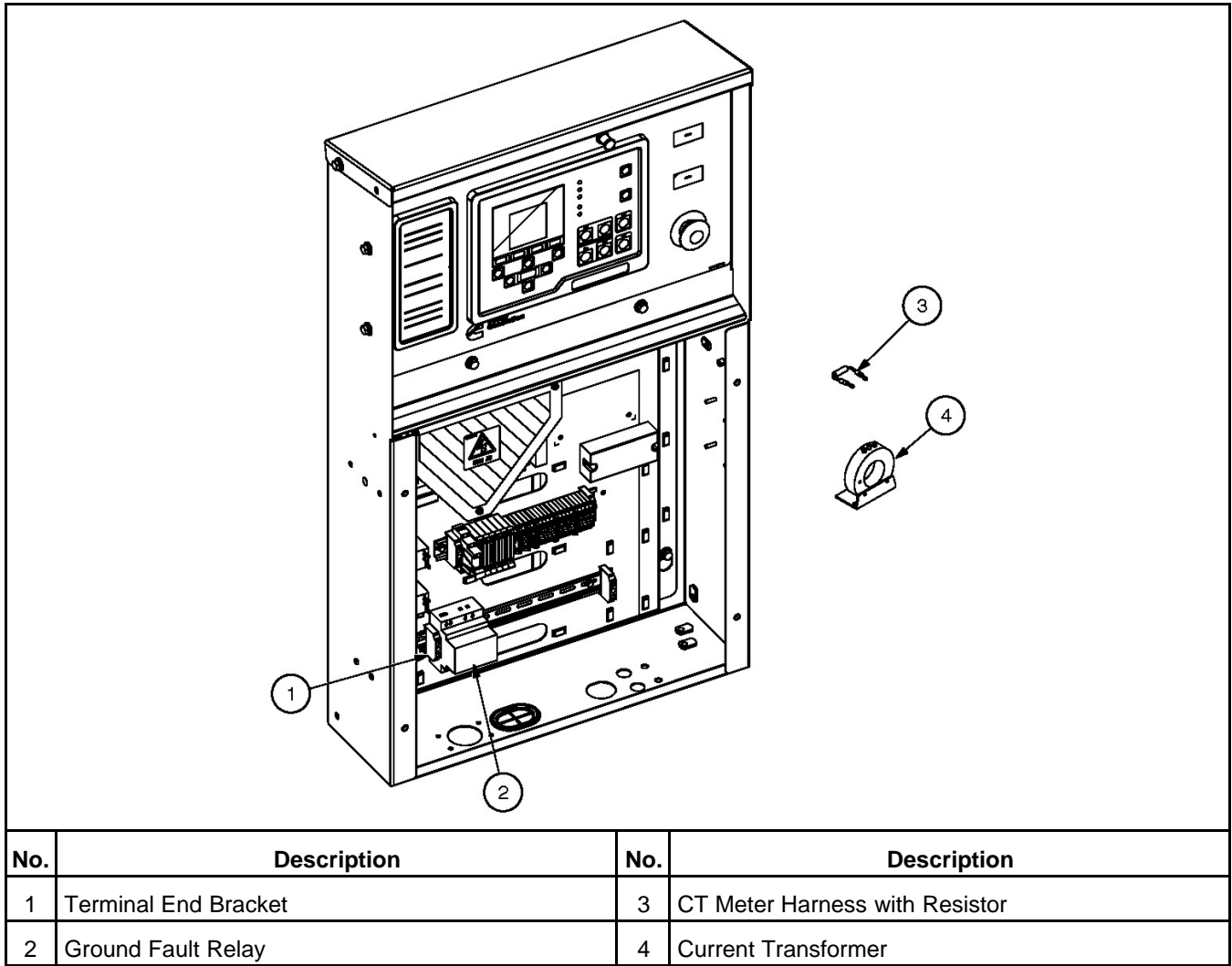
## 8.5 Ground Fault Relays

A Ground Fault Relay (GFR) continuously monitors the neutral-to-ground connection and activates a fault alarm when the connection is broken. During generator set operation, the relay continuously monitors the line-to-neutral and activates a fault alarm when a ground fault is sensed.

A control reset will clear the fault at the control panel and will also reset the ground fault relay.

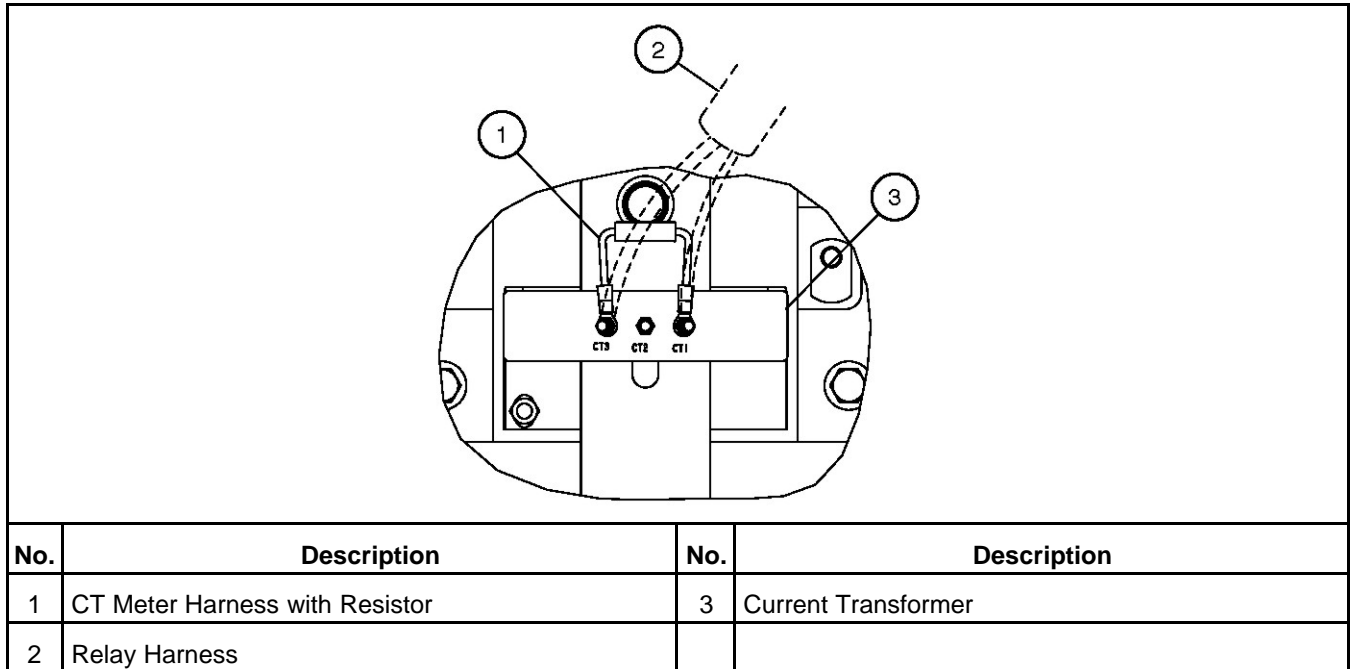
### 8.5.1 Ground Fault Relay with Local Current Transformer

The ground fault relay with a local Current Transformer (CT) is used on generator sets that have their neutrals bonded to ground internally in the circuit breaker or entrance enclosure. The ground bonding jumper is connected between the neutral (L0) bus bar and the equipment grounding bus and passes through the ground fault sensing CT which drives the GFI relay. Generator sets with this feature power separately derived systems via 4-pole transfer switches that switch the neutral conductor as well as the three phases.



**FIGURE 31. GROUND FAULT RELAY USED WITH LOCAL CURRENT TRANSFORMER**

For installations with a local current transformer, the current transformer is mounted inside the control box. The meter harness with resistor is installed on the transformer. The relay harness is connected from the relay to the current transformer.

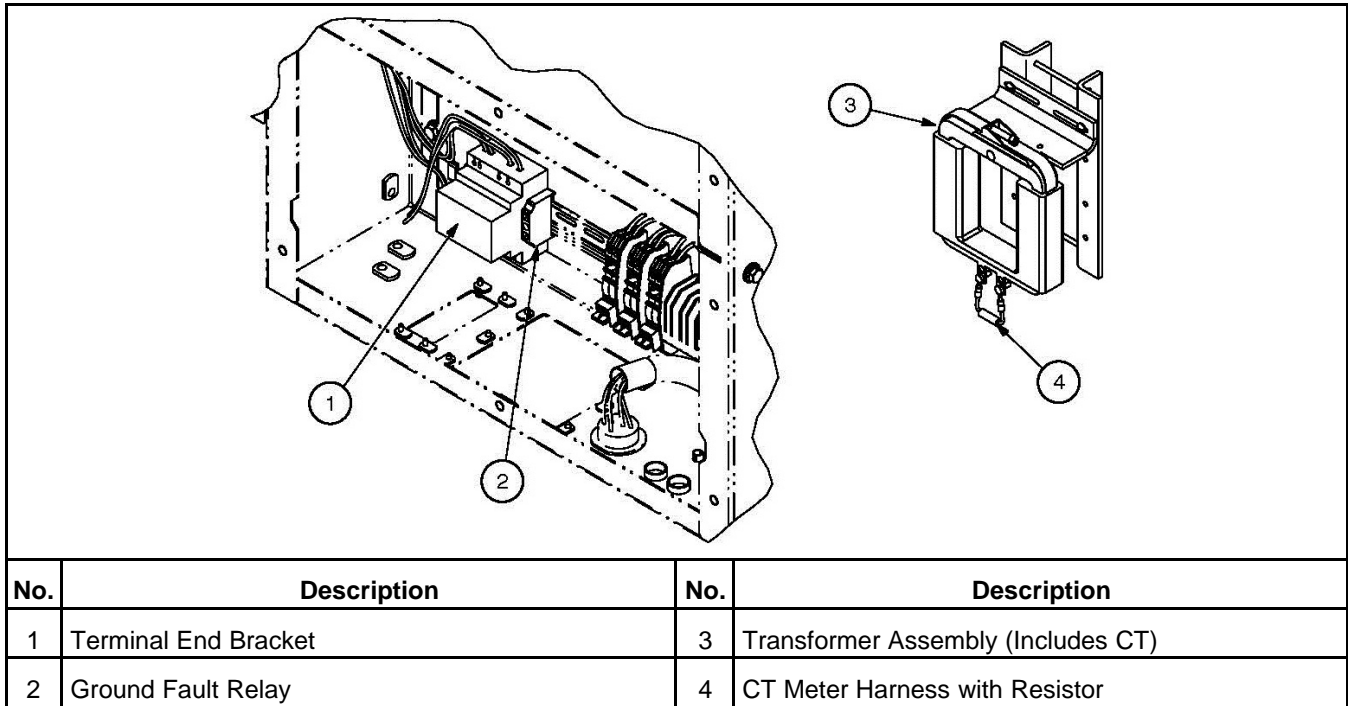


**FIGURE 32. GROUND FAULT METER HARNESS**

### 8.5.2 Ground Fault Relay with Remote Current Transformer

The ground fault relay with a remote CT is used on generator sets with floating neutrals (L0) that are not connected to ground at the set. These generator sets power non-separately derived systems via 3-pole transfer switches which solidly bond the neutral conductors in both the neutral and emergency sides.

For installations with a remote current transformer, the current transformer is mounted on a transformer assembly at a location away from the generator set. The meter harness with resistor is installed on the current transformer. The relay harness is connected from the relay to the current transformer.



**FIGURE 33. GROUND FAULT RELAY COMPONENTS USED WITH REMOTE CURRENT TRANSFORMER**

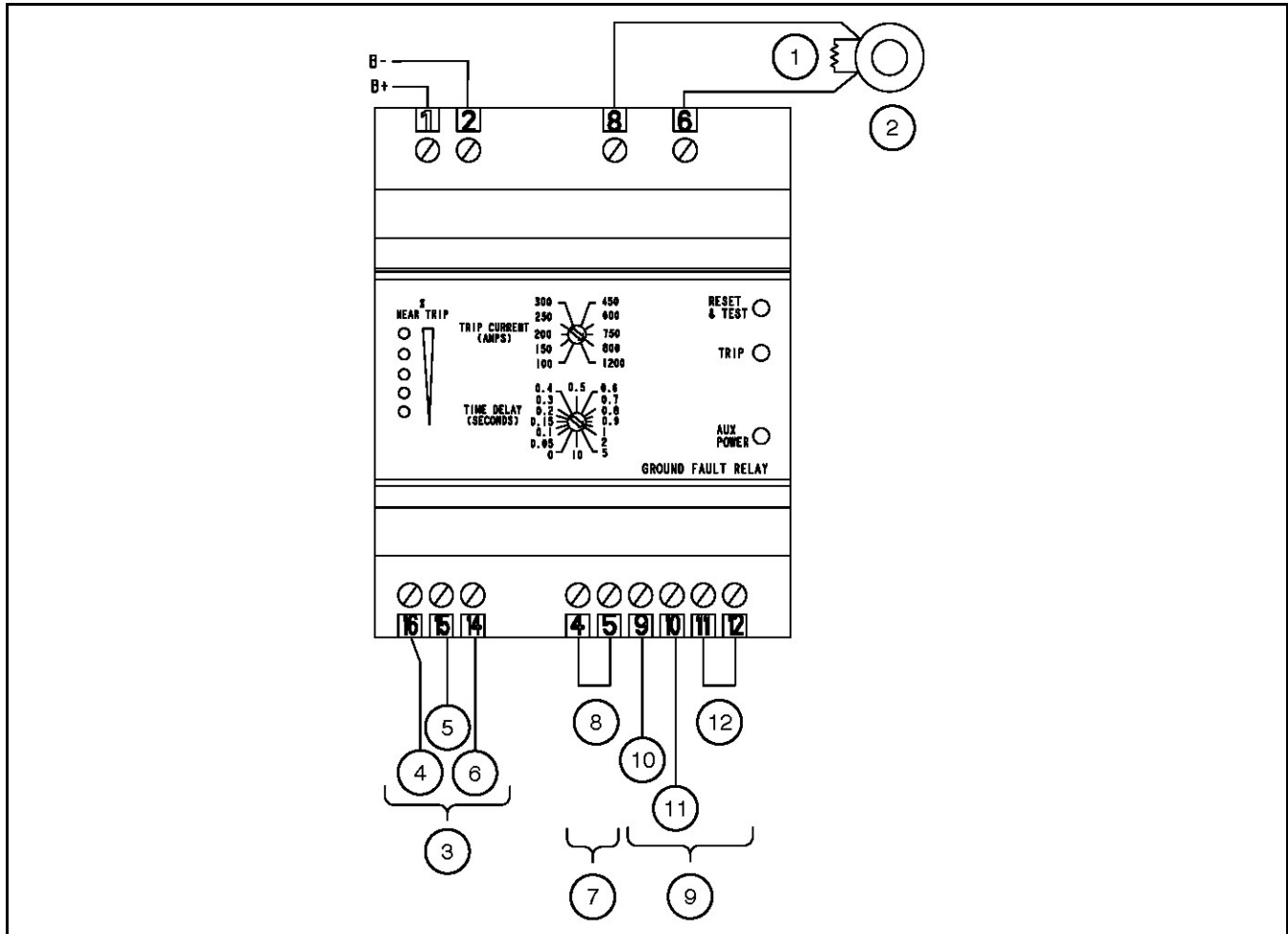
### 8.5.3 Ground Fault Relay Installation

Refer to the following figure when making wiring connections. The connection points on the ground fault relay that are used include:

- GFR-1 - B+
- GFR-2 - B-
- GFR-6 to CT3
- GFR-8 to CT1
- GFR-14 (Signal) to TB1-14
- GFR-15 (Signal Return) to TB1-15

The two leads connected from GFR-14 and GFR-15 to TB1-14 and 15 are configurable inputs.

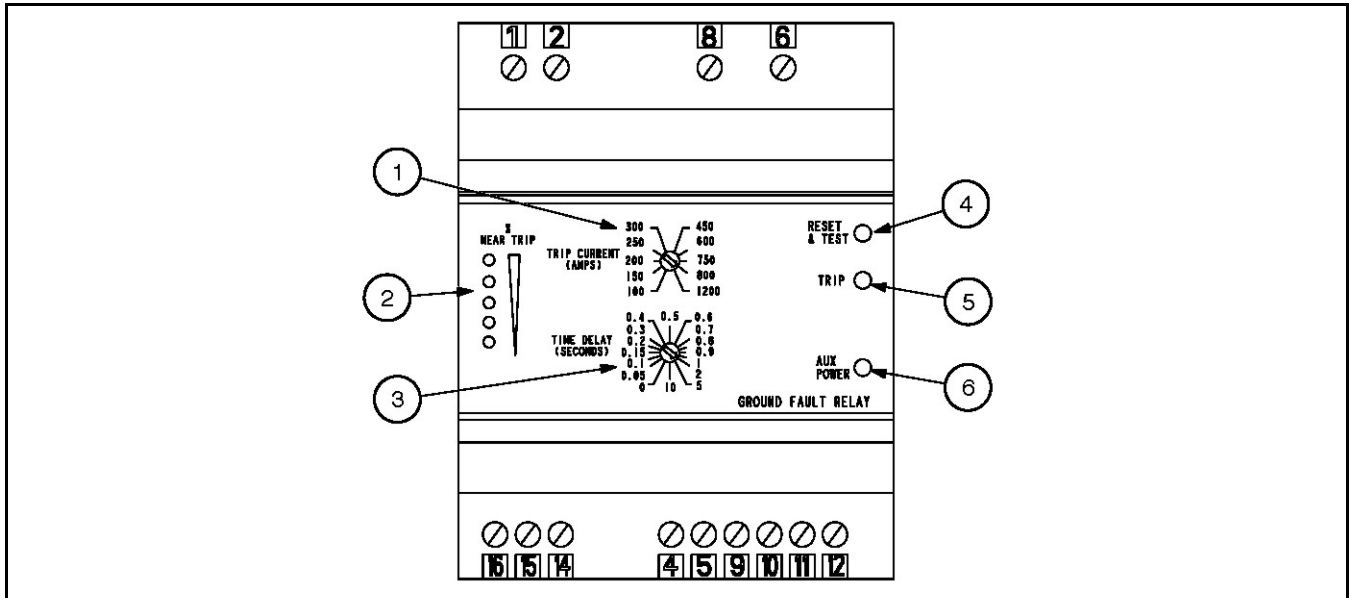
The maximum AC terminal voltage for the ground fault relay is 600 VAC. The supply voltage is 12-48 VDC. The continuous current is 5 amps.



