

# **Installation Manual**

## **Standby Power Generator Set with PC1.1 Control**

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



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# 1 IMPORTANT SAFETY INSTRUCTIONS

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SAVE THESE INSTRUCTIONS.

This manual contains important instructions for the generator set. Follow these instructions during installation, operation, and maintenance of the generator set and batteries.

Thoroughly read the Operator Manual before operating the generator set. Safe operation and top performance can only be obtained when the equipment is properly operated and maintained.

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

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

### DANGER

*Indicates a hazardous situation that, if not avoided, will result in death or serious injury.*

### WARNING

*Indicates a hazardous situation that, if not avoided, could result in death or serious injury.*

### CAUTION

*Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.*

### NOTICE

*Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).*

## 1.2 General Information

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

**NOTICE**

**It is in the operator's interest to read and understand all warnings and cautions contained in the documentation relevant to the generator set operation and daily maintenance.**

## 1.3 General Precautions

- Keep ABC fire extinguishers accessible.
- Make sure that all fasteners are secure and torqued properly.
- Keep the generator set and its compartment clean. Do not store any items in the generator set compartment.
- Before working on the generator set:
  1. Press the Stop Switch and disable AUTO mode.
  2. Disconnect AC power from any battery chargers.
  3. Remove the negative (–) battery cable from the battery to prevent it from contacting the battery terminal post.
- Use caution when making adjustments when the generator set is running, hot, or when parts are electrically live, as all situations may cause personal injury or death.
- Used engine oil has been identified by some state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or come into contact with used oil or its vapors.
- Do not work on the generator set when mentally or physically fatigued or after consuming alcohol or drugs.

**NOTICE**

**Only trained and authorized personnel shall maintain or service the generator set.**

## General Safety Precautions

**⚠ WARNING**

***Coolant under pressure.***

***Hot coolants under pressure can cause severe scalding.***

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

**⚠ WARNING**

***Moving parts.  
Can cause severe personal injury or death.  
Make sure all protective guards are properly in place before starting the generator set.***

**⚠ WARNING**

***Used engine oils.  
Have been identified by some state and federal agencies to cause cancer or reproductive toxicity.  
Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil. Wear protective gloves.***

**⚠ WARNING**

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

**⚠ WARNING**

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

**⚠ WARNING**

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

**⚠ WARNING**

***Generator sets in operation mode emit noise.  
Exposure to noise can cause hearing damage  
Wear appropriate ear protection at all times.***

**⚠ WARNING**

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

**⚠ WARNING**

***Maintaining or installing a generator set.***

***Can cause severe personal injury.***

***Wear personal protective equipment such as safety glasses, protective gloves, hard hats, steel-toed boots, and protective clothing when working on equipment.***

**⚠ WARNING**

***Ethylene glycol.***

***Used as engine coolant, is toxic to humans and animals.***

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

**⚠ WARNING**

***Starting fluids, such as ether.***

***Can cause explosion and generator set engine damage.***

***Do not use.***

**⚠ WARNING**

***Accidental or remote starting.***

***Accidental starting of the generator set while working on it can cause severe personal injury or death.***

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

**⚠ CAUTION**

***Cleaning materials.***

***Loose cleaning materials can become entangled in moving parts or cause a fire hazard.***

***Make sure that all cleaning materials are removed from the generator set before operating the generator.***

**⚠ CAUTION**

***Combustible materials.***

***A build up of combustible materials under the generator set can present a fire hazard.***

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

**⚠ CAUTION**

***Accumulated grease and oil.***

***Can cause overheating and engine damage presenting a potential fire hazard.***

***Keep the generator set clean and make sure oil leaks are repaired promptly.***

**⚠ CAUTION**

***Maintenance and service procedures.***

***Service access doors on generator sets can be heavy.***

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

**⚠ CAUTION**

***Obstructions.***

***Articles left against the generator set or close by may restrict the air flow and cause overheating or a fire hazard.***

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

**NOTICE**

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

**NOTICE**

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

## 1.4 Generator Voltage is Deadly

- Generator output connections must be made by a trained and experienced electrician in accordance with all applicable codes.
- This generator set and the public utility may only be connected to house circuits by means of the automatic transfer switch.

**⚠ CAUTION**

***Improper connections can lead to electrocution of utility workers and damage to equipment. Make sure that the connections are installed properly by a trained technician.***

- Use caution when working on live electrical equipment. Remove jewelry, and make sure clothing and shoes are dry. Stand on a dry wooden platform.

## 1.5 Engine Exhaust is Deadly

- See [The Hazards of Carbon Monoxide](#) to learn the symptoms of Carbon Monoxide poisoning.
- Locate the generator set away from doors, windows, other openings into the house, and where exhaust gases will disperse away from the house.

## 1.6 Fuel is Flammable and Explosive

- Keep flames, cigarettes, sparks, pilot lights, electrical arc-producing equipment, switches, and all other sources of ignition away from areas where fuel fumes are present and areas sharing ventilation.
- Fuel lines must be secured, free of leaks, and separated or shielded from electrical wiring.
- Leaks can lead to explosive accumulations of gas. Prevent leaks and the accumulation of gas. A rotten egg smell indicates a possible natural gas or propane leak.
  - Natural gas rises when released and can accumulate under hoods and inside housings and buildings.
  - Propane sinks when released and can accumulate inside housings and basements and other below-grade spaces.

## 1.7 Batteries Can Explode

Batteries can explode, causing severe skin and eye burns and can release toxic electrolytes.

**⚠ WARNING**

***Do not dispose of the battery in a fire, because it is capable of exploding. Do not open or mutilate the battery. Released electrolytes have been known to be harmful to the skin and eyes and to be toxic. Batteries present the risk to high short circuit current. Remove watches, rings, or other metal objects, and use tools with insulated handles.***

- Wear safety glasses.
- Do not smoke.

- To prevent arcing when disconnecting the battery:
  1. Press the Stop Switch.
  2. Disconnect AC power from any battery chargers.
  3. Remove the negative (-) battery cable to prevent starting.
- To prevent arcing when reconnecting the battery:
  1. Reconnect the positive (+) cable.
  2. Reconnect the negative (-) cable.
  3. Reconnect the battery charger to AC power supply.
- When replacing the generator set battery, always replace it with a battery as specified in the [Model Specifications](#) section of this manual.

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

- Do not wear loose clothing or jewelry near moving parts, such as fans.
- Keep hands away from moving parts.
- Keep guards in place over fans.

## 1.9 The Hazards of Carbon Monoxide

Carbon Monoxide (CO) is an odorless, colorless, tasteless and non-irritating gas (you cannot see it or smell it). Exposure even to low levels of CO for a prolonged period can lead to asphyxiation (lack of Oxygen), resulting in death. Mild effects of CO poisoning include eye irritation, dizziness, headaches, fatigue, and the inability to think clearly. More extreme symptoms include vomiting, seizures, and collapse.

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

### Special Risks of CO Near the Home

Residents can be exposed to lethal levels of CO when the generator set is running. Depending on air temperature and wind, CO can accumulate in or near the home.

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

#### **WARNING**

***Carbon Monoxide (CO) gas can cause nausea, fainting, or death.***

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## Protecting Yourself From CO Poisoning

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



## 2 Introduction

This generator set is intended for stationary installation for emergency use only.

### 2.1 About this Manual



This manual is a guide for the installation of the generator set models listed on the front cover. Proper installation is essential for top performance, reliable operation, and safety. Read through this manual before starting the installation. This manual covers outdoor applications only. For other applications, such as indoor applications, contact your local Cummins dealer or reference the Application Manual at the following link:

<http://www.cumminspower.com/www/literature/applicationmanuals/t030.pdf>

#### NOTICE

**The installation must comply with all applicable building codes.**



See the generator set Operator Manual (A045R242) for operation and maintenance and the Service Manual (A045R243) for service.

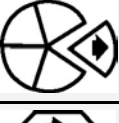
#### NOTICE

**Manuals are updated from time to time to reflect changes in the equipment and its specifications. The most up-to-date version of this manual is found on the QuickServe website (<https://quickserve.cummins.com/info/index.html>).**

### 2.2 Icons

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

| Icon | Description                                      |
|------|--------------------------------------------------|
|      | <b>Clean</b> the part or assembly.               |
|      | Indicates an <b>electrical</b> measurement.      |
|      | Indicates that an <b>inspection</b> is required. |

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

## 2.3 Related Literature



The literature provided with the generator set is as follows.

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

### CAUTION

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

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

- Health and Safety Manual (0908-0110)
- Warranty Statement (A028U870)

- Emissions Component Defect Warranty Statement (A028X278)

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

- Service Manual (A045R243)
- Parts Manual (A046Z674)
- E-Controls, Inc. Service Manual (A035C596)
- Global Control Platform (GCP) Engine Display Interface Software (EDIS) Training Manual (A035C608)
- RA Series Transfer Switch Owner's Manual (A046S594) - if applicable
- PowerCommand® 1302 Controller Owner's Manual (900-0661)
- Standard Repair Times (SRT) Manual (A046Z094)
- Application Manual T-030 - for application information (A040S369)
- Service Tool Manual (A043D529)

## 2.4 Before Installation



Before beginning the installation of the generator set, verify that the unit was correctly selected. Check the following features:

- Model
- Specifications
- Options
- Fuel Supply
  - The gas supplied to the generator set must be of acceptable quality.
  - The gas supply must have sufficient pressure. Care must be taken to be sure that the gas supply at the generator set, not just at the source, is of proper pressure for operation. The specified pressure must be available while the generator set is starting and running at full load.
  - The gas must be supplied to the generator set in sufficient volume to support operation of the generator set. This is normally a matter of selecting fuel line size to be large enough to transport the volume of fuel needed. For liquid propane vapor-withdrawal fuel systems the size and temperature of the fuel tank also affects this requirement.

## 2.5 Model Specifications

**TABLE 1. 2.4L MODEL VARIATIONS**

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

**TABLE 2. COLD WEATHER SPECIFICATIONS**

|                          | All Models                                                                                                                                |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|                          | For NFPA 110 applications, a coolant heater is required. Factory option is available.                                                     |
| Above 40 °F (4 °C)       | No starting aids required.<br>Standard battery (group 26)                                                                                 |
| 0 to 40 °F (-17 to 4 °C) | Additional coolant heater and battery charger recommended for starting.<br>Factory options available.<br>Standard battery (group 26)      |
| Below 0 °F (-17 °C)      | All starting aides (battery heater, coolant heater, battery charger) recommended. Factory options available.<br>Larger battery (group 24) |

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

|                         | C20 N6                          | C22 N6                          | C25 N6                          | C30 N6                          | C36 N6                          | C40 N6                          |
|-------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Full load (propane)     | 105.1 scfh<br>265,000<br>BTU/hr | 112.7 scfh<br>285,000<br>BTU/hr | 125.4 scfh<br>315,000<br>BTU/hr | 164.1 scfh<br>410,000<br>BTU/hr | 182.7 scfh<br>460,000<br>BTU/hr | 193.6 scfh<br>490,000<br>BTU/hr |
| Full load (natural gas) | 259.6 scfh<br>270,000<br>BTU/hr | 278.8 scfh<br>290,000<br>BTU/hr | 309.5 scfh<br>320,000<br>BTU/hr | 380.9 scfh<br>395,000<br>BTU/hr | 472.3 scfh<br>490,000<br>BTU/hr | 519 scfh<br>540,000<br>BTU/hr   |
| Fuel pressure           | 6-14 inch water column          |                                 |                                 |                                 |                                 |                                 |

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

|                         | <b>C30 N6H</b>                  | <b>C36 N6H</b>                  | <b>C40 N6H</b>                  | <b>C45 N6H</b>                  | <b>C50 N6H</b>                  | <b>C60 N6H</b>                  |
|-------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Full load (propane)     | 195.5 scfh<br>490,000<br>BTU/hr | 219.6 scfh<br>550,000<br>BTU/hr | 236.2 scfh<br>595,000<br>BTU/hr | 256.9 scfh<br>645,000<br>BTU/hr | 289.5 scfh<br>725,000<br>BTU/hr | 324.6 scfh<br>820,000<br>BTU/hr |
| Full load (natural gas) | 476.1 scfh<br>495,000<br>BTU/hr | 533.3 scfh<br>555,000<br>BTU/hr | 573.2 scfh<br>595,000<br>BTU/hr | 623.0 scfh<br>645,000<br>BTU/hr | 704.7 scfh<br>730,000<br>BTU/hr | 814.2 scfh<br>840,000<br>BTU/hr |
| Fuel pressure           | 6-14 inch water column          |                                 |                                 |                                 |                                 |                                 |

**TABLE 5. ENGINE SPECIFICATIONS**

| <b>All Models</b>  |                                                                  |
|--------------------|------------------------------------------------------------------|
| Engine             | 4 Cylinder-in-line, SOHC, liquid-cooled, 4-stroke, spark ignited |
| Displacement       | 144 in <sup>3</sup> (2351 cc)                                    |
| Spark plug gap     | 0.040 inch (1.0 mm) (NA)<br>0.030 inch (0.76 mm) (T/TAA)         |
| Spark plug torque  | 15 ft-lb (20 N-m)                                                |
| Oil capacity       | Approximately 4.5 quarts (4.3L)                                  |
| Oil recommendation | 5W30 API SM                                                      |
| Coolant            | 50/50 coolant solution (50% pure water and 50% anti-freeze)      |

**TABLE 6. GENERATOR SET SIZE SPECIFICATIONS**

|                                     | <b>20-25 kW 1800 RPM and 30 kW 3600 RPM</b>              |                    | <b>30-40 kW 1800 RPM and 36-60 kW 3600 RPM</b>           |                    |
|-------------------------------------|----------------------------------------------------------|--------------------|----------------------------------------------------------|--------------------|
|                                     | <b>Propane Vapor</b>                                     | <b>Natural Gas</b> | <b>Propane Vapor</b>                                     | <b>Natural Gas</b> |
| Size (with sound level 1 enclosure) | (L x W x H) 72 x 34 x 45.2 in.<br>(1830 x 864 x 1152 mm) |                    | (L x W x H) 94 x 34 x 45.2 in.<br>(2384 x 864 x 1152 mm) |                    |

**TABLE 7. GENERATOR SET WEIGHT (POUNDS) 60 HZ, 1800 RPM**

|                     | <b>C20 N6</b> | <b>C22 N6</b> | <b>C25 N6</b> | <b>C30 N6</b> | <b>C36 N6</b> | <b>C40 N6</b> |
|---------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Sound level 1 (wet) | 1109          | 1109          | 1147          | 1279          | 1356          | 1424          |

**TABLE 8. GENERATOR SET WEIGHT (POUNDS) 60 HZ, 3600 RPM**

|                     | <b>C30 N6H</b> | <b>C36 N6H</b> | <b>C40 N6H</b> | <b>C45 N6H</b> | <b>C50 N6H</b> | <b>C60 N6H</b> |
|---------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Sound level 1 (wet) | 1134           | 1249           | 1399           | 1399           | 1399           | 1429           |

**TABLE 9. GENERATOR SPECIFICATIONS 60 HZ, 1800 RPM**

|                                  | <b>C20 N6</b>                                    | <b>C22 N6</b>   | <b>C25 N6</b>   | <b>C30 N6</b>   | <b>C36 N6</b>   | <b>C40 N6</b>   |
|----------------------------------|--------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Generator                        | Brushless, 2-pole rotating field, single bearing |                 |                 |                 |                 |                 |
| Power (kVA)<br>1phase/3<br>phase | 20/25                                            | 22/27.5         | 25/31.3         | 30/37.5         | 36/45           | 40/50           |
| Rated voltages<br>(V)            | 120/240<br>1 Ph                                  | 120/240<br>1 Ph | 120/240<br>1 Ph | 120/240<br>1 Ph | 120/240<br>1 Ph | 120/240<br>1 Ph |
|                                  | 120/240<br>3 Ph                                  | 120/240<br>3 Ph | 120/240<br>3 Ph | 120/240<br>3 Ph | 120/240<br>3 Ph | 120/240<br>3 Ph |
|                                  | 120/208<br>3 Ph                                  | 120/208<br>3 Ph | 120/208<br>3 Ph | 120/208<br>3 Ph | 120/208<br>3 Ph | 120/208<br>3 Ph |
|                                  | 277/480<br>3 Ph                                  | 277/480<br>3 Ph | 277/480<br>3 Ph | 277/480<br>3 Ph | 277/480<br>3 Ph | 277/480<br>3 Ph |
|                                  | 347/600<br>3 Ph                                  | 347/600<br>3 Ph | 347/600<br>3 Ph | 347/600<br>3 Ph | 347/600<br>3 Ph | 347/600<br>3 Ph |

**TABLE 10. GENERATOR SPECIFICATIONS 60 HZ, 3600 RPM**

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

**NOTICE****Maximum  $I_2$  = 8%.****TABLE 11. GENERATOR SET DERATING GUIDELINES**

| <b>Model</b> | <b>NG/LP</b> | <b>Guidelines</b>                                                                                                                                                                           |
|--------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C20 N6       | NG, LP       | Engine power available up to 1005 m (3300 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305m (1000 ft) and 2% per 10 °C above 40 °C (104 °F).   |
| C22 N6       | LP           |                                                                                                                                                                                             |
| C30 N6       | LP           |                                                                                                                                                                                             |
| C36 N6       | NG, LP       |                                                                                                                                                                                             |
| C36 N6H      | NG, LP       |                                                                                                                                                                                             |
| C40 N6H      | NG, LP       |                                                                                                                                                                                             |
| C45 N6H      | LP           |                                                                                                                                                                                             |
| C22 N6       | NG           | Engine power available up to 670.5 m (2200 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F). |
| C40 N6       | NG, LP       | Engine power available up to 114 m (375 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F).    |
| C60 N6H      | NG, LP       |                                                                                                                                                                                             |
| C25 N6       | NG           | Engine power available up to 0 m (0 ft) at ambient temperatures up to 25 °C (77 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F).         |
| C25 N6       | LP           | Engine power available up to 114 m (375 ft) at ambient temperatures up to 25 °C (77 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 25 °C (77 °F).      |
| C50 N6H      | NG, LP       |                                                                                                                                                                                             |
| C30 N6       | NG           | Engine power available up to 762 m (2500 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F).   |
| C30 N6H      | NG, LP       | Engine power available up to 945 m (3100 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F).   |

| Model   | NG/LP  | Guidelines                                                                                                                                                                                |
|---------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C45 N6H | NG, LP | Engine power available up to 914 m (3000 ft) at ambient temperatures up to 40 °C (104 °F). Above these elevations derate at 4% per 305 m (1000 ft) and 2% per 10 °C above 40 °C (104 °F). |

**TABLE 12. CONTROL SPECIFICATIONS**

| All Models |                                                                            |
|------------|----------------------------------------------------------------------------|
| Control    | Integrated microprocessor based engine, generator, transfer switch control |

**TABLE 13. DC SYSTEM SPECIFICATIONS**

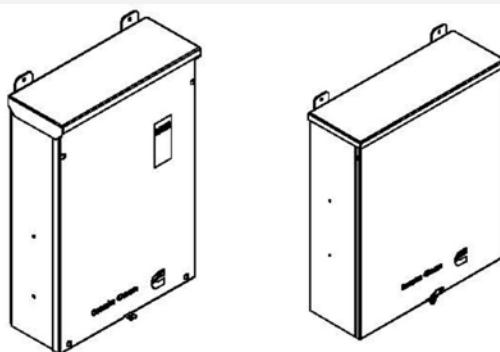
| All Models              |                                                                                            |
|-------------------------|--------------------------------------------------------------------------------------------|
| Nominal battery voltage | 12 VDC                                                                                     |
| Battery group           | 26 standard, 34 high capacity (high capacity battery requires an accessory battery tray)   |
| Battery Type            | Maintenance free                                                                           |
| Minimum cold crank amps | 545 standard, 850 high capacity (high capacity battery requires an accessory battery tray) |

## 2.6 Transfer Switch Requirements

A transfer switch must be a part of every generator set installation. Transfer switches transfer loads to the generator set during power outages.

### NOTICE

**Cummins residential and light commercial transfer switches are available.**

**FIGURE 1. CUMMINS TRANSFER SWITCH (RA SERIES)**



Before beginning the installation of the transfer switch, verify that the unit was correctly selected. Check the following features:

- Specifications (voltage, amperage, frequency, poles, and phases)
- Enclosure (indoor vs. outdoor)
- Model



Refer to the Transfer Switch Installation Manual for more detailed information.

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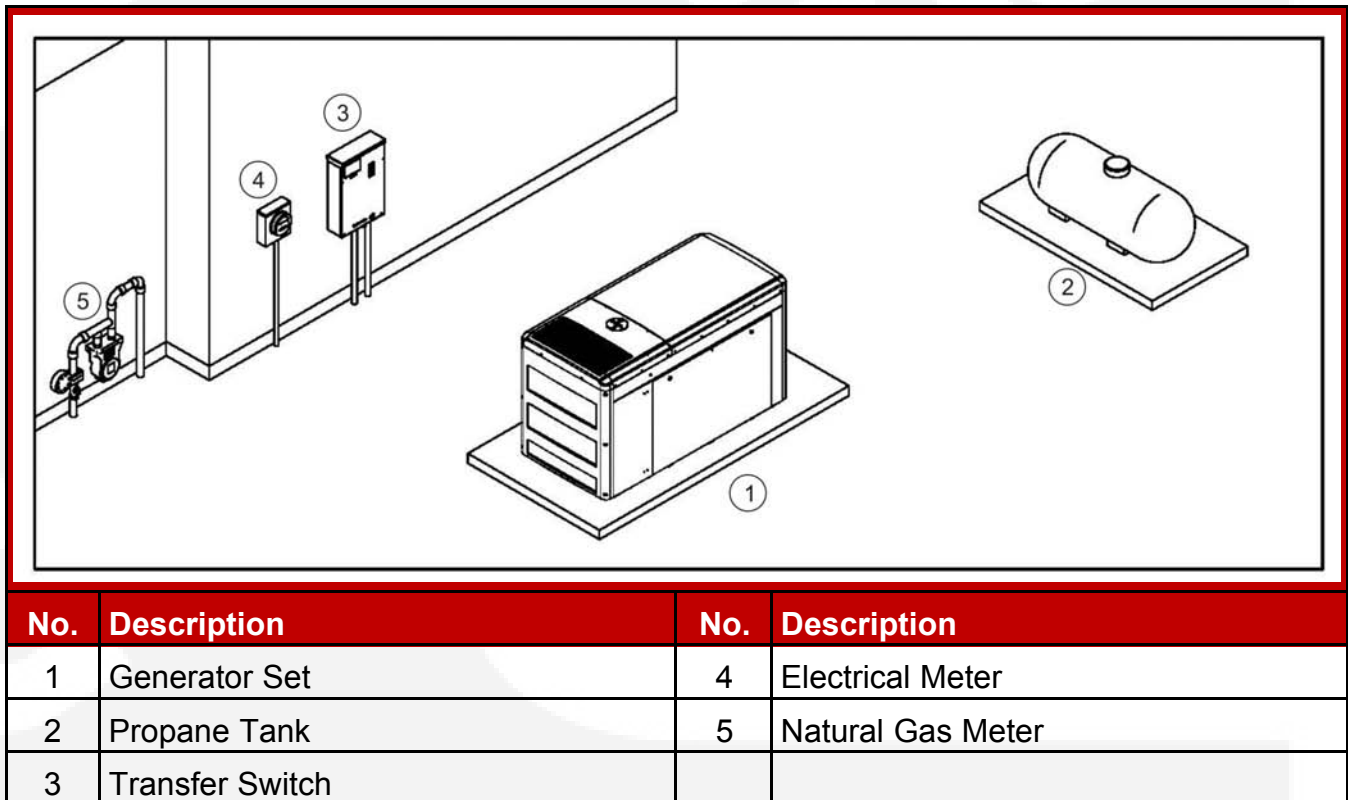


### 3 Pre-Installation Considerations



Before installation begins, certain items must be considered. Prior coordination reduces delays and the amount of time power has to be interrupted.

Areas of consideration:



**FIGURE 2. SITE PREPARATION EXAMPLE**

- Location of the generator set - this is one of the first decisions to be made, as it affects all other aspects of the installation, such as:
  - Length of electric wiring
  - Length of gas lines (natural gas or propane - both must be inspected by the gas utility inspectors and building inspectors)
  - Site preparation:
    - Access to the site
    - Trenches
    - Site preparation materials needed
- Fuel supply pressure
- Automatic transfer switch location and connections

- Tools and materials required
- Minimum distance from the propane tank fill (verify the legal minimum distance with local code officials)
- Accessories required (if any) for the customer's application (utility power may be required at the generator set; make plans accordingly)

**NOTICE**

**Depending on the locality and use of the generator set, it may be necessary to obtain an air quality emissions permit before installation begins. Check with local pollution control or air quality authority to determine permit requirements.**

### 3.1 Installation Codes and Standards for Safety

**NOTICE**

**The generator set installer bears sole responsibility for following all applicable local codes and regulations.**



The following list of codes and standards may apply to the installation and operation of the generator set. This list is for reference only and not intended to be inclusive of all applicable codes and standards. The address of each agency is listed so that copies of the codes may be obtained for reference. Installation codes and recommendations are subject to change, and may vary by location or over time.

