Power Generation

Service Manual

Generator Set

with PowerCommand® 2100 Control

GGPA (Spec A-B)
GGPB (Spec A-B)
GGPC (Spec A-B)

English
Original Instructions

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A030G174 (Issue 3)

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1 Important Safety Instructions

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

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

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

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

⚠ DANGER

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 distributor.

NOTICE

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

1.2.1 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 makes 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 over heating 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.

1.3 Generator Set Safety Code

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

⚠ WARNING

Improper operation and maintenance.

Can lead to severe personal injury, or loss of life and property, by fire, electrocution, mechanical breakdown, or exhaust gas asphyxiation.

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

⚠ WARNING

Lifting and repositioning of the generator set.

Incorrect lifting can result in severe personal injury, death, and/or equipment damage.

Lifting must only be carried out using suitable lifting equipment, shackles, and spreader bars, in accordance with local guidelines and legislation, by suitably trained and experienced personnel. For more information, contact your authorized distributor

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1.3.1 Moving Parts Can Cause Severe Personal Injury Or Death

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, then disconnect the starting batteries using an insulated wrench, negative (**–**) cable first. This will prevent accidental starting.

- Make sure that fasteners on the generator set are secure. Tighten supports and clamps; keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- If any adjustments must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

1.3.2 Positioning of Generator Set

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

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

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

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

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

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- De-energize and lockout/tagout electrical systems prior to working on them. Lockout/Tagout is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy. Please refer to Bad link: /opt/dzd/dzd_prog/prog_docato/docato_4.9.1/docato/work/temp/dzd_temp/topleaf/4b766e8c-4848-4525-ac0e-910e4f2a68ea/en-us/.new_components/generator_set/lockingthegeneratorsetoutofservice.xml (lockout/tagout) for more information.
- De-energize and lockout/tagout all circuits and devices before removing any protective shields or making any measurements on electrical equipment.
- Follow all applicable regional electrical and safety codes.

Guidelines to follow when working on energized electrical systems:

NOTICE

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

NOTICE

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

In summary:

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

1.4.1 AC Supply and Isolation

NOTICE

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

NOTICE

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

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

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

1.4.2 Medium Voltage Equipment (601 V to 15 kV)

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

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

1.5 Fuel And Fumes Are Flammable

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while the engine is running, unless the tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

1.5.1 Spillage

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

1.5.2 Fluid Containment

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

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

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

1.5.3 Do Not Operate in Flammable and Explosive Environments

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

1.6 Exhaust Gases Are Deadly

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

1.6.1 Exhaust Precautions

⚠ WARNING

Hot pipes.
Hot exhaust pipes and charge air pipes can cause severe personal injury or death from direct contact, or from fire hazard.
Wear appropriate PPE when working on hot equipment and avoid physical contact where possible.

⚠ WARNING

Hot exhaust gases.
Can cause burns resulting in severe personal injury.
Wear personal protective equipment when working on equipment.

⚠ WARNING

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

⚠ WARNING

Contaminated insulation.
Is a fire risk which can result in severe personal injury and equipment damage.
Remove any contaminated insulation and dispose of in accordance with local regulations.

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

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

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

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

2 Introduction

⚠ WARNING

Hazardous voltage.
Can cause severe personal injury or death and equipment damage.
Generator electrical output connections must be made by a trained and experienced electrician in accordance with the installation instructions and all applicable codes.

⚠ WARNING

Electrical generating equipment.
Can cause severe personal injury or death.
Generator sets must be installed, certified, and operated by trained and experienced person in accordance with the installation instructions and all applicable codes.

2.1 About This Manual

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

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

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

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

2.2 Test Equipment

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

- True RMS meter for accurate measurement of small AC and DC voltages.
- Grounding wrist strap to prevent circuit board damage due to electrostatic discharge (ESD).
- Battery Hydrometer
- Jumper Leads
- Tachometer or Frequency Meter
- Wheatstone Bridge or Digital Ohmmeter
- Variac

- Load Test Panel
- Megger or Insulation Resistance Meter
- PCC Service Tool Kit (Harness Tool and Sensor Tool)
- InPower Service Tool (PC based Generator Set Service Tool)

2.3 Schedule of Abbreviations

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

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

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

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
Genset	Generator Set	RMS	Root Mean Square
GCP	Generator Control Panel	RTU	Remote Terminal Unit
GND	Ground	SAE	Society of Automotive Engineers
HMI	Human-machine Interface	SCR	Selective Catalytic Reduction
IC	Integrated Circuit	SPN	Suspect Parameter Number
ISO	International Organization for Standardization	SW_B+	Switched B+
LBNG	Lean-burn Natural Gas	UL	Underwriters Laboratories
LCD	Liquid Crystal Display	UPS	Uninterruptible Power Supply

2.4 Related Literature

Before any attempt is made to operate the generator set, the Operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with Warnings and Operating Procedures.

⚠ CAUTION

A generator set must be operated and maintained properly if you are to expect safe and reliable operation.

The relevant publications appropriate to your generator set are also available:

- Operator Manual (A030G173)
- Installation Manual (A030G175)
- Engine Service Manual (A030M990)
- *Specification* and *Data Sheet* (For engineering data specific to the generator set)
- Application Manual T-030, *Liquid Cooled Generator Sets* (For application information)
- Parts Manual (A030F464)

NOTICE

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

Contact your authorized distributor.

2.5 After Sales Services

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

2.5.1 Maintenance

⚠ WARNING

Electrical generating equipment

Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage.

Service personnel must be trained and experienced to perform electrical and/or mechanical service.

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

2.5.2 Warranty

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

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

For further warranty details, contact your authorized distributor.

NOTICE

Damage caused by failure to follow the manufacturers recommendations will not be covered by the warranty. Please contact your authorized distributor.

2.5.2.1 Warranty Limitations

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

2.5.3 How to Obtain Service

When the generator set requires servicing, contact your nearest Cummins Power Generation distributor. To contact your local Cummins Power Generation distributor refer to the **Global Addresses** section contained within this document. When contacting your distributor, always supply the complete Model, Specification, and Serial Number as shown on the nameplate.

3 Control System - PCC 2100

3.1 Control System Description

This manual covers the PowerCommand® Control 2100 (PCC2100) control module for single generator sets. All indicators, control switches/buttons and digital display are located on the face of the control panel as illustrated in the figure below.

The main control panel and its associated equipment are located in the Control Housing, which is mounted at the rear of the generator set. A Load Terminal Box may be mounted on either the left or right side of the housing, as required for the site.

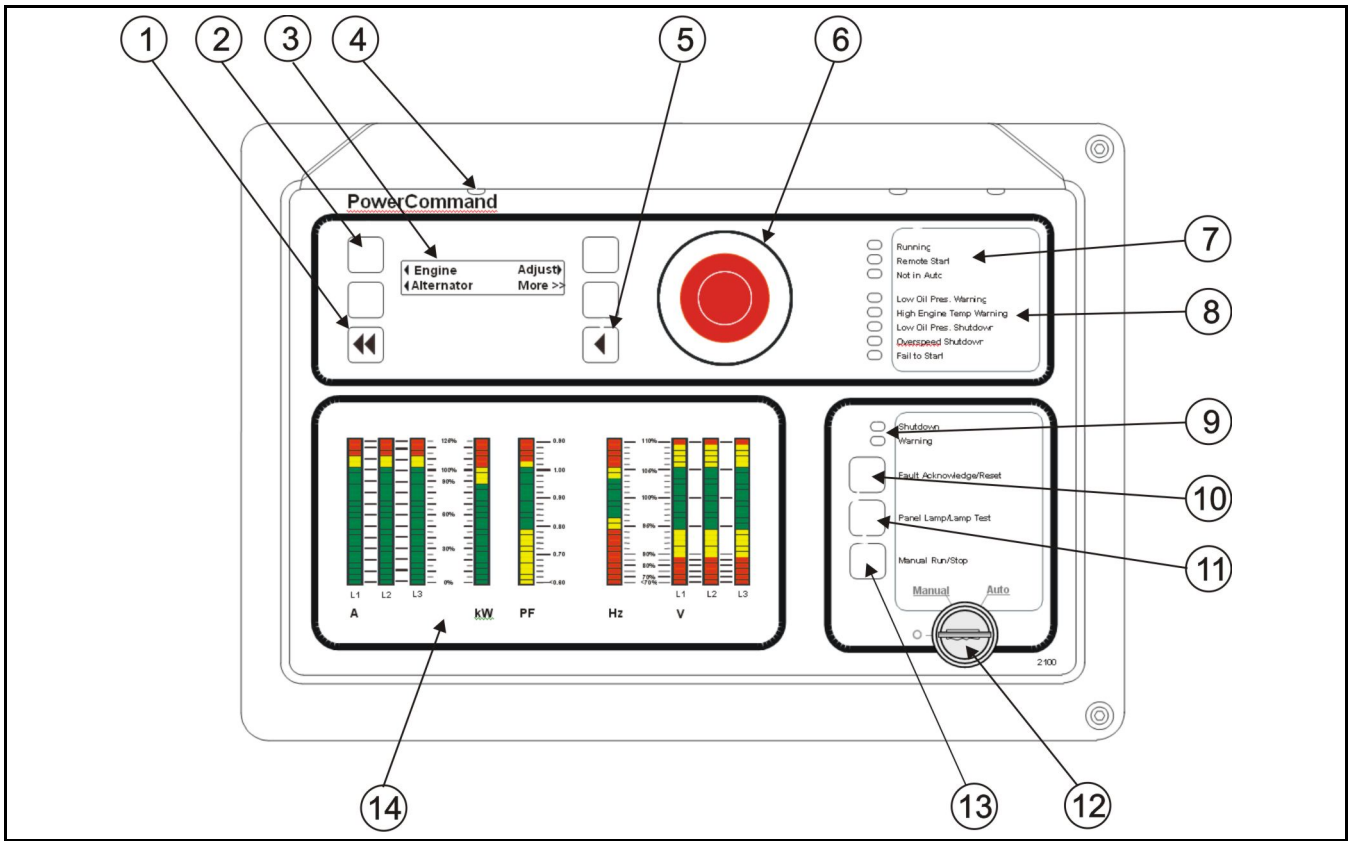
The PCC2100 is a microprocessor-based control for generator sets. It provides fuel control and engine speed governing, main alternator voltage output regulation, and complete generator set control and monitoring. The control also monitors the health of the engine, alternator, and auxiliary systems continuously, and will affect an Automatic Shutdown if a serious fault occurs.

The PCC2100 operates in conjunction with an array of sensors and senders located on the engine, alternator and auxiliary systems. Data is passed between components over a digital data link.

An important function of the control system is to continuously monitor the generator set for faults. If a fault occurs during engine running, the control will provide an indication for the operator and, if the fault is serious, affect an automatic, fully programmed, shutdown. There are two fault level signals generated by the PCC2100. These two fault levels are:

1. **Warning:** signals an imminent or non-critical engine fault. The PCC2100 provides an indication only for this condition.
2. **Shutdown:** signals a potentially critical fault for the engine. The PCC2100 will automatically take the engine off-load and shut it down immediately, without a cooldown run.

The control systems operate on 12 or 24VDC battery power. Data backup is taken care of by a small rechargeable battery installed within the PCC2100 enclosure. Auxiliary equipment operates on low voltage AC power.



NO	DESCRIPTION	NO	DESCRIPTION
1	Home Button	8	Configurable Indicators
2	Menu Selection Button (1 of 4)	9	Shutdown & Warning Status Indicators
3	Digital Display	10	Fault Acknowledgement/Reset Button
4	Panel Lamp	11	Panel Lamp & Lamp Test Button
5	Previous Main Menu Button	12	O/Manual/Auto Key Switch (Mode Switch)
6	Emergency Stop Push Button	13	Manual Run/Stop Button
7	Running/Remote Start/Not in Auto Indicators	14	Analog AC Metering Panel (Optional)

FIGURE 1. FRONT PANEL

3.2 Control Panel Power On/Off Modes

The power on/off modes of the control panel and operating software are Power On, Screen Saver, and Sleep/Awake.