No.	Description	No.	Description
1	Burden Resistor	7	Optional
2	Current Transformer	8	Link for Latching Relay
3	Output Signal	9	Not Used
4	N.O.	10	Analogue +
5	Com.	11	Output -
6	N.C.	12	Link for 200μ Shunt

**FIGURE 34. GROUND FAULT RELAY WIRING CONNECTIONS**

The relay has a time delay setting of zero to ten seconds and a current setting of 100 to 1200 amperes. Adjust the Current and Time Delay controls on the ground fault relay to the customer's specifications.



No.	Description	No.	Description
1	Trip Current Control	4	Reset and Test Button
2	Percent Near Trip Indicators	5	Test Button
3	Time Delay Control	6	Auxiliary Power Indicator

FIGURE 35. GROUND FAULT RELAY



# 9 AC Electrical Connections

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## WARNING

### ***Arc Flash and Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. Make sure that only service personnel who are trained and experienced perform electrical and mechanical component installations. The AC sensing harness and other cabling will become energized when the generator set is in operation.***

## WARNING

### ***Hazardous Voltage***

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

## WARNING

### ***Automated Machinery***

***Accidental or remote starting of the generator set can cause severe personal injury or death. Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [-] first).***

## WARNING

### ***Combustible Gases***

***Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death. Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (-) cable first and reconnect it last.***

## WARNING

### ***Electric Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. Avoid contact with the voltage sense and bus sense leads; voltages of up to 600 VAC may still be present. These voltages could be live even when the generator set is switched off.***

This section provides the procedure that is used to connect the AC electrical system of the generator set.

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Make sure the Operator Panel is in OFF mode. Turn off or remove AC power from the battery charger and then remove the negative (-) battery cable from the set starting battery using an insulated wrench.

If the generator set is being installed in an application where it may parallel with other generators or utility sources, the generator set control system may be energized from an external source. Lock out tag out any external source that can provide AC power to the generator set.

**NOTICE**

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

Connecting the generator set AC electrical system involves:

- Installation of transfer switch
- Installation or verification of paralleling switchboard
- Generator output voltage selection
- Load cable connection
- Standard and optional AC equipment connections (e.g., control box heater, coolant heater, etc.).

For all output connections, including when field connection is made at the alternator terminations, installation should be completed with conductors of appropriate size, type, and rating specified in local codes (or UL). For UL compliant installations, use conductor size, X AWG, 75 °C or 90 °C copper wire, 600V. Where X AWG is the conductor size specified by the local electrical code for 75 °C at the rated output current for the generator set. For non-UL compliant installations, use cable sizes, composition, and rating per local codes. Strain relief, bending space, raceway, and other installation features should be completed in compliance with local code.

Local regulations often require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire sizes, materials used, etc. must conform to the requirements of electrical codes in effect at the installation site.

Before starting the generator set, check to make sure that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation. Check that the load cables from the generator set are properly connected.

**NOTICE**

**Backfeed to a utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after the building main switch is opened.**

## 9.1 Transfer Switch

A transfer switch must be used for switching the load from the normal power source to the generator set (see [Figure 36](#)). Follow the installation instructions provided with the transfer switch when connecting the load and control wiring.

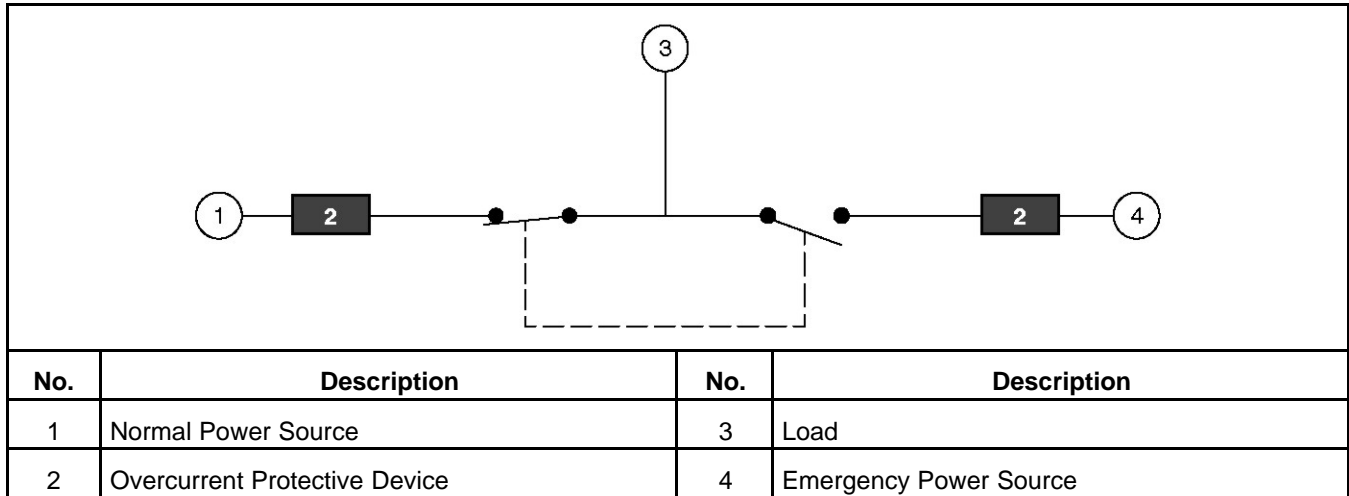


FIGURE 36. TYPICAL LOAD TRANSFER FUNCTION

## 9.2 Alternator Voltage Connections

These alternators can be configured to the nameplate voltages as shown on the Reconnection Diagram decal, attached to the backside of the control box cover. Many of the voltages listed will require reconfiguration of the alternator output leads on the connection terminal block. This reconfiguration must only be done by service personnel that are trained and experienced to perform electrical installation. The generator set was adjusted to produce a specified voltage during production verification testing prior to shipment. The installer must always check the stator lead terminal block connections and perform any necessary reconnect to obtain the voltage required.

Some generator sets are capable of producing a wide range of voltages and connection configurations; others have specific limited capabilities. Refer to wiring diagram and generator voltages (from the nameplate) when reviewing the voltage connection information and use the wiring diagram supplied with your generator set when actually performing load connections.

**NOTICE**

*Reconfiguring generator sets to higher voltages can exceed the voltage capability of the specific generator windings and damage the generator and also decrease line current, rendering line circuit breakers too large. Consult with your authorized distributor before performing reconnection for a different voltage.*

**NOTICE**

*Reconfiguring generator sets to lower voltages can reduce generator set ratings, and also increase line current, rendering line circuit breakers too small. Consult with your authorized distributor before performing reconnection for a different voltage.*

## 9.3 Load Connections

### NOTICE

**Flexible conduit and stranded conductors must be used for connections to take up movement of the generator set.**

All loads are connected to the alternator by bolting stranded load wires to the appropriate terminals on the alternator reconnection terminal block or circuit breaker lugs. The terminals are marked U, V, W, and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2 and L3; and N with L0 respectively). See [Appendix D on page 115](#) for details about the following:

- Load connections
- Conduit
- Cable Size

## 9.4 Load Balancing

When connecting loads to the generator set, balance the loads so that the current flow from each line terminal (L1, L2, and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value and no line current exceeds the name plate rating of the generator. Check the current flow from each line after connections by observing the Operator Panel ammeter.

## 9.5 Fuel Transfer Pump Installation

### ⚠ WARNING

#### ***Combustible Liquid***

***Fuel leaks are a fire and explosion hazard which can cause severe personal injury or death.***

***Make sure that only trained and experienced personnel install and service the generator set in accordance with applicable codes.***

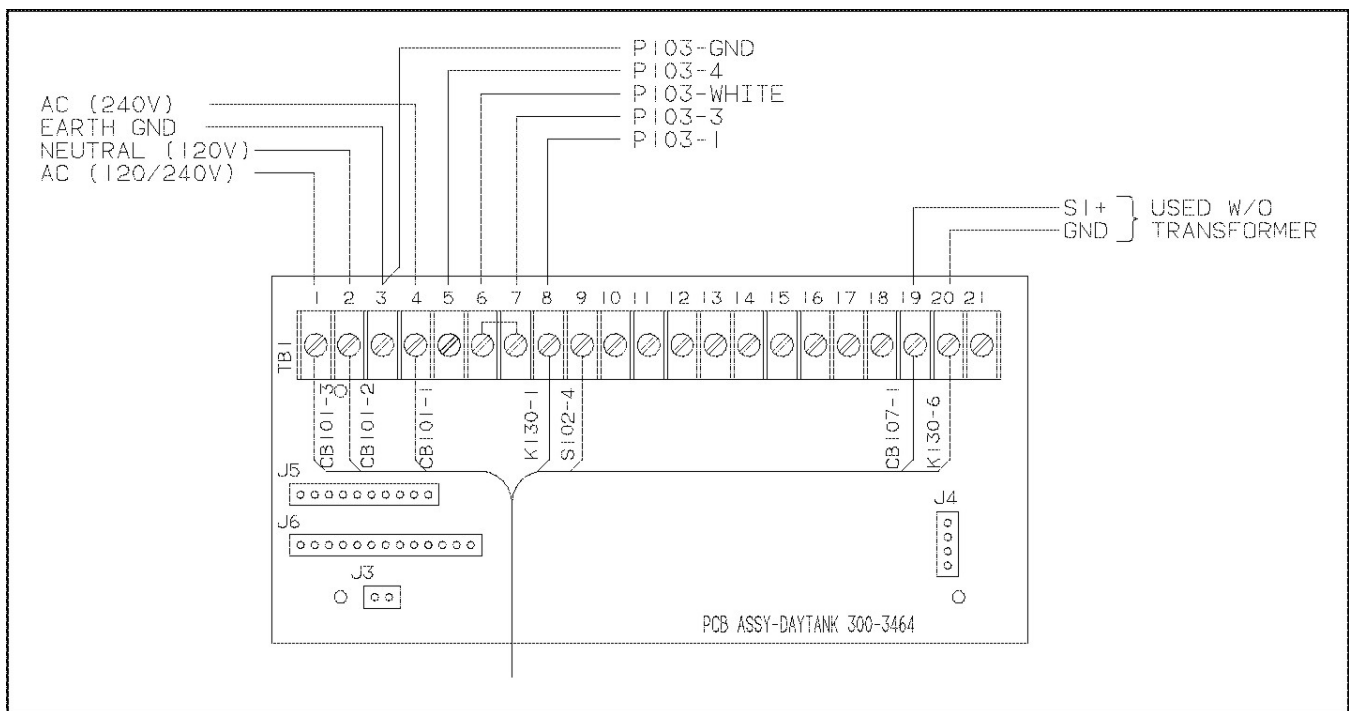
### NOTICE

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

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

### 9.5.1 Fuel Transfer Pump Control AC Connections

See the wiring diagrams provided with your generator set when making connections at the fuel pump control.



**FIGURE 37. FUEL PUMP CONTROL TERMINAL BOARD**

The following should be noted.

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

#### NOTICE

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

- a. Remove the two jumpers between terminals TB1-6 and TB1-7 in the control box, and connect one jumper between terminals TB1-5 and TB1-6 and the other jumper between terminals TB1-7 and TB1-8.
- b. Move selector switch S103 on the control PCB to the up position for 120 V.
- c. On the control transformer, remove the two jumpers between terminals H2 and H3, and connect one jumper between H1 and H3 and the other jumper between H2 and H4.

#### NOTICE

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

- a. Remove the jumpers between terminals TB1-5 and TB1-6 and TB1-7 and TB1-8 in the control box, and connect the two jumpers between terminals TB1-6 and TB1-7.
- b. Move selector switch S103 on the control PCB to the down position for 240 VAC.
- c. On the control transformer, remove the jumpers between terminals H1 and H3 and H2 and H4, and connect the two jumpers between H2 and H3.

2. Attach a tag to the control box indicating the supply voltage.
3. Terminals TB1-8 and TB1-5 are available for connection of a 120 VAC 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.

## 9.6 Current Transformers

Current transformers (CTs) reduce high voltage currents (AC) to enable safe monitoring.

### 9.6.1 Current Transformer Installation Requirements

Current transformers (CTs) reduce high voltage currents (AC) to enable safe monitoring.

The CT has a dot on one side. This dot must be facing toward the alternator reconnection terminal block (conventional current flowing into the dot). A dot is also used to indicate pin 1 of the CT.

Route the load lead through the appropriate CT. See the Alternator Reconnection Drawing section.

The CTs have dual secondaries (3 pins):

- The CT secondary wire marked 1 is connected to pin 1 of the CT.
- The CT secondary wire marked 2/3 is connected to pin 3 for low voltage generator sets.

## 9.7 Coolant Heater

The coolant heaters are designed to allow the generator set to start and pick up load within 10 seconds in a 4.4 °C (40 °F) environment. In colder ambient temperature environments the starting time may be longer.

### 9.7.1 Coolant Heater Connection

#### NOTICE

The coolant heater must not be operated while the cooling system is empty or damage to the heater will occur.

A coolant heater keeps the engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces start-up time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

Refer to [Appendix A on page 103](#) for electrical connections.

### 9.7.2 DSHAD Coolant Heater Specifications

A coolant heater keeps engine coolant warm when the engine is shut down. It heats and circulates the coolant in the engine. The coolant heaters are designed to allow the engine to start and the generator set to pick up load within 10 seconds in a 40 °F (4.4 °C) environment. In colder ambient temperature environments the starting time may be longer.

## 9.8 Alternator Heaters

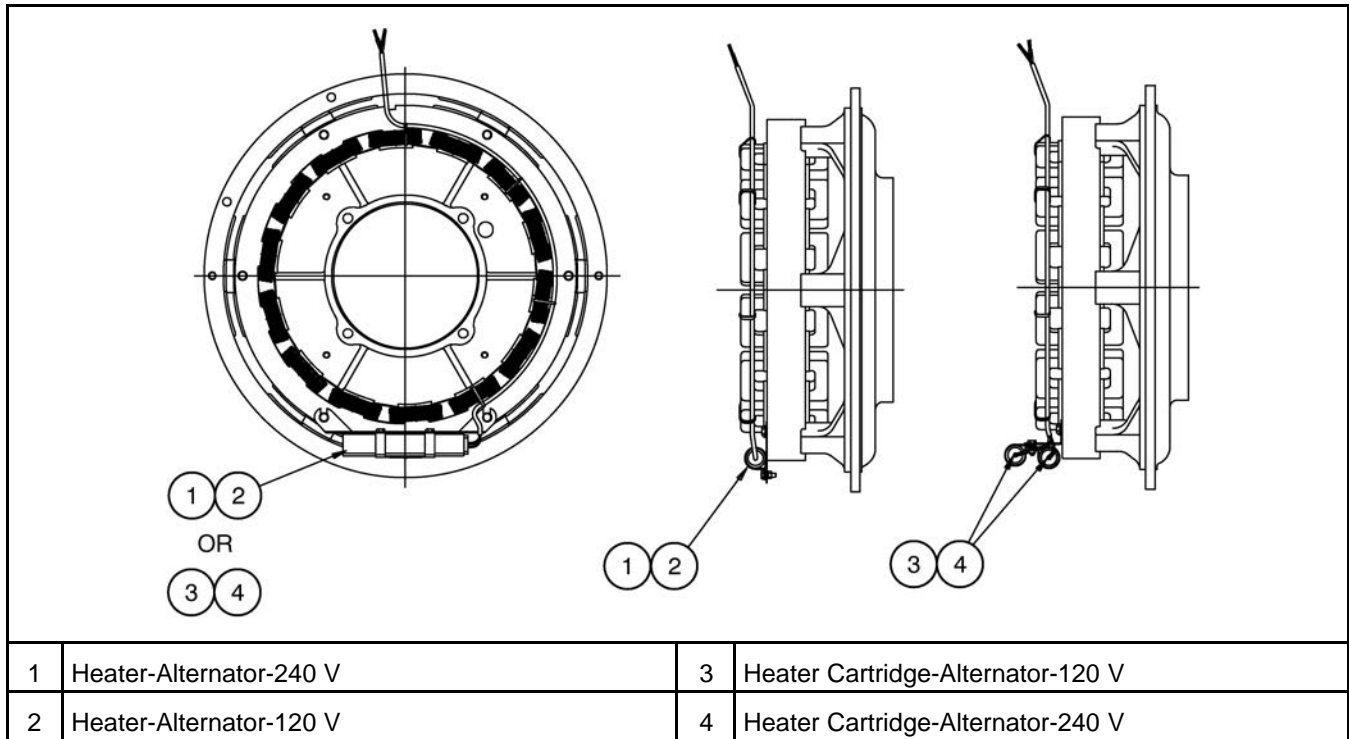
### 9.8.1 Alternator Heater Installation

An alternator heater(s) is used to help keep the alternator free of condensation when the generator set is not running. During cool and humid conditions, condensation can form within a alternator, creating flashing and shock hazards.

**⚠ WARNING**

***Water or moisture inside an alternator increases the possibility of flashing and electrical shock, which can cause equipment damage and severe personal injury or death. Do not use an alternator which is not dry inside and out.***

**Figure 38 on page 85** shows the installation of two heater elements. Connect the heater(s) terminals to a source of power that will be on during the time the engine is not running. Be sure the supply voltage and circuit amperage is correct for the heater element rating.