**TABLE 14. INSTALLATION CODES AND STANDARDS FOR SAFETY RECOMMENDATIONS**

|                                                                                                                                                                                                                                                                                        |                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| NFPA 70 - National Electric Code<br>NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines<br>NFPA 54 - National Fuel Gas Code<br>NFPA 58 - Storage and Handling of Liquefied Petroleum Gases<br>NFPA 110 - Standard for Emergency and Standby Power Systems | National Fire Protection Association<br>470 Atlantic Avenue<br>Boston, MA 02210                                                       |
| CSA Electrical Bulletin<br>CSA C22.2 No. 100<br>CSA C22.2 No. 14                                                                                                                                                                                                                       | Canadian Standards Association<br>Housing and Construction Materials Section<br>178 Rexdale Blvd.<br>Rexdale, Ontario, Canada M9Q 1R3 |

|                                                     |                                                                                        |
|-----------------------------------------------------|----------------------------------------------------------------------------------------|
| California Administrative Code - Title 25 Chapter 3 | State of California<br>Documents Section<br>P.O. Box 1015<br>North Highlands, CA 95660 |
|-----------------------------------------------------|----------------------------------------------------------------------------------------|

## 3.2 Required Items for Installation

Tools and materials are used for the installation of this generator set. These items are identified in the following sections. Please refer to local codes and standards, as they may affect the materials required.

### Materials Required

#### NOTICE

**Refer to local codes and standards, as they may affect the material requirements.**



#### Electrical Materials:

- Appropriately-sized gauge and length AC wires with 75 °C insulation. Four wires; L1, L2, N and Gnd (add another wire for 3-phase)
- Appropriate conduit for all AC wires
- Four 18 AWG 60-75 °C copper DC control wires and conduit for ATS interface (RA Series)
- Code compliant 20A, GFCI circuit for alternator heaters/battery charger/coolant heater (if equipped)



#### Mounting Materials:

- Four base tie-down bolts

#### NOTICE

**Seismic zone installations require compliance to specific mounting configurations.**



#### Fuel Materials:

- Flexible fuel line (provided with generator)
- UL listed pipe thread sealant

- Fuel line (natural gas and propane: 6-14 inch water column fuel pressure) at generator set
- Fuel pressure regulator - as required
- Manual fuel shut-off at generator set ahead of automatic valves on generator set fuel system

## Loose Parts Shipped With the Generator



The following loose parts are shipped with the generator set:

- Flexible fuel hose assembly
- Two enclosure keys (where applicable)
- Battery tie-down
- Sound level 2 baffle (where applicable)
- Literature - Operator Manual, Installation Manual, Health and Safety Manual, and Warranty Statements

## 3.3 Transfer Switch Mounting



1. Consider the location before mounting the transfer switch.
  - Consider the proximity to the utility service entrance and breaker panel. There must be a service disconnect (circuit breaker or fuses) in the power line ahead of the transfer switch, unless a service entrance rated automatic transfer switch is being used.
  - Keep safety concerns in mind. Never mount the transfer switch near hazardous chemicals or gases.
  - Avoid high humidity areas or areas prone to excessive heat or dust.
2. Make sure that the wall is stable and able to support the weight of the transfer switch.
3. Make sure that the transfer switch is mounted according to all applicable building code requirements.
4. Mount the transfer switch per the instructions in the Transfer Switch Installation Manual.

## 4 Installation

---

### NOTICE

The installer is responsible for complying with all applicable installation codes and safety requirements. See the [Installation Codes and Standards for Safety](#) section of this manual for more information.

The following sections cover a step-by-step overview of a typical generator set installation.

Review these sections to become familiar with specific procedures and important safety precautions before beginning the installation.

### 4.1 Site Assessment and Preparation



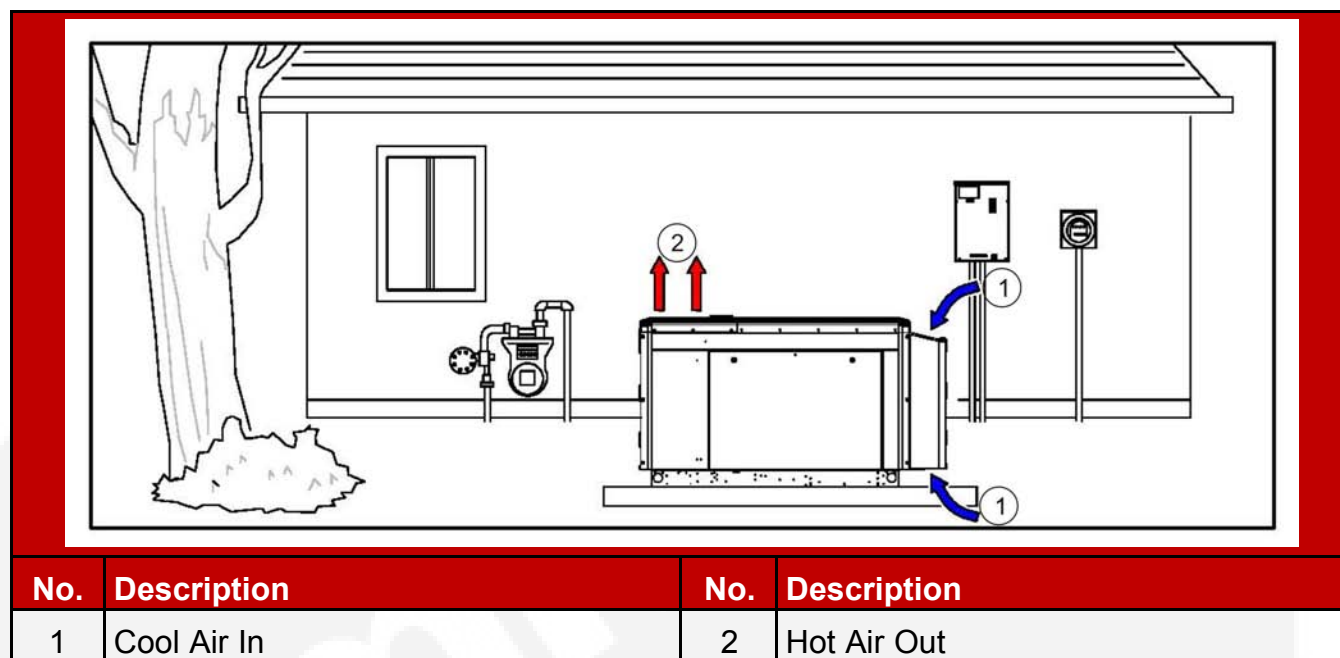
Proper component location and site preparation have a very important impact on completing a successful installation. The major components and sources of power needed for installation include the following items:

- Generator set
- Transfer switch
- Electrical utility
- Fuel source: natural gas or propane vapor
- Accessories (may be required based on certain conditions)

#### Picking a Location

### ⚠ WARNING

***Exhaust gas is deadly. Locate the generator set away from doors, windows, and other openings to the house and where exhaust gases will disperse away from the house.***



**FIGURE 3. GENERATOR SET LOCATION**



Generator set location is critical for safety and performance. Follow the guidelines below.

- Must comply with applicable codes (NFPA, NEC, IBC, etc.).
- Install outdoors only. For other applications, contact your local Cummins dealer or reference the Application Manual at the following link: <http://www.cumminspower.com/www/literature/applicationmanuals/t030.pdf>
- Consider access to utilities (electric/gas meters, transfer switch, remote fuel tank location, etc.).
- Call the local utilities to mark the locations of buried utility services (gas, electric, or telephone) before digging.
- Verify the locations of any other buried components (gas, electric or telephone) with the homeowner before digging.

**Clearances:**

- The exhaust side of the generator set must be located 5 feet from combustible materials (NFPA 37).
- The exhaust side of the generator must be located 5 feet from any opening in a wall (window, door, vent, etc.).
- The generator must be located such that the exhaust is not able to accumulate in an occupied area.
- The generator must have enough room for installation, service, and maintenance.
- The generator must be located to ensure ventilation openings are not blocked.
- Position the generator set so that cooling air is free to enter and leave the area.

- Locate and position the generator set so that prevailing winds carry exhaust gases and potential fuel leaks away from the house or occupied area.

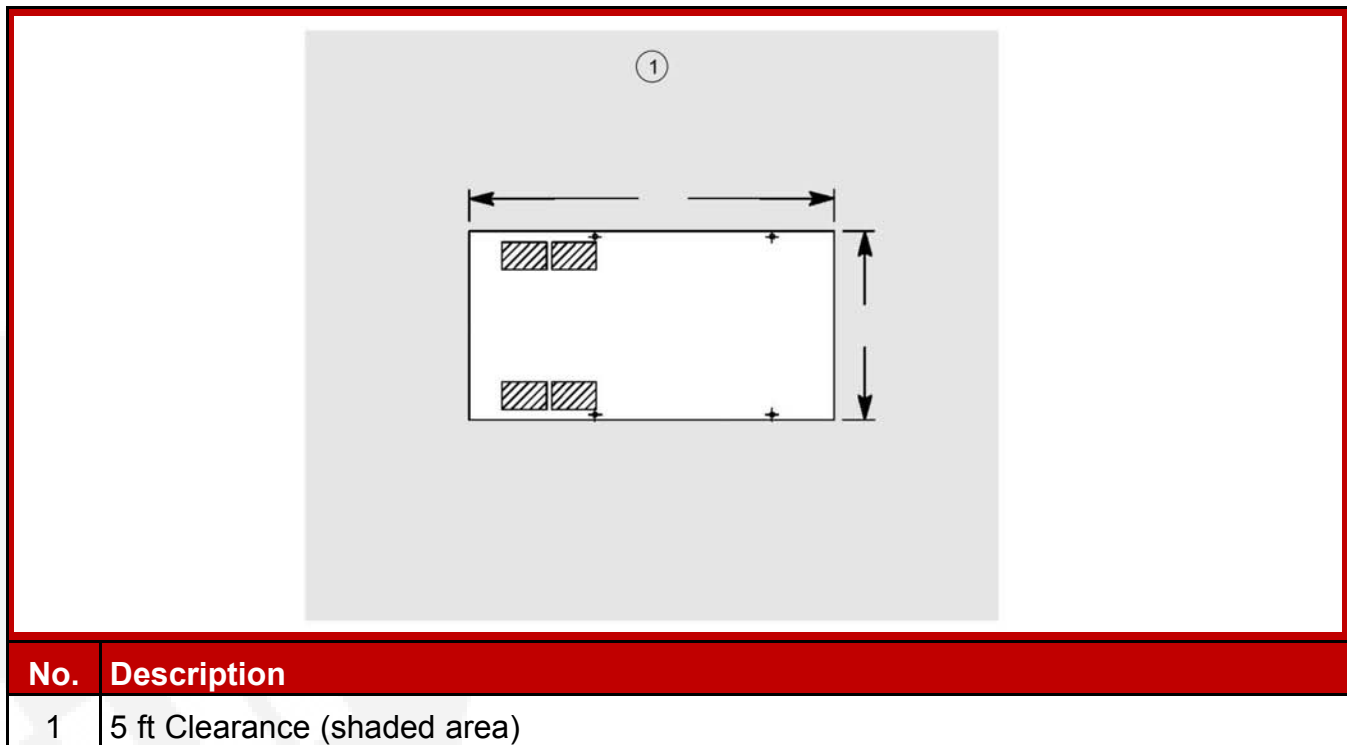


FIGURE 4. CLEARANCES

## Laying the Foundation



When laying the foundation:

1. Clear obstructions, and make sure that there is adequate clearance for access.
2. Level the ground, and make sure that the ground is compact and settled. Ensure that it is stable ground, not subject to flooding.
3. Prepare the concrete pad.
  - The pad should be constructed of reinforced concrete with a 28-day compressive strength of at least 2500-psi (17,236.89 kPa).
  - The pad should be at least 5 inches (127 mm) deep and extend at least 6 inches (150 mm) beyond the skid on all sides.

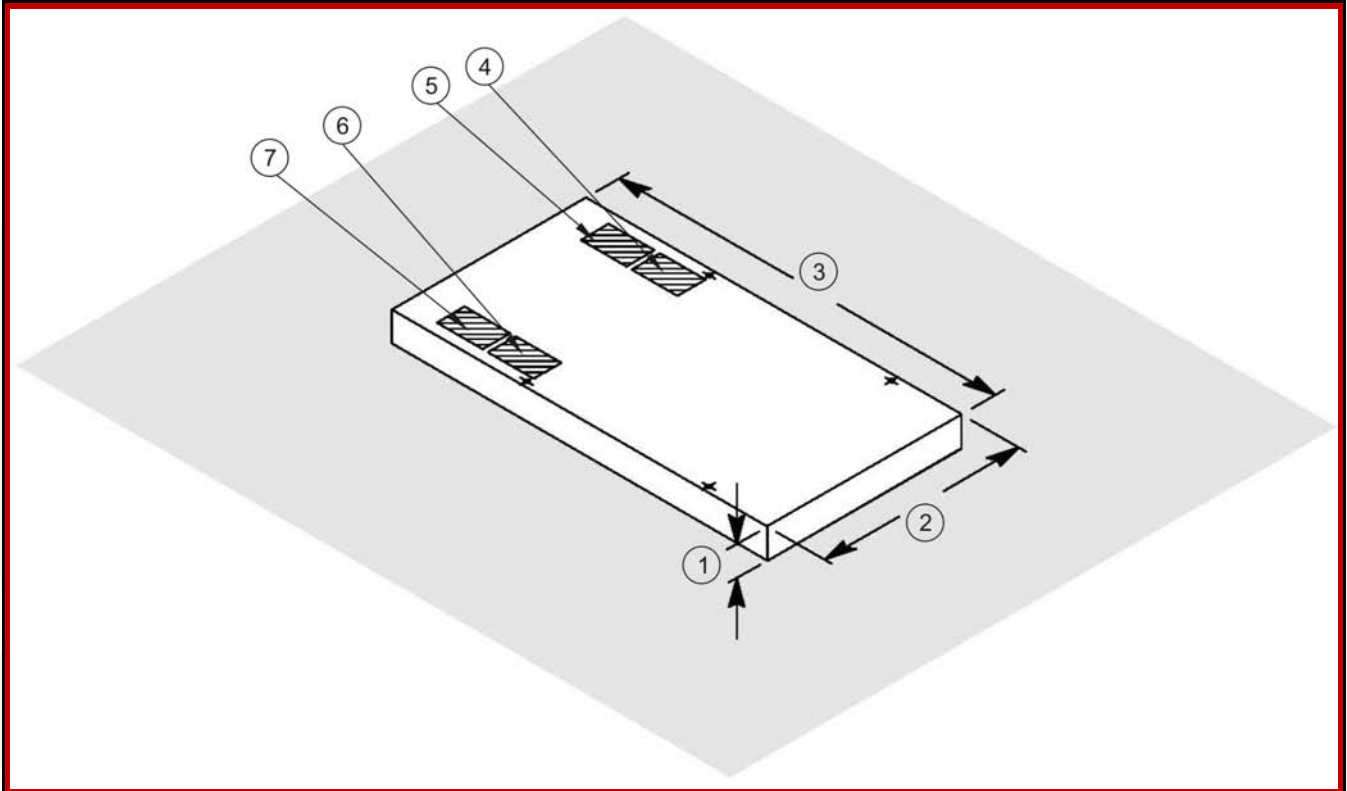
### NOTICE

**Seismic installation may require a different pad and securing devices.**

**NOTICE**

**Local codes and standards may have different requirements.**

4. Lift the generator set onto the pad, and secure it.



| No. | Description                                              | No. | Description                                      |
|-----|----------------------------------------------------------|-----|--------------------------------------------------|
| 1   | Pad Thickness (at least 5 inches deep)                   | 5   | Accessory 120 V AC, 20 A Max Wire Stub-Up        |
| 2   | Width (pad should extend at least 6 inches beyond skid)  | 6   | Circuit Breaker 2 Stub-Up (dual circuit breaker) |
| 3   | Length (pad should extend at least 6 inches beyond skid) | 7   | Circuit Breaker 1 Stub-Up (standard)             |
| 4   | Generator Set Control Wire Stub-Up (DC)                  |     |                                                  |

**FIGURE 5. CONCRETE PAD PREPARATION**

## Lifting and Moving the Generator Set

### WARNING

***The generator set is heavy. Dropping the generator set can cause severe personal injury or death. Keep feet and hands clear when lifting the generator set.***

### CAUTION

***The generator is shipped with oil in the crankcase. Keep the generator set upright.***



- The generator set is heavy. Handle with care.
- Use appropriate lifting techniques to move the generator set. Do not use the lifting eyes on the engine and alternator to lift the entire generator set.

### NOTICE

**Only a certified and trained person should lift from above the generator set.**

## Mounting the Generator Set

Positioning of cast-in bolts can be problematic since even small errors in location can cause time consuming redrilling of the skid base. Some generator set designs allow use of concrete anchor bolts, requiring the mounting points to be carefully laid out based on actual location of the mounting points on the generator set and isolators.



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. Verify that the mounting pad is level lengthwise, widthwise, and diagonally.

### NOTICE

**Seismic installation may require specific anchorage.**

## 4.2 Fuel Selection and Fuel System Connection

For fuel specifications (such as BTU/hr), see the [Model Specifications](#) section.

**NOTICE**

This generator set has a convertible fuel system. The generator may run on natural gas or propane, depending on the preferences of the owner. All generator sets come preconfigured from the factory for natural gas fuel. For more information on converting the fuel system type, reference the Service Manual (A045R243).

**NOTICE**

Fuel systems must be installed by qualified service technicians. Improper installation presents hazards of fire and improper operation, resulting in severe personal injury or property damage.

**⚠ WARNING**

*Gaseous fuels are flammable, explosive, and can cause severe personal injury or death. Do not smoke if you smell gas, are near fuel tanks for fuel-burning equipment, or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs, arc-producing equipment and all other sources of ignition well away. Keep a type ABC fire extinguisher handy.*



In all fuel system installations, cleanliness is extremely important.

- Make every effort to prevent fuel contamination from:
  - Moisture
  - Dirt
  - Excess thread sealant
  - Contaminants of any kind
- Clean all fuel system components before installing.



Gaseous-fuel supply system design, materials, components, fabrication, assembly, installation, testing, inspection, operation, and maintenance must comply with the applicable codes. See NFPA Standards No. 37, 54, and 58. For seismic installation, refer to IBC codes and standards. Where seismic installation is required, there may be specific anchorage requirements for the generator set and other installed components.

Most codes require a manual shutoff valve ahead of a flexible fuel hose. The manual valve should be of the indicating type. The generator set has electric (battery-powered) shutoff valves included.

**NOTICE**

It is recommended that a shutoff valve be located near the generator set for emergency shut off or servicing the generator set. Follow applicable codes.

Until the generator set is connected, cap the fuel line stub-up at the generator set to prevent dirt from entering and gas from discharging if the gas supply shutoff valve is opened accidentally.

To determine the required capacity, add generator set consumption to the gas consumed for heating, cooking, clothes drying, etc. A typical natural gas installation might require a 400,000 BTU meter. Consideration should also be given to utilizing high pressure gas supply if available. This reduces the required size and cost of gas piping, especially if the location of the generator set requires a long supply line.

## Natural Gas Fuel System



Requirements for a natural gas generator set are as follows.

- Adequate fuel supply to operate correctly and run at full load
- Pipeline quality gas
- The length of the fuel supply pipe from the gas service entrance to the generator set must be known to determine the correct fuel pipe size (refer to the [Fuel Line Selection](#) charts)

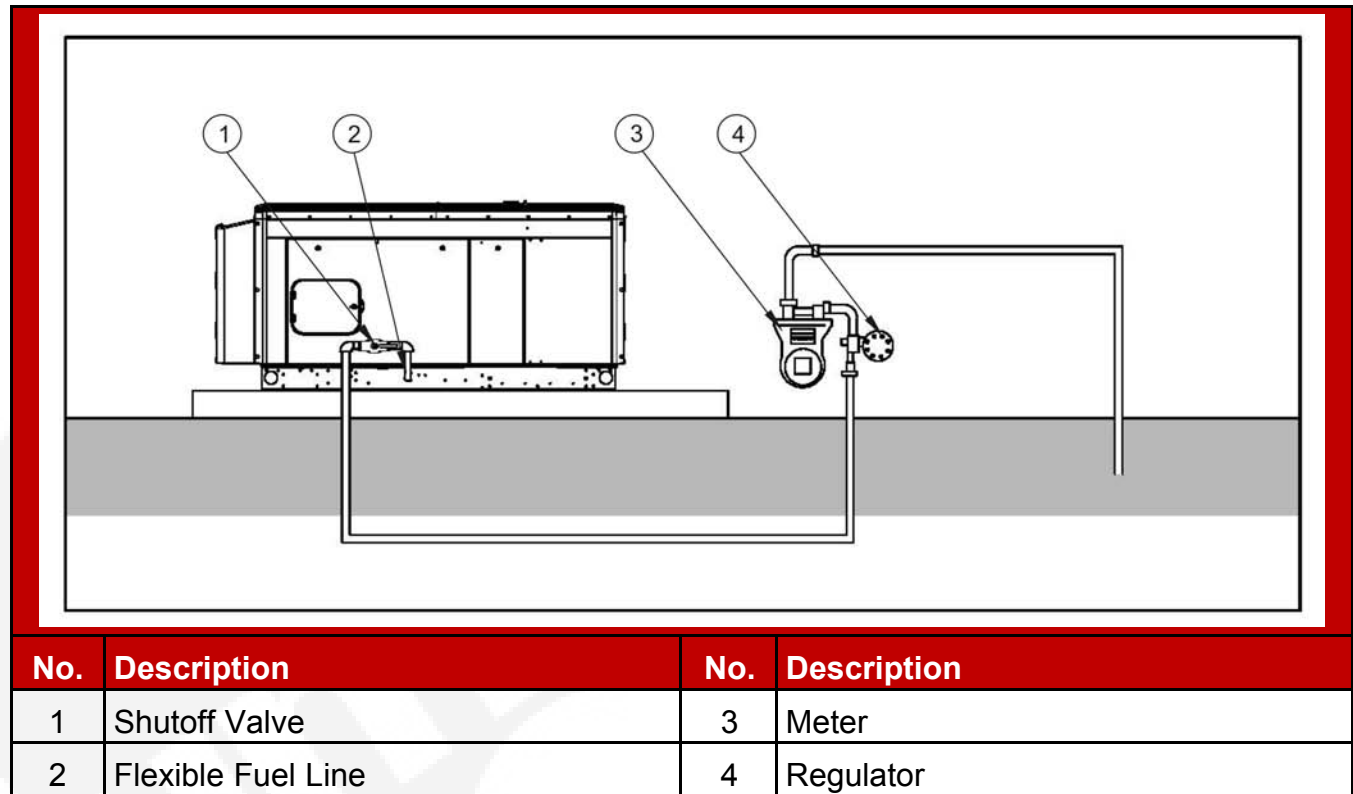
### NOTICE

**Iron pipe must be a minimum of schedule 40 subject to the authority having jurisdiction.**

- Cummins flexible fuel line to protect the fuel system from vibration, expansion, and contraction
- Manual shutoff valve

### ⚠ WARNING

***Fuel leaks can lead to explosive accumulations of gas. Prevent gas leaks and the accumulation of gaseous fuel in the event of a leak.***



**FIGURE 6. TYPICAL NATURAL GAS INSTALLATION**

### Natural Gas Supply Line Size

#### NOTICE

The Natural Gas supply meter may need to be exchanged for a higher capacity meter to supply the additional gas consumed by the generator set.

#### NOTICE

An older site might require upgrading and repair of the gas supply system. Schedule an upgrade or repair to minimize power and gas supply interruptions.

Use the total load requirement of the generator set to determine the size of the fuel supply pipe. Use the [Fuel Line Selection](#) tables and charts in the Appendix to determine the correct pipe size.

#### NOTICE

Make sure the fuel supply pressure at the inlet to the generator fuel shutoff valves is set between 6-14 inch water column for all operating loads (no load to full load).

## Propane Fuel System

Propane vapor can be used as a primary fuel source or as a backup fuel source for the generator sets with two independent fuel sources connected to the generator set.

### NOTICE

**NFPA Standard No. 58 requires all persons handling and operating propane to be trained in proper handling and operating procedures.**

### ⚠ WARNING

***Fuel leaks can lead to explosive accumulations of gas. Propane sinks in air and can accumulate inside housings, basements, and other below-grade spaces. Prevent gas leaks and the accumulation of gaseous fuel in the event of a leak.***



The required components in a propane vapor fuel system are as follows.