3.2.1 Power On Mode

In this mode, power is continuously supplied to the control panel. The control's operating software and control panel LEDs/graphical display will remain active until the Screen Saver mode is activated.

3.2.2 Screen Saver Mode

Power to the graphical display will be removed after 10 minutes (generator set not running or running). The 10 minute timer resets and begins after each control panel action (any button or switch selection) or signal received by the operating software. The bottom LEDs of the Analog AC Metering Panel (bar graphs) may stay On during Screen Saver mode, indicating that the operating software is active (Awake mode).

When a "Warning" signal (for example, low coolant temp) is sensed by the control will display the warning message. The control will remain active until the Fault Acknowledge button is pressed to clear the warning message and start the 10 minute timer.

3.2.3 Sleep/Awake Mode

In the Sleep mode, the control's operating software is inactive and the LEDs and the digital display on the control panel are all off. Sleep mode is a feature used to reduce battery power consumption when the control is not being used and the O/Manual/Auto switch is in the O position.

When all conditions are met (i.e., no unacknowledged faults and O/Manual/Auto switch is in the O position), the Sleep mode is activated.

The operating software is initialized and the digital display and control panel LEDs are turned on in response to moving/pressing the following control panel switch/buttons:

- Off/Manual/Auto switch
- Emergency Stop button
- Fault Acknowledge/Reset button
- Panel Lamp/Lamp Test button

To activate the control and view the menu display without starting the generator set, press the Fault Acknowledge or Panel Lamp button or move the mode switch from O to Manual.

The InPower™ service tool is required to enable or disable the Sleep mode. When shipped from the factory, Sleep mode is disabled. When disabled, the operating software will always remain active (Awake mode). If network and/or power transfer control (PTC) feature is installed, the sleep mode is not available.

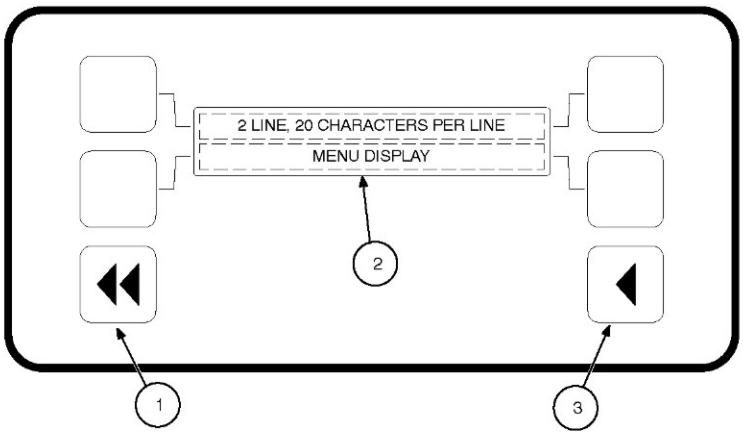
NOTICE
The InPower service tool is required to select the desired mode. Contact an authorized service center for assistance.

3.3 Front Panel

The front panel contains the following components:

3.3.1 Digital Display

This two-line, 20-characters per line alphanumeric display is used to view menus of the menu-driven operating system. Refer to the menu trees later in this section. The display is also used to show warning and shutdown messages.



NO	Description
1	Home Button
2	Digital Display
3	Previous Main Menu Button

FIGURE 2. DIGITAL DISPLAY AND MENU SELECTION BUTTON

3.3.2 Display Menu Selection Button

Four momentary buttons-two on each side of the digital display window-are used to step through the various menu options and to adjust generator set parameters. A green triangle (◄ or ►), arrow (↑, ↓, ←, or →), >>, or plus/minus sign (+ or –) in the digital display adjacent to the button is shown when the button can be used (button is "active").

- In the digital display for main menus, the ◄ or ► symbols indicate that pressing the adjacent button causes the operating program to go to the selected submenu (e.g., Engine Menu).
- In the digital display, the More>> symbol indicates that pressing the adjacent button causes the operating program to go to the next main menu.
- In the digital display, the ↑ or ↓ symbols indicate that pressing the adjacent button causes the operating program to go to the next or previous submenu, as shown in the menu diagrams. Only the ↓ symbol is displayed in the first submenu. Only the ↑ is displayed in the last submenu. Both symbols are displayed in the rest of the submenus.
- In the digital display, the plus or minus symbols (+ or –) indicate that pressing the adjacent button can be used to change a parameter or value shown on the display.

  When there is a choice of two parameters, one parameter is associated with the + symbol and the other is associated with the – symbol.

  When changing values, pressing the button adjacent to the + symbol increases the value and pressing the button adjacent to the – symbol decreases the value. Only one numeric character of a field can be changed at a time.

- In the digital display, the ← or → symbol indicates that pressing the adjacent button causes the operating program to move the cursor to the next numeric character. The selected numeric character can then be changed by pressing the buttons adjacent to the + and – symbols. Only the → symbol is displayed when the cursor is on the first character of a field that can be changed. Only the ← is displayed when the cursor is on the last character. Both symbols are displayed when the cursor is on any other character.
- After adjusting values/parameters, pressing the ► symbol results in the changes being saved. **If the Home button or Previous Main Menu button is pressed before pressing the ► symbol, the changes are not saved.**

3.3.3 Home Button

Press this button (◄◄) to view the Home Menu. Refer to the menu trees that appear later in the manual.

3.3.4 Previous Main Menu Button

Press this button (◄) to view the previous Main Menu. All main menus include both types of green triangles (◄ and ►). Refer to the menu trees later in this manual.

NOTICE
The up and down arrows (↑ and ↓) are used to navigate between the submenus.

3.3.5 Emergency Stop Button

Push this button in for emergency shutdown of the generator set. This will stop the generator set immediately and prevent starting of the set from any location (local and remote).

NOTICE
To avoid equipment damage, the Emergency Stop button must not be used for a normal shutdown, as this will prevent a cooling run in which the lubricating oil and engine coolant carry heat away from the engine combustion chamber and bearings in a safe manner.

If the generator set is not running, pushing the button in will prevent the starting of the engine, regardless of the Start signal source.

NOTICE
Ensure the remote start control is not active when the Emergency Stop is reset. The generator set may start after the Emergency Stop is reset upon receiving a remote start signal.

To reset:

1. Pull the button and allow it to pop out.
2. Turn the O/Manual/Auto switch to O.
3. Press the front panel Fault Acknowledge/Reset button.

4. Select Manual or Auto, as required.

NOTICE

Emergency Stop shutdown can be reset only at the operator panel.

NOTICE

Ensure that the cause of the emergency stop is fully investigated and remedied before a fault Reset and generator Start are attempted.

NOTICE

On enclosed sets, an external Emergency Stop button is situated in close proximity to the control panel viewing window. For open generator sets, it is recommended that an additional Emergency Stop button be situated in close proximity to the plant room exit.

3.3.6 Running Indicator

This green lamp is lit whenever the generator (local or remote) is running.

3.3.7 Remote Start Indicator

This green lamp indicates the control is receiving a remote run signal. When flashing, it indicates a load demand stop mode.

3.3.8 Not in Auto

This red lamp flashes continuously when the O/Manual/Auto switch is not in the Auto position.

NOTICE

If the switch is in the Auto position and the lamp is still flashing, service is required.

3.3.9 Analog AC Metering Panel

This panel simultaneously displays 3-phase line to line AC volts and current, kW, power factor and frequency.

The meter panel is composed of a series of LEDs, that are configured in bar graphs for each function. The LEDs are color coded, with green indicating normal range values, amber for warning levels, and red for shutdown conditions.

Scales for each function are in % of nominal values. Resolution is 1% for values close to nominal, and increases at values further from nominal.

3.3.10 Shutdown Status

This red lamp is lit when the control detects a Shutdown condition. The generator set cannot be started when this lamp is on. After the condition has been corrected, the lamp can be reset by turning the O/Manual/Auto switch to the O position, and pressing the Fault Acknowledge button. The generator set cannot be started when this lamp is on.

Dependent upon the specific fault that occurs, the engine may or may not shut down immediately. A fault that could cause engine damage, causes an immediate engine shutdown (bypasses engine cooldown sequence). All other faults would allow the engine to run during the cooldown sequence before engine shutdown. In this case, the Shutdown Status indicator blinks during the cooldown period.

3.3.11 Warning Status Indicator

This yellow lamp is lit whenever the control detects a warning condition. After the condition is corrected, warning indicators can be reset by pressing the Fault Acknowledge button. (It is **not** necessary to stop the generator set if the fault becomes inactive during generator set operation.) In auto mode, warning indicators can also be reset by cycling the remote reset input after the condition is corrected.

Some warnings remain active after the condition is corrected and the control reset button is pressed. This will require the generator set to be shut down to reset the warning indicator.

3.3.12 Fault Acknowledgement/Reset Button

Press this button to acknowledge warning and shutdown messages after the fault has been corrected. Pressing this button clears the fault from the current fault list.

To acknowledge a Warning message, the O/Manual/Auto switch can be in any position. (It is not necessary to stop the generator set to acknowledge an inactive Warning condition.) To acknowledge a shutdown message with this button, the O/Manual/Auto switch must be in the O position.

3.3.13 Panel Lamp and Lamp (LED) Test Button

Press this button to turn the control panel lamps on or off. The lights will shut off after about ten minutes. Press and hold this button to test all front panel LEDs and meters. The meters will light one bar at a time.

3.3.14 Manual Run/Stop Button

This button starts and stops the generator set locally and will bypass the Time Delay to Start and Stop sequences. The O/Manual/Auto switch must be in the Manual position to enable this button.

3.3.15 O/Manual/Auto Switch

Manual position enables the use of the switch panel Manual Run/Stop button.

Auto position enables start/stop control of the engine from a remote location. (Disable the use of the switch panel Manual Run/Stop button.)

O (off) position prevents the starting of the set (local or remote).

NOTICE
If moved to the O position during set operation, this will cause an immediate engine shutdown (bypasses cooldown timers). Hot shutdowns should be avoided to prolong the reliability of the generator set. Hot shutdowns are logged by the system software.

NOTICE

When the generator set is operating in Auto, removing the Remote Start Command does not shut off the engine if the load is more than 10 percent, the cooldown timer is set to zero, and the control is configured for a single unit (not in parallel). The generator set continues to operate until it runs out of fuel, the E-stop button is used, or the load is removed.

3.3.16 Configurable Indicators

The following configurable indicators (default values shown) can be changed with the InPower service tool.

- **Low Oil Pressure Warning Indicator:** This yellow lamp indicates the oil pressure is lower than the normal range of operation.
- **High Engine Temperature Warning Indicator:** This yellow lamp indicates the engine temperature is higher than the normal range of operation.
- **Low Oil Pressure Shutdown Indicator:** This red lamp indicates the engine has shut down because of low oil pressure.
- **Overspeed Shutdown Indicator:** This red lamp indicates the engine has shut down because of excessive speed.
- **Fail to Start Indicator:** This red map indicates the engine failed to start.