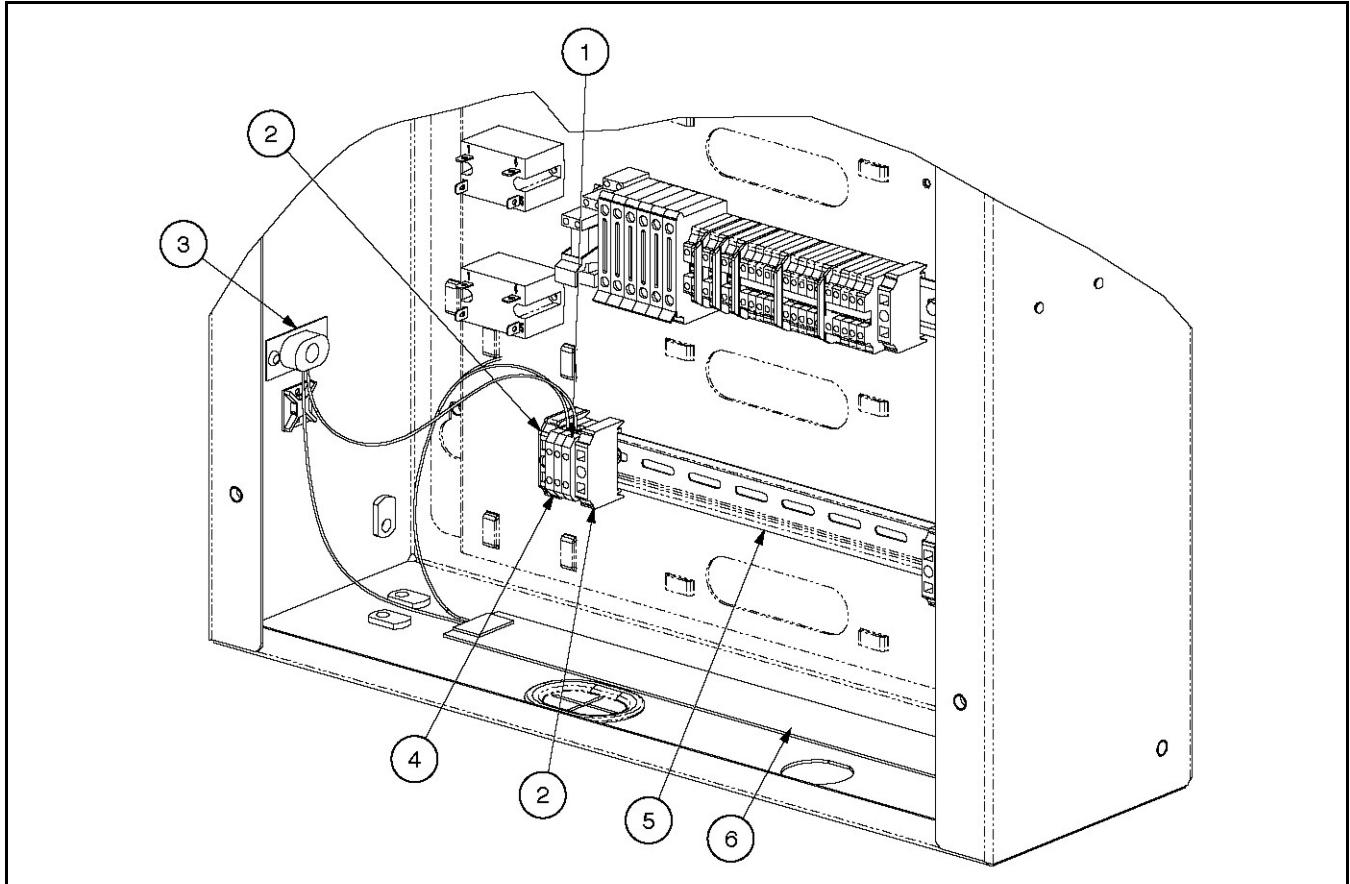
**FIGURE 38. TYPICAL ALTERNATOR HEATERS**

## 9.9 Control Box Heater

### 9.9.1 Control Box Heater Installation

A thermostat controlled heater is installed inside the control cabinet. The heater may be attached to the bottom or the side of the control box. [Figure 39](#) shows a typical heater. [Figure 40](#) shows typical heater wiring.

The heater power cord must be connected to a grounded outlet.



No.	Description	No.	Description
1	Terminal Block (Ground)	4	Terminal Block
2	Terminal Endplate	5	Terminal DIN Rail
3	Thermostat	6	Flexible Heater Pad

**FIGURE 39. TYPICAL CONTROL BOX HEATER**



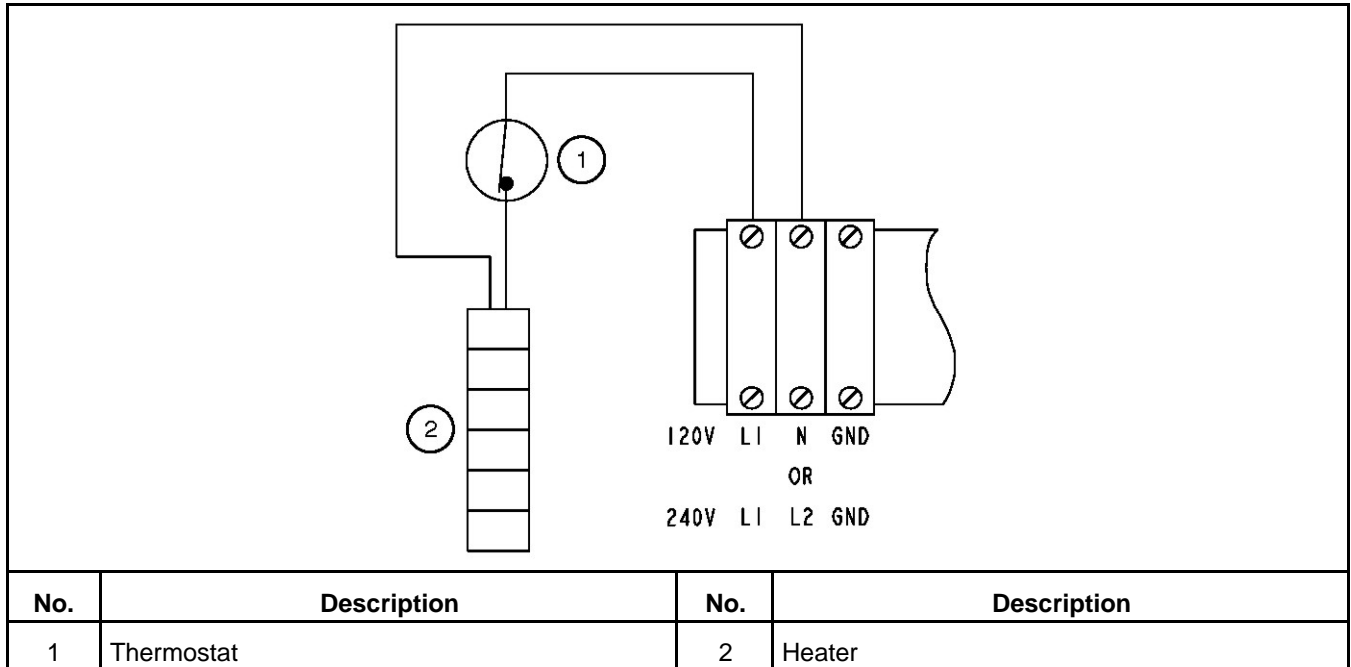


FIGURE 40. TYPICAL HEATER WIRING DIAGRAM

## 9.10 Oil Heaters

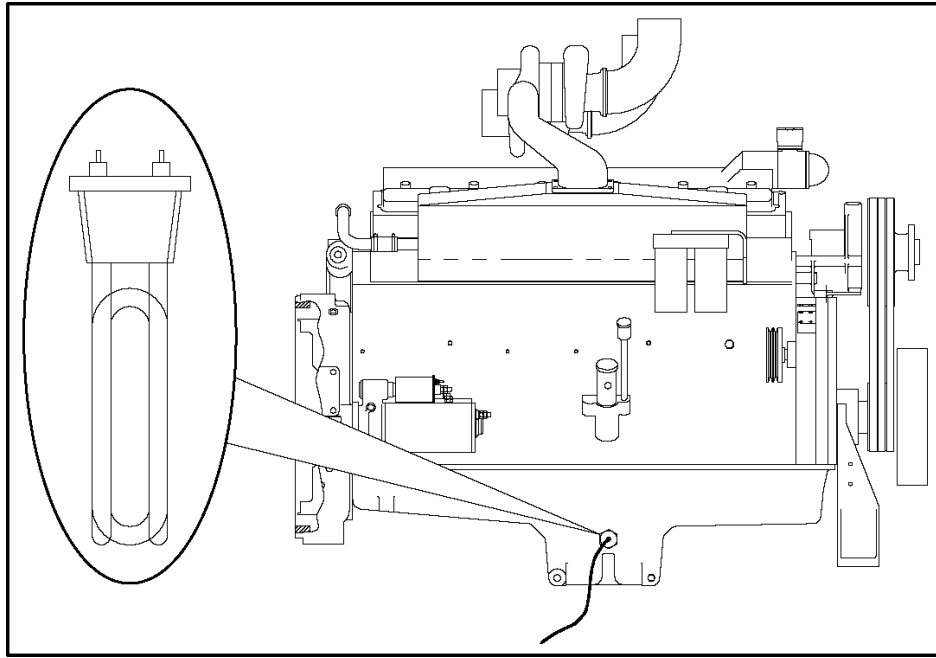
### 9.10.1 Oil Pan Heater Installation

Oil pan heaters require an external power source.

The oil pan heater used in 120 V or 208/240 V applications is shown below.

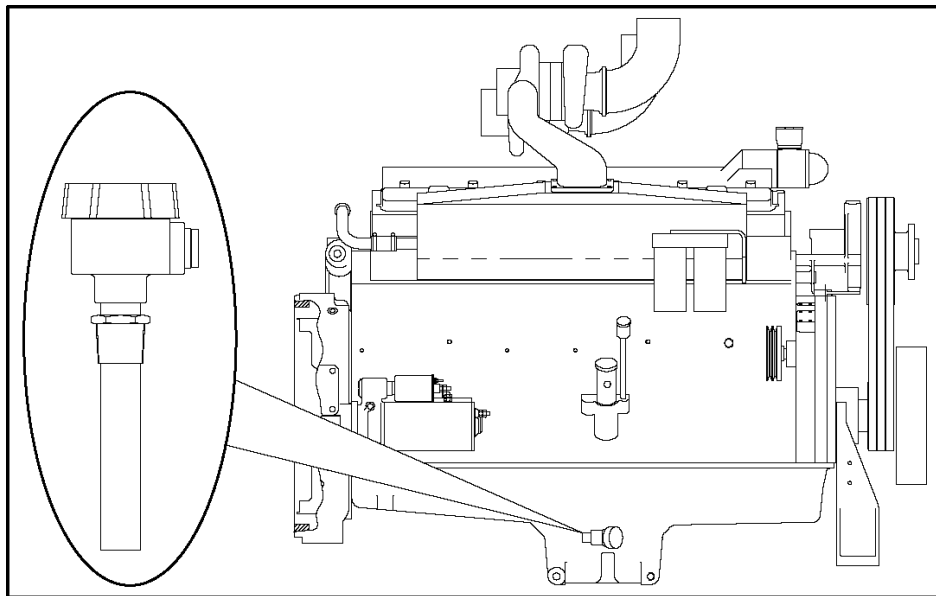
**NOTICE**

For 120 V applications, the optional location is shown. The primary location is on the left hand side of the oil pan.



**FIGURE 41. 300 W OIL PAN HEATER USED IN 120 V AND 208/240 V APPLICATIONS**

The oil pan heater used in 480 V applications is shown below.



**FIGURE 42. 300 W OIL PAN HEATER USED IN 480 V APPLICATIONS**

## 9.11 Annunciators

### 9.11.1 PowerCommand Universal Annunciator

A universal annunciator provides lamps and a horn to annunciate the operating status and fault conditions of an emergency power system. It is designed for connection to either a 12 VDC or a 24 VDC control system. It can be configured to be either a positive or negative signal device.

Two versions of the PowerCommand universal annunciator are available.

- Panel Mounted
- Panel with Enclosure

The universal annunciator can communicate using either a PCCNet or a Modbus network.

Refer to the PowerCommand Universal Owners Manual for more information.

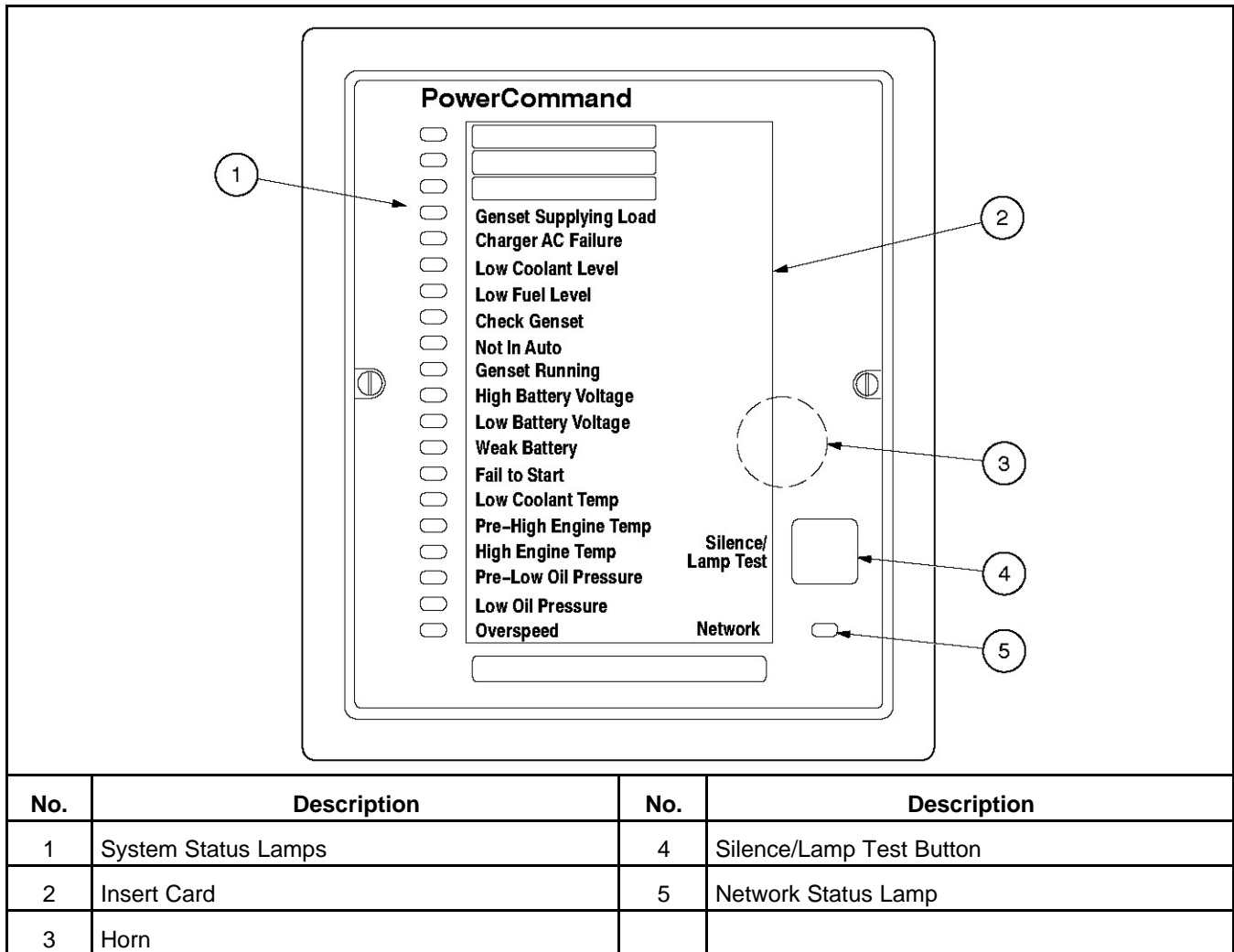
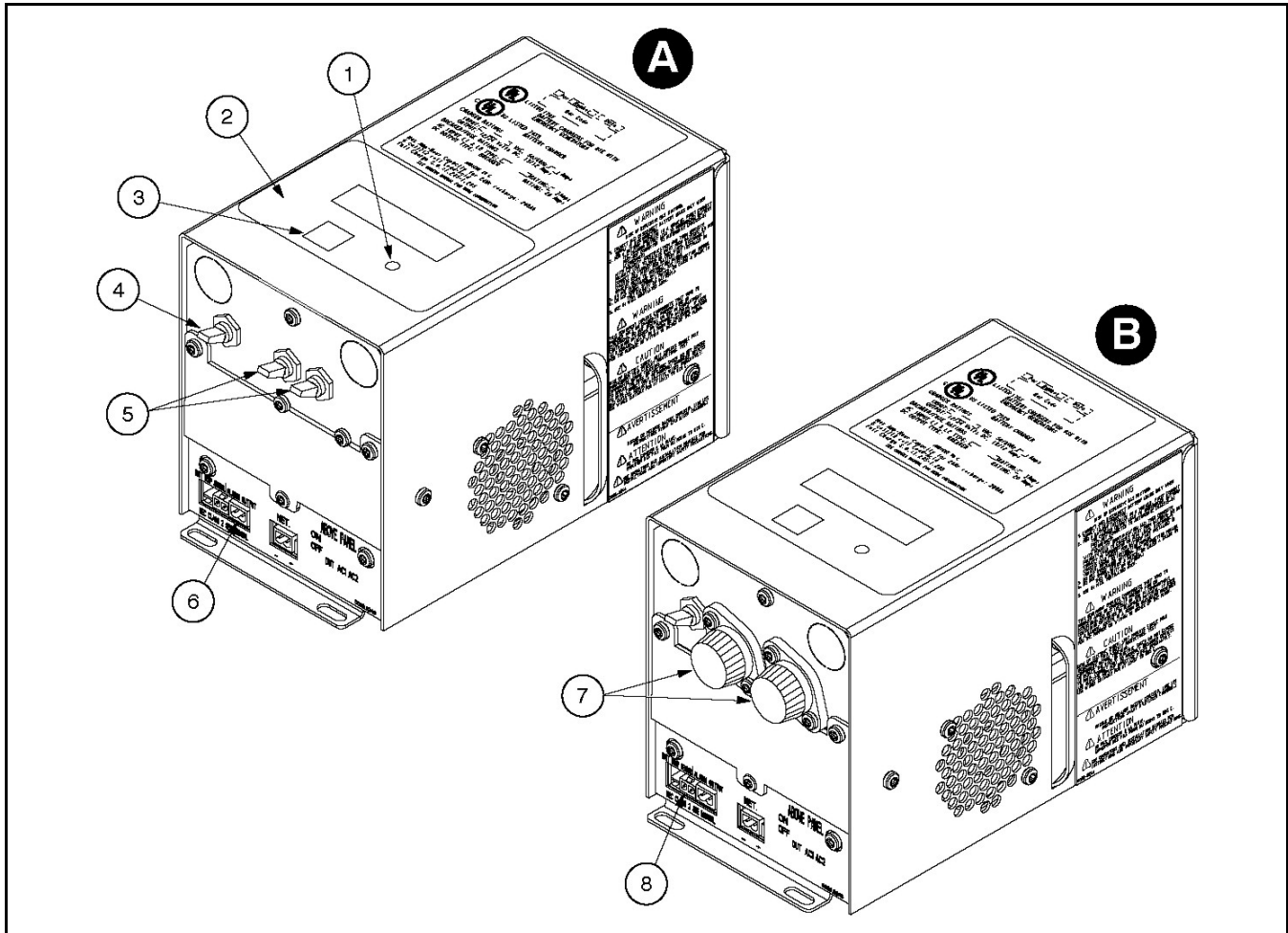


FIGURE 43. ANNUNCIATOR COMPONENTS

## 9.12 Battery Charger

### 9.12.1 PowerCommand Battery Charger - 15 Amp @ 12 Volt and 12 Amp @ 24 Volt

The two available types of 15/12-amp PowerCommand battery chargers are shown below. For more information, refer to the battery charger owner's manual.