- Propane tank - Make sure to identify and utilize the correct tank size based on fuel flow requirements and the lowest average temperature for your region. If the tank is sized incorrectly, the generator set could run out of fuel. Refer to the Minimum LPG Tank Size figure in the [Fuel Line Selection](#) Appendix.
- Shutoff valve - Useful during installation or in the event of a leak (may be required to meet local codes).
- Primary regulator - Located at the tank outlet, the primary regulator reduces the tank pressure to the working pressure in the fuel supply line. Primary and secondary regulators must be properly matched for a safe and functional system. Consult with your propane supplier to ensure that the regulators are properly sized.
- Secondary regulator - Located near the generator set, the secondary regulator reduces the higher line pressure to a working pressure of 6-14 inch water column. Higher pressure before the secondary regulator is necessary to ensure that there is enough fuel available at the secondary regulator for a fully loaded generator set.
- Fuel line - Connects to the fuel supply. It must be sized properly using the propane fuel line sizing charts (see the [Fuel Line Selection](#) Appendix). Installation must comply with all national, state, and local codes.
- Cummins flexible fuel line - Protects the fuel system from vibration, expansion, and contraction.

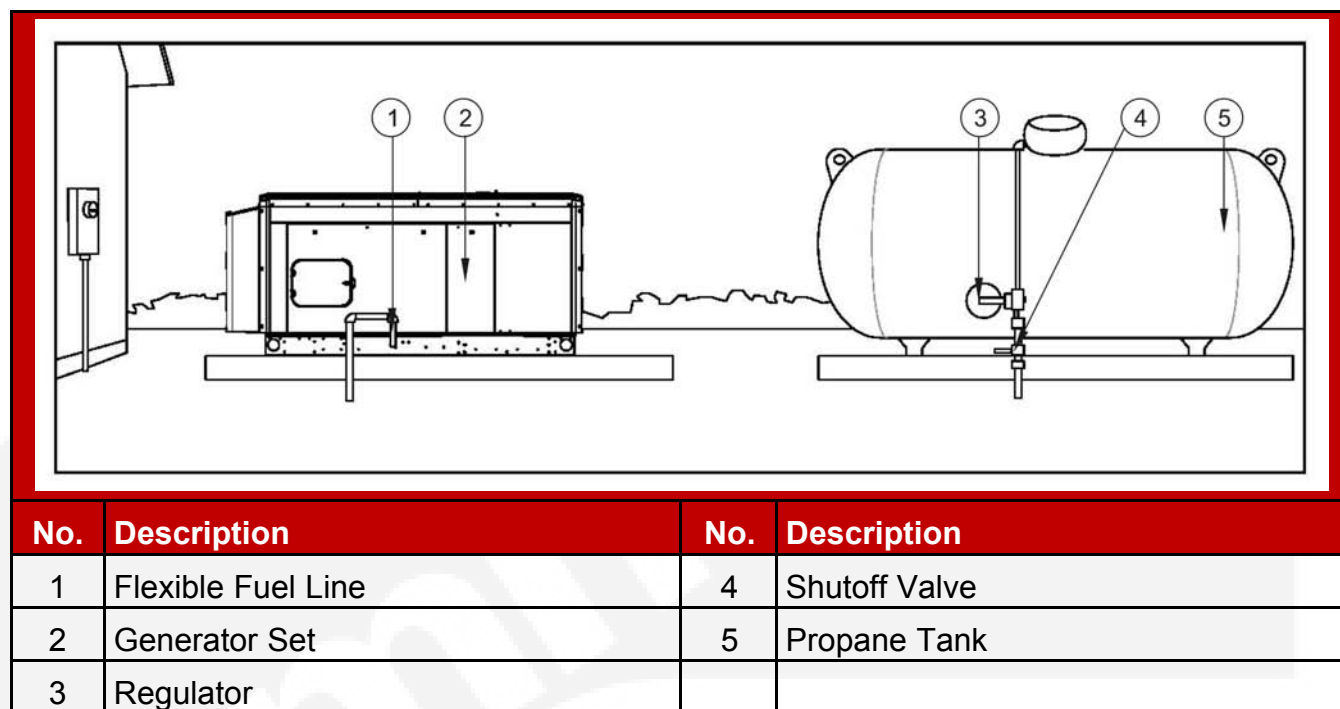


FIGURE 7. TYPICAL PROPANE INSTALLATION

### Recommended Fuel (Propane)

#### ⚠ WARNING

**Propane presents the hazard of fire or explosion that can cause severe personal injury or death. Do not permit any flame, spark, arc-producing equipment, switch, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.**

Use clean, fresh HD-5 grade propane or equivalent product consisting of at least 90% propane.

#### NOTICE

**Commercial propane may contain more than 2.5% butane, which can result in poor fuel vaporization and low tank pressure, resulting in poor engine starting and operation in below 32 °F (0 °C) temperatures.**

### Propane Tank Size

When propane is used, size the tank correctly to ensure successful generator set operation.

Considerations when figuring the proper propane tank size:

- Temperature is a critical factor that affects the size of the tank.
  - Ambient temperatures can affect how quickly liquid is converted to gas.
  - Generator set fuel consumption is the same regardless of the surrounding temperatures.
  - Colder weather climates require larger fuel tanks. Larger tanks have greater surface area, allowing more liquid propane to vaporize and maintain the required fuel rate.
  - Propane is stored as liquid. Keep the fuel tank at least 50% full to operate properly. Fuel tanks that are less than 50% full may not have the capacity to vaporize enough propane to operate the generator set and other LP appliances.
- Propane tanks are sized by their internal volume in gallons, not the amount of fuel they can hold (which is less).
- Propane tanks are generally filled to only 80% of their capacity. Therefore, a 500-gallon tank results in 400-gallon tank capacity.
- Low ambient temperatures affect the amount of fuel available from the propane tank.
- Approximately 60% of the fuel (in gallons) filled in the tank can be effectively used. Therefore, a 500-gallon tank results in 240-gallon usable capacity.

To assist in the proper installation of the propane tank, follow the guidelines below.

- Fit the propane tanks with a pressure reducing regulator before connection to the generator set to prevent fuel system damage.
- Locate the propane tanks at least 10 feet (3 meters) from any source of combustion (including the generator set).
- Install the propane tanks according to all national and local codes and standards.

Refer to the [Fuel Line Selection](#) Appendix for propane figures and tables.

## Sizing Fuel Lines

Incorrect fuel line size may cause the generator set to not run or provide a full load. Fuel line sizes for installations typically range from 1/4-in. to 2 or more inches in diameter.

To determine the optimal fuel line size, the following information is needed:

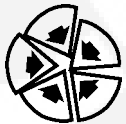
- Fuel flow requirements for the generator set - Larger kW generator sets generally have higher fuel consumption and fuel line size requirements.

- The fuel source (natural gas or propane vapor) - Fuel sources can affect fuel line size. Natural gas installations generally require a higher fuel flow rate compared to propane vapor installations, since propane has a higher energy content.
- Fuel line length (including fittings) - Factor in the equivalent lengths of all of the fittings (elbows, tees, valves) in the installation in addition to the fuel line length. Longer lengths require larger diameters.
- Fuel line type (e.g., copper tubing or iron pipe) - Most fuel line types are iron pipe or copper tubing. Be sure to use the sizing chart for the line type when sizing the fuel line.



There are some basic but very important steps all installers must follow to make sure that fuel lines are sized correctly.

1. Verify adequate fuel flow, quality, and pressure available from utility connection.
2. Determine fuel requirements at full load. (See the Fuel Specifications table in the [Model Specifications](#) section to determine the fuel flow requirements.)
3. Determine equivalent length of fuel line fittings required (See the Fuel Line Size Based on Fitting table in the [Fuel Line Selection](#) Appendix to determine the equivalent lengths for elbows, tees, and valves. Add this length to fuel line length to determine total equivalent length.)
4. Determine required fuel line size at full load. (See the Fuel Line Sizing table in the [Fuel Line Selection](#) Appendix to determine the fuel line size.)



To calculate the minimum pipe size:

1. Make a list of all the fittings and valves in a proposed system and add their equivalent lengths.
2. Add all lengths of straight pipe to arrive at a total equivalent length to the fittings/valves total.
3. Choose the applicable table based on the fuel system and fuel line material.
4. Obtain the maximum fuel requirements for the specific generator set from the manufacturer's specification sheets. Convert to ft<sup>3</sup>/hr as needed.
5. Refer to the fuel line sizing charts in the [Fuel Line Selection](#) Appendix. Locate the equivalent length of pipe (or next larger equivalent length) in the left hand column. Move across the row to where the maximum capacity number is as large as or larger than the maximum fuel consumption (or next larger). At the top of that column is the minimum nominal pipe size or tubing size required for the system as designed.

## Installing Fuel Lines



The basic components required for fuel line installation are as follows.

- Flexible connection
- Fuel line
- Shutoff valve
- Fuel supply



To install the fuel lines:

1. Connect a flexible fuel line to the fuel connection ports on the generator set.
2. Connect the opposite end of the flexible fuel line to the fuel source line.

### NOTICE

**A shutoff valve is recommended and often required by local and state codes.**

## Testing the Fuel System for Leaks

After assembly and before initial operation, all of the fuel system components must be tested and proven free of any leaks.

### ⚠ CAUTION

***Fuel presents the hazard of explosion or fire which can result in severe personal injury or death. Do not use an open flame to check for leaks. Do not smoke or allow any flame, spark, pilot light, arc-producing equipment, switch or other ignition sources around fuel or fuel components.***

### NOTICE

**Follow any local codes and standards, as they may require a different method or documentation of a leak test.**



After assembly, and before initial operation, all fuel system connections, hose, valves, regulators and fittings must be tested and proven free of leaks using a soap-and-water (or equivalent) solution while the system is under gas or air pressure of at least 1.5 times the supply pressure or 3 psi (20.7 kPa) minimum.

1. Pressurize the system to a minimum of one and a half times the required fuel supply pressure.
2. Use a mixture of dish soap and water. Spray on all the joints.
3. Inspect all of the joints and monitor the line pressure. If bubbles appear, there is a leak.

4. If a leak is found, tighten the joints, recheck for leaks, and repair or replace component(s) as needed.

## 4.3 Engine Exhaust

The exhaust system for this generator set is complete and was designed specifically for this engine. Do not modify or add to the exhaust system of this generator set.

### WARNING

***Exhaust gas is deadly. Make sure that the exhaust system terminates away from building vents, windows, doors, and sheltered spaces that may not have ample fresh air ventilation.***

### WARNING

***Engine discharge air and exhaust carry carbon monoxide gas (odorless and invisible) which can cause asphyxiation and death. Never use engine discharge air or exhaust for heating a room or enclosed space.***

## 4.4 Electrical Connections

### NOTICE

**Refer to regional codes and the National Electrical Code (NFPA 70) for all electrical installation requirements.**

### WARNING

***Improper installation can lead to electrocution and damage to property. Electrical connections must be made by a licensed electrician.***

### WARNING

***Automatic startup of the generator set during installation can cause severe personal injury or death. Assure the generator set operation switch is in the OFF position. Disconnect the negative cable from the battery and secure it to prevent contact of the cable to the battery terminal and from starting the generator set.***

Separate conduits are required for:

- Main wiring for generator AC voltage: conductors between the generator set breaker and transfer switch.
- 120 VAC 60 Hz utility house power: power to operate the optional battery charger, coolant heater, or alternator heater.
- Communications: low voltage signals between generator set and transfer switch, data signals between the control and optional remote display, auxiliary input/output signals to/from the control.

## AC Connections

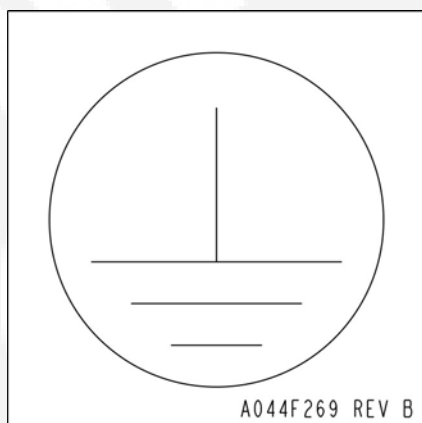
### WARNING

***Automatic startup of the generator set during installation can cause severe personal injury or death. Push the control switch OFF and disconnect the negative (-) cable from the battery and prevent the cable (any electrical connection) from contacting the battery B-terminal to keep the generator set from starting.***

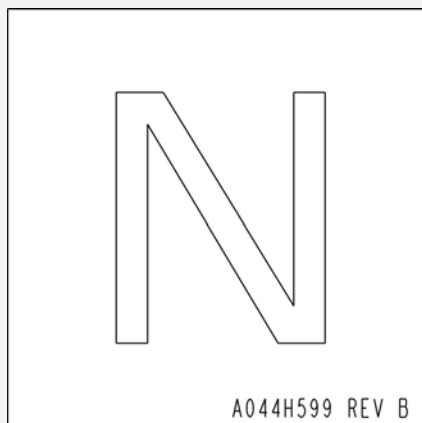
### NOTICE

**Use copper conductors only. 250 amp, 100% rated circuit breaker assembly requires 194 °F (90 °C) conductors.**

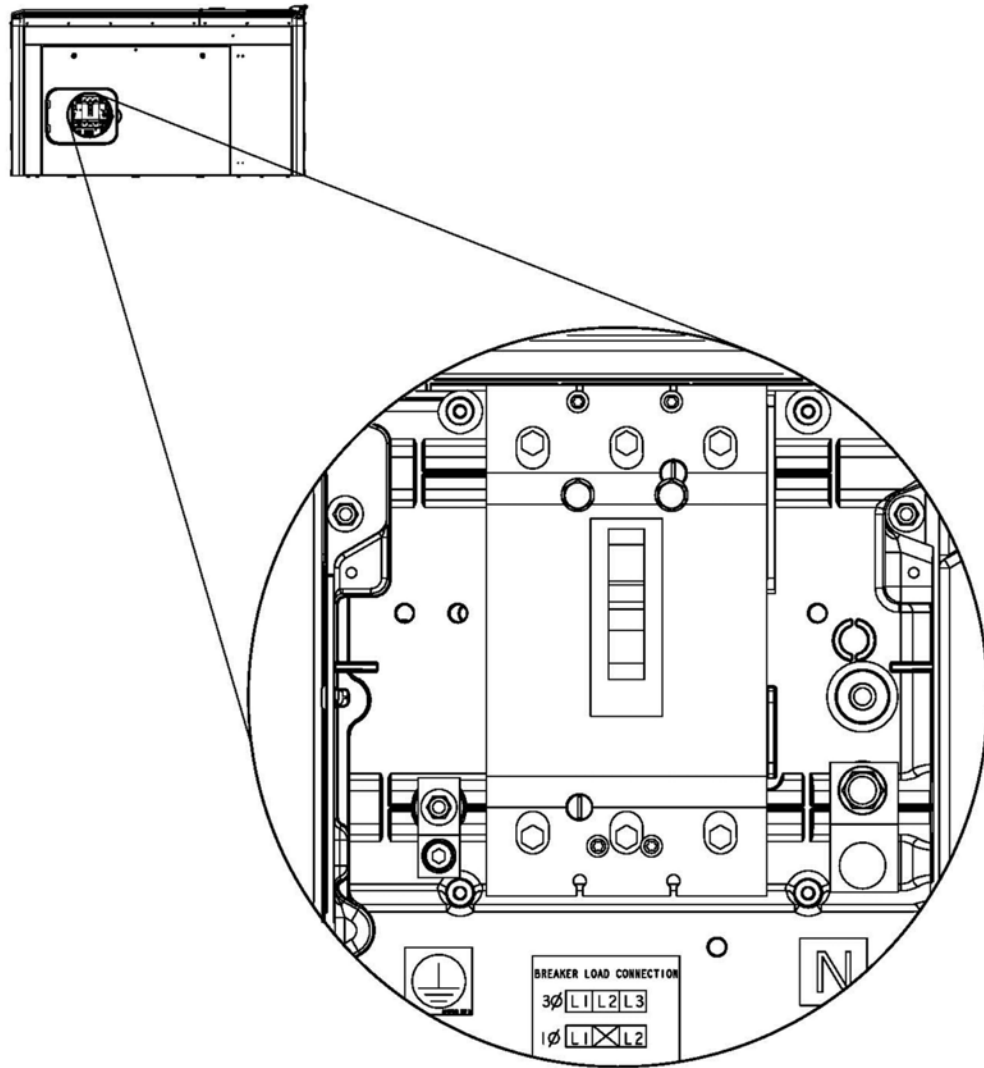
For grounding and neutral connections, look for the following symbols on the generator set circuit breaker cabinets.



**FIGURE 8. EQUIPMENT GROUNDING CONDUCTOR SYMBOL**



**FIGURE 9. EQUIPMENT NEUTRAL CONNECTION SYMBOL**



**FIGURE 10. CIRCUIT BREAKER AC LOAD CONNECTIONS LOCATION**



For connection to the generator set, AC load connections are made in the circuit breaker box. To access:

1. Remove the enclosure side panel to gain access to main circuit breaker box.
2. Place the circuit breaker handle in the OFF position.
3. Remove the four bolts holding the circuit breaker cover.
4. Install the conductors to the circuit breaker load-side terminals, neutral lug, and equipment grounding lug.
5. Torque the circuit breaker terminals per specifications on the circuit breaker label.
6. Torque the neutral lug to 275 inch-pounds (31.1 Nm).
7. Torque the equipment grounding lug to 120 inch-pounds (13.8 Nm).

8. Fill in the stub-up openings with an approved duct seal or mastic tape to keep out insects and rodents.
9. Install the circuit breaker cover.

### Automatic Transfer Switch AC Connections

#### WARNING

*Failure to use an approved transfer switch can lead to the electrocution of personnel working on the utility lines, damage to equipment, fire, or personal injury. An approved switching device must be used to prevent interconnection to the public utility.*



Install the transfer switch in accordance with the Transfer Switch Installation Manual.

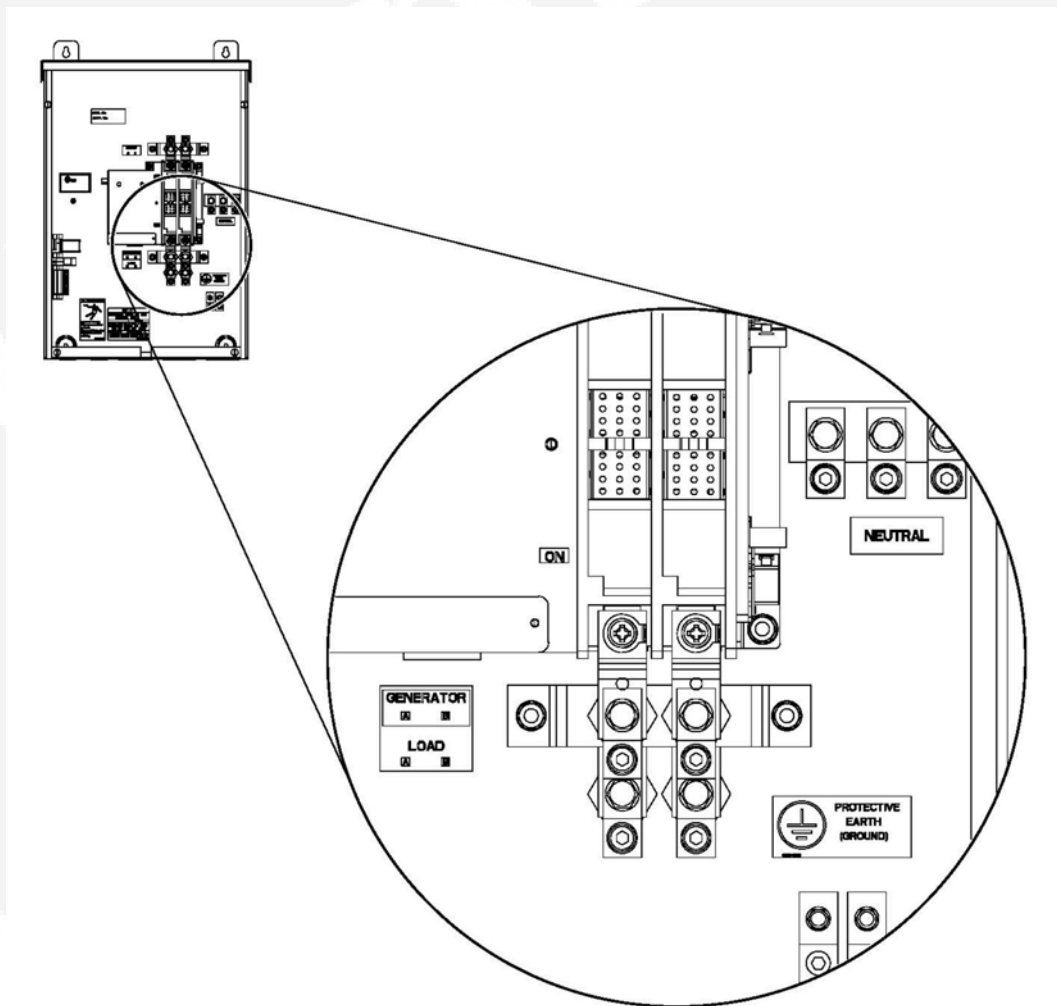


FIGURE 11. RA SERIES TRANSFER SWITCH CONNECTIONS LOCATION

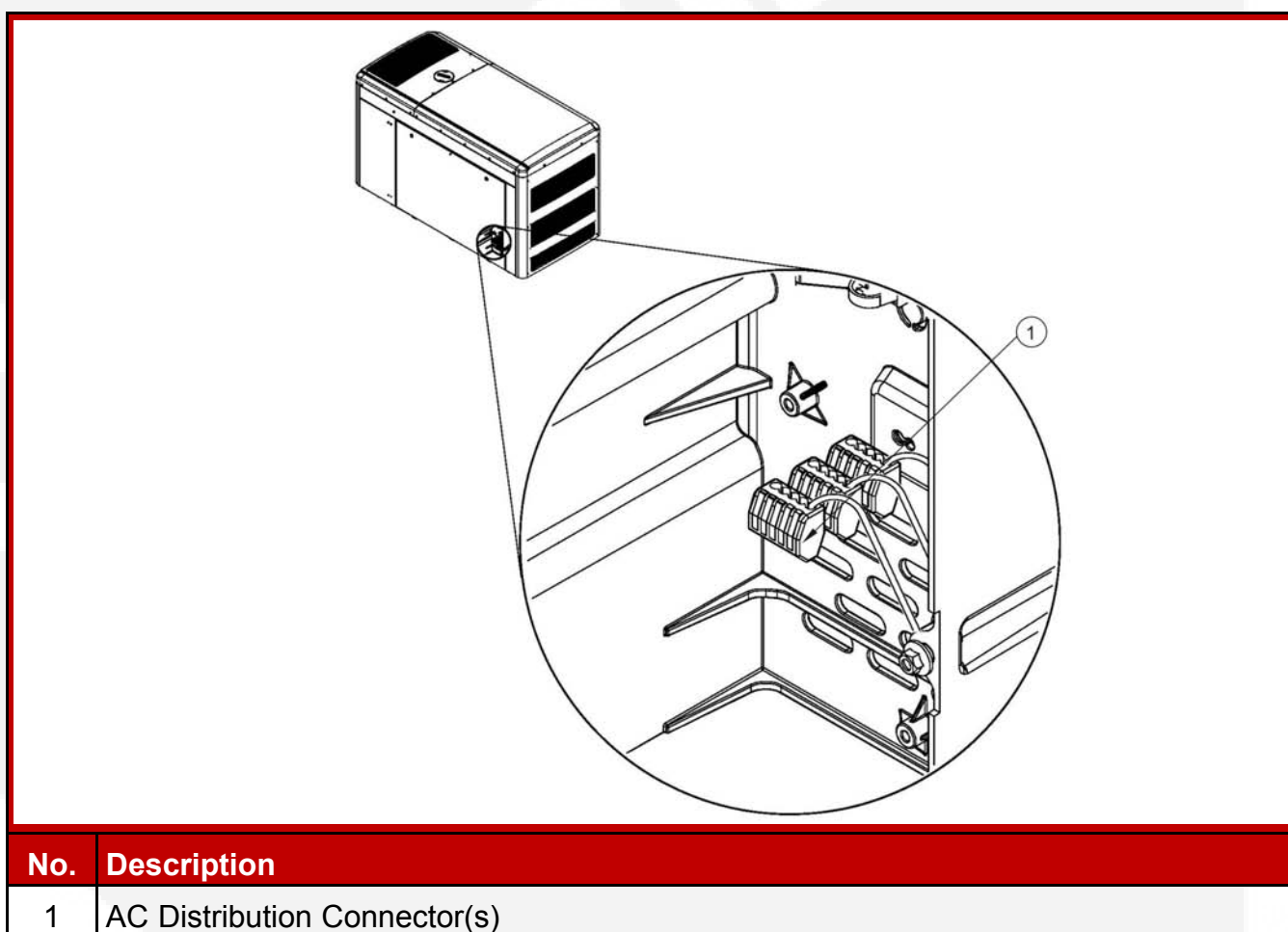
## Factory Option and Accessory Connections

### NOTICE

**Use copper conductors only.**

AC powered options or accessories available:

- Battery charger
- Engine coolant heater
- Alternator heater
- Battery warmer



**FIGURE 12. AC ACCESSORY CONNECTIONS**

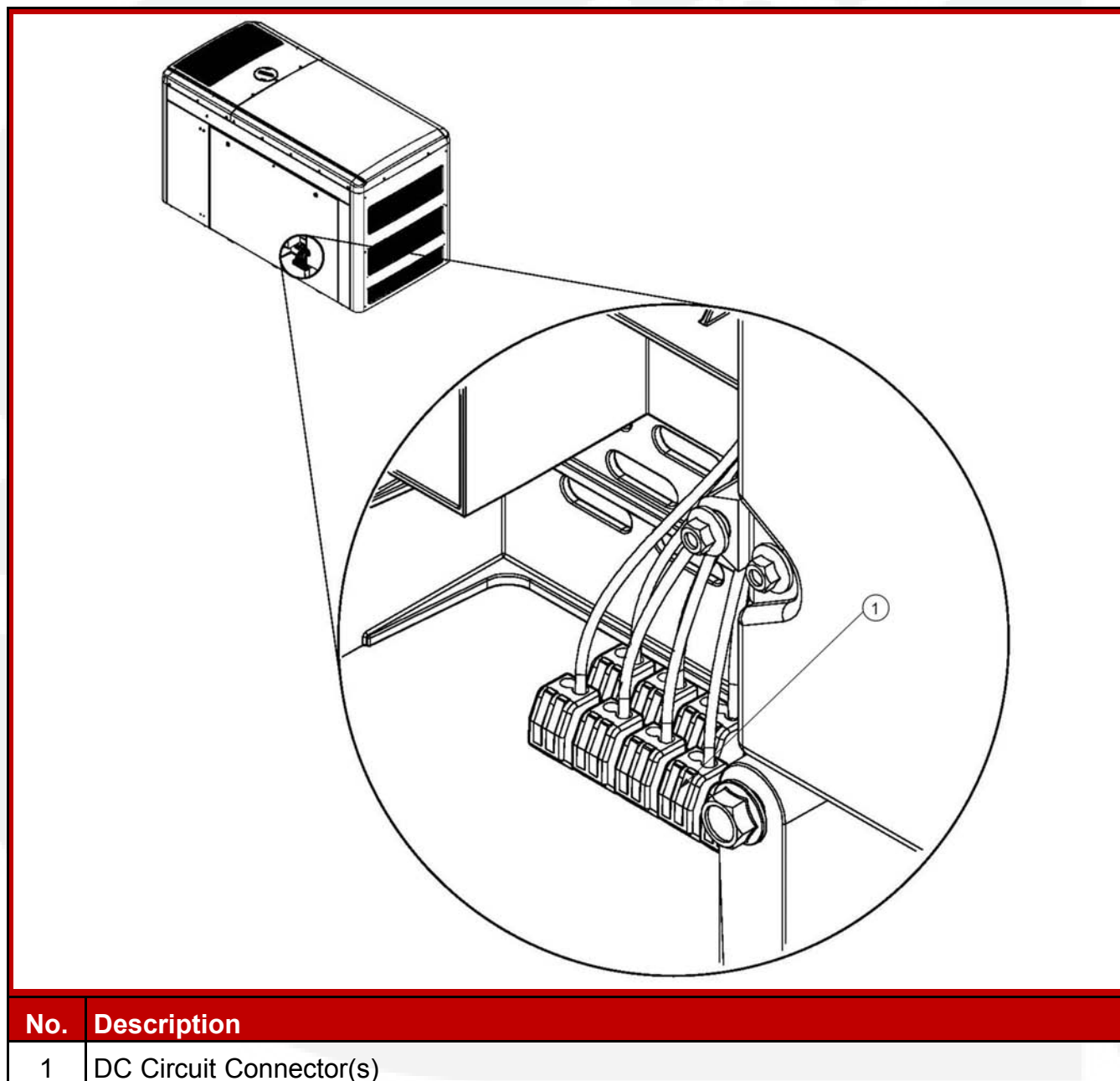


The battery charger, engine coolant heater, alternator heater, and battery warmer require power from a 120 VAC, 20 amp protected circuit from the Main Distribution Panel. Use 12 AWG 167°F (75 °C) conductors to make connection to the generator set AC distribution connector.

## DC Connections

### NOTICE

When selecting and installing conduit to the generator set, account for any needed accessories, such as a remote display, etc.



**FIGURE 13. DC CUSTOMER CONNECTIONS**

## Automatic Transfer Switch DC Connections

### **⚠ WARNING**

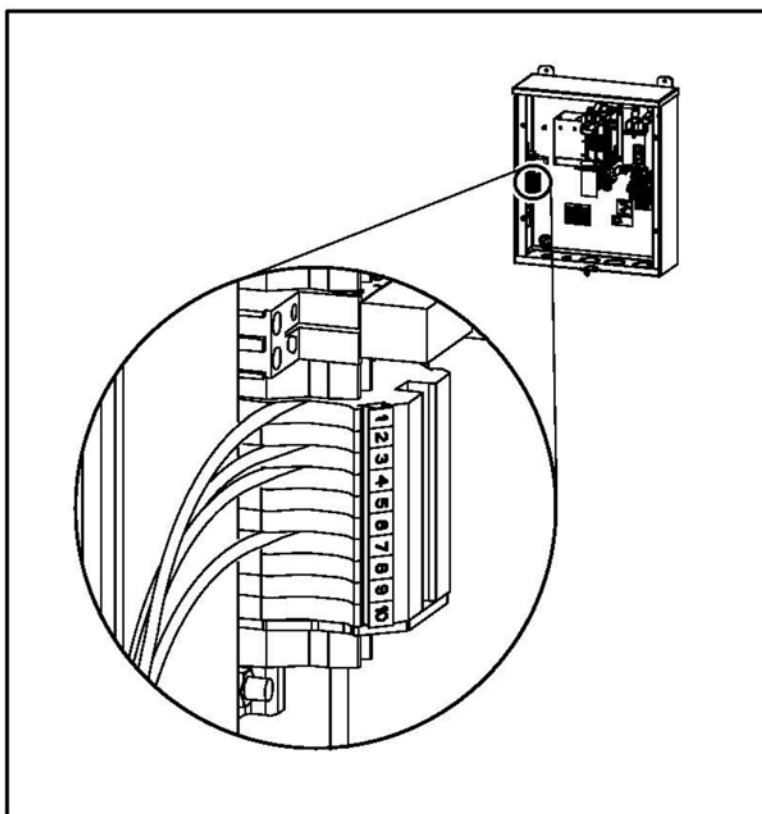
***An approved switching device must be used to prevent interconnection to the public utility. Failure to do so can lead to the electrocution of personnel working on the utility lines, damage to equipment, fire, or personal injury.***



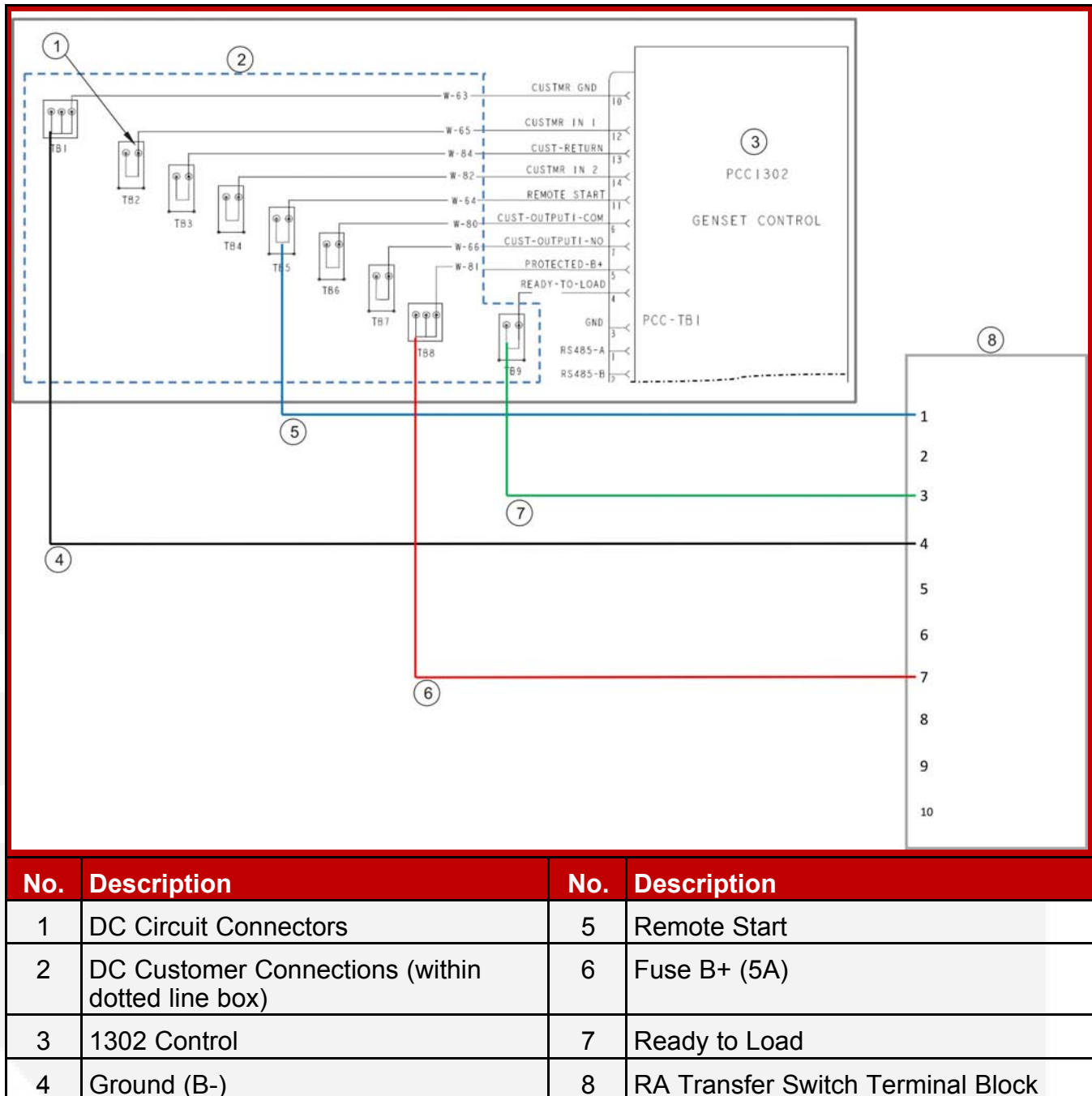
Install the transfer switch in accordance with its Installation Manual. The following images show the location of the Cummins RA Series Transfer Switch customer connections.

### **NOTICE**

**Class 1 wiring methods should be used for connecting the generator set and transfer switch signal wiring.**



**FIGURE 14. RA SERIES TRANSFER SWITCH CONNECTIONS LOCATION**

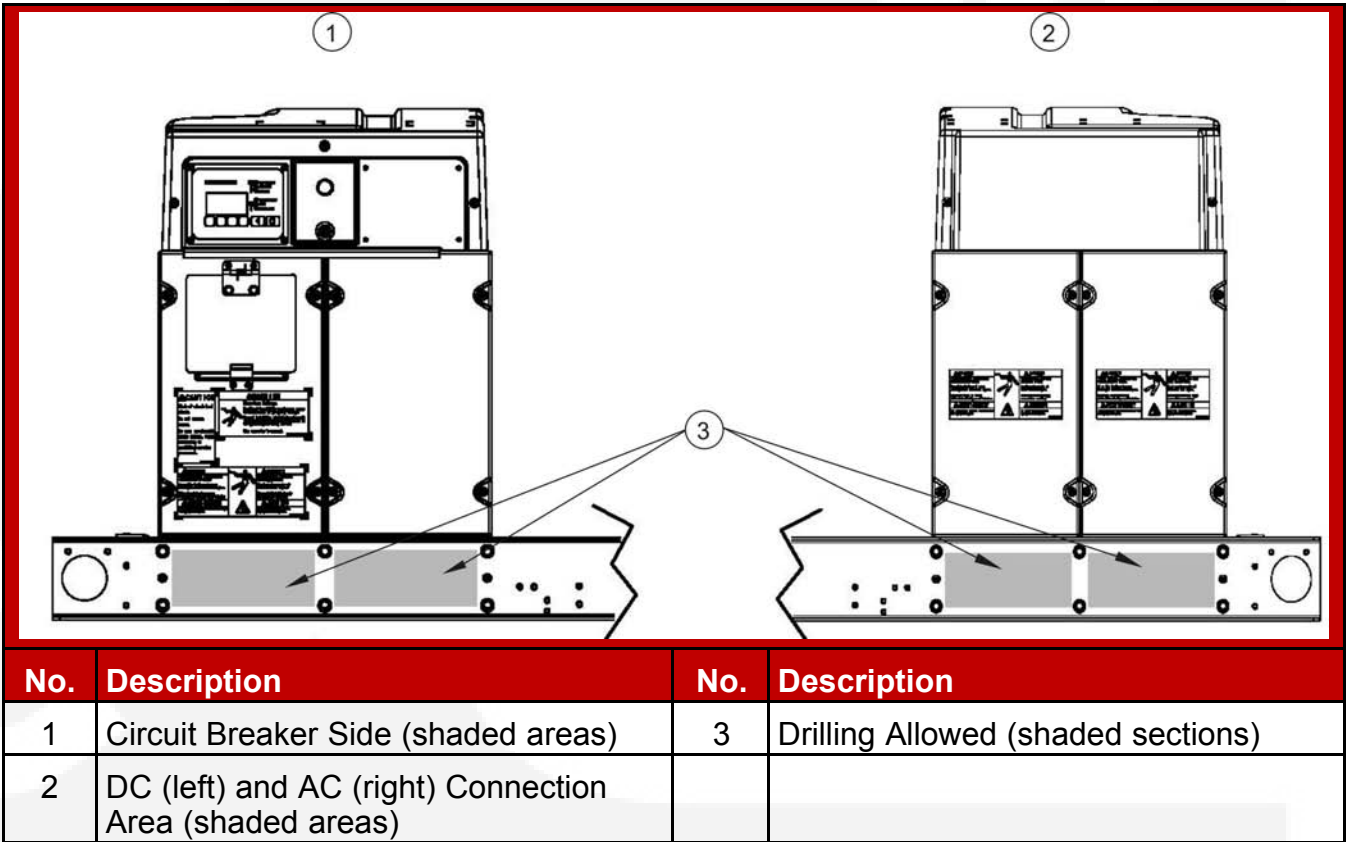


**FIGURE 15. GENERATOR SET TO RA TRANSFER SWITCH DC CUSTOMER CONNECTIONS**

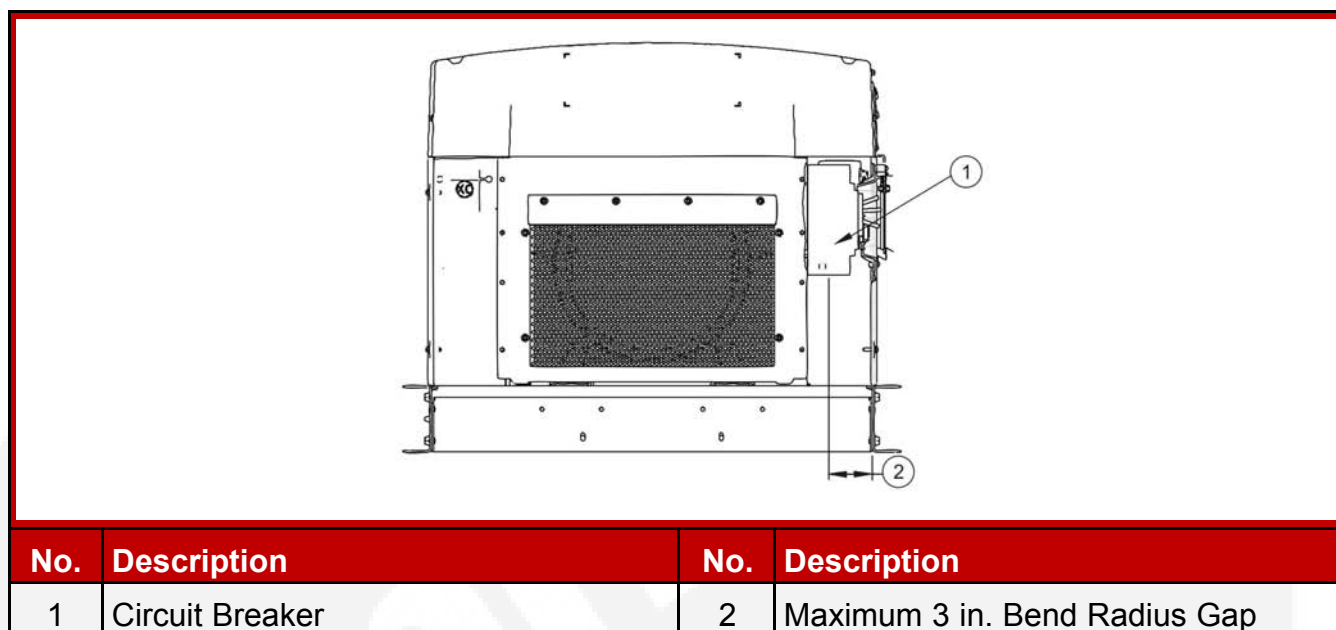
## Drilling Locations for Electrical Connections

Preferred routing of electrical leads is vertically through conduit that is installed in the mounting pad that terminates in the electrical connection areas. Refer to the generator set Foundation Outline drawing in the [Outline and System Drawings Appendix](#) for location of electrical connection areas. In some cases, it may be necessary to route electrical leads horizontally in conduits that pass through the

generator set chassis. Refer to the figure below for available drilling space for conduit holes in the side of the chassis. Holes up to 3 inches in diameter can be made in the chassis in the areas shown. Exceeding 3 inches in diameter may cause failure of the chassis. Comply to NEC and local codes and standards for installation of wires for electrical circuits. Refer to NEC standards for required wire bend radius and ampacity of load leads.



**FIGURE 16. DRILLING LOCATIONS FOR SIDE ELECTRICAL CONNECTIONS**



**FIGURE 17. CABLING ROOM FOR CIRCUIT BREAKER**

## Grounding

### NOTICE

The generator set is shipped from the factory with the neutral and equipment ground not bonded together.

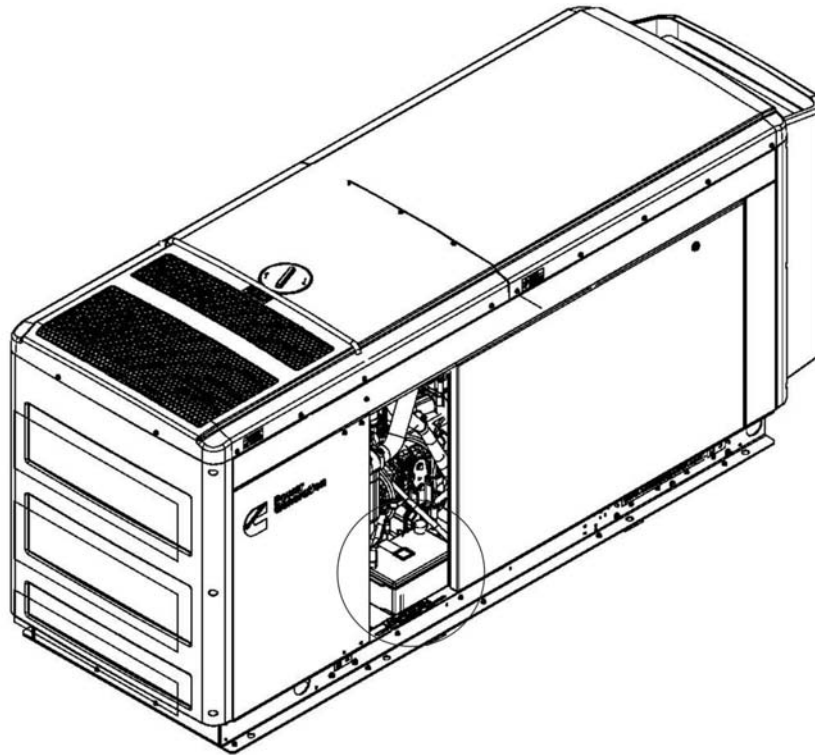
Refer to local codes and standards for grounding procedures.

## Battery

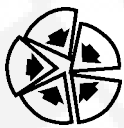


The generator set requires a 12V battery (negatively grounded) for engine cranking and powering the electronic control system. When the generator set is running, the battery is charged from the engine-driven battery alternator. When the set is not running, an AC powered battery charger is needed to keep the battery charged.

As part of the installation, make sure that the battery is secured to the battery tray with the strap provided.



**FIGURE 18. BATTERY LOCATION**



To connect the battery:

1. Connect the positive battery terminal.
2. Connect the negative battery terminal.
3. Make sure that the black and red battery cable boots are in place.

Refer to the [Model Specifications section](#) for battery specifications.

An optional thermostatically controlled battery heater is available for more reliable starting in ambient temperatures down to -40 °F (-40 °C).

To prevent injury due to accidental startup, do not connect the battery cables to the battery until the installation has been completed; tools, rags, and body parts are away from any rotating parts or electrically live parts; and it is time to start the set.

**NOTICE**

**Ensure that the AC power to the battery charger is disconnected when installing the battery.**

**NOTICE**

**Wear proper safety protection when working around batteries. Keep open flames and sparks away from the equipment.**

**NOTICE**

**Only personnel knowledgeable of batteries and required precautions should perform or supervise battery servicing.**



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## 5 Startup and Configuration

---

### 5.1 Brightness and Contrast

The Screen Adjust Menu allows the contrast, brightness, and units to be set. To access the Screen Adjust Menu:

1. From any Information screen, hold down the up and down arrows simultaneously for two seconds to gain access to the Service Menu screen.
2. Select **Screen Adjust**.

To adjust the contrast, brightness, or units from the Screen Adjust screen:

1. From the Screen Adjust Menu, select **Adjust** to access the screen variables.
2. Press the right arrow to move between the variables.
3. Adjust settings, and press **Save** to save any changes.

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

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

#### **NOTICE**

The following screens represent the standard operator panel (HMI211). If using an in-home operator panel, which may be additionally purchased as an option, the screens may look slightly different. This procedure applies to both operator panels.

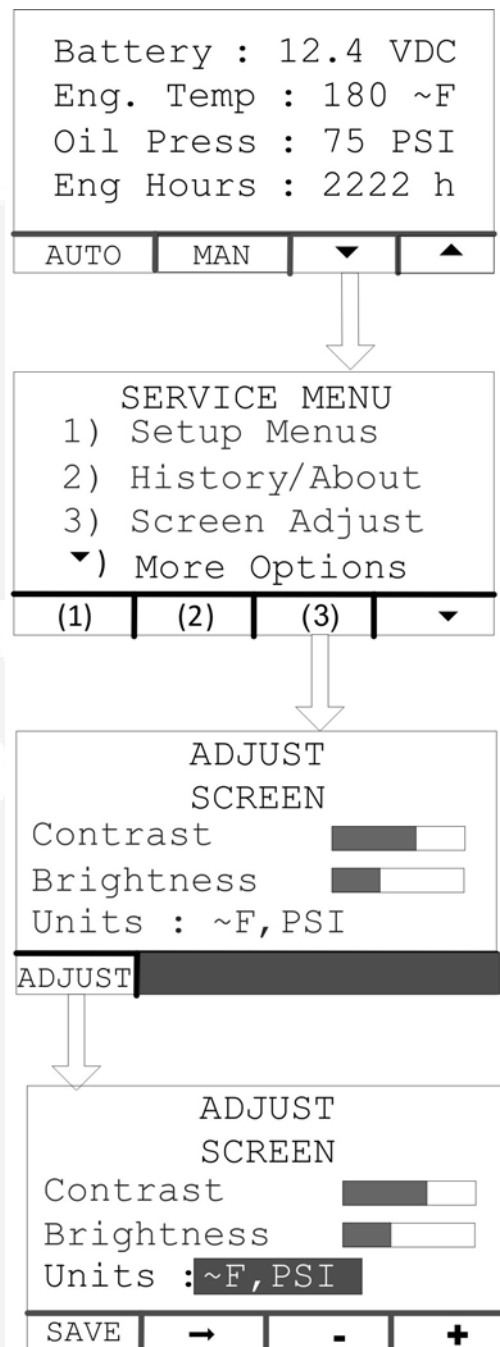


FIGURE 19. BRIGHTNESS AND CONTRAST MENU NAVIGATION

**NOTICE**

Adjusting the brightness on the Operator Panel adjusts the brightness of both the LCD backlight and the LEDs on the display. The contrast should never be 0 or 100% on any of the screens. The default value for Brightness is 50%.