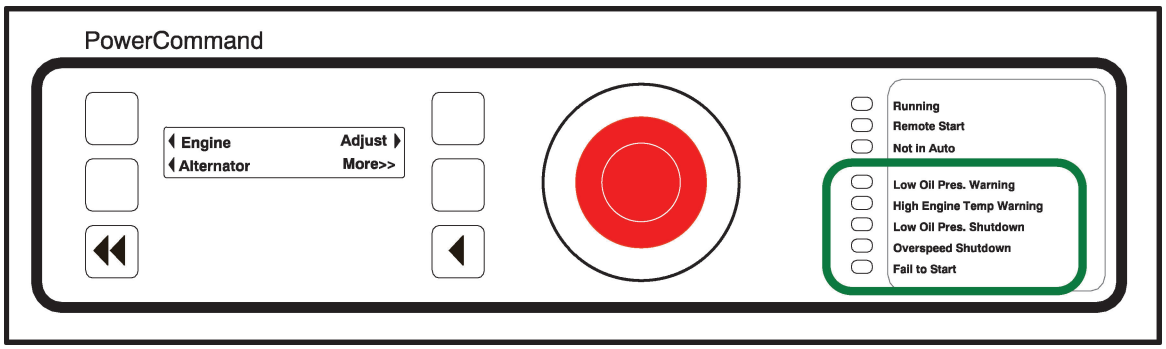


FIGURE 3. CONFIGURABLE INDICATORS

The configurable items are: Change Generator Event and LED Color (green, yellow or red), and Enable/Disable Indicator.

NOTICE

The InPower service tool is required to select the desired settings. Contact an authorized service center for assistance.

3.3.17 Low Oil Pressure Warning Indicator

This yellow lamp indicates the oil pressure is lower than the normal range of operation.

3.3.18 High Engine Temperature Warning Indicator

This yellow lamp indicates the engine temperature is higher than the normal range of operation.

3.3.19 Low Oil Pressure Shutdown Indicator

This red lamp indicates the engine has shut down because of low oil pressure.

3.3.20 Overspeed Shutdown Indicator

This red lamp indicates the engine has shut down because of excessive speed.

3.3.21 Fail to Start Indicator

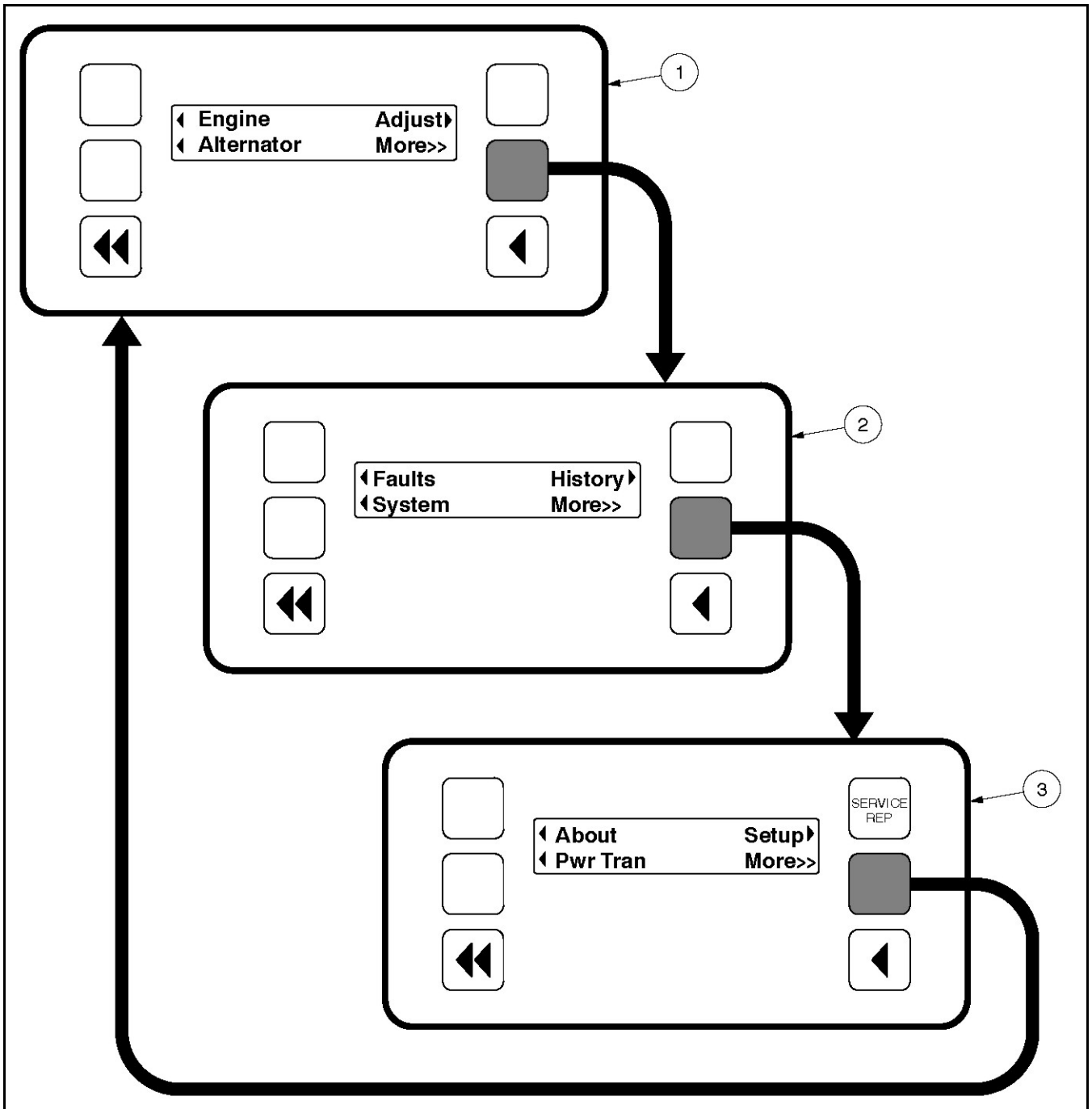
This red lamp indicates the engine failed to start.

3.4 Control Menus

3.4.1 Main Menus

The figure below shows the three major main menus available to the user. When viewing a submenu, you can press the previous main menu button at any time to view its main menu.

As shown in the illustration, each main menu can branch into one of four directions. Press the button next to "More>>" in the display to view the next Main menu. Main Menu 1 is redisplayed when you press the button next to "More>>" in the Main Menu 3 display.



NO	DESCRIPTION	NO	DESCRIPTION
1	Main Menu 1	3	Main Menu 3
2	Main Menu 2		

FIGURE 4. MAIN MENUS

3.4.1.1 Main Menu 1

Main Menu 1 is also the Home menu. When viewing any of the other main menus or any submenu, you can press the home button to view this menu.

To display engine parameters, such as coolant temperature, oil pressure, oil temperature, etc., press the button next to the word "Engine" in the display. Refer to the Engine menu diagram.

To display alternator parameters, such as line-to-line voltage, line-to-neutral voltage, amperage, frequency, etc., press the button next to the word "Alternator" in the display. Turn to the Alternator menu diagram.

To adjust generator parameters, such as idle start, voltage, frequency, start delay, and stop delay, press the button next to the word "Adjust" in the display. Turn to the Adjust menu diagram.

To view one of the other main menus, press the button next to "More>>" in the display.

3.4.1.2 Main Menu 2

To display system faults, press the button next to the word "Faults" in the display. Up to 20 of the most recent/current faults can be displayed. Refer to the Faults menu diagram.

To view network system parameters, such as on the automatic transfer switch (ATS), Master, or Genset system, press the button next to the word "System" in the display. Refer to the System menu diagram.

To display historical engine parameters such as number of starts, engine hours, control hours, kilowatt hours, and genset duty cycle, press the button next to the word "History" in the display. Refer to the History menu diagram.

To view one of the other main menus, press the button next to "More>>" in the display.

3.4.1.3 Main Menu 3

To view parameters on the generator, such as model, standby rating, and software version, press the button next to the word "About" in the display. Refer to the About menu diagram.

To view power transfer parameters, such as source power, frequency, generator, utility, and active transfer timer, press the button next to the word "Pwr Tran" in the display. Refer to the Power Transfer Menu

Main Menu 3 also includes a link to the Setup menus. These menus can be viewed but changes to these menus are restricted to service personnel with the appropriate access code.

To view one of the other main menus, press the button next to "More>>" in the display.

3.4.2 Adjusting Default Settings

The Controller Configuration Menu can be used to adjust the following default settings:

- Language - Select from available loaded languages
- Temperature Units - Fahrenheit or Centigrade
- Fluid Pressure Units - kPA or PSI

For more information on adjusting these settings, turn to the Controller Configuration menu diagram.

3.4.3 System Messages

A system message pop-up screen is displayed when the event it is displaying becomes active. These pop-up screens remain displayed until pre-empted by another pop-up screen or until any display button is pressed. Once a button is pressed, the previous menu is redisplayed. To return to an active pop-up screen from the previous menu, select the following menu:

- *Engine* to redisplay Time Delay Idle
- *Faults* to redisplay Faults

Pop-up screens are displayed for the following:

- Faults
- Power Transfer Control timer
- Time Delay - Start, Stop, and Idle

An example of a Time Delay Idle pop-up screen is shown below. A countdown, in seconds, is included in the display.

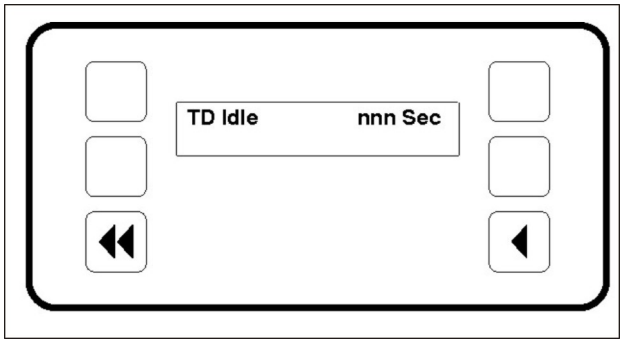


FIGURE 5. TIME DELAY IDLE POP-UP SCREEN

3.4.4 Controller Configuration Menu

Figure 6 on page 25 shows a block representation of the Controller Configuration menus. These menus are used to change the default language, temperature units, and pressure units to be displayed in menus.

To view the first Controller Configuration menu, make sure Main Menu 1 is displayed and simultaneously press the Home Menu and Previous Main Menu buttons.

As shown in the diagram, the Controller Configuration menu has three submenus.

- **Language Selected submenu:** Used to select desired language (default = English).
- **Temperature Units submenu:** Used to select Fahrenheit or Centigrade for temperature readings.
- **Fluid Pressure Units submenu:** Used to select PSI or kPA for pressure readings.

Press the buttons next to the up and down arrows in the digital display to navigate between the menus.

Press the button next to the ► symbol in the display until the + and - symbols are displayed.

Press the button next to the + or – symbol to select the desired option.

After selecting option, pressing the ► symbol results in the changes being saved. If the Home button or Previous Main Menu button is pressed before pressing the ► symbol, the changes are not saved.