No.	Description	No.	Description
A	120, 208, and 240 VAC Battery Charger	4	20 Amp DC Circuit Breaker Switch (Shown in the "On" position)
B	277, 380, 416, 480, and 600 VAC Battery Charger	5	10 Amp AC Circuit Breaker Switches (Shown in the "On" position)
1	Status LED	6	Fault Alarm Output Connector
2	Control Panel	7	10 Amp AC Fuse Holders
3	Reset Button	8	Connector for Optional Battery Temperature Sensor

FIGURE 44. 15/12-AMP POWERCOMMAND BATTERY CHARGERS

### 9.12.2 Mains (Utility) Battery Charger - Set Mounted

Single phase mains (utility) powered battery chargers, which are set mounted, are available in 3, 4, 5, 7, and 10 amp ratings, dependent on the generator set configuration. For more information, see the Battery Charger section of the generator set Operator Manual.

### 9.12.3 Mains (Utility) Battery Charger - Wall Mounted

Mains (utility) powered battery chargers, which are wall mounted, are available in 5 and 10 amp ratings, dependent on the generator set configuration. For more information, see the Battery Charger section of the generator set Operator Manual.

## 9.13 Grounding

#### WARNING

##### ***Electric Shock Hazard***

***Voltages and currents present an electrical shock hazard that can cause severe burns or death. Make sure that only service personnel who are trained and experienced perform electrical and mechanical component installations. Bonding and grounding must be done properly. All metallic parts that could become energized under abnormal conditions must be properly grounded.***

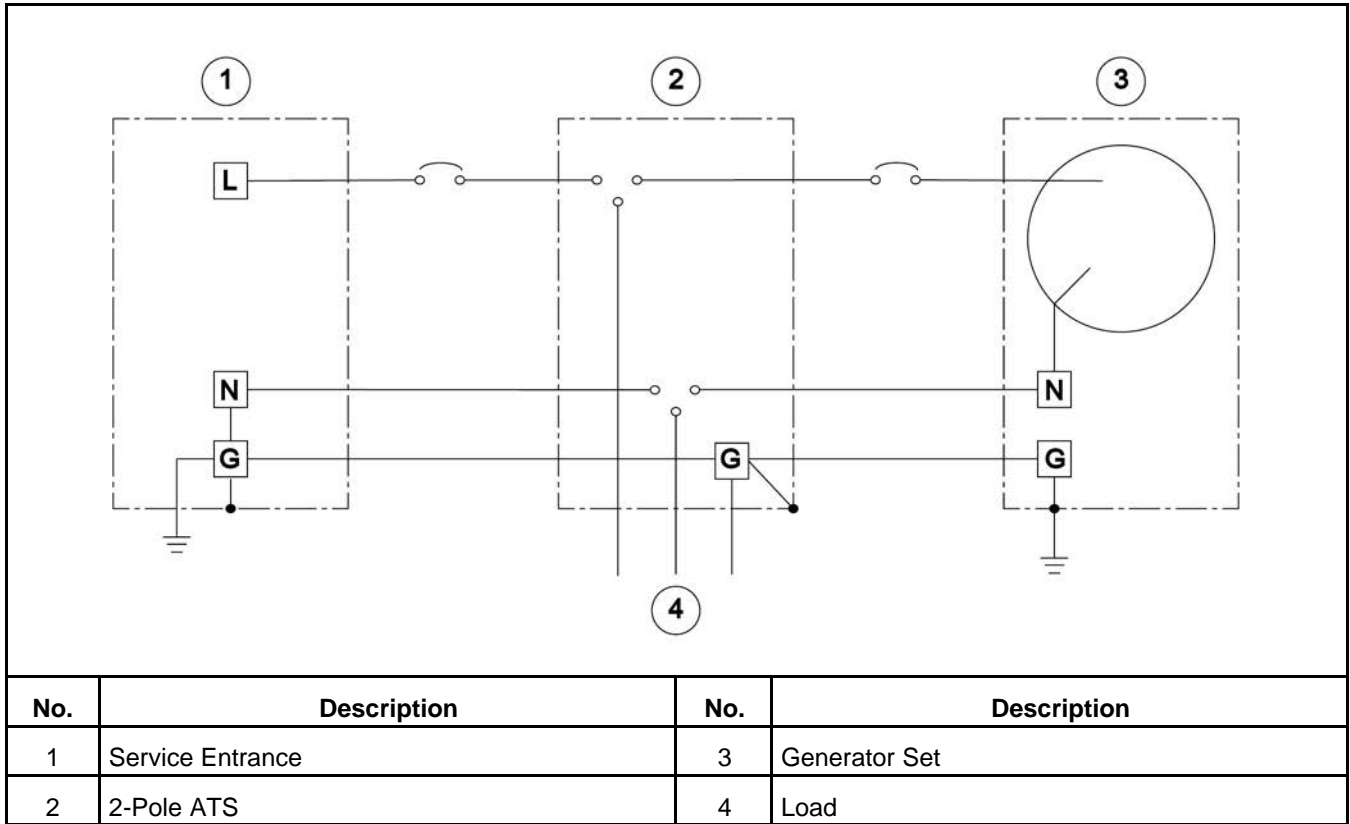
The following is a brief description of system and equipment grounding of permanently installed AC generators within a facility wiring system.

#### NOTICE

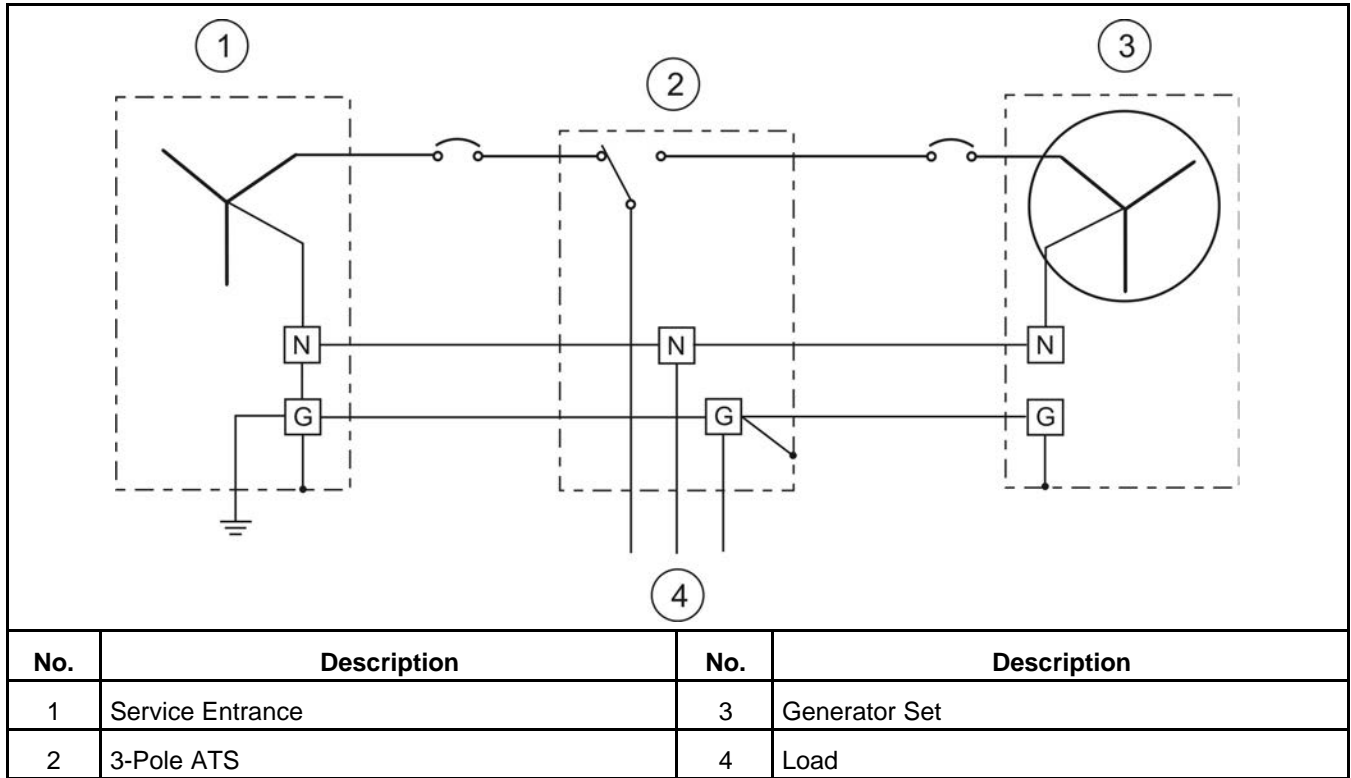
***It is important to follow the requirements of the local electrical code.***

[Figure 45](#), [Figure 46](#) and [Figure 47](#) illustrate typical system grounding for a 2-pole, 3-pole, and 4-pole Automatic Transfer Switch (ATS). In the 2-pole and 3-pole ATS, note that the generator neutral is connected to the ATS and is NOT bonded to ground at the generator. In the 4-pole ATS system, a grounding electrode conductor and a bonding jumper are used to connect the generator neutral to ground.

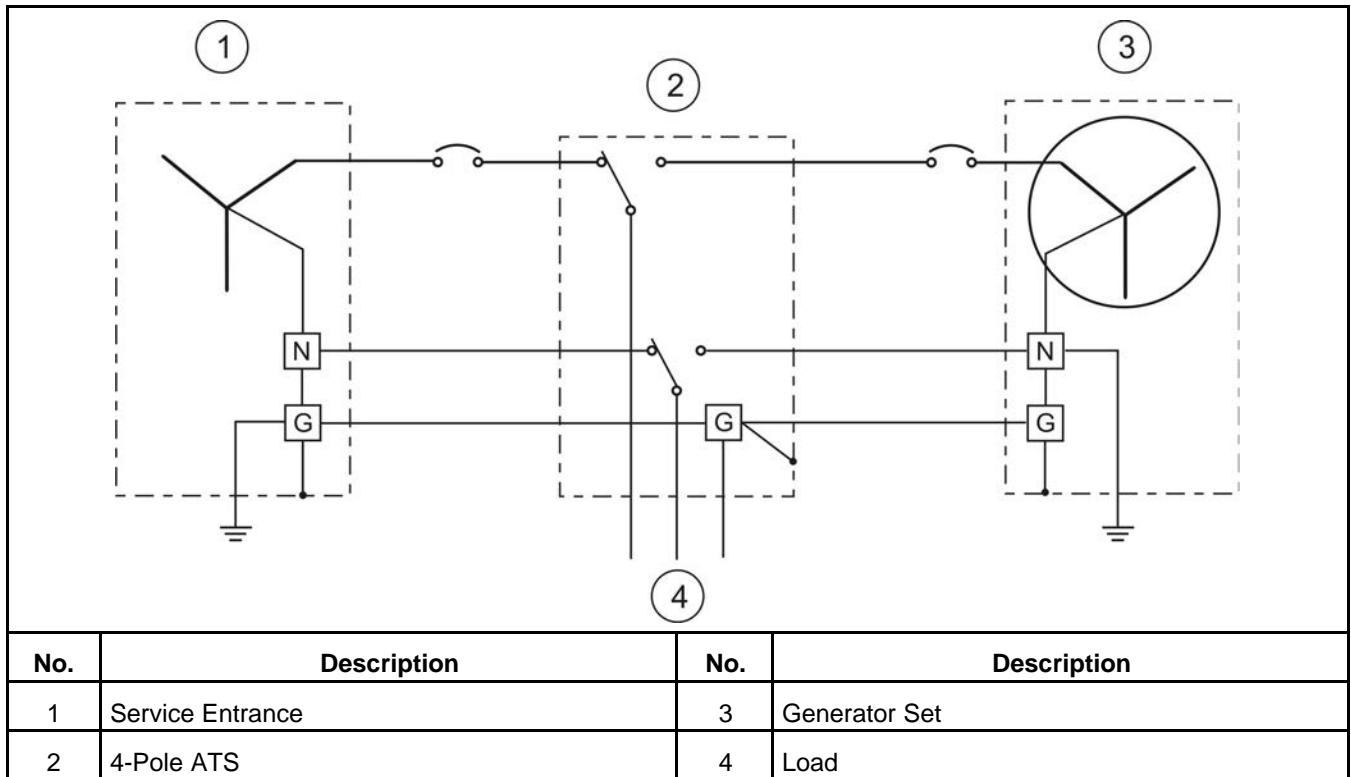
Make sure the generator set is grounded to earth in one location only. On generator sets without a circuit breaker, ground to the point indicated on the top of the generator. On generator sets with circuit breakers, use the ground lug provided in the circuit breaker box.



**FIGURE 45. TYPICAL SYSTEM - ONE-PHASE, THREE WIRE UTILITY, TWO-POLE ATS**



**FIGURE 46. TYPICAL SYSTEM - THREE-PHASE, FOUR WIRE UTILITY, THREE-POLE ATS**



**FIGURE 47. TYPICAL SYSTEM - THREE-PHASE, FOUR WIRE UTILITY, FOUR-POLE ATS**

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# 10 Pre-Start Preparation

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## WARNING

### ***Electrical Generating Equipment***

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

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

Before an initial start of the generator set, complete the Installation Checklist, see [Chapter 11 on page 97](#).

## 10.1 Electrical System

Verify all electrical connections are secure and all wiring is complete and inspected. Replace and secure any access panels that may have been removed during installation.

## 10.2 Battery Connections

### WARNING

#### ***Automated Machinery***

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

***Make sure that the generator set cannot be started accidentally or remotely before starting work on the generator.***

### WARNING

#### ***Combustible Gases***

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

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

Starting the unit requires one or more batteries. For more information on batteries, refer to the Model Specifications section. To prevent arcing, use an insulated wrench to connect the positive battery cable, then connect the negative battery cable.

If an automatic transfer switch is installed without a built-in charge circuit, connect a separate battery charger. Proper selection and maintenance of batteries and battery chargers is essential for system reliability.

---

## 10.3 Site-Specific Configuration

**NOTICE**

**Site-specific configuration is to be undertaken by suitably trained and qualified service personnel only.**

The generator set is configured at the factory. Before starting the generator set, any site-specific configuration should be completed by qualified service personnel.

## 10.4 Starting

Refer to the generator set Operator manual for important safety precautions and recommended procedures for starting the generator set and verifying proper operation. Start the generator set and verify all engine and generator set menus are displaying the correct values.

# 11 Installation Checklist

## 11.1 Checklist

Tick	General Items
	Generator set wattage capacity is sufficient to handle maximum anticipated load.
	At least 3 feet (914.4 mm) of clearance (or greater for housing door) is provided around the entire generator set for service and ventilation.
	The generator set is located in an area not subject to flooding.
	All operating personnel have read and are familiar with the generator set Operator manual, all health and safety procedures, warnings, cautions, precautions, and the other documentation supplied with the generator set.
	All operators have been thoroughly briefed on preventative maintenance procedures.
	All operators have read and understand all important safety instructions.
	<b>Generator Set Support</b>
	The floor, roof, or earth on which the generator set rests is strong enough and will not allow shifting or movement. Observe local codes on soil bearing capacity due to freezing and thawing.
	The generator set is properly supported and retained to an approved base
	The supporting base is large enough and is of non-combustible material, extending 6 inches (152.4 mm) all around the generator set.
	<b>Cooling Air Flow</b>
	Generator set air inlet is faced into direction of strongest, prevailing winds.
	Air inlet openings are unrestricted and are at least 1 to 1½ times larger than air outlet area.
	Cooling air outlet is on downwind side of building (if not, wind barrier is constructed).
	Proper ducting material (sheet metal, canvas) is used between radiator and air outlet.
	<b>Diesel Fuel System (if applicable)</b>
	Fuel tanks meet or exceed all Local, State, or National codes (if applicable).
	Fuel lines are properly installed, supported, and protected against damage.
	The fuel filters have been installed.
	Approved flexible fuel line is installed between the main fuel supply and the generator set's fuel system near the generator set, to protect it against damage caused by vibration, expansion, and contraction.
	Strainer or fuel screen (100 to 200 mesh) is installed in the fuel supply line to protect the fuel lift pump, day tank transfer pump, or float valve seat from fuel tank debris (if applicable).
	The fuel filter assembly shipped with the generator set is installed and operational (if applicable).
	Fuel supply shutoff valves are installed to prevent fuel flow in case of leaks.
	No shutoff valves are installed on engine fuel return line (if applicable).
	External fuel pumps are connected and operational at all times - generator set started or shut down (if applicable).