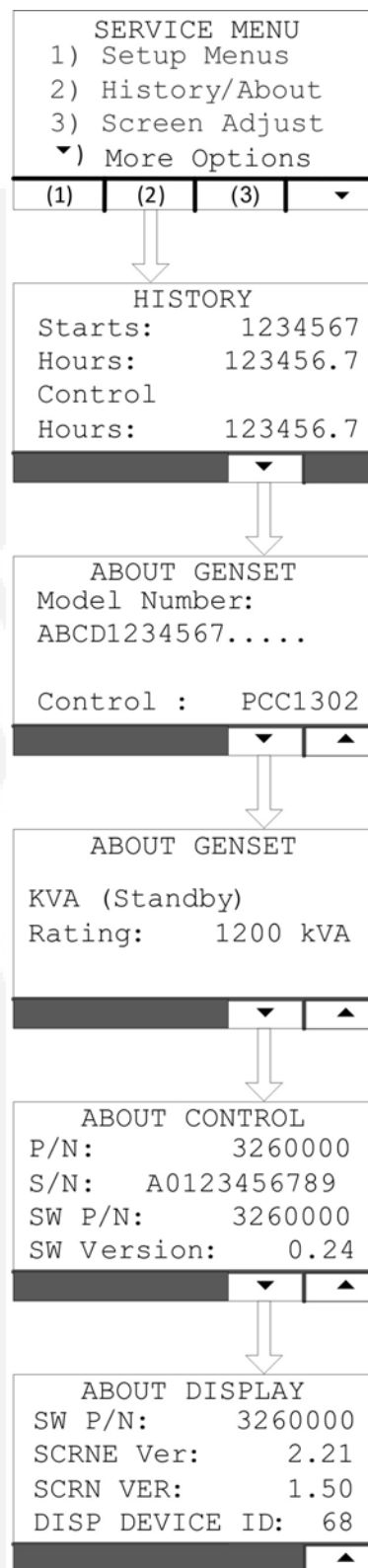
## 5.2 History and About Menu

To access the History/About Menu:

1. From any Information Menu, hold down the up and down arrows simultaneously for two seconds. The Service Menu appears.
2. Select **History/About**.
3. Advance through the screens to view information about the generator set, control, and display.

### NOTICE

**The following screens represent the standard operator panel (HMI211). If using an in-home operator panel, which may be additionally purchased as an option, the screens may look slightly different. This procedure applies to both operator panels.**

**FIGURE 20. HISTORY/ABOUT MENU**

## 5.3 Time Setup

### NOTICE

**When battery power is lost, these settings must be reset.**

To set up the generator set clock for the current date and time:

1. Access the Time Setup Menu by selecting **Clock Exerciser** on the Genset Service Menu.
2. Select **Adjust**.

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

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

TIME SETUP

Date : 00:00:00  
mm:dd:yy

Time : 00:00 AM

ADJUST

TIME SETUP

Date : 00:00:00  
mm:dd:yy

Time : 00:00 AM

SAVE → - +

**FIGURE 21. TIME SETUP SCREEN**

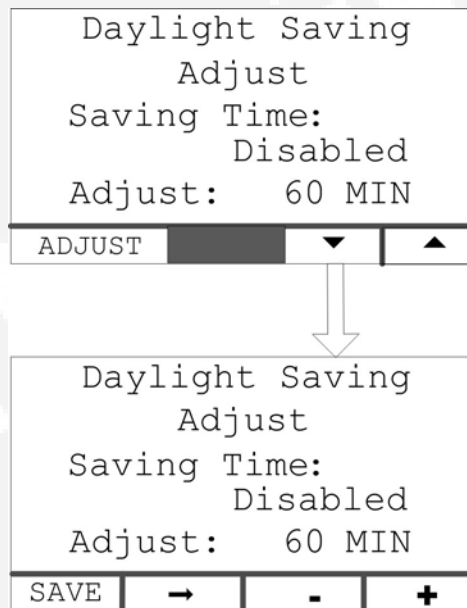
### Updating Daylight Saving Adjust Menu

To update the Savings Time and Adjustment on the Daylight Saving Adjust Menu:

1. Press the down key on the Time Setup Menu to access the Daylight Saving Adjust Menu.
2. Select **Adjust**.

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

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



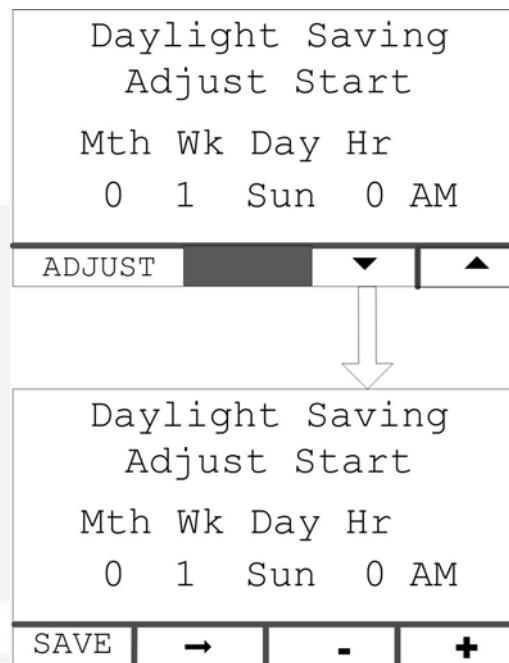
**FIGURE 22. DAYLIGHT SAVING ADJUST MENU NAVIGATION**

To access and update the Daylight Saving Adjust Start Menu:

1. Press the down key on the Daylight Saving Adjust Menu.
2. Press **Adjust**.

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

- The horizontal right arrow key is used to select successive blocks for editing settings on the screen.
- Use the + or - keys to edit the following settings:
  - Month
  - Week
  - Day
  - Hour
- Press **Save** to save any changes. After savings, the Save button changes to the Adjust button.



**FIGURE 23. DAYLIGHT SAVING ADJUST START MENU**

To access and update the Daylight Saving Adjust End Menu:

1. Press the down key on the Daylight Saving Adjust Start Menu.
2. Press **Adjust**.

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

- The horizontal right arrow key is used to select successive blocks for editing settings on the screen.
- Use the + or - keys to edit the following settings:
  - Month
  - Week
  - Day
  - Hour
- Press **Save** to save any changes. After savings, the Save button changes to the Adjust button.

The diagram illustrates the 'Daylight Saving Adjust End' menu. The top screen shows the title 'Daylight Saving Adjust End' and fields for 'Mth', 'Wk', 'Day', and 'Hr' with values '0', '1', 'Sun', and '0 AM' respectively. Below these fields is a control bar with the label 'ADJUST', a solid black bar, a downward arrow, and an upward arrow. A large downward arrow points from this screen to a second, identical screen. The second screen's control bar features a 'SAVE' button, followed by right, left, and plus/minus navigation arrows.

FIGURE 24. DAYLIGHT SAVING ADJUST END MENU

## 5.4 Exercise Settings

### NOTICE

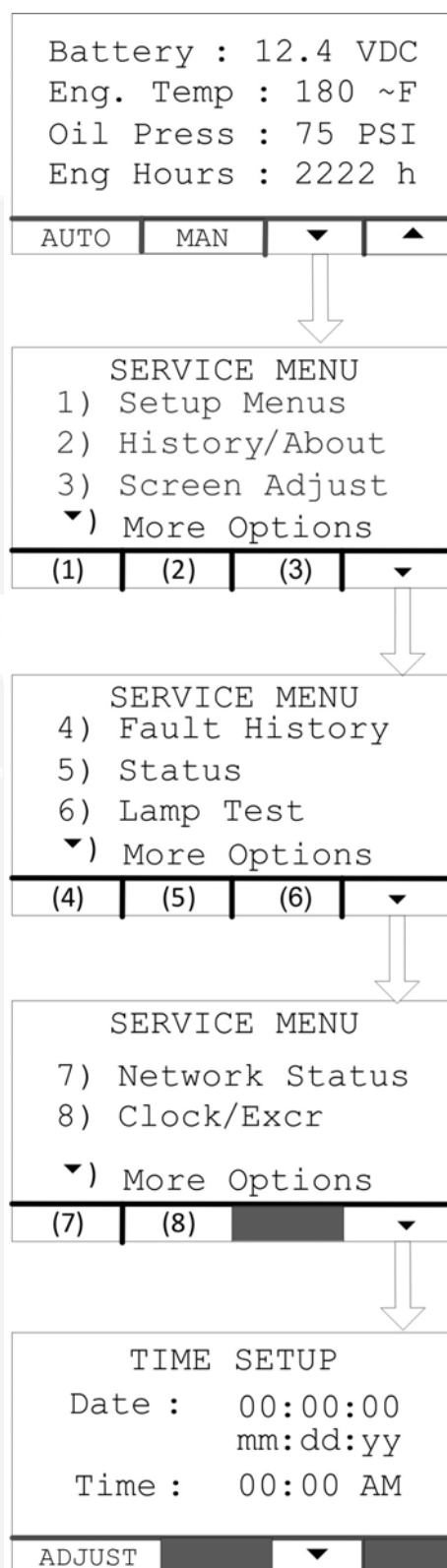
**When the battery power is lost, these settings must be reset.**

To access the Clock/Exerciser Menu:

1. From any Information Menu, hold down the up and down arrows simultaneously for two seconds. The Service Menu appears.
2. Navigate through the screens to find and select **Clock/Excr** in the Service Menu.

### NOTICE

**The following screens represent the standard operator panel (HMI211). If using an in-home operator panel, which may be additionally purchased as an option, the screens may look slightly different. This procedure applies to both operator panels.**

**FIGURE 25. CLOCK/EXERCISER MENU NAVIGATION**

## Updating Exercise Frequency

To update the exercise frequency and dates on the Clock/Exerciser Menu:

1. Press **Exercise Schdr** on the Daylight Saving Adjust End Menu.
2. Press **Adjust**.

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

- The horizontal right arrow key is used to select successive blocks for editing settings on the screen.
- Use the + or - keys to edit the following settings:
  - Schdr Enable: Enable or Disable
  - Exercise Schedule: Semi-Annual (every six months), Quarterly, Monthly, Bi-Weekly (every two weeks) , or Weekly
  - Exercise Schedule: Day, Hours, Minutes, AM/PM
- Press **Save** to save any changes. After savings, the Save button changes to the Adjust button.

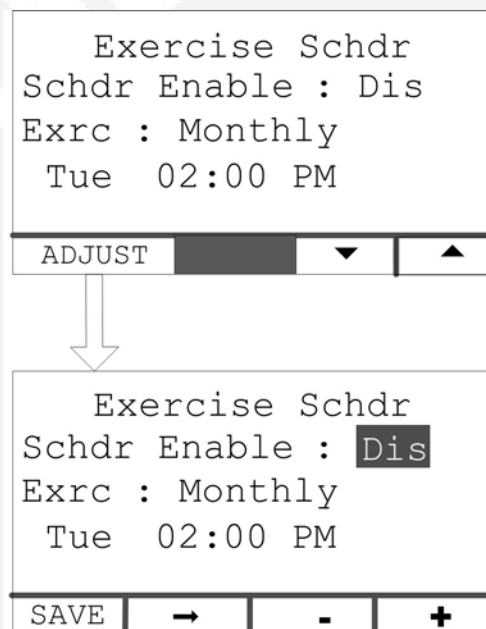


FIGURE 26. EXERCISE FREQUENCY NAVIGATION

## Updating Exercise Duration

To update the exercise duration on the Clock/Exerciser Menu:

1. Press the down key on the Exercise Schdr Menu.
2. Press **Adjust**.

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

- The horizontal right arrow key is used to select the duration block for editing exercise duration.

- Use the + or - keys to edit the exercise duration minutes.
- Press **Save** to save any changes. After savings, the Save button changes to the Adjust button.

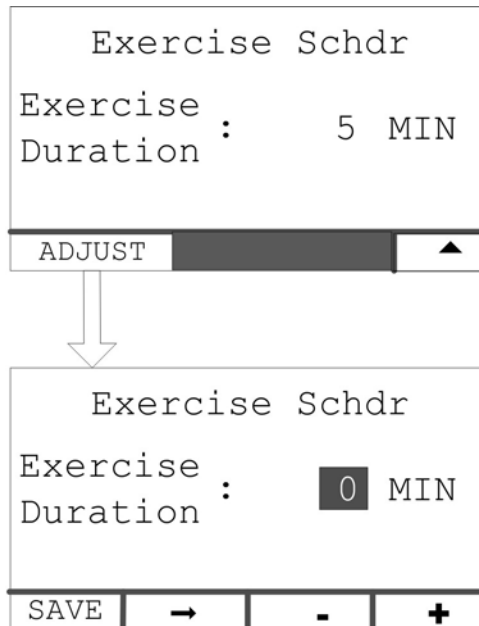


FIGURE 27. EXERCISE DURATION NAVIGATION

## 5.5 Commissioning Checklist



The commissioning checklist should be completed for each installation. There are four sections. It is important to complete the information to validate the completion of the generator set startup procedure under Cummins Power Generation recommendations. For a copy of the commissioning checklist, download it from ChannelOne Portal or contact your local dealer.

## 5.6 Startup

### ⚠ WARNING

***Automatic startup of the generator set during installation can cause severe personal injury or death. Push the control switch OFF and disconnect the negative (-) cable from the battery to keep the generator set from starting.***

After verifying that the installation was completed correctly, start and test the system. Make sure to connect the battery cables to the battery with the positive (+) cable first.



Read through the Operator Manual and perform the maintenance and pre-start checks as instructed. The generator set is shipped from the factory with the proper level of engine oil and coolant, but should be checked before it is started. Start and operate the generator set following all the instructions and precautions in the Operator Manual. Ensure that the bonding bolts are reinstalled into the service panels before leaving the site.

**NOTICE**

**Before leaving the site, if the generator set is ready to be placed in service, set the control switch to the AUTO position to provide automatic standby power.**

**NOTICE**

**Contact your local Cummins service representative if you encounter a fault code.**

# Appendix A. Fuel Line Selection

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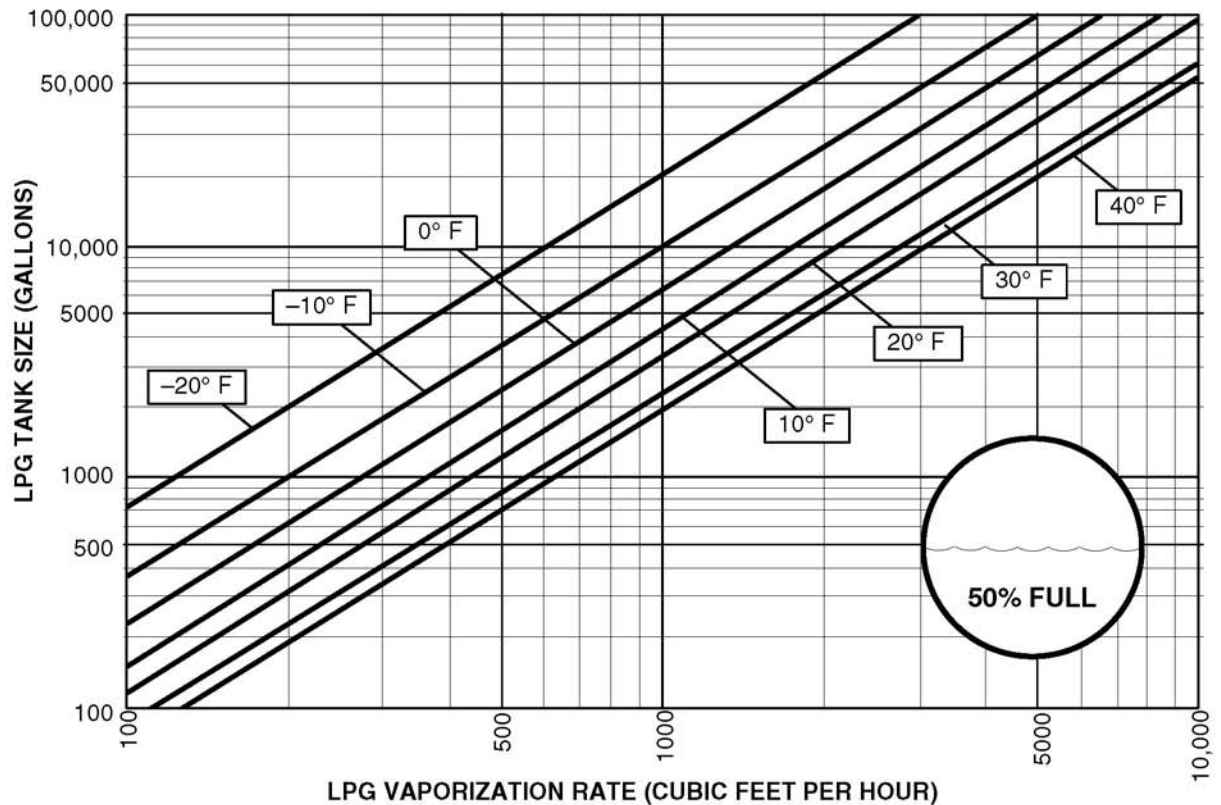
## A.0 Gas Pipe Sizing

Sizing of gas piping for proper fuel delivery, both flow and pressure, can become quite complex. However, a simplified method, is to convert all fittings, valves, etc. to equivalent lengths of pipe in the diameter(s) being considered. The total equivalent length can then be related to flow capacity.

Tables are included for natural gas, propane liquid withdrawal and propane vapor withdrawal under specified conditions. Consult NFPA 54 or other applicable codes for other operating conditions or other fuel system installation requirements. The tables displayed in this section are reprinted with permission from NFPA 54-2002, National Fuel Gas Code, Copyright © 2002, National Fire Protection Association, Quincy, MA 02169. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety.

A calculation of minimum pipe size is fairly straightforward:

- Make a list of all the fittings and valves in a proposed system and sum their equivalent lengths using the table.
- Add to this total, all lengths of straight pipe to arrive at a total equivalent length.
- Choose the applicable table based on the fuel system.
- Obtain the maximum fuel requirements for the specific generator set(s) from the manufacturer's specification sheets. Convert to ft<sup>3</sup>/hr as needed.
- Locate the equivalent length of pipe (or next larger equivalent length) in the left hand column. Move across the row to where the maximum capacity number is as large as or larger than the maximum fuel consumption (or next larger). At the top of that column is the minimum nominal pipe size or tubing size required for the system as designed.



**FIGURE 28. MINIMUM LPG TANK SIZE (50% FULL) REQUIRED TO MAINTAIN 5 PSIG AT SPECIFIC WITHDRAWAL RATE AND MINIMUM EXPECTED WINTER TEMPERATURE**

**TABLE 16. NATURAL GAS SCHEDULE 40 IRON PIPE SIZING**

| <b>Gas: Natural</b><br><b>Inlet Pressure: 0.5 psi or less</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 0.60</b> |                                                |       |       |       |       |       |       |       |       |       |       |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                                                                      | Pipe Size (in.)                                |       |       |       |       |       |       |       |       |       |       |
| Nominal                                                                                                                              | 1/4                                            | 3/8   | 1/2   | 3/4   | 1     | 1 1/4 | 1 1/2 | 2     | 2 1/2 | 3     | 4     |
| Actual ID                                                                                                                            | 0.364                                          | 0.493 | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| Length (ft)                                                                                                                          | Maximum Capacity in Cubic Feet of Gas per Hour |       |       |       |       |       |       |       |       |       |       |

| <b>Gas: Natural</b><br><b>Inlet Pressure: 0.5 psi or less</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 0.60</b> |    |    |     |     |     |      |      |      |      |       |       |
|--------------------------------------------------------------------------------------------------------------------------------------|----|----|-----|-----|-----|------|------|------|------|-------|-------|
| <b>10</b>                                                                                                                            | 43 | 95 | 175 | 360 | 680 | 1400 | 2100 | 3950 | 6300 | 11000 | 23000 |
| <b>20</b>                                                                                                                            | 29 | 65 | 120 | 250 | 465 | 950  | 1460 | 2750 | 4350 | 7700  | 15800 |
| <b>30</b>                                                                                                                            | 24 | 52 | 97  | 200 | 375 | 770  | 1180 | 2200 | 3520 | 6250  | 12800 |
| <b>40</b>                                                                                                                            | 20 | 45 | 82  | 170 | 320 | 660  | 990  | 1900 | 3000 | 5300  | 10900 |
| <b>50</b>                                                                                                                            | 18 | 40 | 73  | 151 | 285 | 580  | 900  | 1680 | 2650 | 4750  | 9700  |
| <b>60</b>                                                                                                                            | 16 | 36 | 66  | 138 | 260 | 530  | 810  | 1520 | 2400 | 4300  | 8800  |
| <b>70</b>                                                                                                                            | 15 | 33 | 61  | 125 | 240 | 490  | 750  | 1400 | 2250 | 3900  | 8100  |
| <b>80</b>                                                                                                                            | 14 | 31 | 57  | 118 | 220 | 460  | 690  | 1300 | 2050 | 3700  | 7500  |
| <b>90</b>                                                                                                                            | 13 | 29 | 53  | 110 | 205 | 430  | 650  | 1220 | 1950 | 3450  | 7200  |
| <b>100</b>                                                                                                                           | 12 | 27 | 50  | 103 | 195 | 400  | 620  | 1150 | 1850 | 3250  | 6700  |
| <b>125</b>                                                                                                                           | 11 | 24 | 44  | 93  | 175 | 360  | 550  | 1020 | 1650 | 2950  | 6000  |
| <b>150</b>                                                                                                                           | 10 | 22 | 40  | 84  | 160 | 325  | 500  | 950  | 1500 | 2650  | 5500  |
| <b>175</b>                                                                                                                           | 9  | 20 | 37  | 77  | 145 | 300  | 460  | 850  | 1370 | 2450  | 5000  |
| <b>200</b>                                                                                                                           | 8  | 19 | 35  | 72  | 135 | 280  | 430  | 800  | 1280 | 2280  | 4600  |

**TABLE 18. NATURAL GAS SEMI-RIGID COPPER TUBING SIZING**

| <b>Gas: Natural</b><br><b>Inlet Pressure: 0.5 psi or less</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 0.6</b> |                 |                                                |       |       |       |       |       |       |       |       |       |
|-------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Gas: Natural</b><br><b>Inlet Pressure: 0.5 psi or less</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 0.6</b> |                 |                                                |       |       |       |       |       |       |       |       |       |
|                                                                                                                                     | Tube Size (in.) |                                                |       |       |       |       |       |       |       |       |       |
| Nominal                                                                                                                             | K & L           | 1/4                                            | 3/8   | 1/2   | 5/8   | 3/4   | 1     | 1 1/4 | 1 1/2 | 2     | 2 1/2 |
|                                                                                                                                     | ACR             | 3/8                                            | 1/2   | 5/8   | 3/4   | 7/8   | 1 1/8 | 1 3/8 | 1 5/8 | 2 1/8 | 2 5/8 |
| Outside                                                                                                                             |                 | 0.375                                          | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 | 2.625 |
| Inside                                                                                                                              |                 | 0.305                                          | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 | 2.435 |
| Length (ft)                                                                                                                         |                 | Maximum Capacity in Cubic Feet of Gas per Hour |       |       |       |       |       |       |       |       |       |

| <b>Gas: Natural</b><br><b>Inlet Pressure: 0.5 psi or less</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 0.6</b> |     |     |     |     |     |     |      |      |      |      |
|-------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| <b>10</b>                                                                                                                           | 27  | 55  | 111 | 195 | 276 | 590 | 1062 | 1675 | 3489 | 6173 |
| <b>20</b>                                                                                                                           | 18  | 38  | 77  | 134 | 190 | 406 | 730  | 1151 | 2398 | 4242 |
| <b>30</b>                                                                                                                           | 15  | 30  | 61  | 107 | 152 | 326 | 586  | 925  | 1926 | 3407 |
| <b>40</b>                                                                                                                           | 13  | 26  | 53  | 92  | 131 | 279 | 502  | 791  | 1648 | 2916 |
| <b>50</b>                                                                                                                           | 11  | 23  | 47  | 82  | 116 | 247 | 445  | 701  | 1461 | 2584 |
| <b>60</b>                                                                                                                           | 10  | 21  | 42  | 74  | 105 | 224 | 403  | 635  | 1323 | 2341 |
| <b>70</b>                                                                                                                           | 9.3 | 19  | 39  | 68  | 96  | 206 | 371  | 585  | 1218 | 2154 |
| <b>80</b>                                                                                                                           | 8.6 | 18  | 36  | 63  | 90  | 192 | 345  | 544  | 1133 | 2004 |
| <b>90</b>                                                                                                                           | 8.1 | 17  | 34  | 59  | 84  | 180 | 324  | 510  | 1063 | 1880 |
| <b>100</b>                                                                                                                          | 7.6 | 16  | 32  | 56  | 79  | 170 | 306  | 482  | 1004 | 1776 |
| <b>125</b>                                                                                                                          | 6.8 | 14  | 28  | 50  | 70  | 151 | 271  | 427  | 890  | 1574 |
| <b>150</b>                                                                                                                          | 6.1 | 13  | 26  | 45  | 64  | 136 | 245  | 387  | 806  | 1426 |
| <b>175</b>                                                                                                                          | 5.6 | 12  | 24  | 41  | 59  | 125 | 226  | 356  | 742  | 1312 |
| <b>200</b>                                                                                                                          | 5.2 | 11  | 22  | 39  | 55  | 117 | 210  | 331  | 690  | 1221 |
| <b>250</b>                                                                                                                          | 4.7 | 10  | 20  | 34  | 48  | 103 | 186  | 294  | 612  | 1082 |
| <b>300</b>                                                                                                                          | 4.2 | 8.7 | 18  | 31  | 44  | 94  | 169  | 266  | 554  | 980  |

Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 20. PROPANE VAPOR SCHEDULE 40 IRON PIPE SIZING**

| <b>Gas: Undiluted Propane</b><br><b>Inlet Pressure: 11.0 in. w.c.</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 1.50</b><br><b>Special Use: Pipe sizing between single or second stage (low pressure regulator) and appliance.</b> |                                                      |       |       |       |       |       |       |       |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                                                                                                                                                                                        | <b>Pipe Size (in.)</b>                               |       |       |       |       |       |       |       |       |
| <b>Nominal Inside</b>                                                                                                                                                                                                                                  | 1/2                                                  | 3/4   | 1     | 1 1/4 | 1 1/2 | 2     | 3     | 3 1/2 | 4     |
| <b>Actual:</b>                                                                                                                                                                                                                                         | 0.622                                                | 0.824 | 1.049 | 1.38  | 1.61  | 2.067 | 3.068 | 3.548 | 4.026 |
| <b>Length (ft)</b>                                                                                                                                                                                                                                     | <b>Maximum Capacity in Thousands of Btu per Hour</b> |       |       |       |       |       |       |       |       |

| <b>Gas: Undiluted Propane</b><br><b>Inlet Pressure: 11.0 in. w.c.</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 1.50</b><br><b>Special Use: Pipe sizing between single or second stage (low pressure regulator) and appliance.</b> |     |     |      |      |      |      |       |       |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|------|------|-------|-------|-------|
| <b>10</b>                                                                                                                                                                                                                                              | 291 | 608 | 1145 | 2352 | 3523 | 6786 | 19119 | 27993 | 38997 |
| <b>20</b>                                                                                                                                                                                                                                              | 200 | 418 | 787  | 1616 | 2422 | 4664 | 13141 | 19240 | 26802 |
| <b>30</b>                                                                                                                                                                                                                                              | 160 | 336 | 632  | 1298 | 1945 | 3745 | 10552 | 15450 | 21523 |
| <b>40</b>                                                                                                                                                                                                                                              | 137 | 287 | 541  | 1111 | 1664 | 3205 | 9031  | 13223 | 18421 |
| <b>50</b>                                                                                                                                                                                                                                              | 122 | 255 | 480  | 984  | 1475 | 2841 | 8004  | 11720 | 16326 |
| <b>60</b>                                                                                                                                                                                                                                              | 110 | 231 | 434  | 892  | 1337 | 2574 | 7253  | 10619 | 14793 |
| <b>80</b>                                                                                                                                                                                                                                              | 94  | 197 | 372  | 763  | 1144 | 2203 | 6207  | 9088  | 12661 |
| <b>100</b>                                                                                                                                                                                                                                             | 84  | 175 | 330  | 677  | 1014 | 1952 | 5501  | 8055  | 11221 |
| <b>125</b>                                                                                                                                                                                                                                             | 74  | 155 | 292  | 600  | 899  | 1730 | 4876  | 7139  | 9945  |
| <b>150</b>                                                                                                                                                                                                                                             | 67  | 140 | 265  | 543  | 814  | 1568 | 4418  | 6468  | 9011  |
| <b>200</b>                                                                                                                                                                                                                                             | 58  | 120 | 227  | 465  | 697  | 1342 | 3781  | 5536  | 7712  |
| <b>250</b>                                                                                                                                                                                                                                             | 51  | 107 | 201  | 412  | 618  | 1189 | 3351  | 4906  | 6835  |
| <b>300</b>                                                                                                                                                                                                                                             | 46  | 97  | 182  | 373  | 560  | 1078 | 3036  | 4446  | 6193  |
| <b>350</b>                                                                                                                                                                                                                                             | 42  | 89  | 167  | 344  | 515  | 991  | 2793  | 4090  | 5698  |
| <b>400</b>                                                                                                                                                                                                                                             | 40  | 83  | 156  | 320  | 479  | 922  | 2599  | 3805  | 5301  |

**TABLE 22. PROPANE VAPOR SEMI-RIGID COPPER TUBING SIZING**

| <b>Gas: Undilute Propane</b><br><b>Inlet Pressure: 11.0 in w.c.</b><br><b>Pressure Drop: 0.5 in. w.c.</b><br><b>Specific Gravity: 1.50</b><br><b>Special Use: Sizing between single or second stage (low pressure regulator) and appliance</b> |       |                 |       |       |       |       |       |       |       |       |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                                                                                                                                                                                |       | Tube Size (in.) |       |       |       |       |       |       |       |       |       |
| Nominal                                                                                                                                                                                                                                        | K & L | 1/4             | 3/8   | 1/2   | 5/8   | 3/4   | 1     | 1 1/4 | 1 1/2 | 2     | 2 1/2 |
|                                                                                                                                                                                                                                                | ACR   | 3/8             | 1/2   | 5/8   | 3/4   | 7/8   | 1 1/8 | 1 3/8 | 1 5/8 | 2 1/8 | 2 5/8 |
| Outside                                                                                                                                                                                                                                        |       | 0.375           | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 | 2.625 |
| Inside                                                                                                                                                                                                                                         |       | 0.305           | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 | 2.435 |

**Gas: Undilute Propane****Inlet Pressure: 11.0 in w.c.****Pressure Drop: 0.5 in. w.c.****Specific Gravity: 1.50****Special Use: Sizing between single or second stage (low pressure regulator) and appliance**

| <b>Length (ft)</b> | <b>Maximum Capacity in Thousands of Btu per Hour</b> |    |     |     |     |     |      |      |      |       |
|--------------------|------------------------------------------------------|----|-----|-----|-----|-----|------|------|------|-------|
| <b>10</b>          | 45                                                   | 93 | 188 | 329 | 467 | 997 | 1795 | 2830 | 5895 | 10429 |
| <b>20</b>          | 31                                                   | 64 | 129 | 226 | 321 | 685 | 1234 | 1945 | 4051 | 7168  |
| <b>30</b>          | 25                                                   | 51 | 104 | 182 | 258 | 550 | 991  | 1562 | 3253 | 5756  |
| <b>40</b>          | 21                                                   | 44 | 89  | 155 | 220 | 471 | 848  | 1337 | 2784 | 4926  |
| <b>50</b>          | 19                                                   | 39 | 79  | 138 | 195 | 417 | 752  | 1185 | 2468 | 4366  |
| <b>60</b>          | 17                                                   | 35 | 71  | 125 | 177 | 378 | 681  | 1074 | 2236 | 3956  |
| <b>70</b>          | 16                                                   | 32 | 66  | 115 | 163 | 348 | 626  | 988  | 2057 | 3639  |
| <b>80</b>          | 15                                                   | 30 | 61  | 107 | 152 | 324 | 583  | 919  | 1914 | 3386  |
| <b>90</b>          | 14                                                   | 28 | 57  | 100 | 142 | 304 | 547  | 862  | 1796 | 3177  |
| <b>100</b>         | 13                                                   | 27 | 54  | 95  | 134 | 287 | 517  | 814  | 1696 | 3001  |
| <b>125</b>         | 11                                                   | 24 | 48  | 84  | 119 | 254 | 458  | 722  | 1503 | 2660  |
| <b>150</b>         | 10                                                   | 21 | 44  | 76  | 108 | 230 | 415  | 654  | 1362 | 2410  |
| <b>175</b>         | 10                                                   | 20 | 40  | 70  | 99  | 212 | 382  | 602  | 1253 | 2217  |
| <b>200</b>         | 8.9                                                  | 18 | 37  | 65  | 92  | 197 | 355  | 560  | 1166 | 2062  |
| <b>225</b>         | 8.3                                                  | 17 | 35  | 61  | 87  | 185 | 333  | 525  | 1094 | 1935  |
| <b>250</b>         | 7.9                                                  | 16 | 33  | 58  | 82  | 175 | 315  | 496  | 1033 | 1828  |
| <b>275</b>         | 7.5                                                  | 15 | 31  | 55  | 78  | 166 | 299  | 471  | 981  | 1736  |
| <b>300</b>         | 7.1                                                  | 15 | 30  | 52  | 74  | 158 | 285  | 449  | 936  | 1656  |

Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 24. EQUIVALENT LENGTHS OF PIPE FITTINGS IN FEET (METERS)**

| <b>TYPE OF FITTING</b>    | <b>NOMINAL INCH (MILLIMETER) PIPE SIZE</b> |                       |                   |                     |                    |                    |                    |                    |                     |                     |                     |                     |                     |
|---------------------------|--------------------------------------------|-----------------------|-------------------|---------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                           | <b>2<br/>(50)</b>                          | <b>2-1/2<br/>(65)</b> | <b>3<br/>(80)</b> | <b>3.5<br/>(90)</b> | <b>4<br/>(100)</b> | <b>5<br/>(125)</b> | <b>6<br/>(150)</b> | <b>8<br/>(200)</b> | <b>10<br/>(250)</b> | <b>12<br/>(300)</b> | <b>14<br/>(350)</b> | <b>16<br/>(400)</b> | <b>18<br/>(450)</b> |
| 90° Stand. Elbow          | 5.2<br>(1.6)                               | 6.2<br>(1.9)          | 7.7<br>(2.3)      | 9.6<br>(2.9)        | 10<br>(3.0)        | 13<br>(4.0)        | 15<br>(4.6)        | 21<br>(6.4)        | 26<br>(7.9)         | 32<br>(9.8)         | 37<br>(11.3)        | 42<br>(12.8)        | 47<br>(14.3)        |
| 90° Med. Radius Elbow     | 4.6<br>(1.4)                               | 5.4<br>(1.6)          | 6.8<br>(2.1)      | 8<br>(2.4)          | 9<br>(2.7)         | 11<br>(3.4)        | 13<br>(4.0)        | 18<br>(5.5)        | 22<br>(6.7)         | 26<br>(7.9)         | 32<br>(9.8)         | 35<br>(10.7)        | 40<br>(12.2)        |
| 90° Long Radius Elbow     | 3.5<br>(1.1)                               | 4.2<br>(1.3)          | 5.2<br>(1.6)      | 6<br>(1.8)          | 6.8<br>(2.1)       | 8.5<br>(2.6)       | 10<br>(3.0)        | 14<br>(4.3)        | 17<br>(5.2)         | 20<br>(6.1)         | 24<br>(7.3)         | 26<br>(7.9)         | 31<br>(9.4)         |
| 45° Elbow                 | 2.4<br>(0.7)                               | 2.9<br>(0.9)          | 3.6<br>(1.1)      | 4.2<br>(1.3)        | 4.7<br>(1.4)       | 5.9<br>(1.8)       | 7.1<br>(2.2)       | 6<br>(1.8)         | 8<br>(2.4)          | 9<br>(2.7)          | 17<br>(5.2)         | 19<br>(5.8)         | 22<br>(6.7)         |
| TEE, Side Inlet or Outlet | 10<br>(3.0)                                | 12<br>(3.7)           | 16<br>(4.9)       | 18<br>(5.5)         | 20<br>(6.1)        | 25<br>(7.6)        | 31<br>(9.4)        | 44<br>(13)         | 56<br>(17)          | 67<br>(20)          | 78<br>(23.8)        | 89<br>(27.1)        | 110<br>(33.5)       |
| 18 Inch Flex Tube         | 3<br>(0.9)                                 | 3<br>(0.9)            | 3<br>(0.9)        | 3<br>(0.9)          | 3<br>(0.9)         | 3<br>(0.9)         | 3<br>(0.9)         | 3<br>(0.9)         | 3<br>(0.9)          | 3<br>(0.9)          | 3<br>(0.9)          | 3<br>(0.9)          | 3<br>(0.9)          |
| 24 Inch Flex Tube         | 4<br>(1.2)                                 | 4<br>(1.2)            | 4<br>(1.2)        | 4<br>(1.2)          | 4<br>(1.2)         | 4<br>(1.2)         | 4<br>(1.2)         | 4<br>(1.2)         | 4<br>(1.2)          | 4<br>(1.2)          | 4<br>(1.2)          | 4<br>(1.2)          | 4<br>(1.2)          |

# Appendix B. Outline and System Drawings

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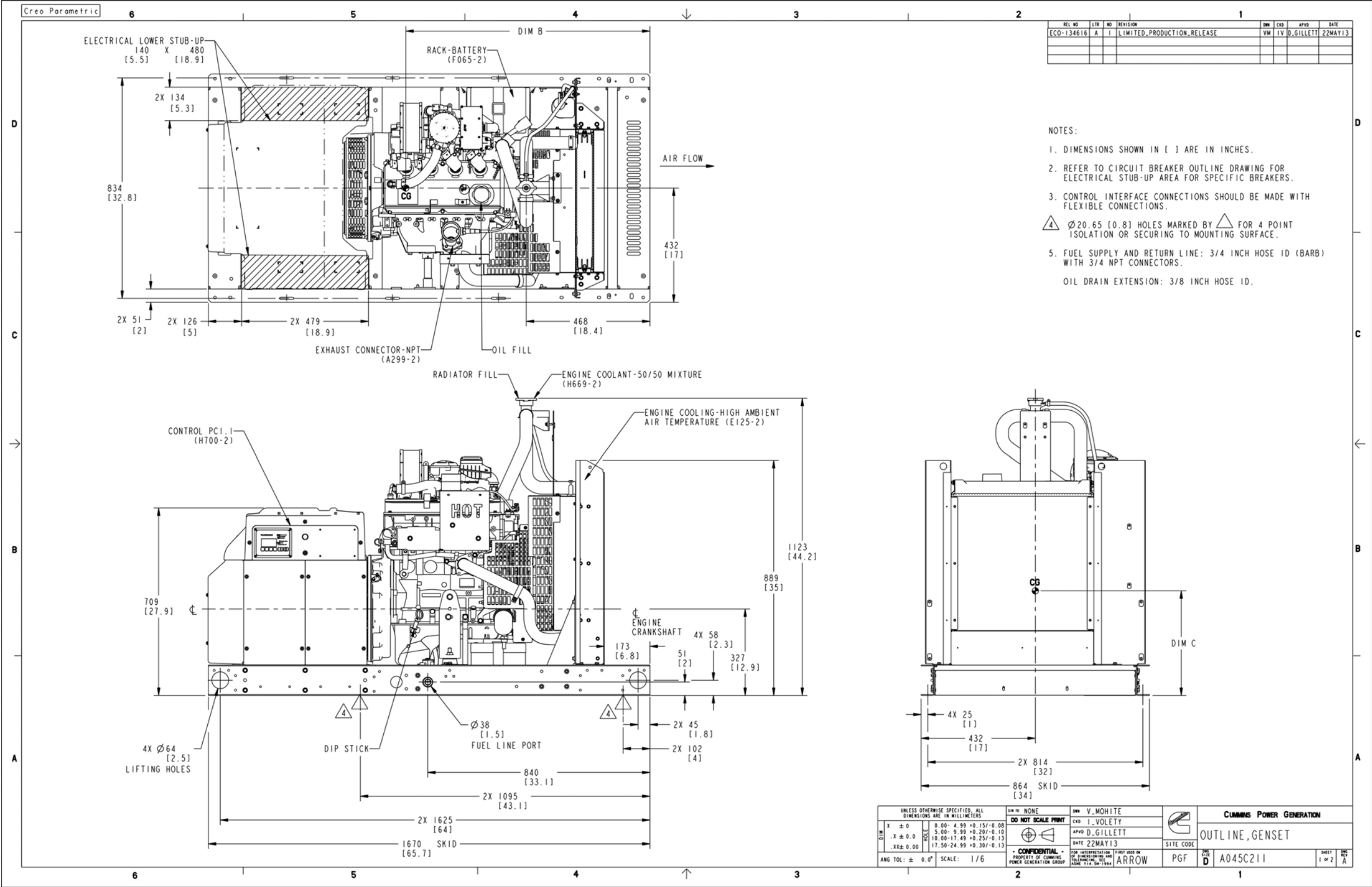


FIGURE 29. GENERATOR SET OUTLINE, 20-25 KW 1800 RPM, 30 KW 3600 RPM (SHEET 1 OF 2)

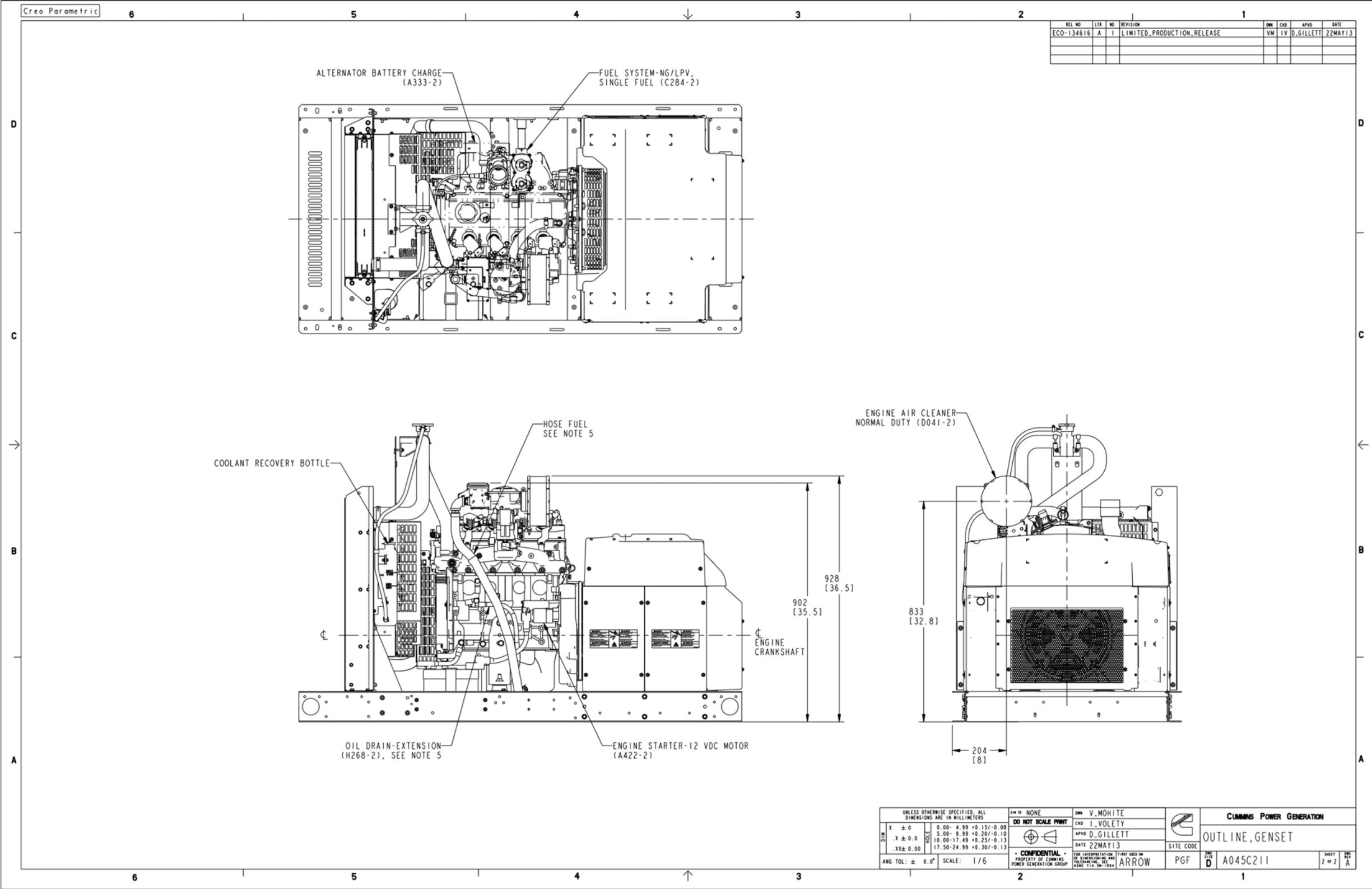
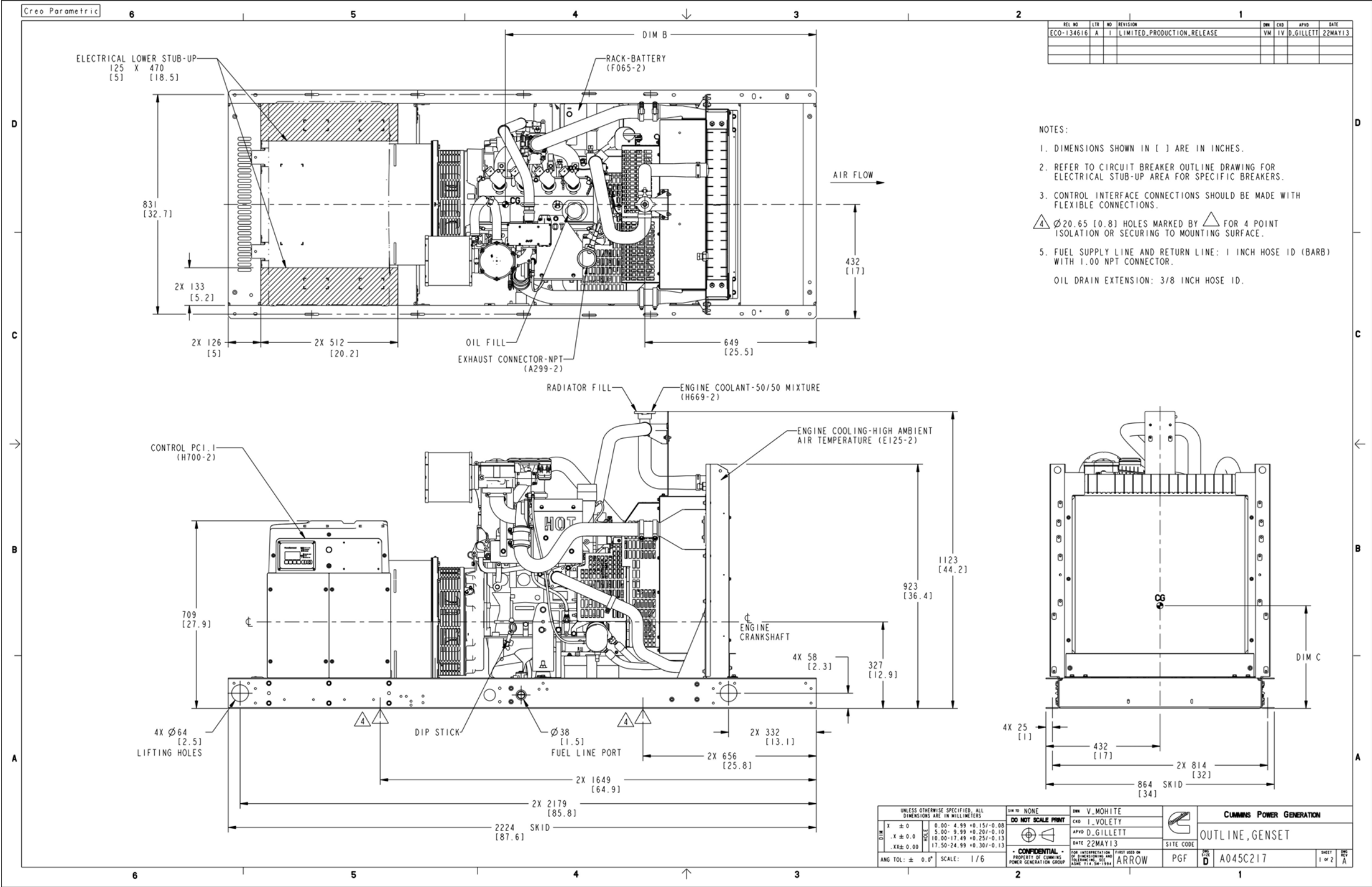


FIGURE 30. GENERATOR SET OUTLINE, 20-25 KW 1800 RPM, 30 KW 3600 RPM (SHEET 2 OF 2)