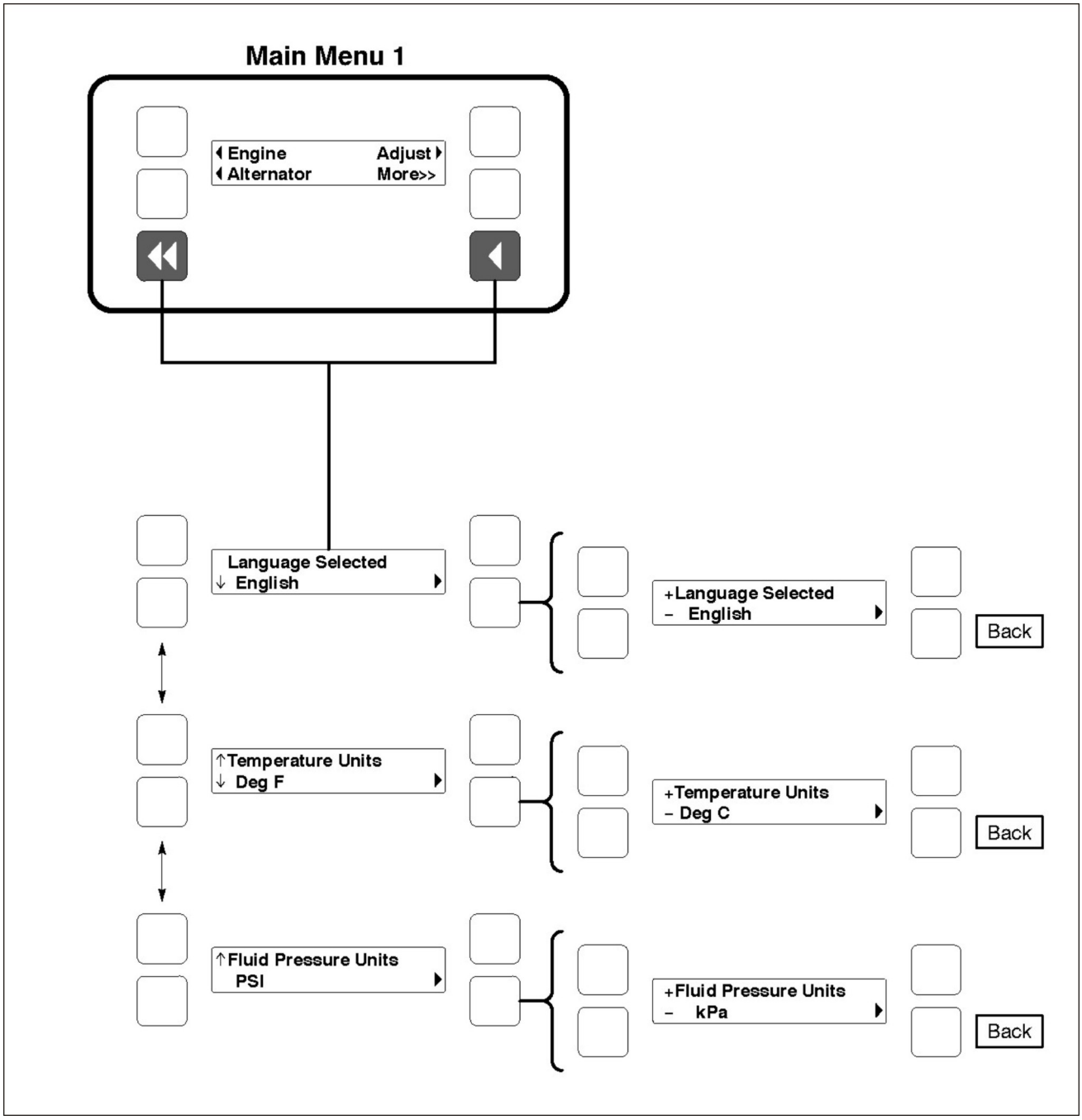


FIGURE 6. CONTROLLER CONFIGURATION MENU

3.4.5 Engine Menu

Figure 7 on page 27 shows a block representation of the Engine menu. If you press the button next to the word "Engine" in the display, the first Engine submenu is displayed.

As shown in the diagram, the Engine menu has seven submenus. The data in the submenus will vary according to the type and number of sensors provided with the engine.

- **Coolant Temperature submenu:** This submenu displays the engine coolant temperature which can be viewed in degrees Fahrenheit or Centigrade (see the **Section 3.4.4**).
- **Oil Pressure submenu:** This submenu displays the engine oil pressure which can be viewed in PSI or kPA (see **Section 3.4.4 on page 24**).
- **Oil Temperature submenu (Only available on some models):** This submenu displays the engine oil temperature which can be viewed in degrees Fahrenheit or Centigrade (see **Section 3.4.4 on page 24**).
- **Engine Speed submenu:** This submenu displays the engine RPM.
- **Battery Voltage submenu:** This submenu displays the engine battery voltage.
- **Governor Duty Cycle submenu:** This submenu displays the governor duty cycle (drive) levels in percentage of maximum.
- **Active Time Delay submenu:** This submenu displays the time delay that is currently active: warm-up, cooldown, start, or stop delays.

Press the buttons next to the ↓ and ↑ symbols in the digital display to navigate between the menus. Press the Home button or the Previous Main Menu button to return to Main Menu 1.

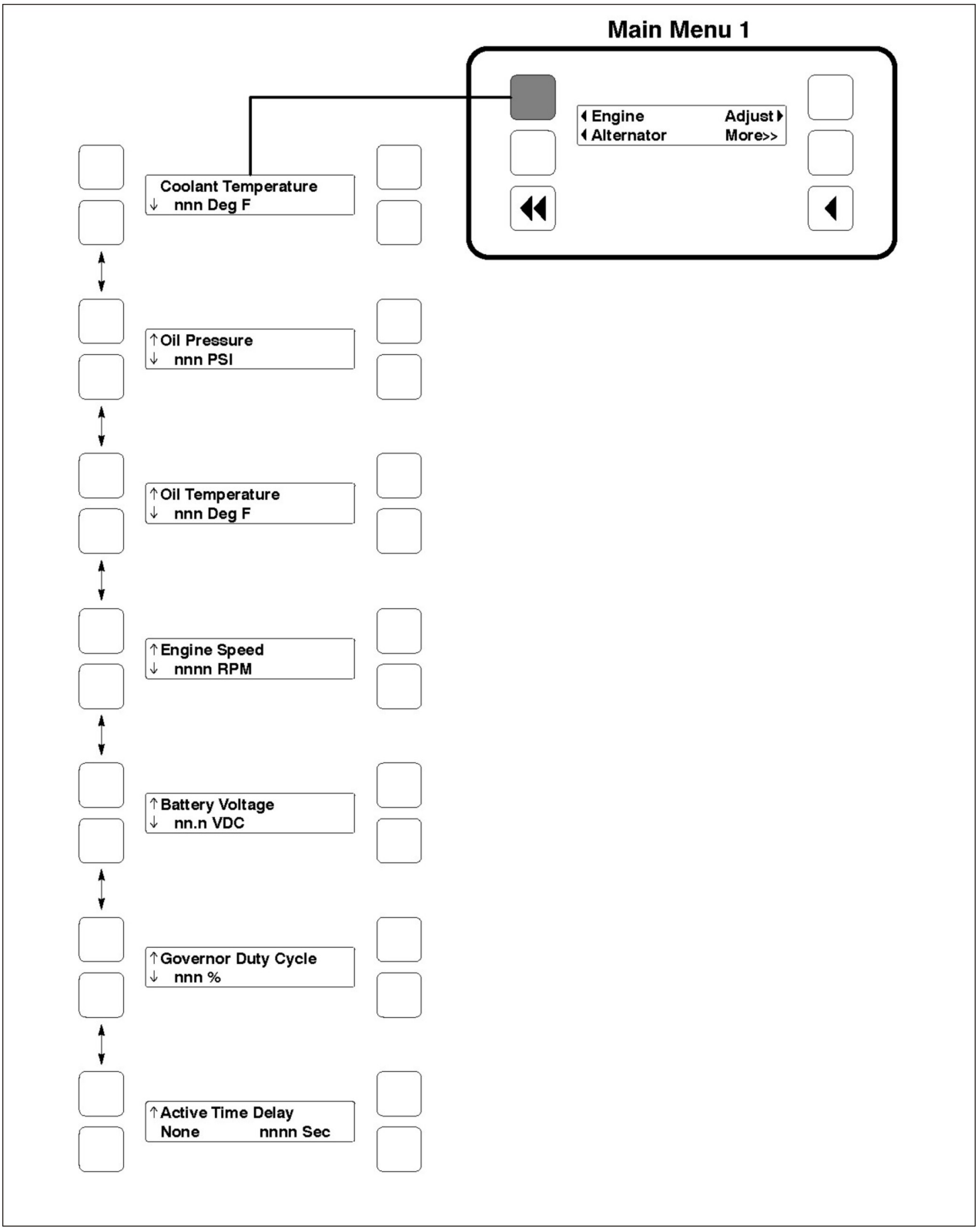


FIGURE 7. ENGINE MENU

3.4.6 Alternator Menu

Figure 8 on page 29 shows a block representation of the Alternator menu. If you press the button next to the word "Alternator" in the display, the first Alternator submenu is displayed.

As shown in the diagram, the Alternator menu has eleven submenus.

- **Line-to-Line Voltage submenu:** The voltages Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively. (Single phase - L1 to L2 only.)
- **Line-to-Neutral Voltage submenu:** Note that the Line-to -Neutral menu will not be displayed for a 3 phase/3 wire system. Single phase - L1 to N and L2 to N.
- **Amps submenu:** All phases. (Single phase - L1 and L2 only.)
- **Frequency submenu:** Generator set output frequency.
- **Total Real Power submenu:** This submenu displays the total amount of real power output, in kilowatts (kW).
- **Real Power submenu:** This submenu displays the amount of real power output for L1, L2, and L3, in kilowatts (kW). (Single phase - L1 and L2 only.)
- **Total Apparent Power submenu:** This submenu displays the total amount of apparent power output, in kilovolt amps (kVA).
- **Apparent Power submenu:** This submenu displays the amount of apparent power output for L1, L2, and L3, in kilovolt amps (kVA). (Single phase - L1 and L2 only.)
- **Total Power Factor submenu:** This submenu displays the power factor with leading/lagging indication.

  The PF reading will contain an asterisk if the power factor is leading (for example, Total PF 0.9).*
- **Power Factor submenu:** This submenu displays a power factor value for L1, L2, and L3. (Single phase - L1 and L2 only.)

  The PF reading will contain an asterisk if the power factor is leading (for example, PF L1 0.9).*
- **AVR Duty Cycle submenu:** This submenu displays the voltage regulator (drive) level in percentage of maximum. (Where maximum is 100% Duty Cycle, software clamps Duty Cycle maximum to 60% for PMG and 90% for shunt.)

Press the buttons next to the ↑ and ↓ arrows in the digital display to navigate between the menus. Press the Home button or the Previous Main Menu button to return to Main Menu 1.