	Fuel tanks are filled with the correct grade / type of fuel (if applicable).
	Fuel system is properly primed.
	No fuel leaks are found in supply line or engine fuel system.
	<b>Gaseous Fuel System (if applicable)</b>
	Check fuel line and use equations to verify it has proper volume capability.
	Check if fuel pressure is between 7-13 inches water column.
	Check for any gas leaks.
	If necessary, perform initial demand regulator adjustment procedure.
	Make sure fuel pressure does not drop below 7 inches water column under full load.
	<b>Exhaust System</b>
	The breather tube routing is set up to blow the fumes away from the generator set (if applicable)
	Operators are thoroughly briefed on the dangers of carbon monoxide gas.
	If the installation includes a heavy duty air cleaner, it has been installed.
	Areas around generator set are well ventilated. No possibility of exhaust fumes entering building doors, windows, or intake fans.
	Exhaust gases are piped safely outside and away from building.
	The correct length of approved rigid pipe is connected to the generator set flexible pipe using approved securing methods with no weight resting on engine exhaust components. There are no bends in flex section.
	Condensation drain is provided in lowest section of exhaust piping.
	Exhaust piping is insulated to guard against burns to personnel.
	Exhaust piping passing through walls or ceilings have approved fire-proof materials and are in compliance with all codes.
	Exhaust piping is large enough in diameter to prevent excessive back pressure on engine.
	Verify that the pyrometer meters are functioning.
	<b>AC and DC Wiring</b>
	For bottom entry circuit breaker installations, the cable chute has been installed (if applicable).
	Wire sizes, insulation, conduits and connection methods all meet applicable codes.
	AC and DC wires are separated in their own conduit to prevent electrical induction.
	All load, line and generator connections are well made and correct.
	Flexible conduit is used between the generator and the building or surrounding structure.
	Check phase rotation.
	<b>Generator Set Pre-Start</b>
	Generator set engine is properly serviced with oil and coolant.
	Battery charger is installed using the appropriate cable size and is operational.
	Battery charger is configured for the proper DC battery voltage, battery type, and float voltage.
	Batteries are properly installed, serviced and charged.

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	Battery temperature sensor is connected and operational (if applicable).
	Engine coolant heater is connected and operational.
	All generator set covers and safety shields are installed correctly.
	All fuel and coolant shutoff valves are operational.
	Radiator fan and other external moving parts including drive belts are unrestricted.

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# 12 Manufacturing Facilities

U.S. and CANADA	EMEA, CIS	EMEA, CIS
Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Inc. Columbus Avenue Manston Park Manston, Ramsgate Kent CT12 5BF United Kingdom	Cummins Inc. Royal Oak Way South Daventry Northamptonshire NN11 8NU United Kingdom
Toll Free 1-800-CUMMINS™ (1-800-286-6467) Phone +1 763-574-5000 Fax +1 763-574-5298	Phone +44 1843 255000 Fax +44 1843 255902	Phone +44 1327 88-6453 Fax +44 1327 88-6125
BRAZIL	CHINA	INDIA
Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 CNPJ: 43.2201.151/0001-10 Brazil	Cummins Inc. No.118 South Quanli Road , Wuhan Economic& Technological Development Zone , Hubei, P.R.China 430058	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka- Phaltan Dist- Satara, Maharashtra 415523 India
Phone 0800 286 6467	Phone + 86 (27) 8421 4008 Fax + 86 (27) 8421 4804	Phone +91 021 66305514
LATIN AMERICA	MEXICO	ASIA PACIFIC
3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	Cummins Sales and Service Singapore Pte Ltd 85 Tuas South Avenue 1 Singapore 637419
Phone +1 954 431 551 Fax +1 954 433 5797	Phone +52 444 870 6700 Fax +52 444 824 0082	Fax +65 6265 6909

## 12.1 How to Obtain Service

When a product requires servicing, contact the nearest Cummins service provider. To locate the distributor, go to [www.cummins.com/support](http://www.cummins.com/support) and select Sales and Service Locator. When contacting the service provider, always supply the complete model, specification, and serial number as shown on the nameplate.

### 12.1.1 Locating a Distributor

In the U.S. and Canada

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

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

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

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

**Outside the U.S. and Canada**

Refer to [www.cummins.com/support](http://www.cummins.com/support) and select Sales and Service Locator, or send an email to [ask.powergen@cummins.com](mailto:ask.powergen@cummins.com).



# Appendix A. Wiring Diagrams

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## Table of Contents

Figure 48. Wiring Diagram with PowerCommand 2100 Control (Sheet 1) ..... 105  
Figure 49. Wiring Diagram with PowerCommand 2100 Control (Sheet 2) ..... 106

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

# A.1 Wiring Diagram with PowerCommand 2100 Control

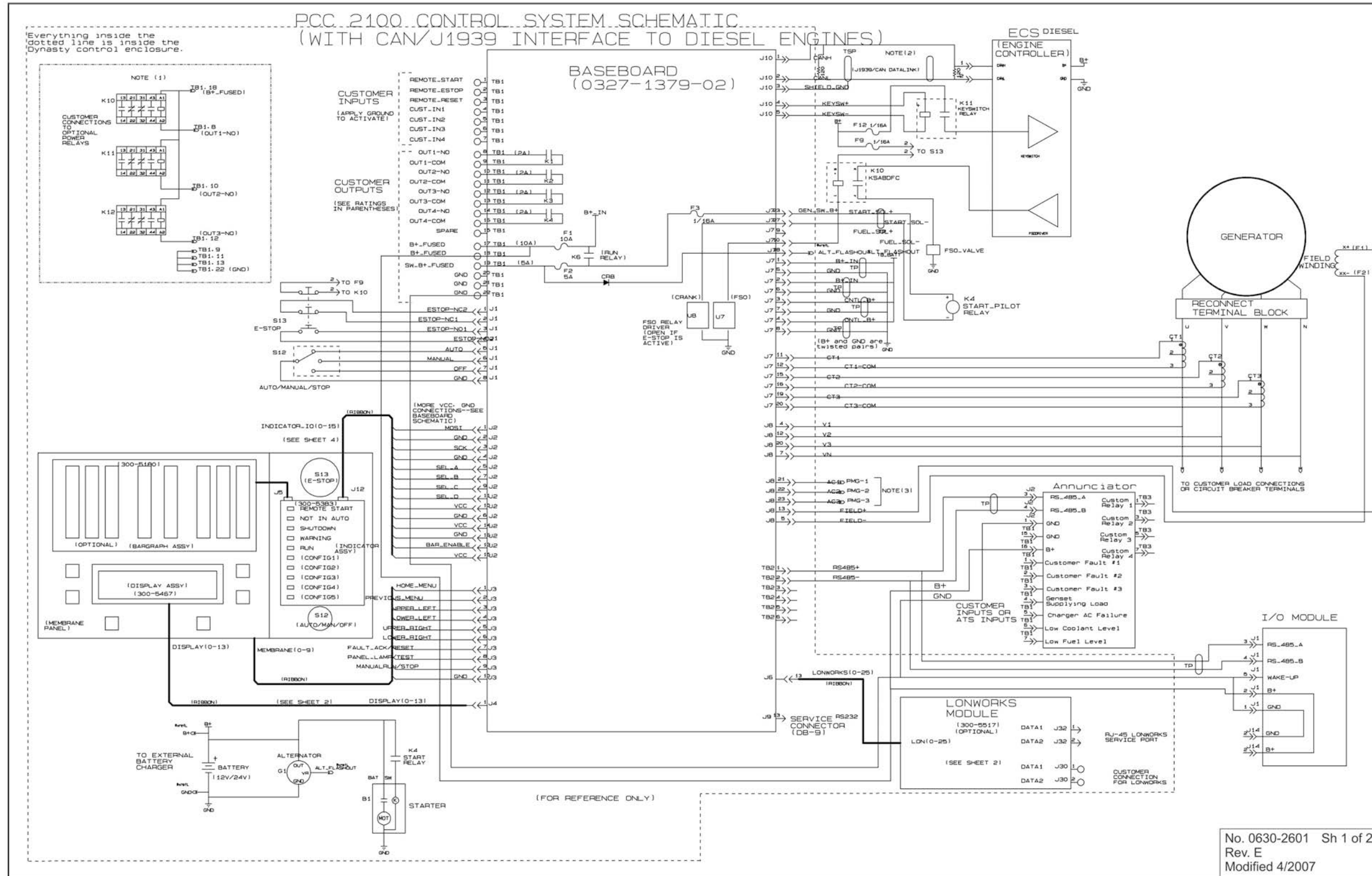


FIGURE 48. WIRING DIAGRAM WITH POWERCOMMAND 2100 CONTROL (SHEET 1)

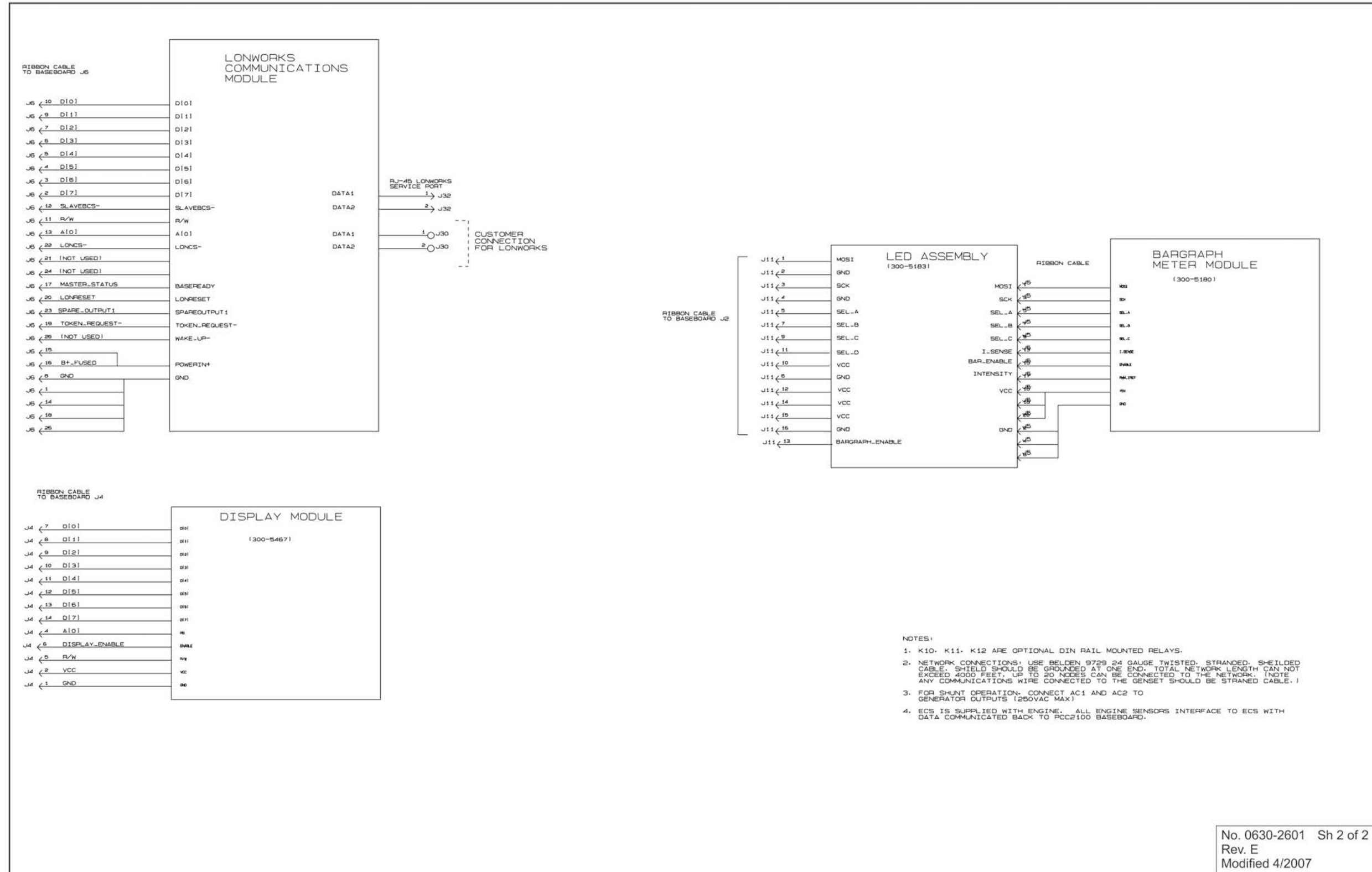


FIGURE 49. WIRING DIAGRAM WITH POWERCOMMAND 2100 CONTROL (SHEET 2)

# Appendix B. Customer Connections

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## Table of Contents

Figure 50. Customer Connections with PowerCommand 2100 Control (Sheet 1) ..... 109  
Figure 51. Customer Connections with PowerCommand 2100 Control (Sheet 2) ..... 110

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

# B.1 Customer Connections with PowerCommand 2100 Control

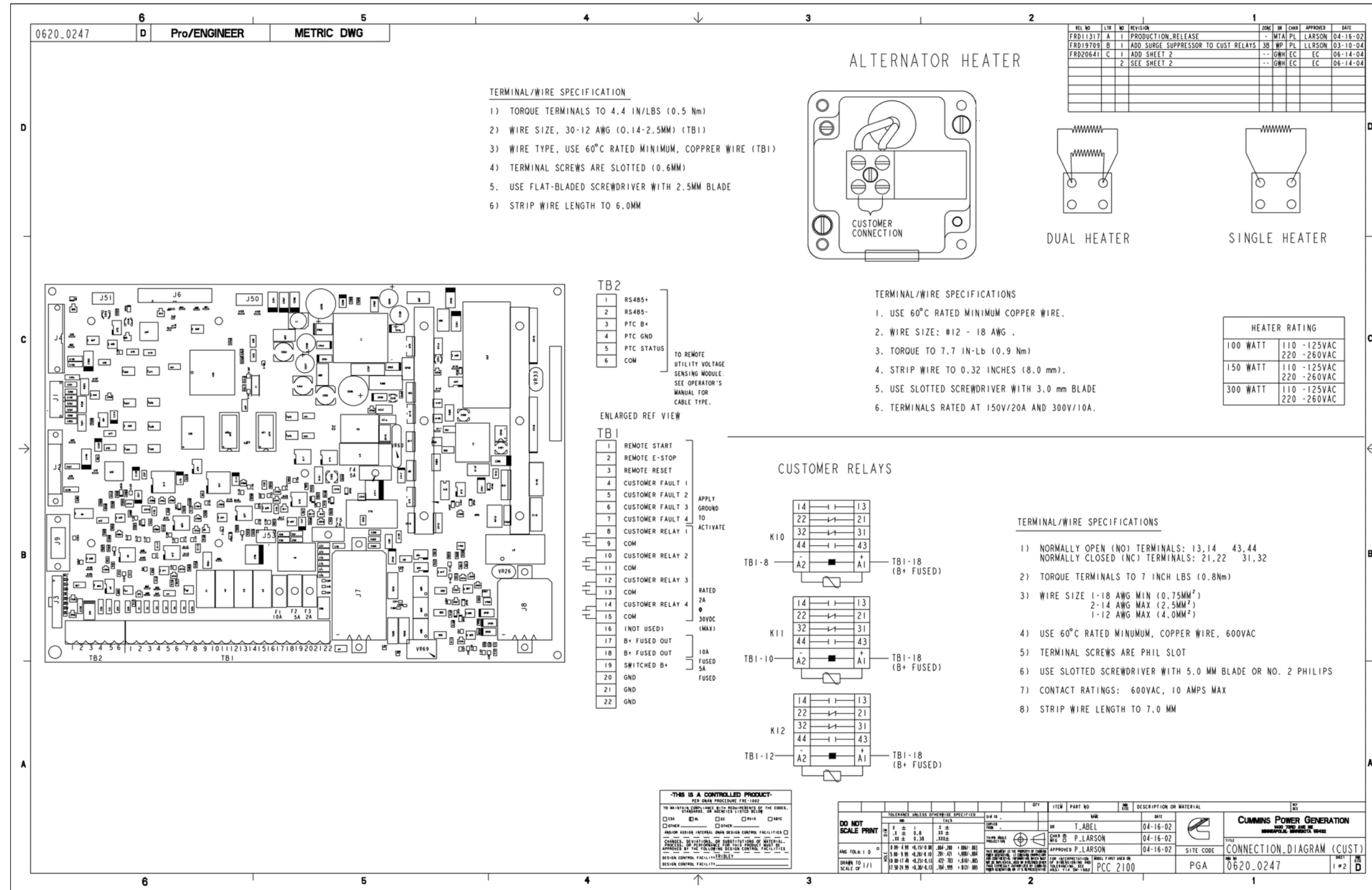


FIGURE 50. CUSTOMER CONNECTIONS WITH POWERCOMMAND 2100 CONTROL (SHEET 1)