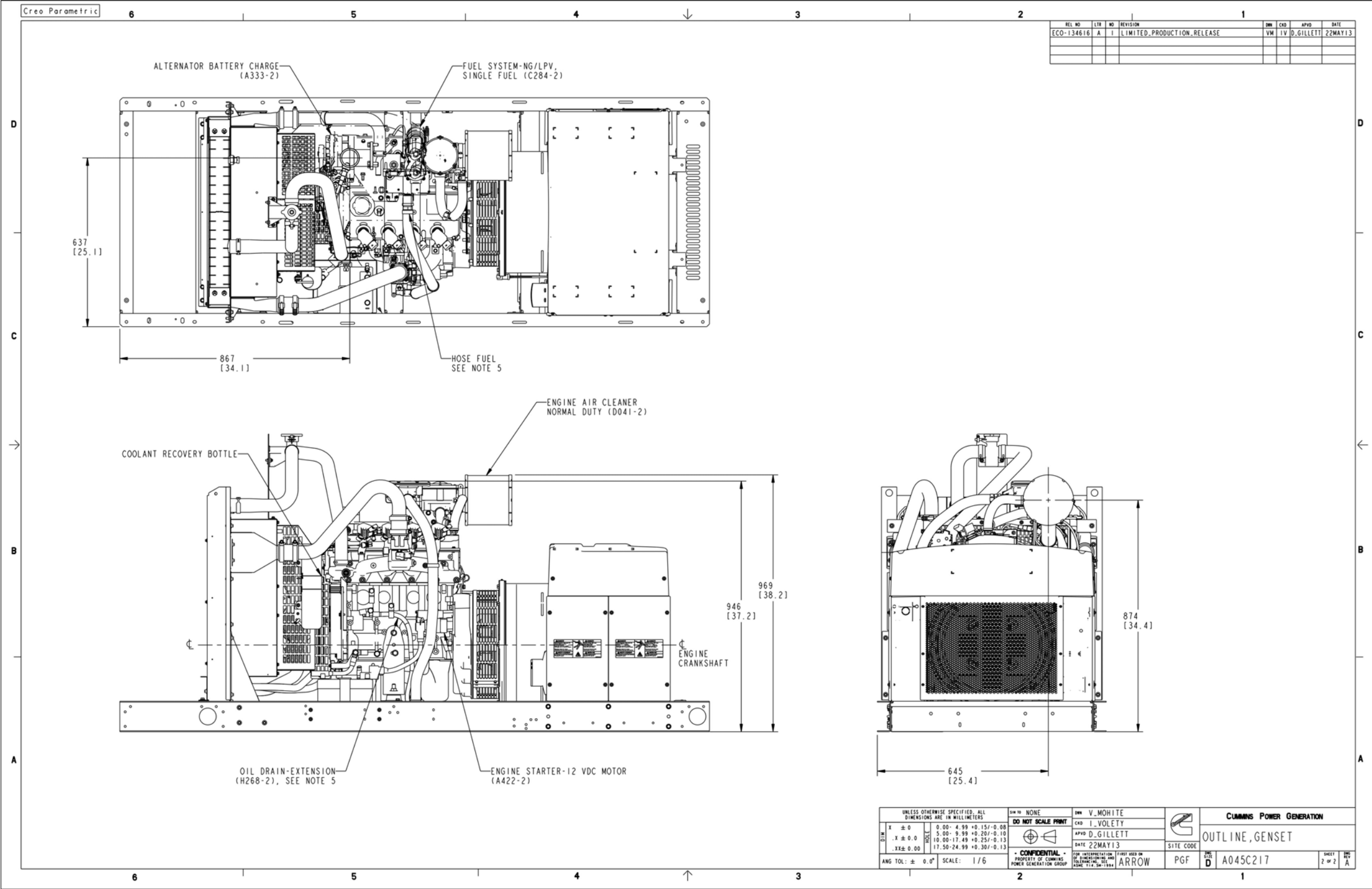
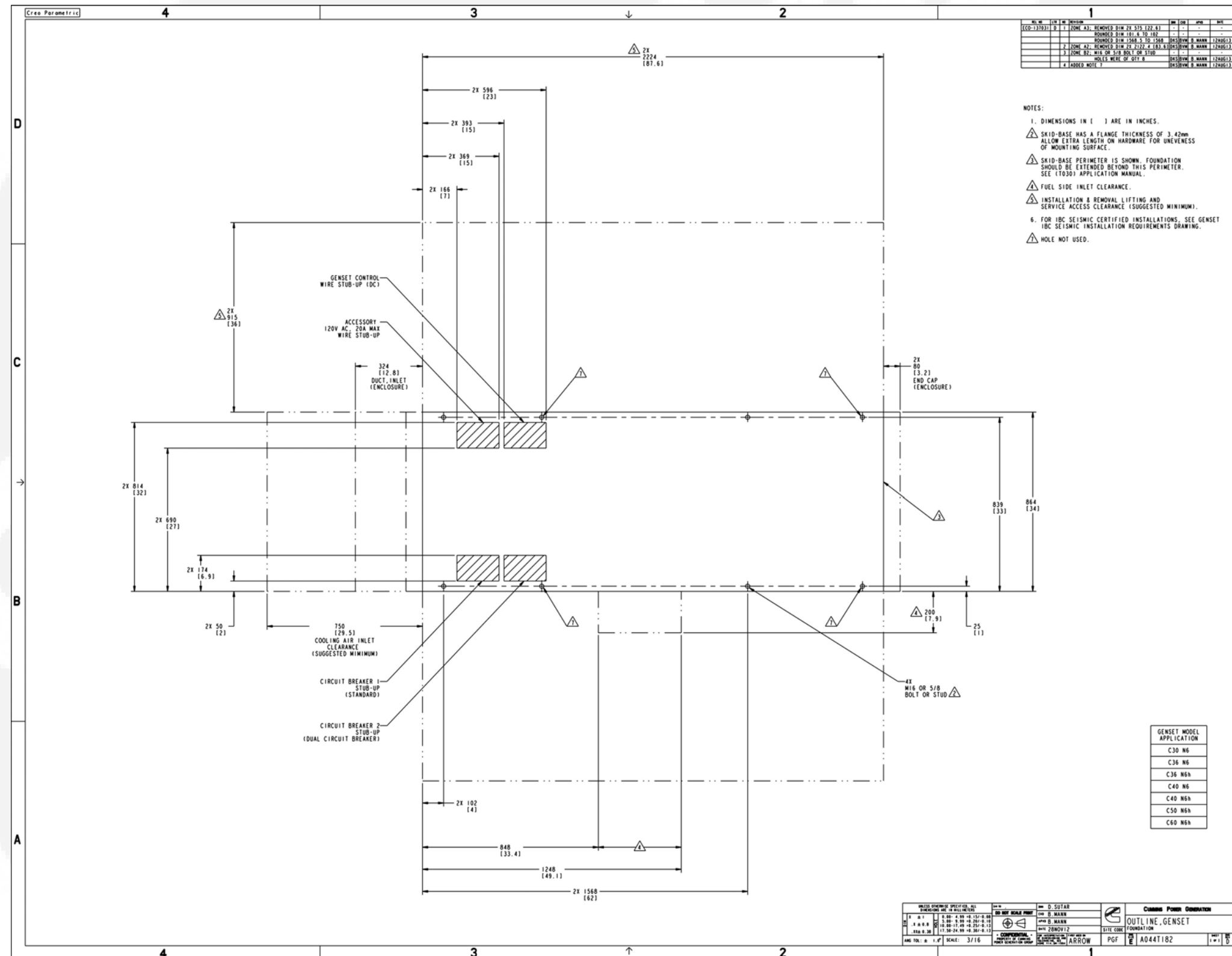
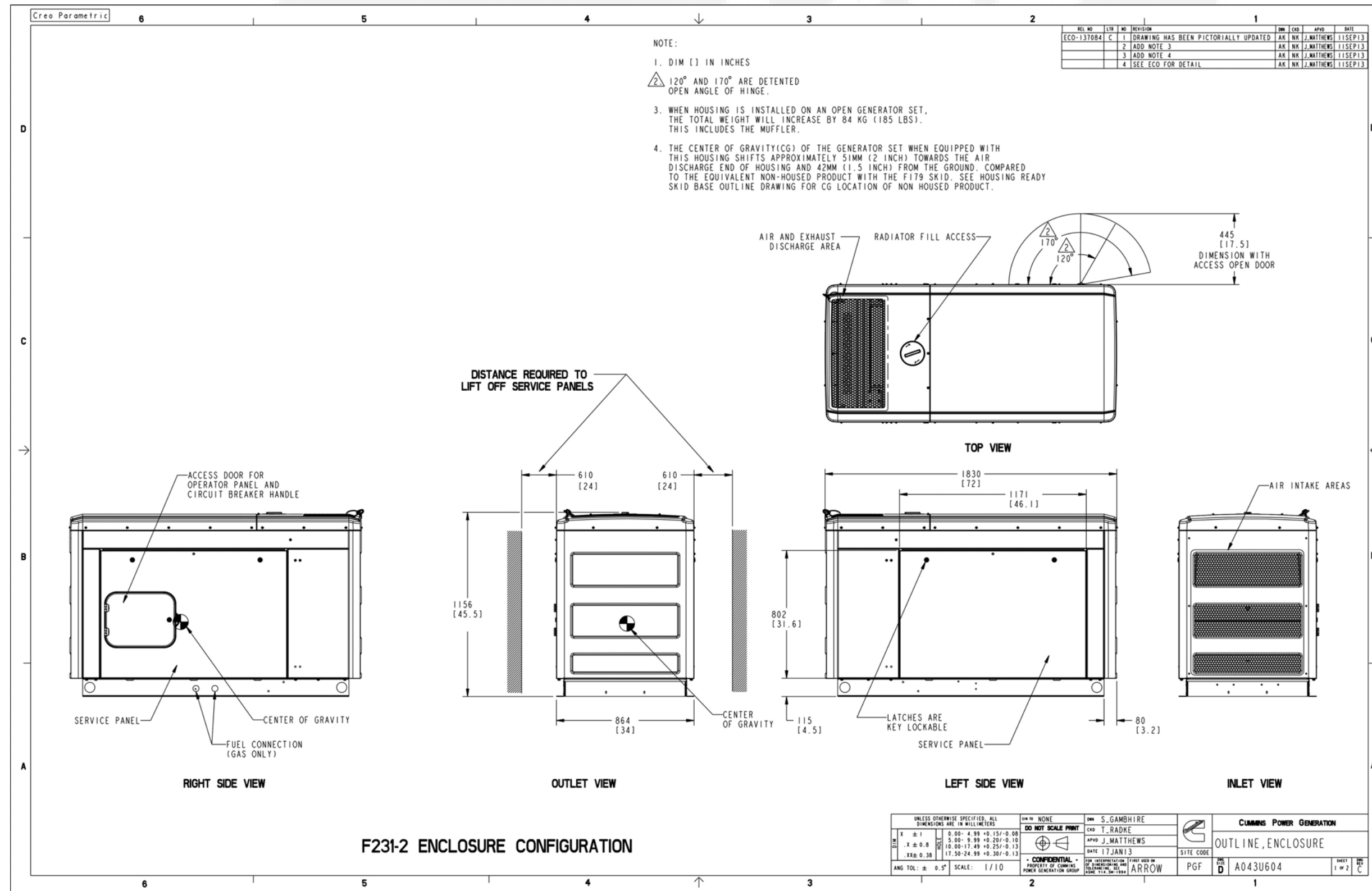


FIGURE 32. GENERATOR SET OUTLINE, 30-40 KW 1800 RPM, 36-60 KW 3600 RPM (SHEET 2 OF 2)



**FIGURE 33. FOUNDATION OUTLINE, 20-25 KW 1800 RPM, 30 KW 3600 RPM (SHEET 1 OF 1)**





**FIGURE 35. ENCLOSURE OUTLINE, 20-25 KW 1800 RPM, 30 KW 3600 RPM (SHEET 1 OF 2)**

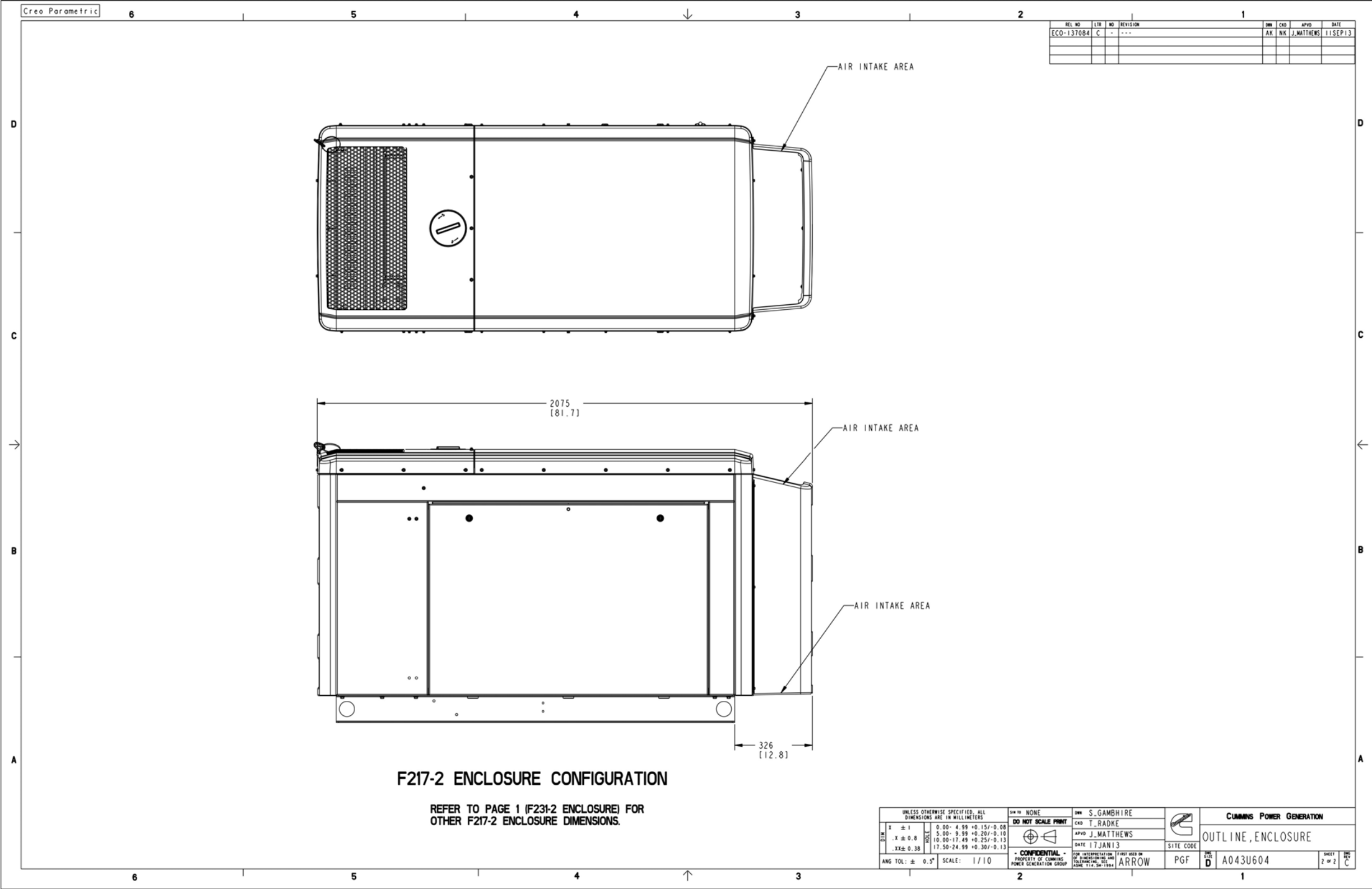
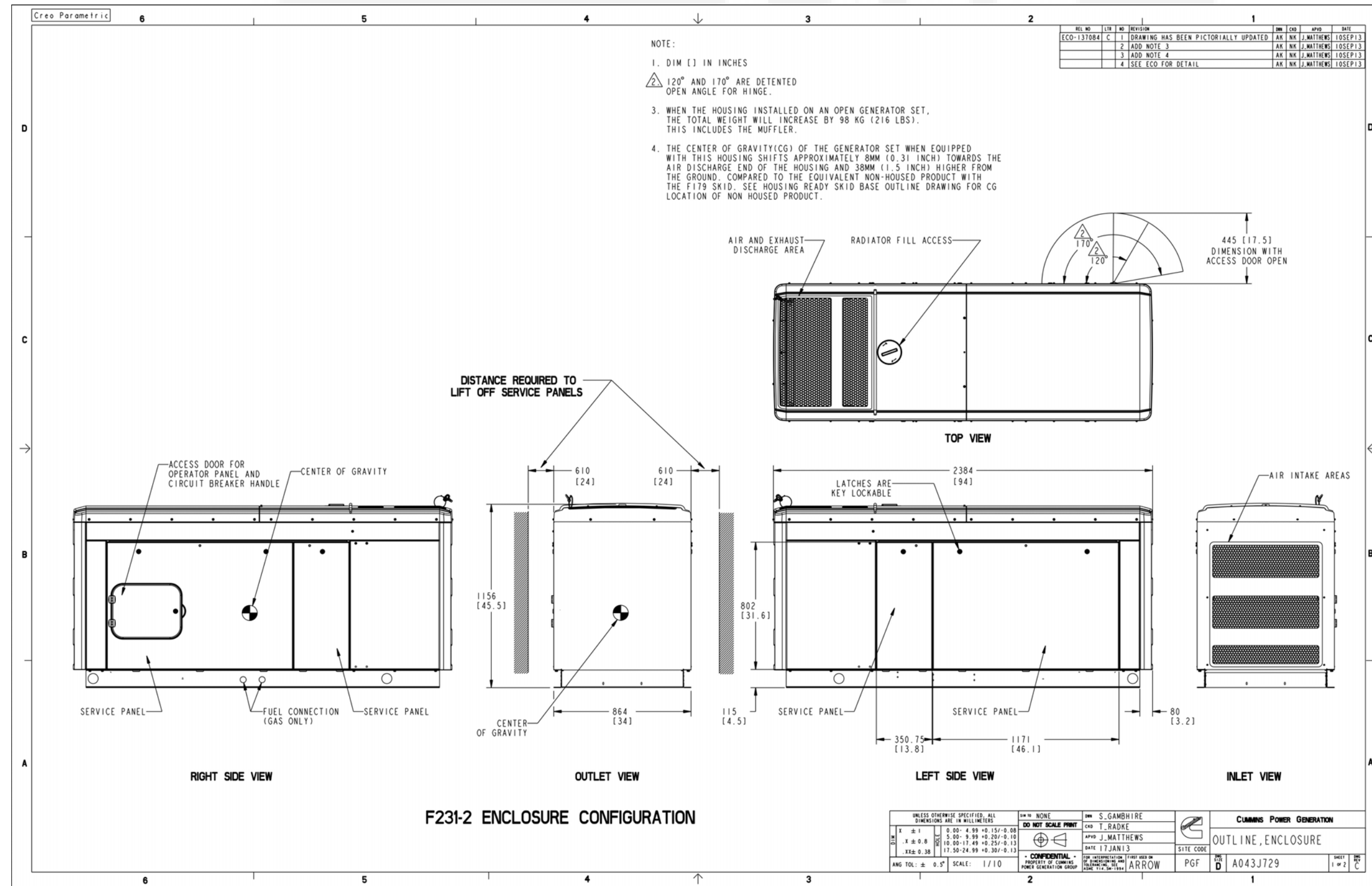


FIGURE 36. ENCLOSURE OUTLINE, 20-25 KW 1800 RPM, 30 KW 3600 RPM (SHEET 2 OF 2)



**FIGURE 37. ENCLOSURE OUTLINE, 30-40 KW 1800 RPM, 36-60 KW 3600 RPM (SHEET 1 OF 2)**

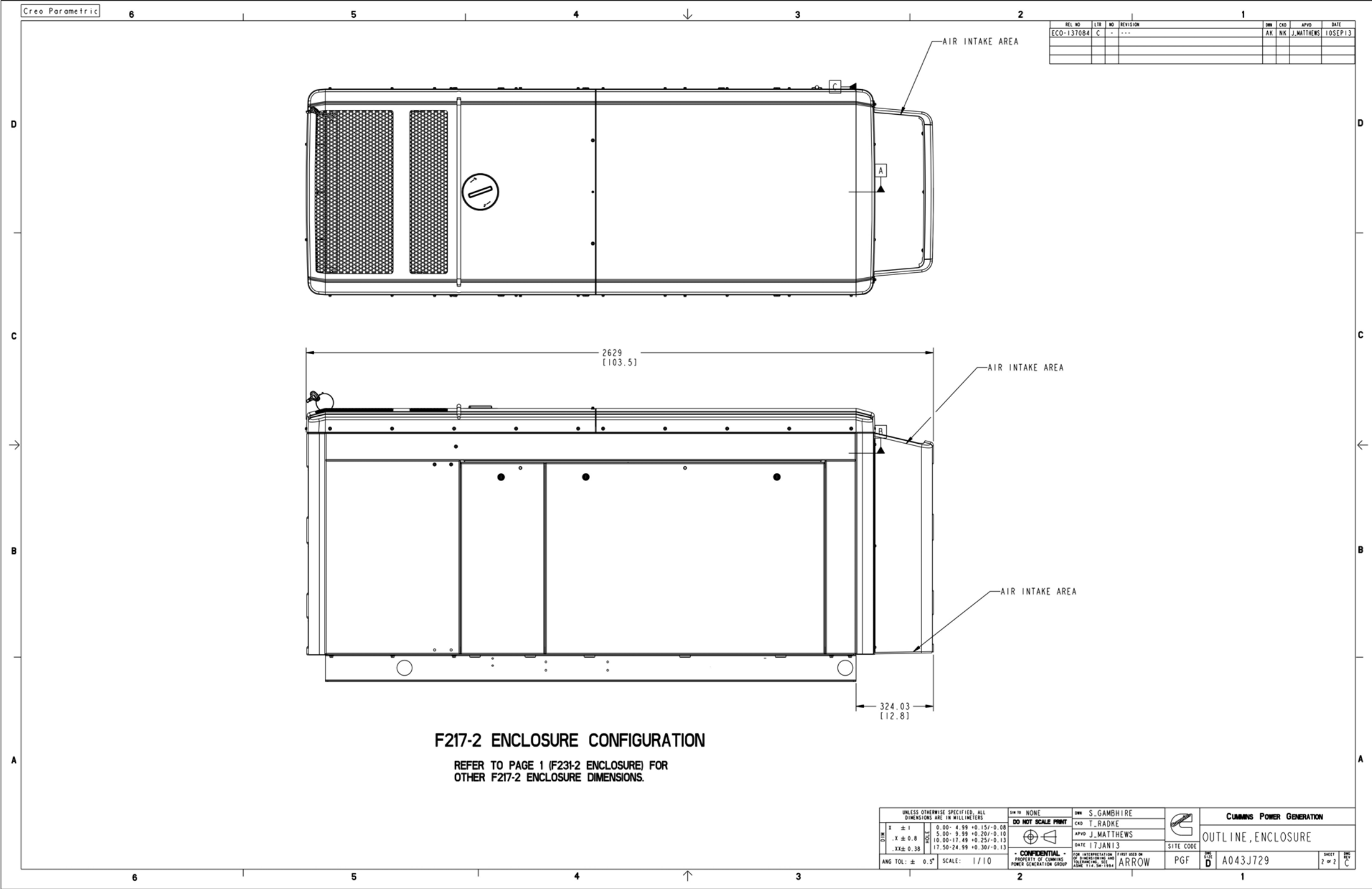
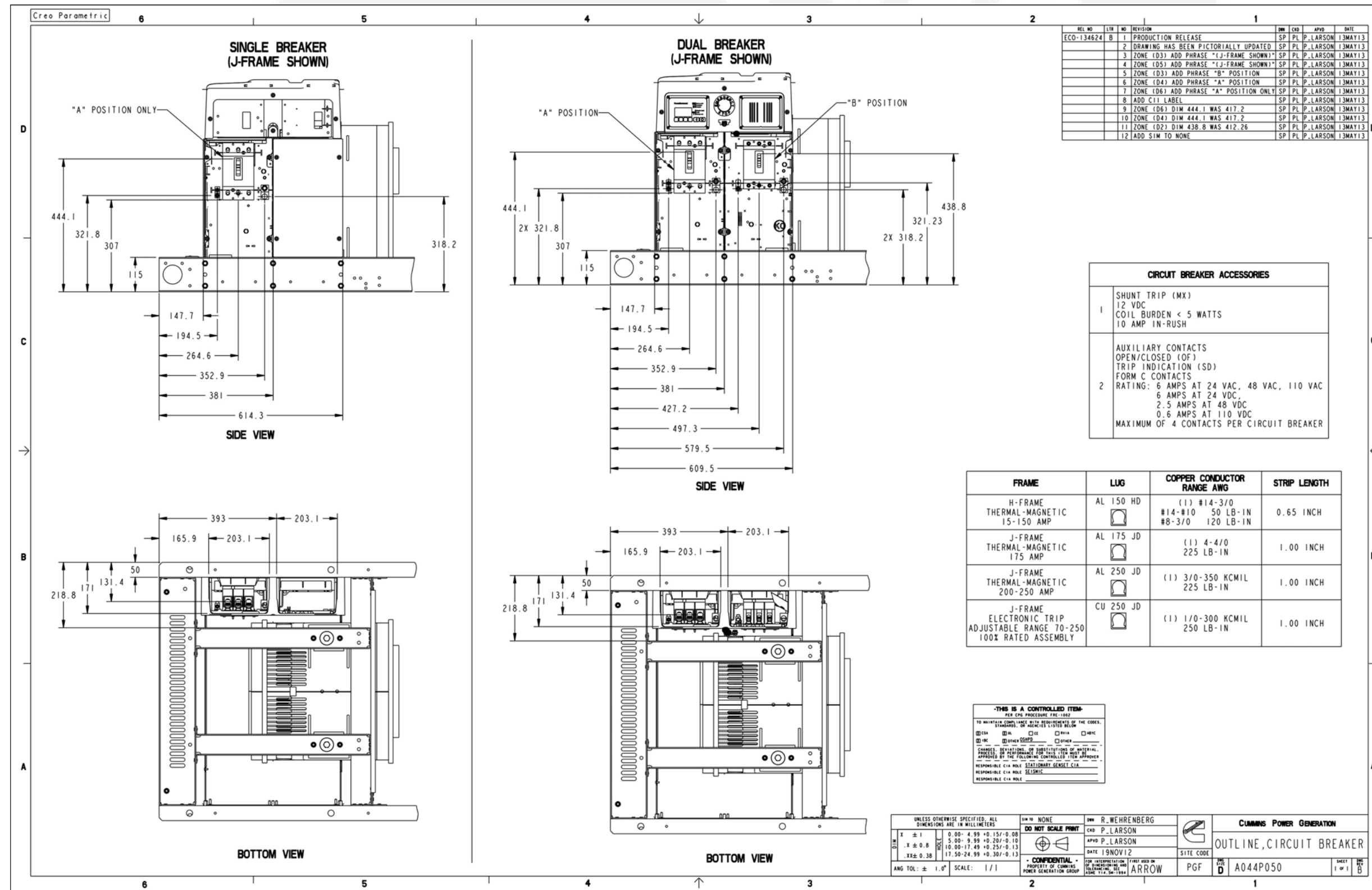