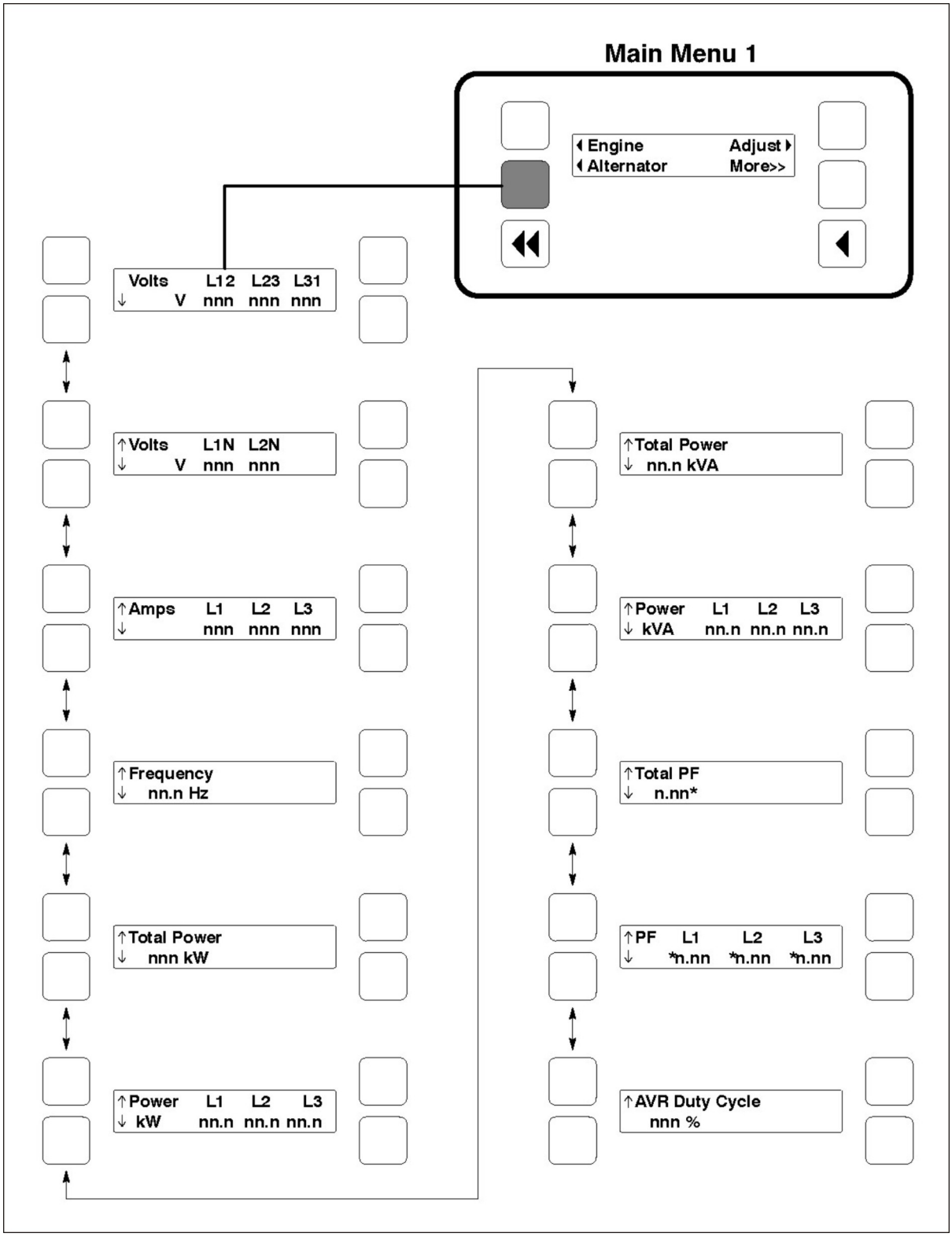


FIGURE 8. ALTERNATOR MENU

3.4.7 Adjust Menu

Figure 9 on page 31 shows a block representation of the Adjust menu. If you press the button next to the word "Adjust" in the display, the first Adjust submenu is displayed.

As shown in the diagram, the Adjust menu has six submenus. Each submenu includes a parameter or value that can be changed.

- **Voltage Adjust submenu:** Voltage can be adjusted to 5 percent of the nominal voltage. For example, if generator set output voltage is 208 volts, the voltage can be adjusted from 198 to 218 volts.

  If the displayed value is greater or less than the allowed (5%) range, the control will not except the entry and will return to the previous setting. Retry by entering a smaller change in one volt increments.

- **Frequency Adjust submenu:** Frequency can be adjusted to 5 percent of the nominal frequency. For example, if the generator set frequency is 60.0 Hz, the frequency can be adjusted from 57.0 to 63.0 Hz.

- **Start Delay submenu:** Start Delay can be set from 0 to 300 seconds (default = 0). (Enter 1 or more to enable.) This function is bypassed during a manual start/stop sequence.

- **Stop Delay submenu:** Stop Delay can be set from 0 to 600 seconds (default = 0). (Enter 1 or more to enable.) This function is bypassed during a manual start/stop sequence and engine shutdown faults.

- **Rated To Idle (Beginning Version 2.303):** Rated To Idle delay can be set from 0 to 10 seconds (default = 0). (Enter 1 or more to enable.) Entering a non-zero delay will cause the generator set to delay the transition to Cooldown At Idle.

- **Idle Start submenu (Only available on some models):** Idle Start can be enabled or disabled (default = Disable). This function is only enabled when the generator set is started in manual mode. Idle Start can also be enabled while the generator set is running in manual mode. (Auto/remote start is not affected by this setting.)

Press the buttons next to the ↑ and ↓ arrows in the digital display to navigate between the menus. Press the Home button or the Previous Main Menu button to return to Main Menu 1.

Adjusting Values/Parameters:

1. Press the button next to the ► symbol in the display until the + and - symbols are displayed.
2. If necessary, press the button next to the symbols to move to the numeric character you wish to change.
3. Press the button next to the + symbol to increase the value or select parameter; press the button next to the – symbol to decrease the value or select parameter.
4. After adjusting values/selecting parameters, pressing the ► symbol results in the changes being saved. (When adjusting values, make sure the cursor is on the last numeric character before pressing the ► symbol).

   If the Home button or Previous Main Menu button is pressed before pressing the ►

   symbol, the changes are not saved.

Enabling Idle Start will cause the generator set to run in idle mode until Idle Start is disabled. A warning is displayed if generator set is left in idle more than 10 minutes. Long periods of engine idling can eventually affect engine performance and may void engine warranty.

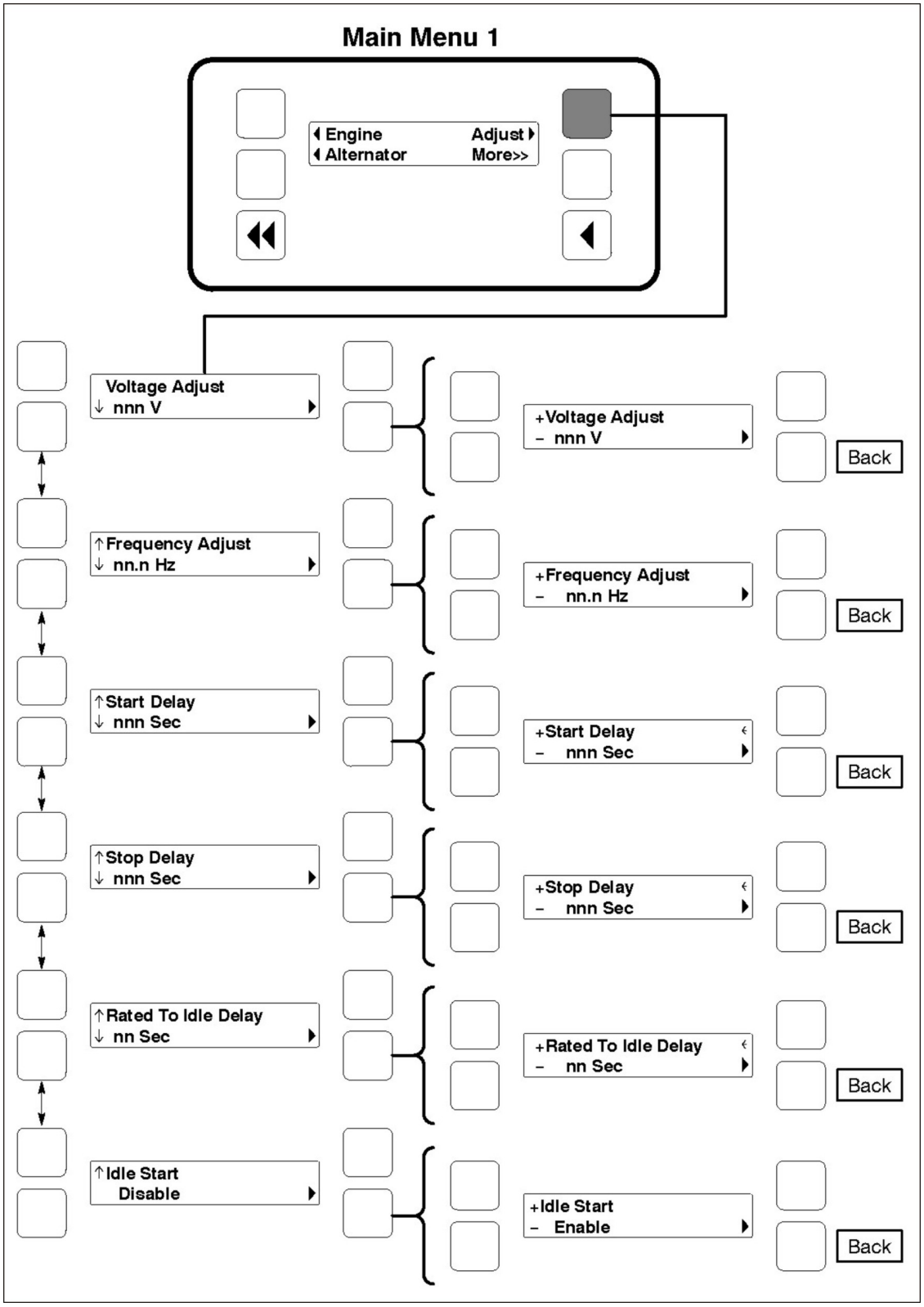


FIGURE 9. ADJUST MENU

3.4.8 Faults Menu

Figure 10 shows a block representation of the Faults menu. Up to 20 of the most recent faults can be viewed. An example of how a fault code is displayed is shown in Figure 11 on page 33.