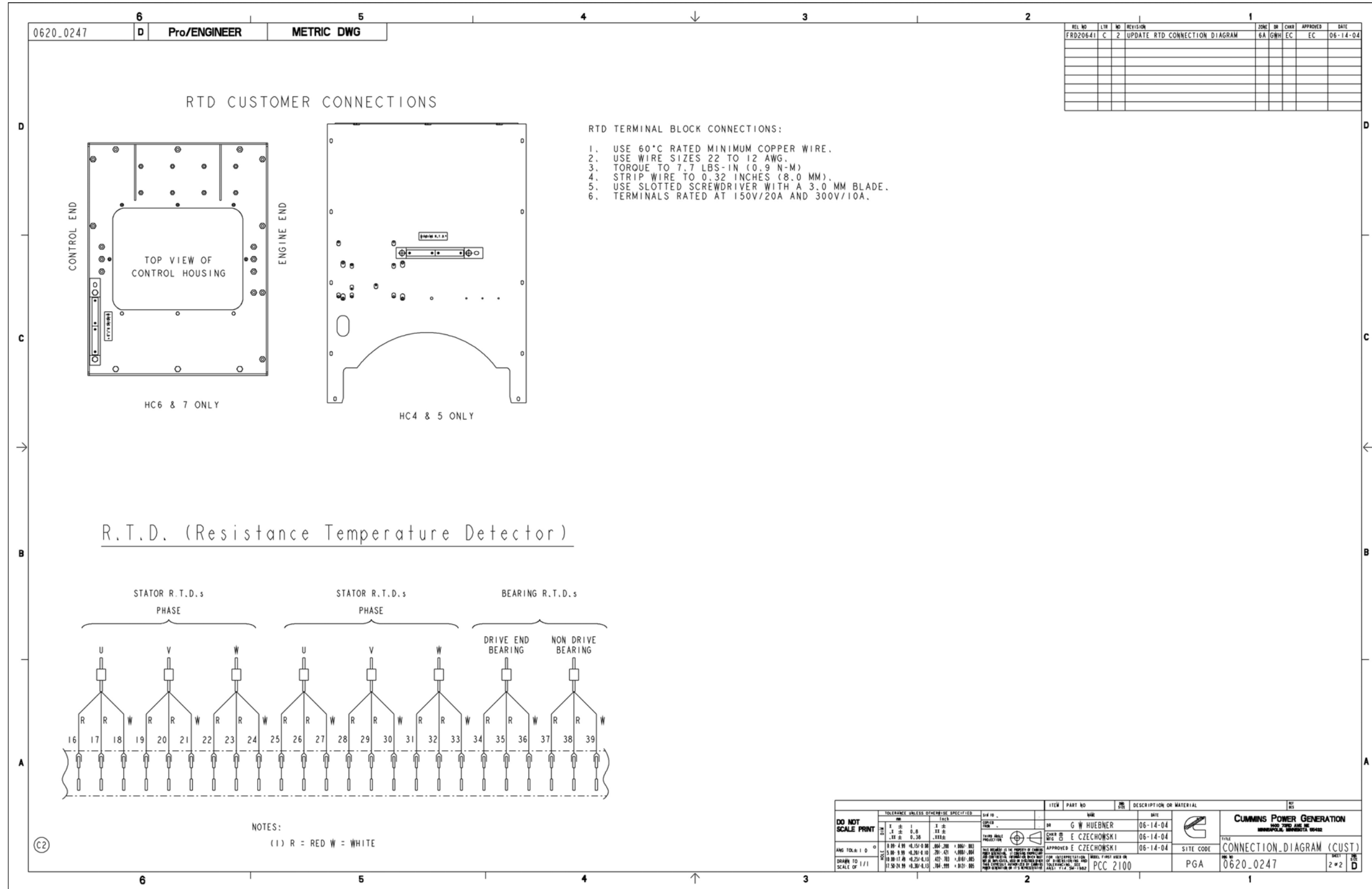


FIGURE 51. CUSTOMER CONNECTIONS WITH POWERCOMMAND 2100 CONTROL (SHEET 2)



# Appendix C. Alternator Reconnect Drawing

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## Table of Contents

Figure 52. Alternator Reconnect Drawing (Sheet 1) ..... 113  
Figure 53. Alternator Reconnect Drawing (Sheet 2) ..... 114

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

# C.1 Alternator Reconnect Drawing

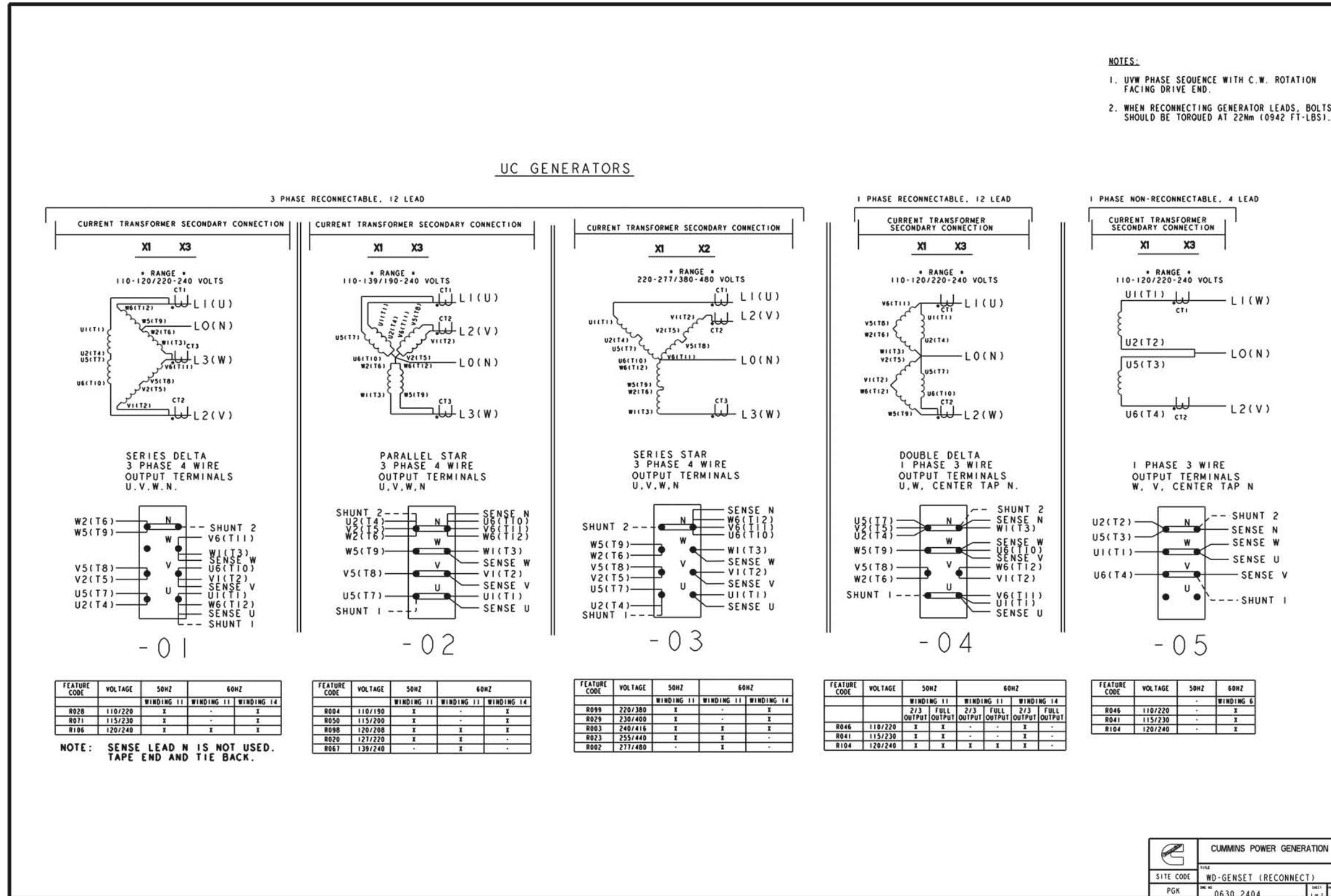
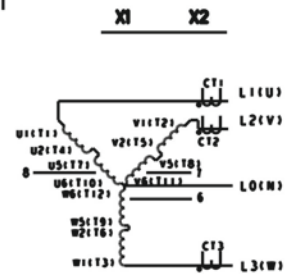


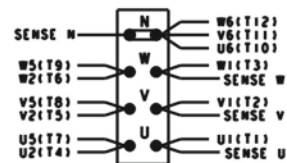
FIGURE 52. ALTERNATOR RECONNECT DRAWING (SHEET 1)

# UC GENERATORS

## 3 PHASE RECONNECTABLE CURRENT TRANSFORMER SECONDARY CONNECTION



SERIES STAR  
3 PHASE 4 WIRE  
OUTPUT TERMINALS  
U, V, W, N



NOTE:  
FOR SHUNT OPERATION, CONNECT AC HARNESS LEADS:  
PMG2 TO GENERATOR TAP LEAD 8  
PMG3 TO GENERATOR TAP LEAD 7  
PMG4 NOT CONNECTED  
TAPE & TIE BACK PMG4 AND LEAD 6

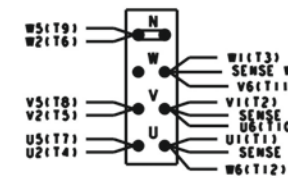
-06

FEATURE CODE	VOLTAGE	50HZ	60HZ
R114	600	-	X

## 3 PHASE NON-RECONNECTABLE CURRENT TRANSFORMER SECONDARY CONNECTION



SERIES DELTA  
3 PHASE 4 WIRE  
OUTPUT TERMINALS  
U, V, W, N



NOTES:  
1. SENSE LEAD W IS NOT USED.  
TAPE END AND TIE BACK.  
2. PMG MUST BE USED.  
SHUNT NOT ALLOWED

-07

FEATURE CODE	VOLTAGE	50HZ	60HZ
R019	120/240	X	-
R119	240/480	-	X

PCC2100 CONTROL

CUMMINS POWER GENERATION	
SITE CODE	WD-GENSET (RECONNECT)
PGK	0630 2404

FIGURE 53. ALTERNATOR RECONNECT DRAWING (SHEET 2)

# Appendix D. Outline Drawings

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

# D.1 Outline Drawing - Basic Skid Base

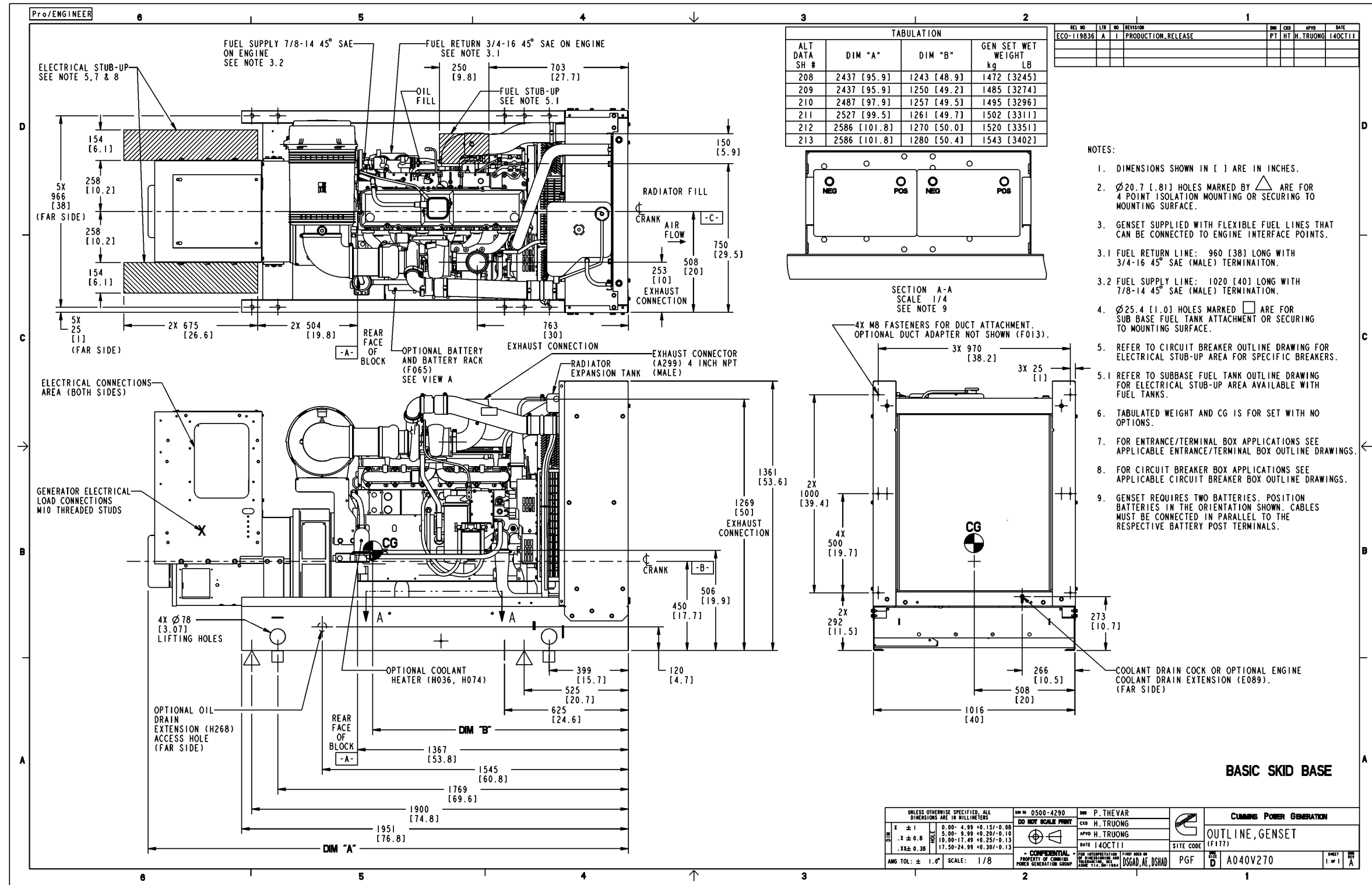


FIGURE 54. OUTLINE DRAWING - BASIC SKID BASE (SHEET 1)

## D.2 Outline Drawing - Housing Ready Skid Base

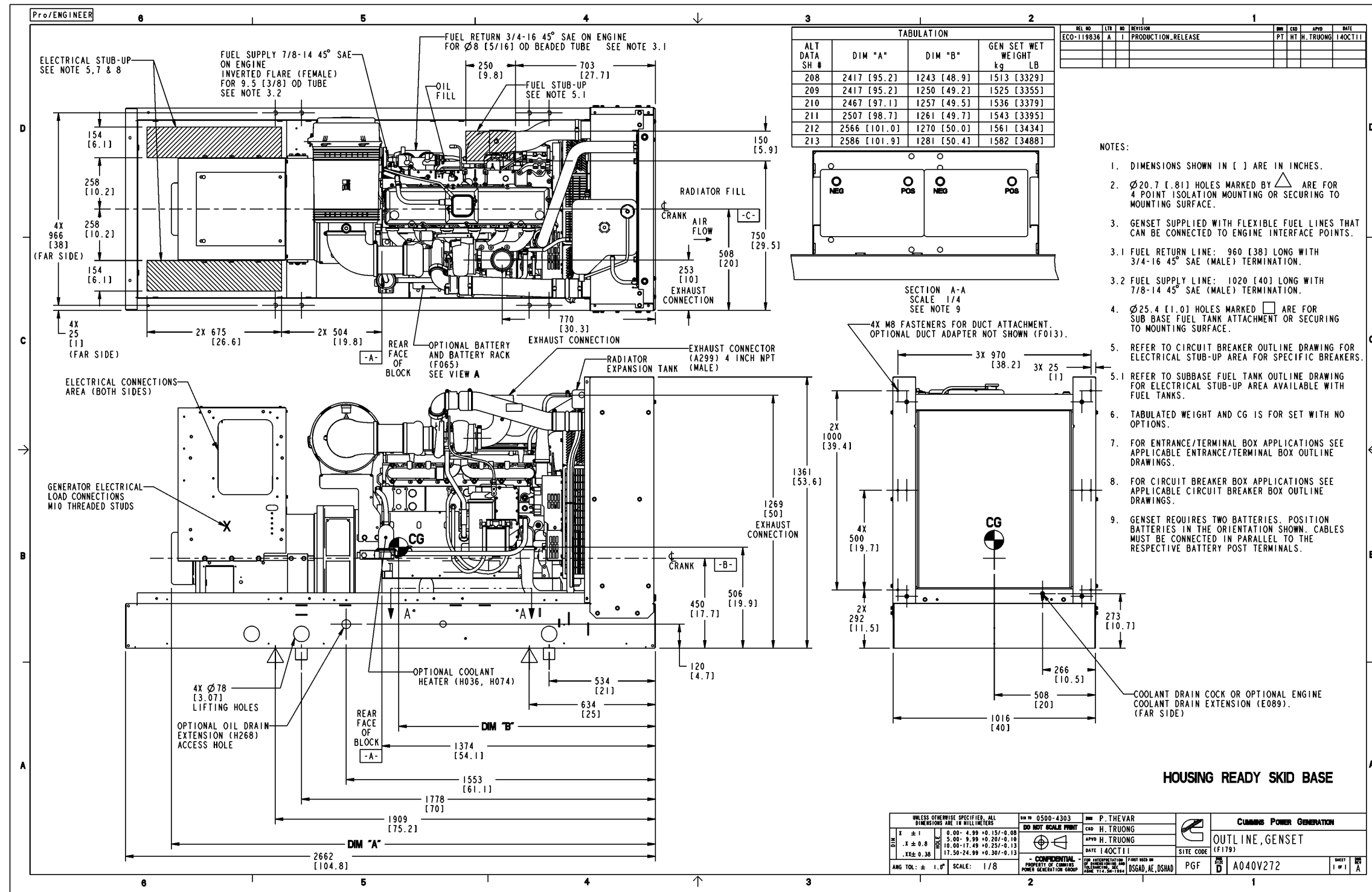


FIGURE 55. OUTLINE DRAWING - HOUSING READY SKID BASE (SHEET 1)