FIGURE 38. ENCLOSURE OUTLINE, 30-40 KW 1800 RPM, 36-60 KW 3600 RPM (SHEET 2 OF 2)



**FIGURE 39. CIRCUIT BREAKER OUTLINE (SHEET 1 OF 1)**

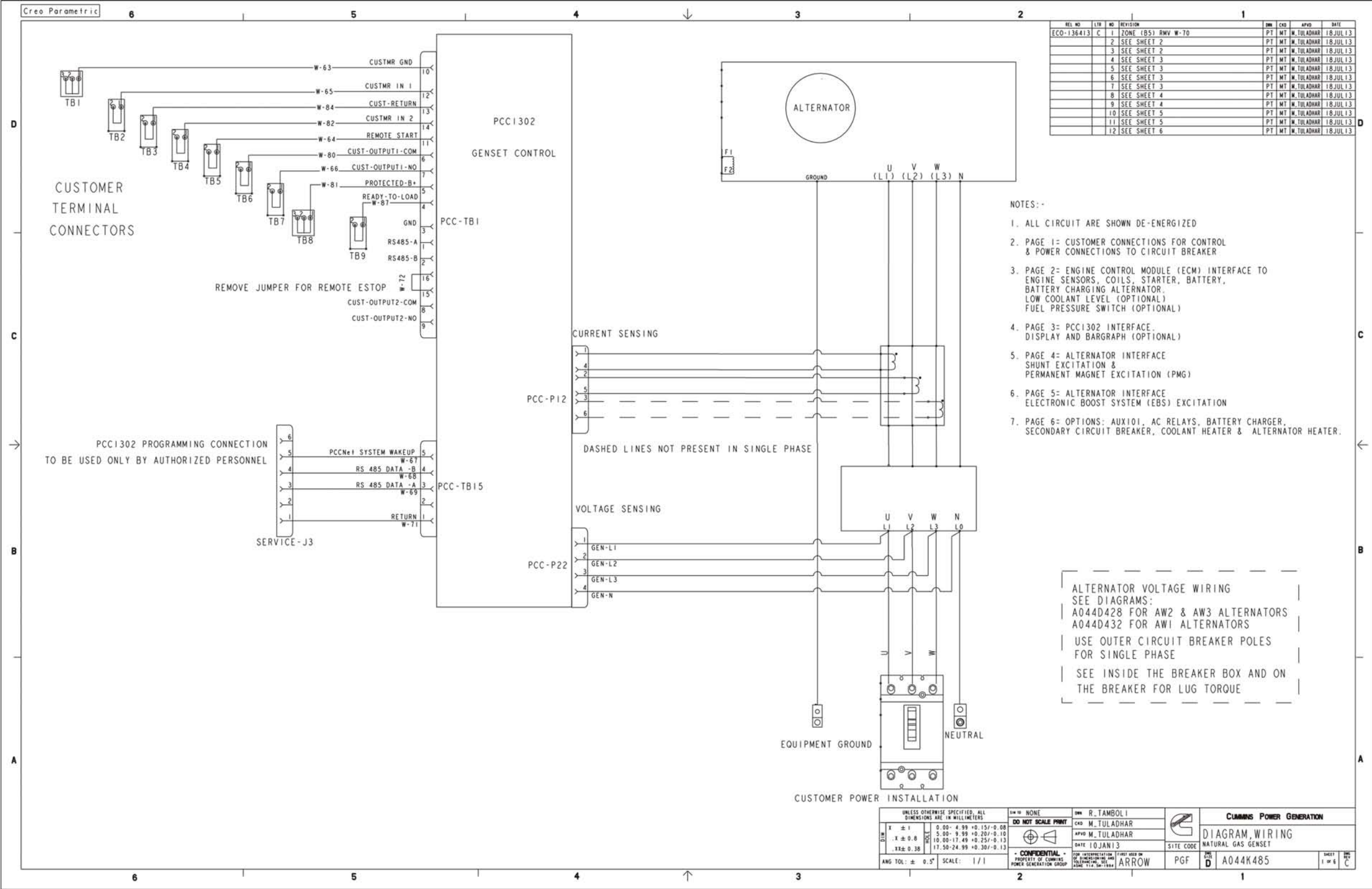


FIGURE 40. WIRING DIAGRAM (SHEET 1 OF 6)

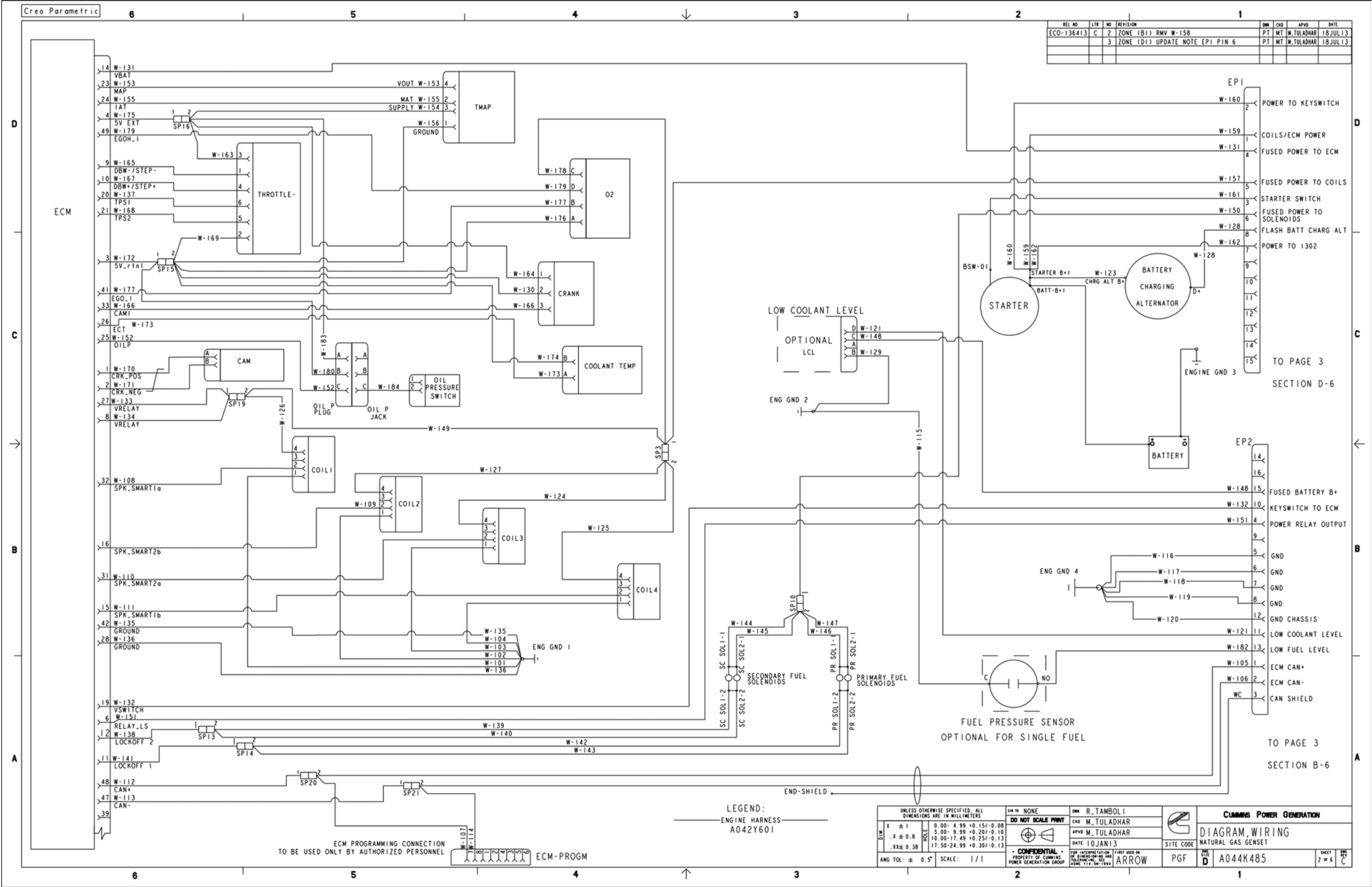


FIGURE 41. WIRING DIAGRAM (SHEET 2 OF 6)

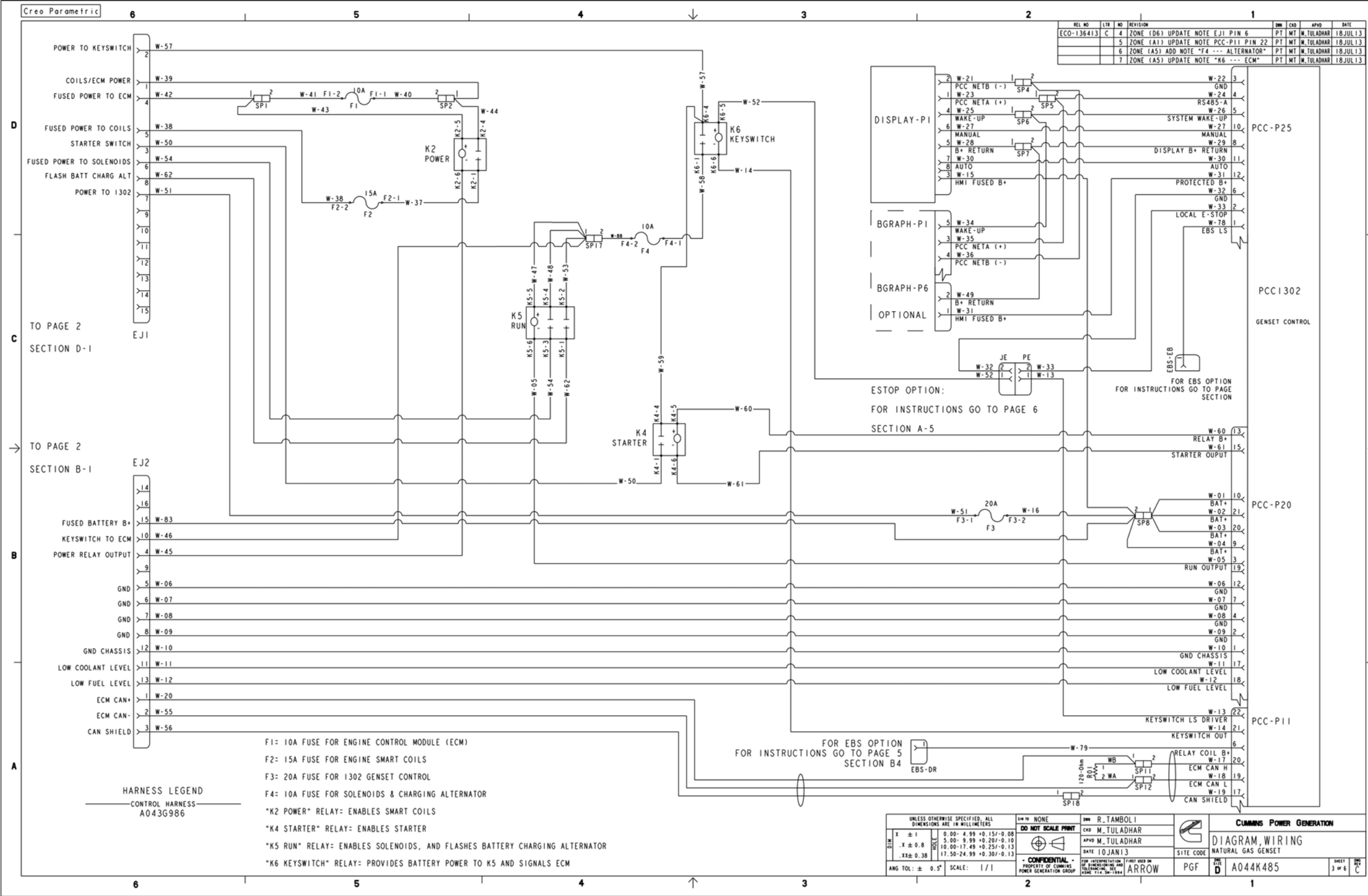


FIGURE 42. WIRING DIAGRAM (SHEET 3 OF 6)

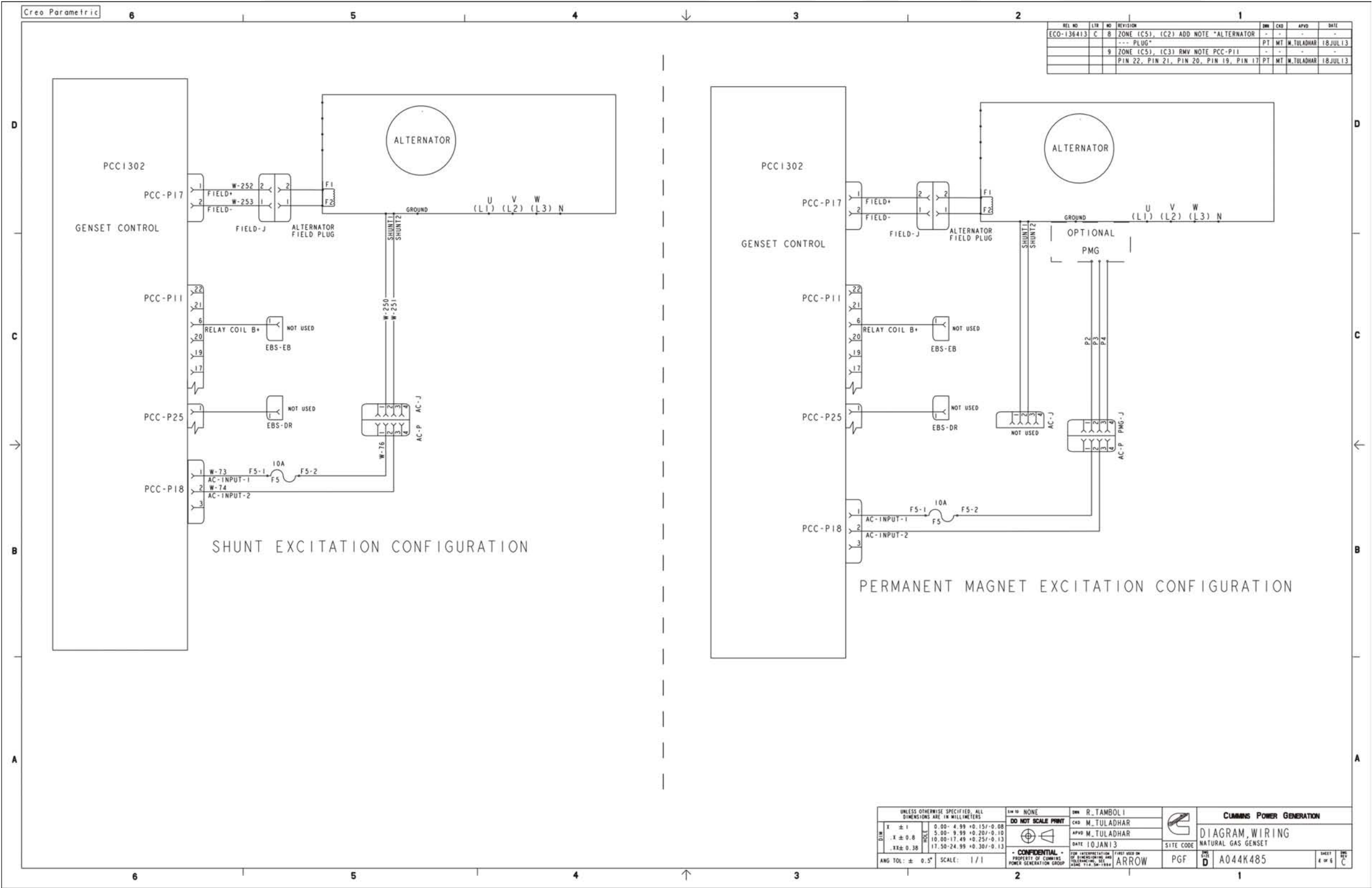


FIGURE 43. WIRING DIAGRAM (SHEET 4 OF 6)

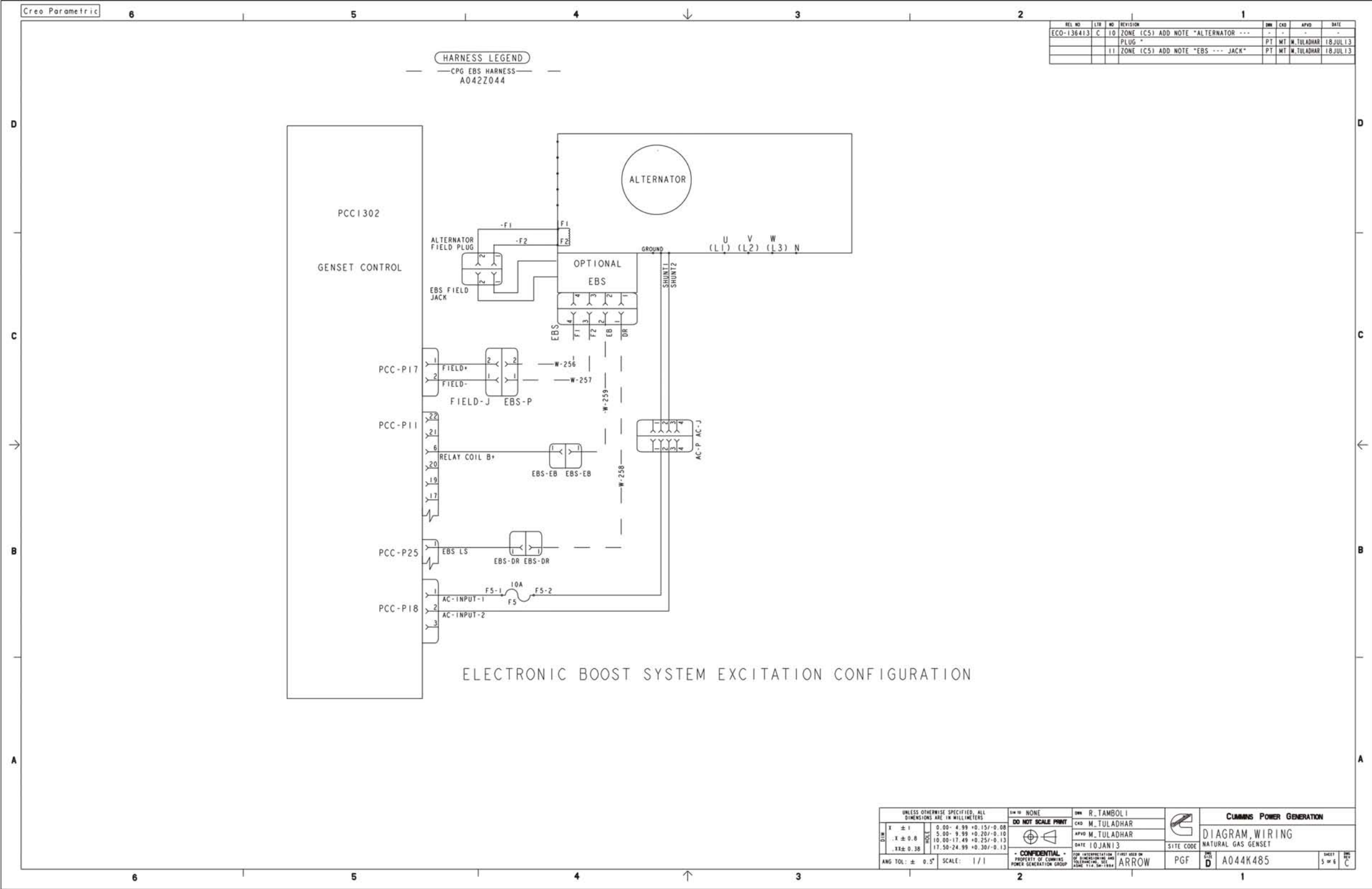


FIGURE 44. WIRING DIAGRAM (SHEET 5 OF 6)

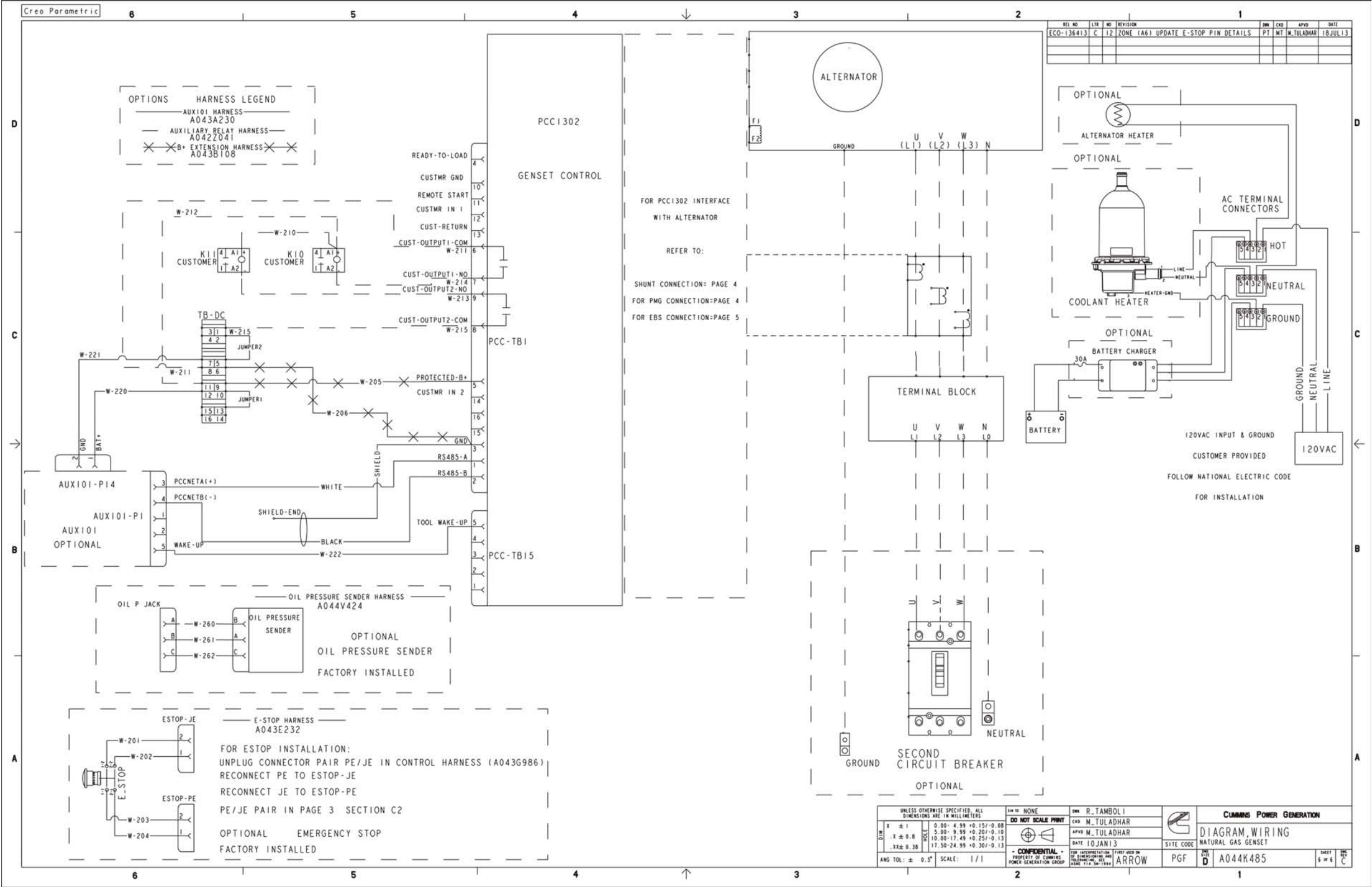


FIGURE 45. WIRING DIAGRAM (SHEET 6 OF 6)

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