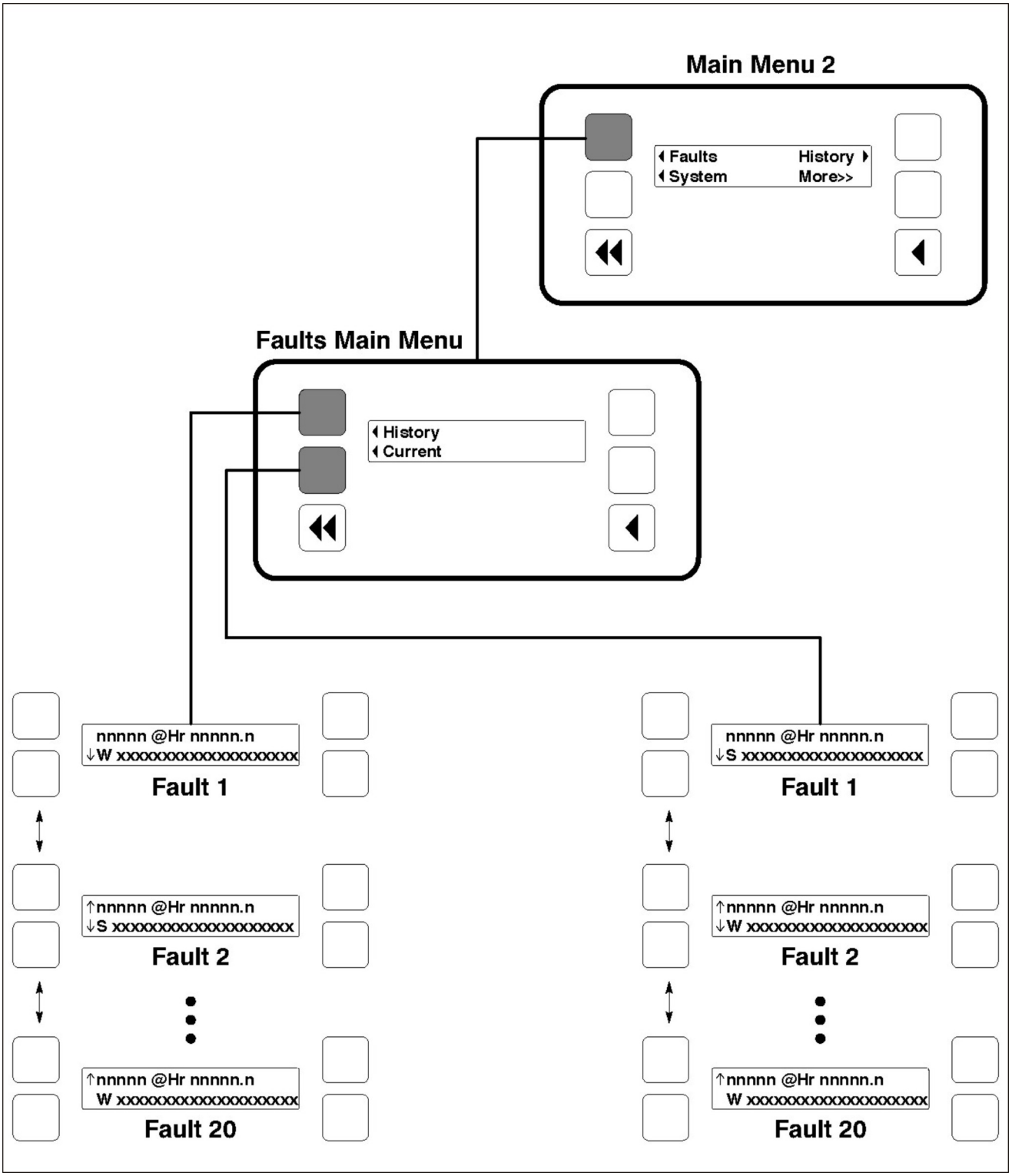


FIGURE 10. FAULTS MENU

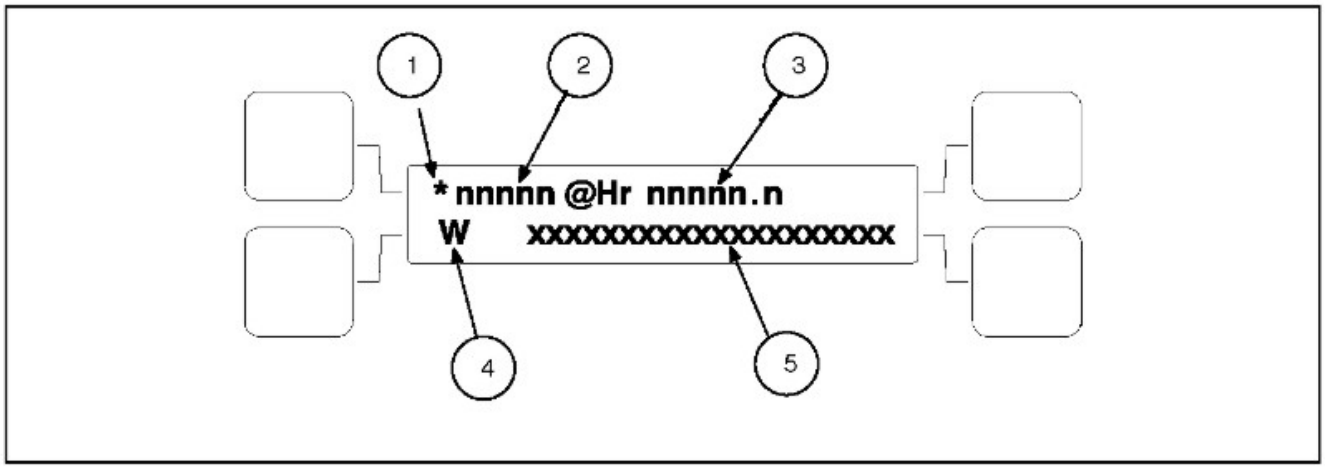
The available menus are dependent on the number of faults that have occurred.

- **History submenu:** From the Faults Main Menu, press the button next to the word "History" in the display to view up to twenty of the most recent acknowledged faults. Press the buttons next to the ↑ and ↓ symbols in the digital display to navigate between the menus. Press the Previous Main Menu button to return to the Faults Main Menu.
- **Current Fault submenu:** From the Faults Main Menu, press the button next to the word "Current" in the display to view up to twenty of the most recent unacknowledged faults. Press the Previous Main Menu button to return to the Faults Main Menu.

If there are no faults, the ◄ symbol next to the word "Faults" is not displayed and no Fault menus are available.

If more than one fault has occurred, press the button next to the word "Fault" in the screen display to view the Faults Main Menu. As shown in the diagram, the Faults Main Menu has two submenus. Press the Previous Main Menu button to return to the Faults Main Menu. Press the Previous Main Menu button a second time to return to Main Menu 2.

Press the Home button at any time to return to Main Menu 1.



NO	DESCRIPTION	NO	DESCRIPTION
1	Asterisk = Active Fault	4	W=Warning S=Shutdown
2	Fault Code	5	Fault Description
3	Hour Fault Occurred		

FIGURE 11. HISTORY/CURRENT FAULT SUBMENU

3.4.9 System Menu

Figure 12 on page 34 shows a block representation of the System menu. If you press the button next to the word "System" in the display, the System Main Menu is displayed. This menu is displayed only if the network communications module (NCM) feature is installed. The System Main Menu allows you to view the status and load of other PCC equipment connected on a common network with the PCC 2100 control.

As shown in the diagram, the System Main Menu has one set of submenus.

- **Genset System submenus:** From the System Main Menu, press the button next to the word "Genset" in the display to view the first of up to 16 Genset System submenus. One generator set must be available in the network to display this submenu.

  The genset submenu allows viewing of the generator set name (configured with InPower), kW load and operational state.

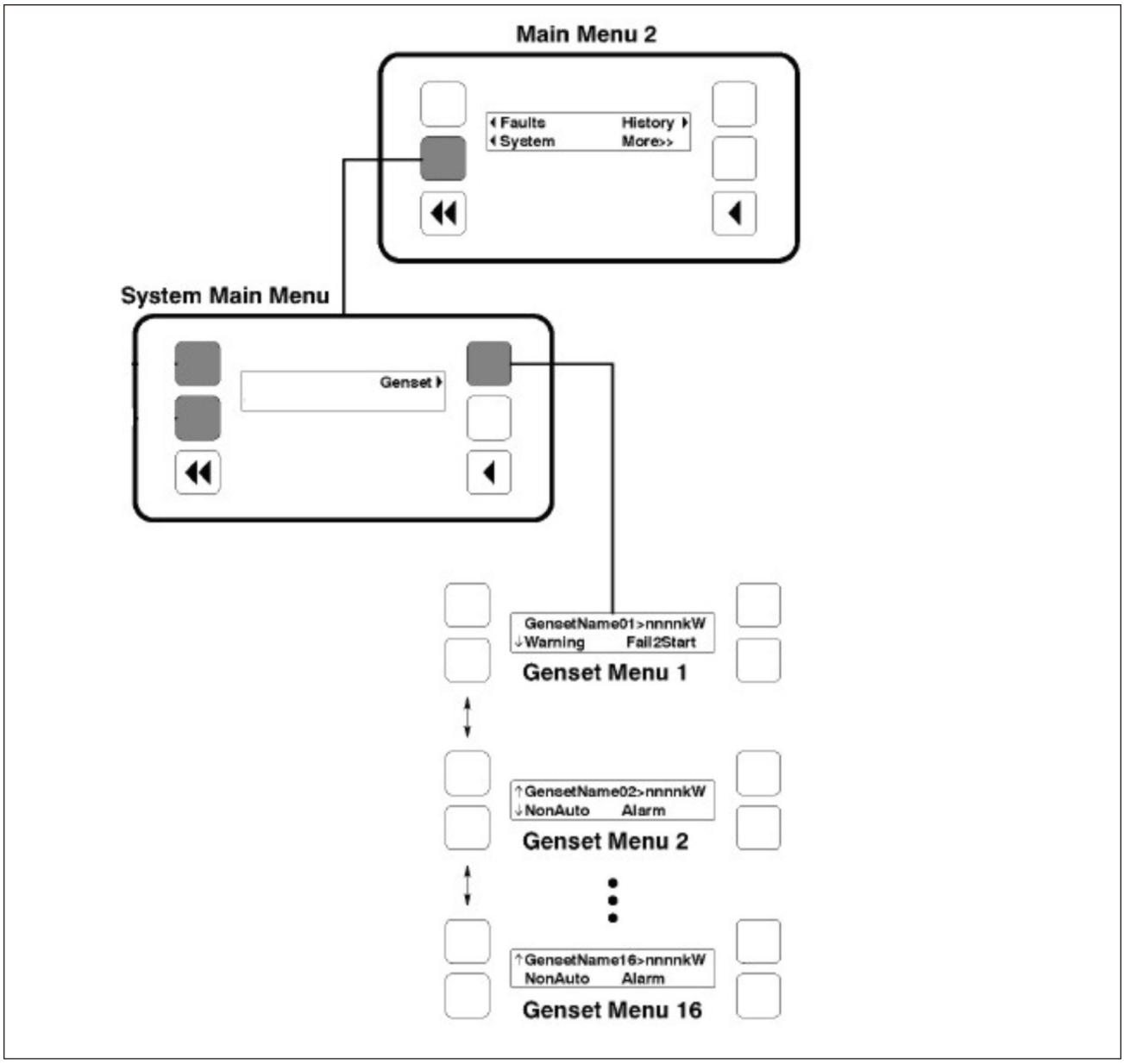


FIGURE 12. SYSTEM MENU

3.4.10 History Menu

Figure 13 on page 36 shows a block representation of the History menu. If you press the button next to the word "History" in the display, the first History submenu is displayed.

As shown in the diagram, the History menu has five submenus. This information is stored in non-volatile memory and will not be deleted due to loss of battery power.

- **Number of Starts submenu:** This submenu shows the number of engine starts.
- **Engine Hours submenu:** This submenu shows the number of operating hours for the engine.
- **Control Hours submenu:** This submenu shows the number of operating hours for the control.
- **Kilowatt Hours submenu:** This submenu shows the number of kilowatt (kW) or megawatt (MW) hours.
- **Genset Duty Cycle submenu:** This submenu shows the percent of generator set operating hours that are less than 30 percent of rated load and percent of hours that are greater than 90 percent.

Press the buttons next to the ↑ and ↓ symbols in the digital display to navigate between the menus. Press the Previous Main Menu button to return to Main Menu 2. Press the Home button to return to Main Menu 1.