### D.3 Outline Drawing - Generator Set Options

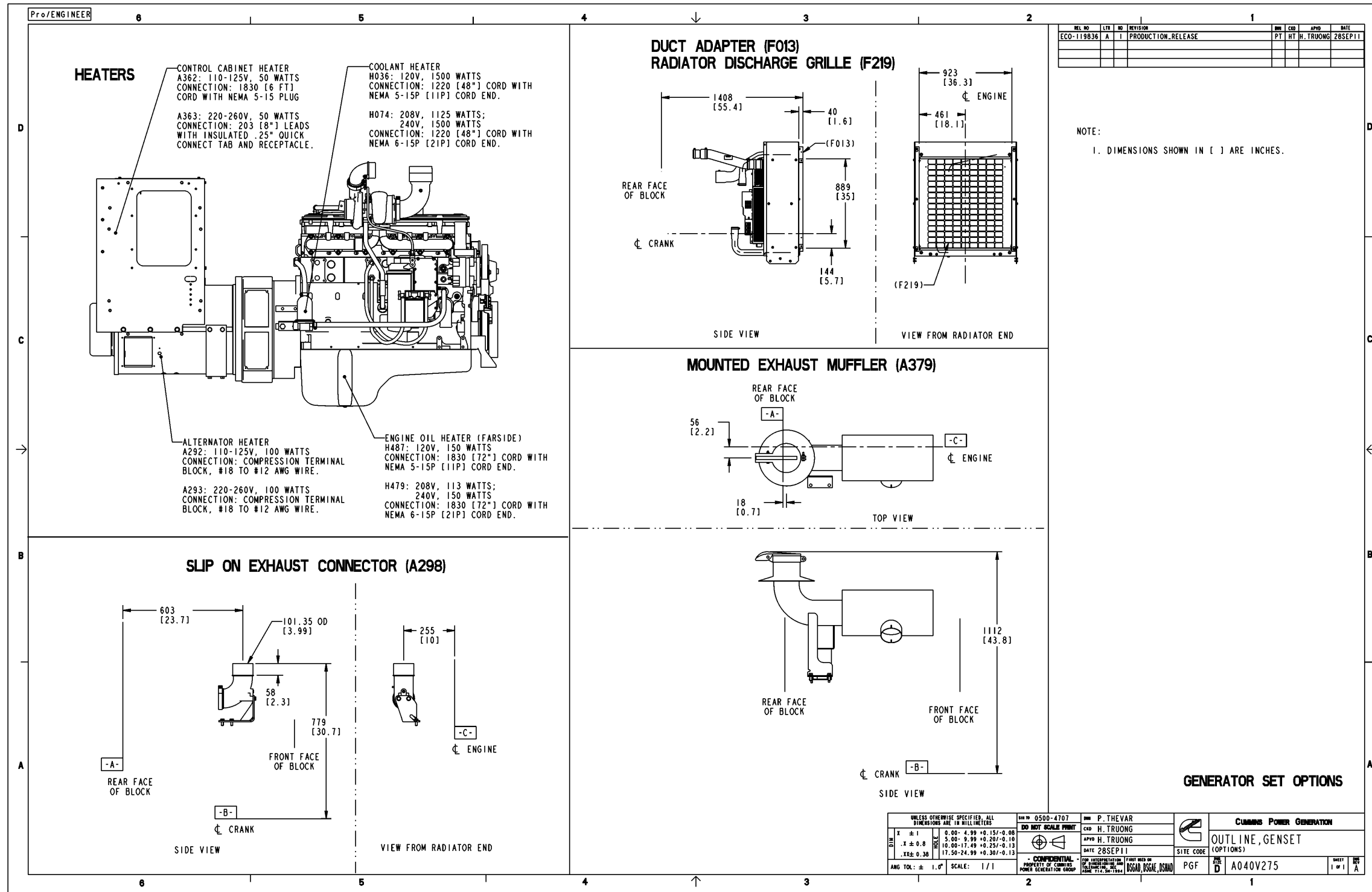


FIGURE 56. OUTLINE DRAWING - GENERATOR SET OPTIONS (SHEET 1 OF 1)

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# Appendix E. Breakerless Conductor Terminal Box Outline Drawings

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

# E.1 Breakerless Conductor Terminal Box Outline Drawing

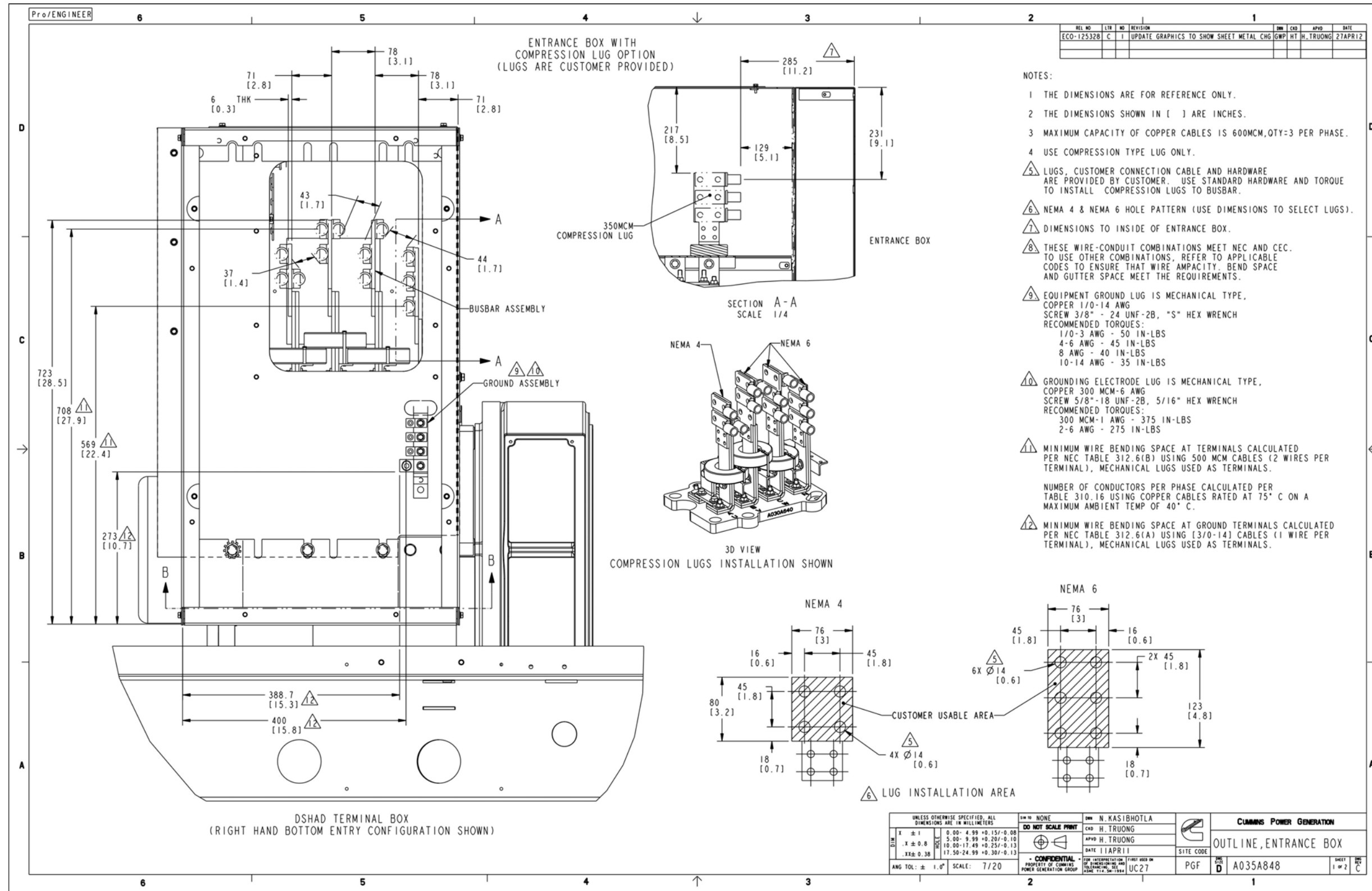


FIGURE 57. BREAKERLESS CONDUCTOR TERMINAL BOX OUTLINE DRAWING (SHEET 1)

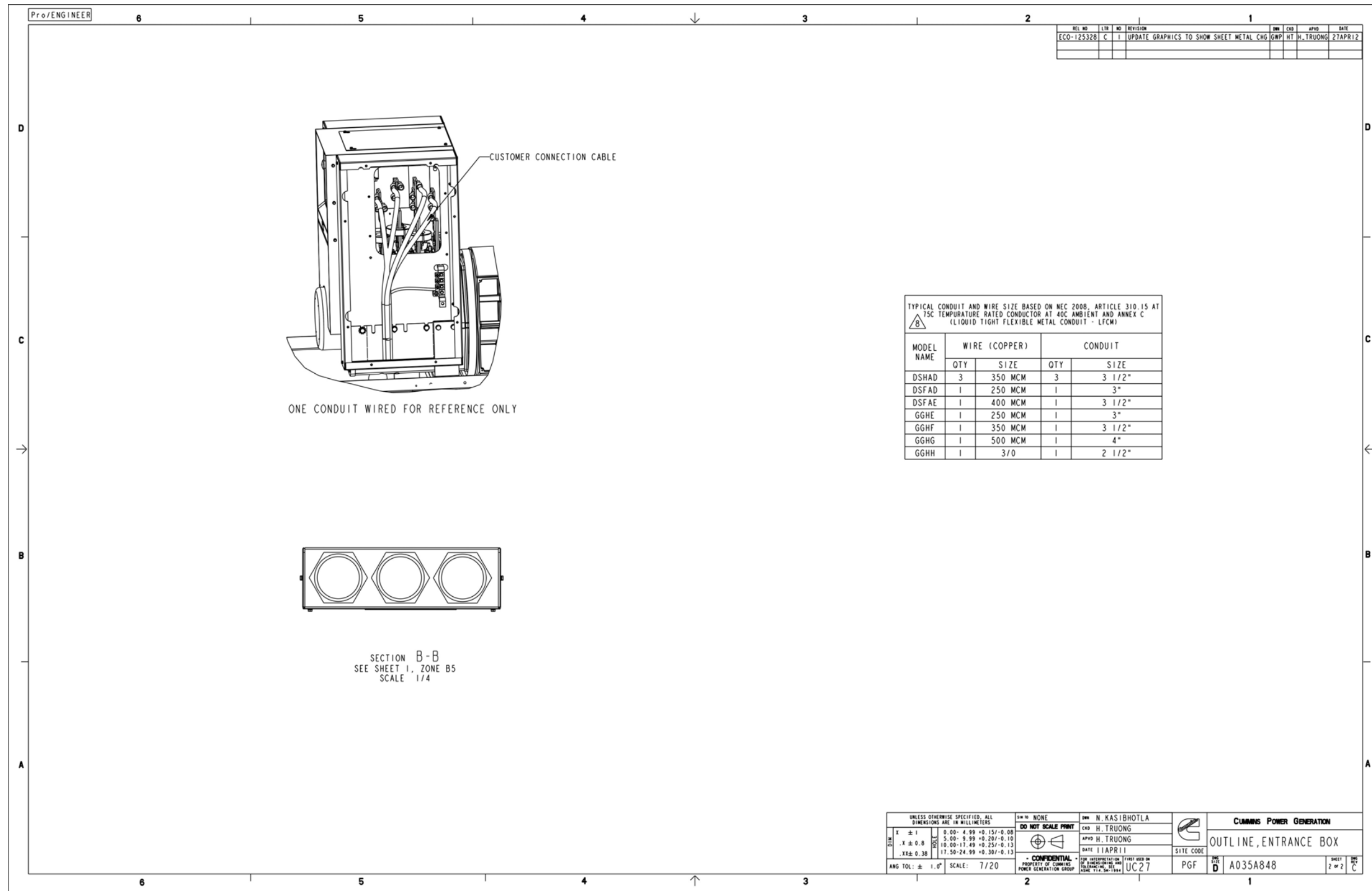


FIGURE 58. BREAKERLESS CONDUCTOR TERMINAL BOX OUTLINE DRAWING (SHEET 2)

# Appendix F. Seismic Requirements

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Figure 63. Seismic Installation Instructions (Sheet 5 of 5) ..... 131

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



# F.1 Seismic Installation Instructions

Creo Parametric					
6 5 4 3 2 1					
<b>REQUIREMENTS FOR GENSETS</b> DSFAE, DSFAD, DSFAC, DSFAB, DSFAA					
PARAMETERS	IBC 2012	IBC 2009/2006	IBC 2009/2006	IBC 2003/2000	IBC 2003/2000
	$S_{ds} \leq 2.28$	$S_{ds} \leq 1.93$	$1.93 \leq S_{ds} \leq 2.28$	$S_{ds} \leq 2.41$	$S_{ds} \leq 2.46$
	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$
	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.00$	$ap/Rp \leq 1.00$
	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 0.77$	$z/h \leq 1.00$	$z/h \leq 0.97$
<b>REQUIREMENTS FOR GENSETS</b> DSKCA, DSKBA, DSKAB, DSKAA, GGJ, GGHH, GGHG, GGHF, GGHE					
PARAMETERS	IBC 2012	IBC 2009	IBC 2006	IBC 2003	IBC 2000
	$S_{ds} \leq 2.48$	$S_{ds} \leq 2.28$	$S_{ds} \leq 2.28$	$S_{ds} \leq 2.46$	$S_{ds} \leq 2.46$
	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$
	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.00$	$ap/Rp \leq 1.00$
	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 1.00$
<b>REQUIREMENTS FOR GENSETS</b> DSHAD, DSHAC, DSHAB, DGHE, DGHD, DGGD, GGLB, GGLA GGMC, GGMB, GGMA, GGFE, GGFD, GGPA, GGPB, GGPC					
PARAMETERS	IBC 2009	IBC 2006	IBC 2003	IBC 2000	
	$S_{ds} \leq 2.28$	$S_{ds} \leq 2.28$	$S_{ds} \leq 2.46$	$S_{ds} \leq 2.46$	
	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	
	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.00$	$ap/Rp \leq 1.00$	
	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 1.00$	$z/h \leq 1.00$	
<b>REQUIREMENTS FOR GENSETS</b> DSGAA, DSGAB, DSGAC, DSGAD, DSGAE					
PARAMETERS	IBC 2009/2006	IBC 2009/2006	IBC 2003/2000	IBC 2003/2000	
	$S_{ds} \leq 1.93$	$1.93 \leq S_{ds} \leq 2.28$	$S_{ds} \leq 2.41$	$S_{ds} \leq 2.46$	
	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	
	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.25$	$ap/Rp \leq 1.00$	$ap/Rp \leq 1.00$	
	$z/h \leq 1.00$	$z/h \leq 0.77$	$z/h \leq 1.00$	$z/h \leq 0.97$	
<b>REQUIREMENTS FOR GENSETS</b> DGHDA, DGHDB					
PARAMETERS	IBC 2000, 2003, 2006, 2009, 2012				
	$S_{ds} \leq 1.93$				
	$I_p \leq 1.5$				
	$ap/Rp \leq 1.25$				
	$z/h \leq 1.00$				
<b>REQUIREMENTS FOR GENSETS</b> DGHCC, DGHCB, DGHCA					
PARAMETERS	IBC 2000, 2003, 2006, 2009, 2012				
	$S_{ds} \leq 2.48$				
	$I_p \leq 1.5$				
	$ap/Rp \leq 1.25$				
	$z/h \leq 1.00$				

**SEISMIC INSTALLATIONS NOTES:**

- THE DESIGN OF POST-INSTALLED ANCHORS IN CONCRETE USED FOR THE COMPONENT ANCHORAGE IS PRE-QUALIFIED FOR SEISMIC APPLICATIONS IN ACCORDANCE WITH "ACI 308.2" AND DOCUMENTED IN A REPORT BY A REPUTABLE TESTING AGENCY. (EX. THE EVALUATION SERVICE REPORT ISSUED BY THE INTERNATIONAL CODE COUNCIL)
- ANCHORS MUST BE INSTALLED TO AN EMBEDMENT DEPTH AS RECOMMENDED IN THE PER-QUALIFICATION TEST REPORT AS DEFINED IN NOTE 1. FOR "IBC 2000" AND "IBC 2003" APPLICATIONS, THE MINIMUM EMBEDMENT MUST BE 8X THE ANCHOR DIAMETER.
- ANCHORS MUST BE INSTALLED IN MINIMUM 4000 PSI COMPRESSIVE STRENGTH NORMAL WEIGHT CONCRETE. CONCRETE AGGREGATE MUST COMPLY WITH "ASTM C33". INSTALLATION IN STRUCTURAL LIGHTWEIGHT CONCRETE IS NOT PERMITTED UNLESS OTHERWISE APPROVED BY THE STRUCTURAL ENGINEER OF RECORD.
- ANCHORS MUST BE INSTALLED TO THE TORQUE SPECIFICATION AS RECOMMENDED BY THE ANCHOR MANUFACTURER TO OBTAIN MAXIMUM LOADING.
- ANCHORS MUST BE INSTALLED IN LOCATIONS SPECIFIED ON THIS INSTALLATION DRAWING.
- WIDE WASHERS MUST BE INSTALLED AT EACH ANCHOR LOCATION BETWEEN THE ANCHOR HEAD AND EQUIPMENT FOR TENSION LOAD DISTRIBUTION. WIDE WASHERS MUST BE SERIES "W" OF AMERICAN NATIONAL STANDARD TYPE "A" PLAIN WASHERS (ANSI B18.22.1-1965, R1975) WITH THE NOMINAL WASHER SIZE SELECTED TO MATCH THE SPECIFIED NOMINAL ANCHOR DIAMETER.
- CONCRETE FLOOR SLAB AND CONCRETE HOUSEKEEPING PADS MUST BE DESIGNED AND REBAR REINFORCED FOR SEISMIC APPLICATIONS IN ACCORDANCE WITH "ACI 318". THE DESIGN LOADS SHALL BE TAKEN AS THOSE PUBLISHED ON THIS CUMMINS INSTALLATION DRAWING.
- ALL HOUSEKEEPING PAD THICKNESSES MUST BE DESIGNED IN ACCORDANCE WITH THE PRE-QUALIFICATION TEST REPORT AS DEFINED IN NOTE 1 OR A MINIMUM OF 1.5X THE ANCHOR EMBEDMENT DEPTH, WHICHEVER IS LARGEST.
- ALL HOUSEKEEPING PADS MUST BE DOWELLED OR CAST INTO THE BUILDING STRUCTURAL FLOOR SLAB AND DESIGNED FOR SEISMIC APPLICATION PER "ACI 318" AND AS APPROVED BY THE STRUCTURAL ENGINEER OF RECORD.
- WALL MOUNTED EQUIPMENT MUST BE INSTALLED TO A REBAR REINFORCED STRUCTURAL CONCRETE WALL THAT IS SEISMICALLY DESIGNED AND APPROVED BY THE ENGINEER OF RECORD TO RESIST THE ADDED SEISMIC LOADS FROM COMPONENTS BEING ANCHORED TO THE WALL.
- FLOOR MOUNTED EQUIPMENT (WITH OR WITHOUT A HOUSEKEEPING PAD) MUST BE INSTALLED TO A REBAR REINFORCED STRUCTURAL CONCRETE FLOOR THAT IS SEISMICALLY DESIGNED AND APPROVED BY THE ENGINEER OF RECORD TO RESIST THE ADDED SEISMIC LOADS FROM COMPONENTS BEING ANCHORED TO THE FLOOR.
- WHEN INSTALLING TO A FLOOR OR WALL, REBAR INTERFERENCE MUST BE CONSIDERED.
- ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY FLOOR OR WALL OTHER THAN THOSE CONSTRUCTED OF STRUCTURAL CONCRETE AND DESIGNED TO ACCEPT THE SEISMIC LOADS FROM SAID EQUIPMENT IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
- ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY FLOOR CONSTRUCTED OF LIGHT WEIGHT CONCRETE OVER STEEL DECKING IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
- ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY CONCRETE BLOCK WALLS OR CINDER BLOCK WALLS IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
- INSTALLATION UPON A ROOFTOP STEEL DUNNAGE SHALL BE COORDINATED WITH THE STRUCTURAL ENGINEER OF RECORD.
- INSTALLATION UPON ANY ROOFTOP CURB SHALL BE COORDINATED WITH THE CURB MANUFACTURER AND THE STRUCTURAL ENGINEER OF RECORD. ANY CURB OR CONCRETE PAD THAT SUPPORTS THE GENSET UNIT IS BEYOND THE SCOPE OF THIS CERTIFICATION.
- CONNECTIONS TO THE EQUIPMENT, INCLUDING BUT NOT LIMITED TO CONDUIT, WIRING FROM CABLE TRAYS, OTHER ELECTRICAL SERVICES, DUCTING, PIPING SUCH AS EXHAUST, STEAM, WATER, COOLANT, REFRIGERANT, FUEL, OR OTHER CONNECTIONS, ARE THE RESPONSIBILITY OF THE INSTALLING CONTRACTOR AND BEYOND THE SCOPE OF THIS DOCUMENT. TYPICAL REQUIREMENTS FOR THESE CONNECTIONS ARE STATED IN THE EQUIPMENT INSTALLATION MANUAL. SPECIAL CONSIDERATIONS FOR SEISMIC APPLICATIONS ARE AS FOLLOWS: CONNECTIONS TO NON-ISOLATED COMPONENTS OR EQUIPMENT MAY BE INSTALLED AS TYPICAL FOR THAT PARTICULAR APPLICATION. CONNECTIONS TO ISOLATED COMPONENTS (EX. BREAKER BOX BOLTED DIRECTLY TO AN ISOLATED GENSET) OR ISOLATED EQUIPMENT (EX. AN ENCLOSED GENSET MOUNTED ON EXTERNAL ISOLATORS) MUST BE FLEXIBLY ATTACHED. THE FLEXIBLE ATTACHMENT MUST PROVIDE FOR ENOUGH RELATIVE DISPLACEMENT TO REMAIN CONNECTED TO THE EQUIPMENT AND FUNCTIONAL DURING AND AFTER A SEISMIC EVENT.