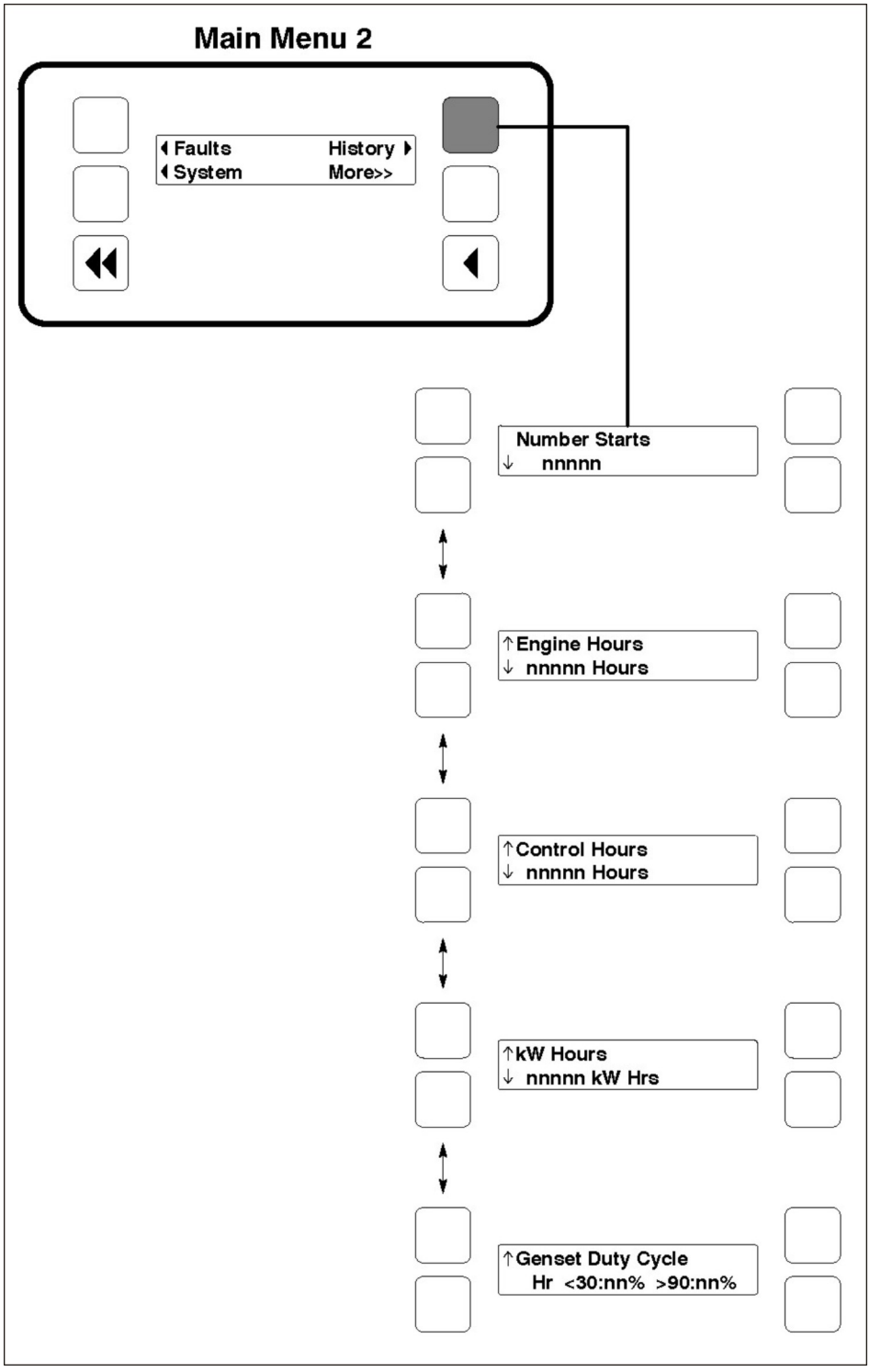


FIGURE 13. HISTORY MENU

3.4.11 About Menu

Figure 14 on page 37 shows a block representation of the About menu. If you press the button next to the word "About" in the display, the first About submenu is displayed.

As shown in the diagram, the About menu has three submenus.

- **Model submenu:** This submenu shows the generator set model.
- **Rating submenu:** This submenu shows the rating (Standby or Prime and number of kilowatts (kW)).
- **Software Version submenu:** This submenu shows the software version level. This information is required to service the generator set.

Press the buttons next to the ↑ and ↓ symbols in the digital display to navigate between the menus. Press the Previous Main Menu button to return to Main Menu 3. Press the Home button to return to Main Menu 1.

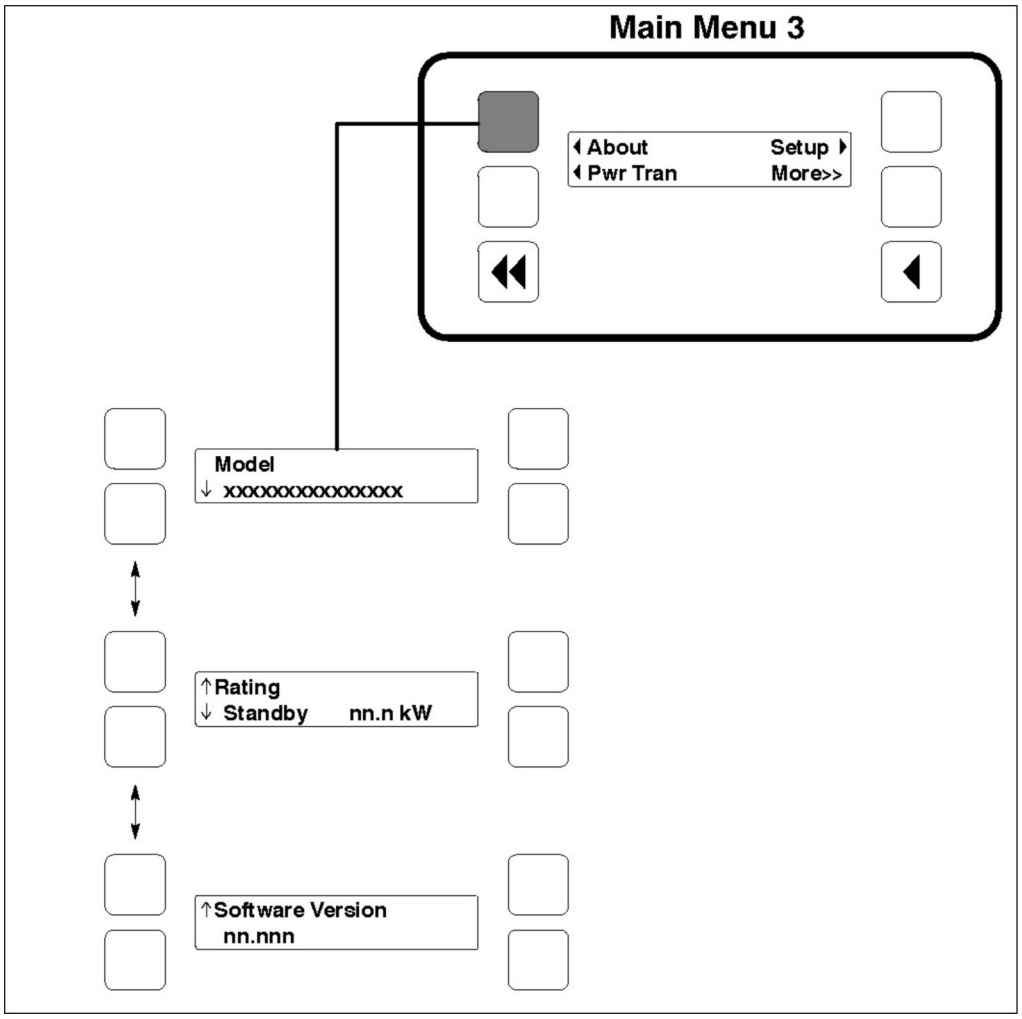


FIGURE 14. ABOUT MENU

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4 Circuit Boards

4.1 General

⚠ WARNING

HAZARDOUS VOLTAGE. Touching uninsulated parts inside the control panel box can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching hazardous voltage parts.

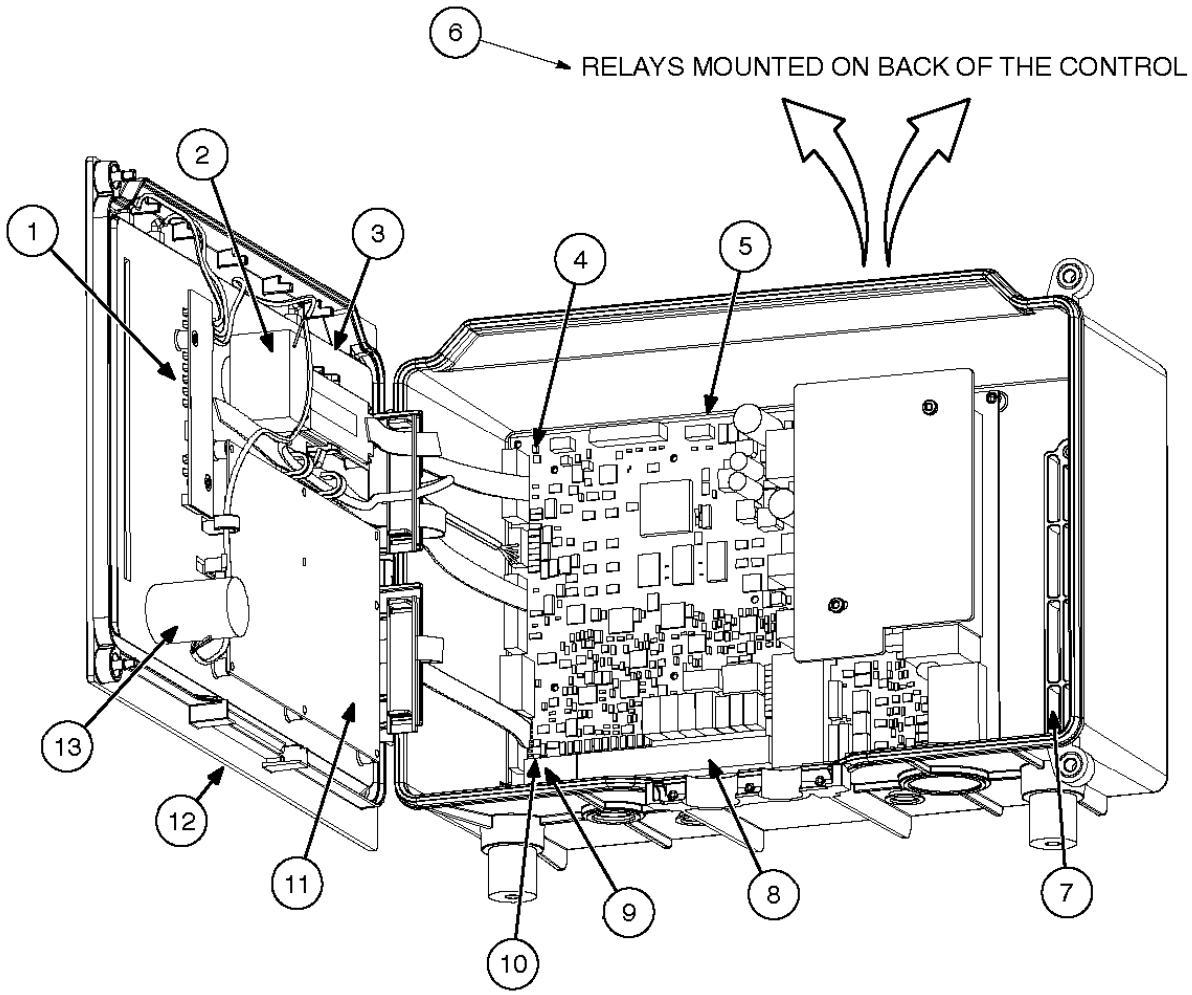
⚠ WARNING

To avoid personal injury or harm, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.

This section describes the function of the PowerCommand® 2100 Control (PCC) base circuit board that is contained in the control panel box (**Figure 15**). The block diagram in **Figure 16**, shows the external connections of the PCC system. The system schematics are provided in *Section 9* of this manual.

⚠ CAUTION

Electrostatic discharge will damage circuit boards. Always wear a grounding wrist strap when touching or handling circuit boards.