**-THIS IS A CONTROLLED ITEM-**  
PER CUMMINS PROCEDURE 100-1002

TO MAINTAIN COMPLIANCE WITH REQUIREMENTS OF THE CODES, STANDARDS, OR REGULATIONS, THE FOLLOWING CHANGES, DEVIATIONS, OR SUBSTITUTIONS OF MATERIAL, PROCESS, OR PERFORMANCE FOR THIS ITEM MUST BE APPROVED BY THE FOLLOWING CONTROLLED ITEM APPROVER:

RESPONSIBLE CUMMINS ROLE: \_\_\_\_\_

RESPONSIBLE CUMMINS ROLE: \_\_\_\_\_

RESPONSIBLE CUMMINS ROLE: \_\_\_\_\_

**CUMMINS POWER GENERATION**

**INSTALLATION, GENSET**


SEISMIC REQUIREMENTS

SITE CODE: PGF  
REV: D  
A029J530

SHEET 1 OF 6  
REV G

FIGURE 59. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 1 OF 5)

Creo Parametric								
ROOF MOUNTED GENERATOR SETS								
	CUMMINS GENSET MODEL	RANGE	CONFIGURATION	CONCRETE ANCHORS	ANCHOR EMBEDMENT	ANCHOR SPACING	DISTANCE TO THE NEAREST EDGE	CONCRETE SLAB THICKNESS
1	DSHAD, DSHAC, DSHAB	$(0 < Sds \leq 1.36)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
2	DSHAD, DSHAC, DSHAB	$(1.36 < Sds \leq 2.28)$	SKID/TANK/ENCLOSURE	FOR THIS APPLICATION SEE DIAGRAM ON SHEET #4	SEE TABLE ON SHEET #4	SEE TABLE ON SHEET #4	SEE TABLE ON SHEET #4	SEE TABLE ON SHEET #4
3	DSHAD, DSHAC, DSHAB	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
4	DSGAA, DSGAB, DSGAC	$(0 < Sds \leq 1.35)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
5	DSGAA, DSGAB, DSGAC, DSGAD, DSGAE	$(1.35 < Sds \leq 1.93)$	SKID/TANK/ENCLOSURE	FOR THIS APPLICATION SEE DIAGRAM ON SHEET #5	SEE TABLE ON SHEET #5	SEE TABLE ON SHEET #5	SEE TABLE ON SHEET #5	SEE TABLE ON SHEET #5
6	DSGAA, DSGAB, DSGAC, DSGAD, DSGAE, DGHDA, DGHDB	$(0 < Sds \leq 1.93)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
7	DSFAE, DSFAD, DSFAC, DSFAB, DSFAA, DGHE, DGHF, DGGD (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 2.28)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
8	DSFAE, DSFAD, DSFAC, DSFAB, DSFAA, DGHE, DGHF, DGGD (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
9	DSKCA, DSKBA, DSKAB, DSKAA (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 2.28)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-500L CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	5" MIN. 127mm MIN.	15" MIN. 381mm MIN.	7.5" MIN. 190.5mm MIN.	7.5" MIN. 190.5mm MIN.
10	DSKCA, DSKBA, DSKAB, DSKAA (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
11	GGHJ, GGH, GGHG, GGHF, GGHE (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
12	GGFE, GGFD	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	4-3/4" MIN. 120.65mm MIN.	9.5" MIN. 241.3mm MIN.	9" MIN. 228.6mm MIN.	8" MIN. 203.2mm MIN.
13	GGMC, GGMB, GGMA, GGMD	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 5/8" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-1/8" MIN. 79.38mm MIN.	6-1/4" MIN. 158.75mm MIN.	7" MIN. 177.8mm MIN.	5" MIN. 127mm MIN.
14	GGLB, GGLA	$(0 < Sds \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
15	GGPA, GGPB, GGPC	$(0 < Sds \leq 2.27)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) M16X190/40 HILTI HDA-P CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	7.5" MIN. 190.5mm MIN.	39" MIN. 990.6mm MIN.	12" MIN. 304.8mm MIN.	12" MIN. 304.8mm MIN.
16	DSGAD, DSGAE	$(0 < Sds \leq 1.35)$	SKID/TANK/ENCLOSURE	(QTY 6) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.
17	DGHDA, DGHDB (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < Sds \leq 1.93)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-1000H CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	10" MIN. 254mm MIN.	30" MIN. 762mm MIN.	15" MIN. 381mm MIN.	15" MIN. 381mm MIN.



**CUMMINS POWER GENERATION**  
**INSTALLATION, GENSET**  
 SEISMIC REQUIREMENTS

SITE CODE	PGF	REV	D	A029J530	SHEET	2 of 6	REV	G
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FIGURE 60. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 2 OF 5)

GRADE MOUNTED GENERATOR SETS								
	CUMMINS GENSET MODEL	RANGE	CONFIGURATION	CONCRETE ANCHORS	ANCHOR EMBEDMENT	ANCHOR SPACING	DISTANCE TO THE NEAREST EDGE	CONCRETE SLAB THICKNESS
1	DSHAD, DSHAC, DSHAB	$(0 < S_{ds} \leq 2.28)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-500L CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	5" MIN. 127mm MIN.	15" MIN. 381mm MIN.	7.5" MIN. 190.5mm MIN.	7.5" MIN. 190.5mm MIN.
2	DSHAD, DSHAC, DSHAB	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
3	DSGAA, DSGAB, DSGAC	$(0 < S_{ds} \leq 1.93)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-500L CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	5" MIN. 127mm MIN.	15" MIN. 381mm MIN.	7.5" MIN. 190.5mm MIN.	7.5" MIN. 190.5mm MIN.
4	DSGAA, DSGAB, DSGAC, DSGAD, DSGAE	$(0 < S_{ds} \leq 1.93)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. USP DUC34-500L CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	5" MIN. 127mm MIN.	15" MIN. 381mm MIN.	7.5" MIN. 190.5mm MIN.	7.5" MIN. 190.5mm MIN.
5	DSFAE, DSFAD, DSFAC, DSFAB, DSFAA, DGHE, DGHG, DGGD (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 2.28)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
6	DSFAE, DSFAD, DSFAC, DSFAB, DSFAA, DGHE, DGHG, DGGD (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
7	DSKCA, DSKBA, DSKAB, DSKAA (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 2.28)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
8	DSKCA, DSKBA, DSKAB, DSKAA (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
9	GGHJ, GGHK, GGHG, GGHF, GGHE (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
10	GGFE, GGFD	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
11	GGMC, GGMB, GGMA, GGMD	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 5/8" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-1/8" MIN. 79.38mm MIN.	6-1/4" MIN. 158.75mm MIN.	7" MIN. 177.8mm MIN.	5" MIN. 127mm MIN.
12	GGLB, GGLA	$(0 < S_{ds} \leq 2.28)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
13	GGPA, GGPB, GGPC	$(0 < S_{ds} \leq 2.27)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 5/8" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-1/8" MIN. 79.38mm MIN.	39" MIN. 990.6mm MIN.	6" MIN. 152.4mm MIN.	6" MIN. 152.4mm MIN.
14	DSGAD, DSGAE	$(0 < S_{ds} \leq 1.93)$	SKID/TANK/ENCLOSURE	(QTY 6) 3/4" DIA. USP DUC34-500L CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	5" MIN. 127mm MIN.	15" MIN. 381mm MIN.	7.5" MIN. 190.5mm MIN.	7.5" MIN. 190.5mm MIN.
15	DGHDA, DGHDB (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 1.93)$	SKID/TANK/ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.
16	DGHDA, DGHDB (REFER TO TABLE ON SHEET 6 FOR 2009/2012 IBC ANCHORAGE)	$(0 < S_{ds} \leq 1.93)$	SKID WITH OR WITHOUT ENCLOSURE	(QTY 4) 3/4" DIA. HILTI KB-TZ CONCRETE ANCHORS THRU THE BASE RAIL MOUNTING HOLES.	3-3/4" MIN. 95.25mm MIN.	7.5" MIN. 190.5mm MIN.	10" MIN. 254mm MIN.	6" MIN. 152.4mm MIN.

CUMMINS POWER GENERATION	
INSTALLATION, GENSET	
SEISMIC REQUIREMENTS	
SITE CODE	PGF D A029J530
SHEET	3 of 6

FIGURE 61. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 3 OF 5)

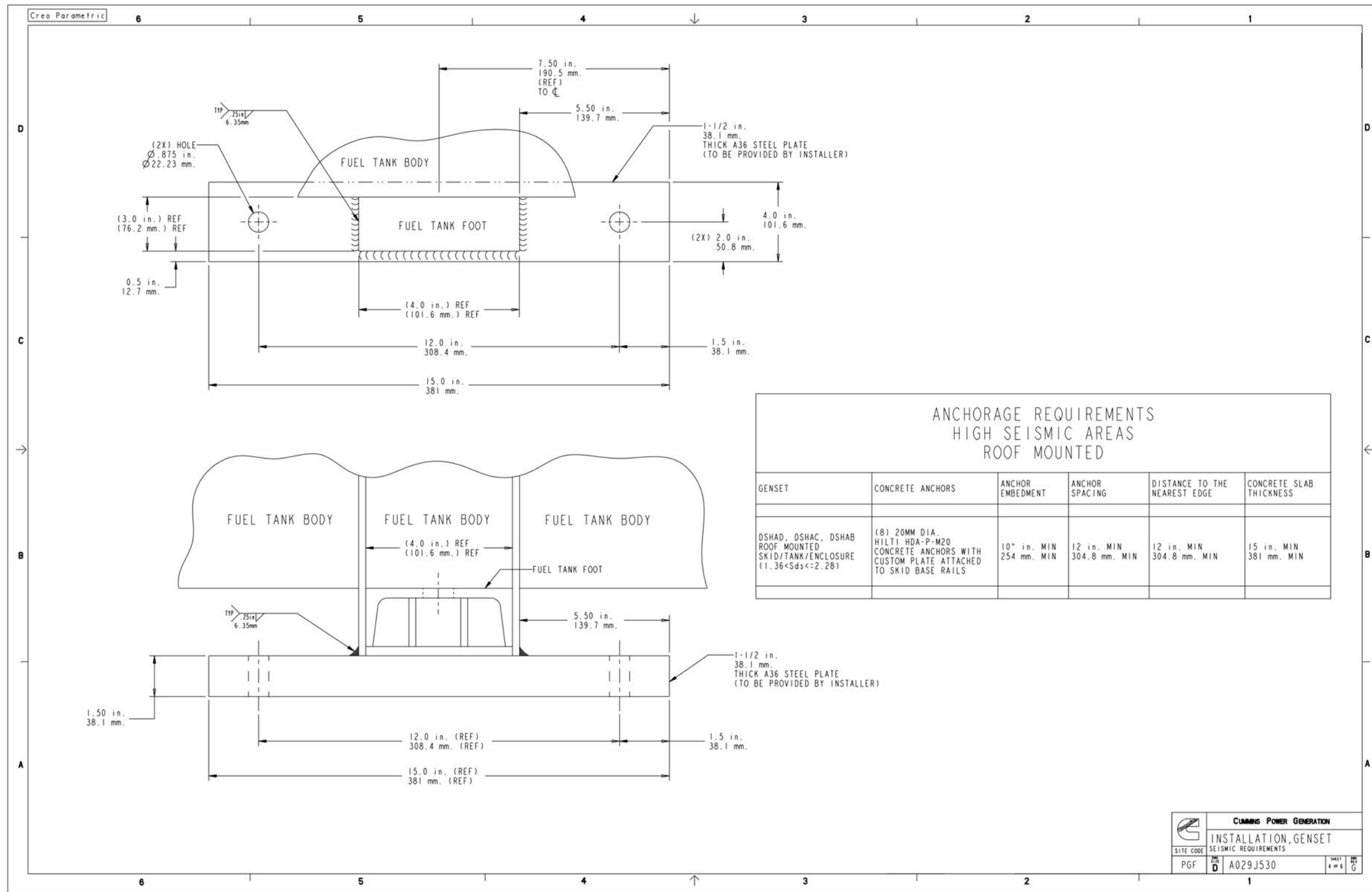


FIGURE 62. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 4 OF 5)

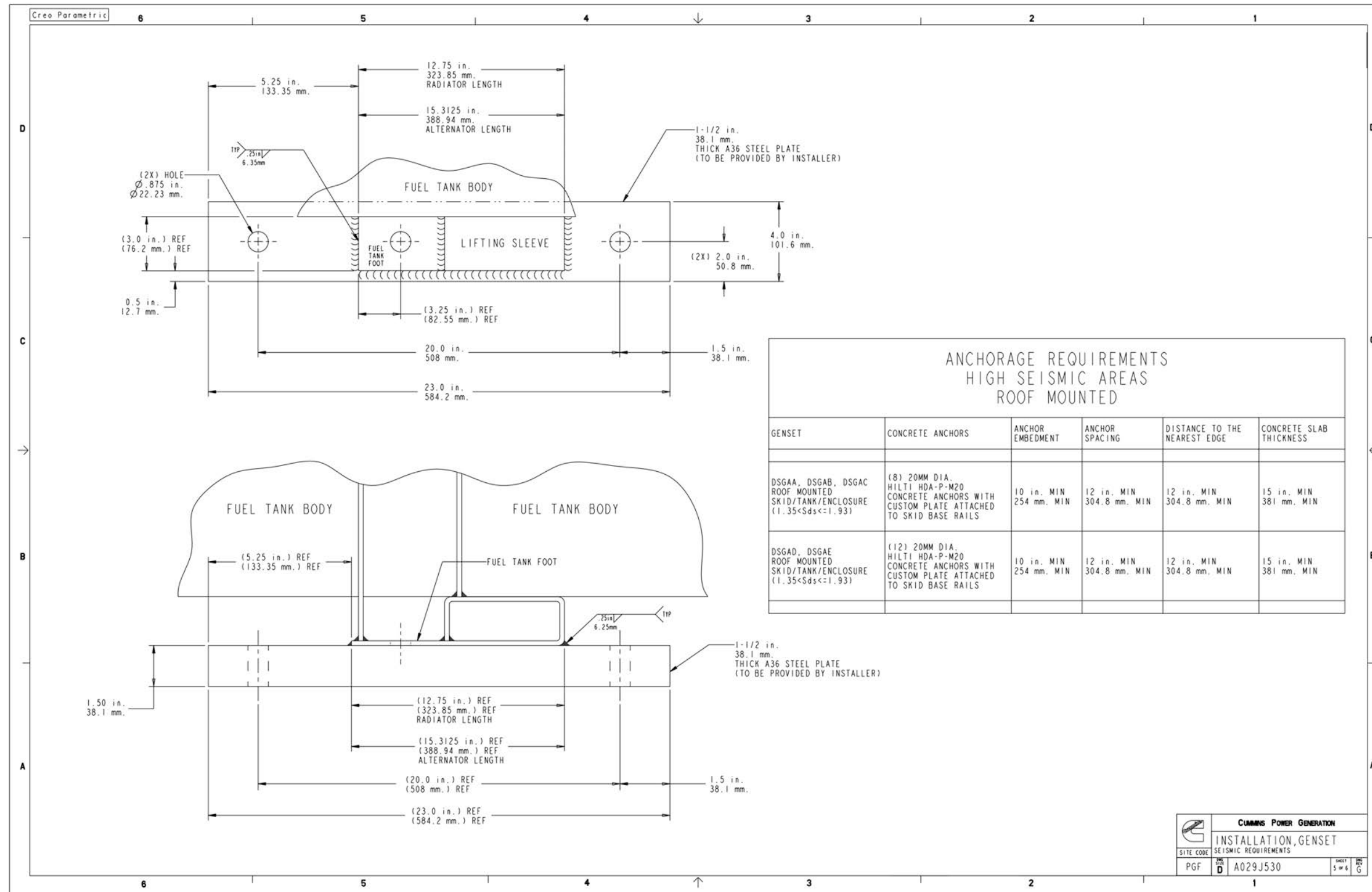


FIGURE 63. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 5 OF 5)

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