NO	DESCRIPTION	NO	DESCRIPTION
1	Indicator Board	8	TB1 (1-22)
2	Emergency Stop Button	9	TB2 (1-6)
3	Display Board	10	Chassis Ground Screw
4	Control Alive Indicator	11	Bargraph Board (Optional)
5	Base Board	12	Front Control Panel Assembly (Membrane Buttons)
6	Relays	13	O/Manual/Auto Switch (S12)
7	AUX Relays (Optional)		

FIGURE 15. CIRCUIT BOARD LOCATIONS

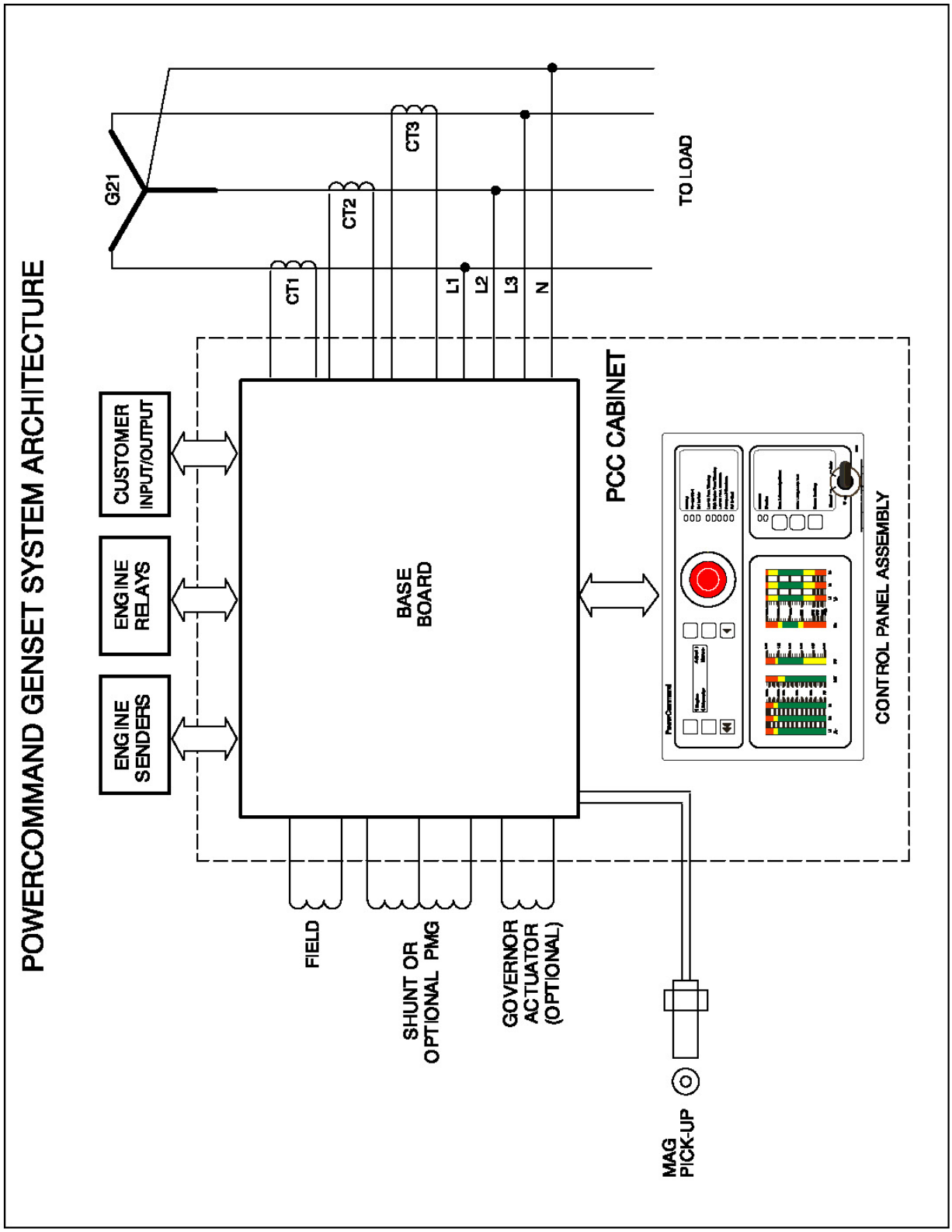


FIGURE 16. BLOCK DIAGRAM

4.2 Base Board

The base circuit board (Figure 17) contains all of the electronic circuitry required to operate the generator set. The Base board provides fuel control and engine speed governing, main alternator voltage output regulation, and complete generator set control and monitoring.

The following paragraphs describe each of the connectors (J), fuses (F) and terminal boards (TB) shown in Figure 17.

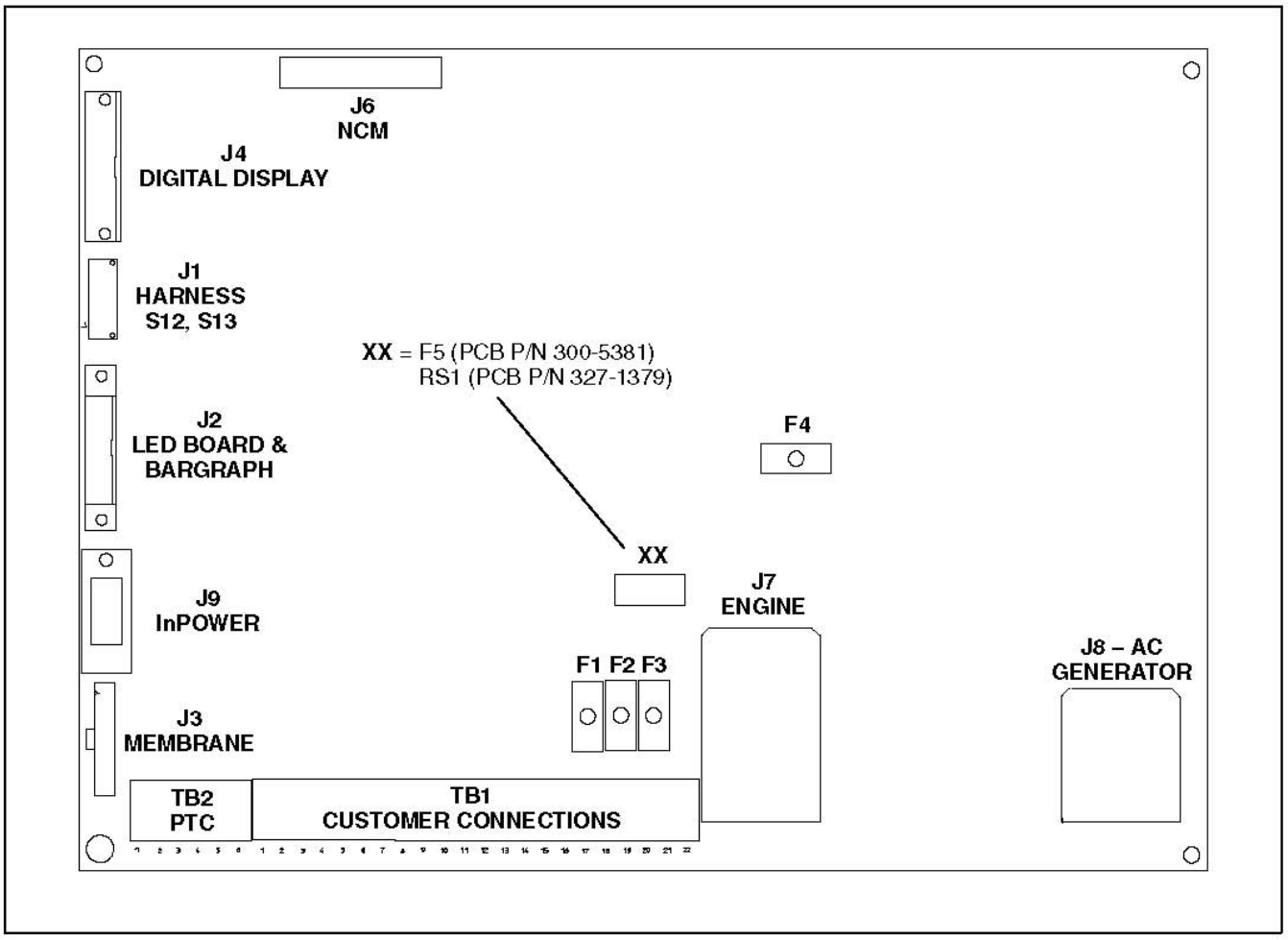


FIGURE 17. BASE BOARD

4.3 Connector J1

J1 connects to the Emergency Stop switch (S13) and the O/Manual/Auto control panel switch (S12).

TABLE 1. WIRE TABULATION

SIGNAL	FROM	TO
GND	S12-4	J1-8
OFF (O)	S12-1	J1-7

MANUAL	S12-3	J1-6
AUTO	S12-5	J1-5
ESTOP-NC1	S13-1	J1-2
ESTOP-NC2	S13-2	J1-1
ESTOP-NO1	S13-3	J1-3
ESTOP-NO2	S13-4	J1-4

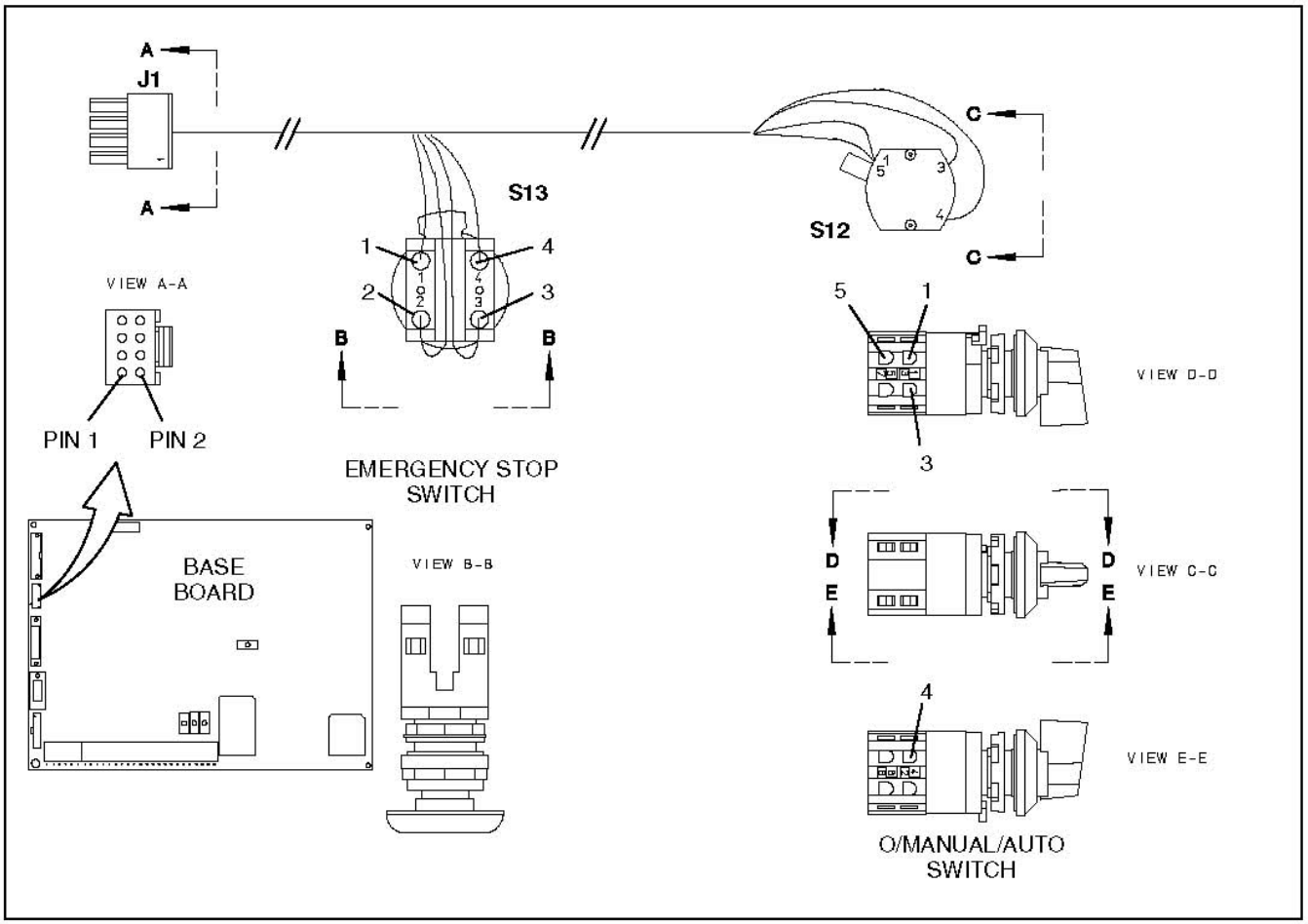


FIGURE 18. CONNECTOR J1 (CONTROL HARNESS)

4.4 Connector J2

J2 connects to LED (indicator) board and bargraph board of front control panel assembly.

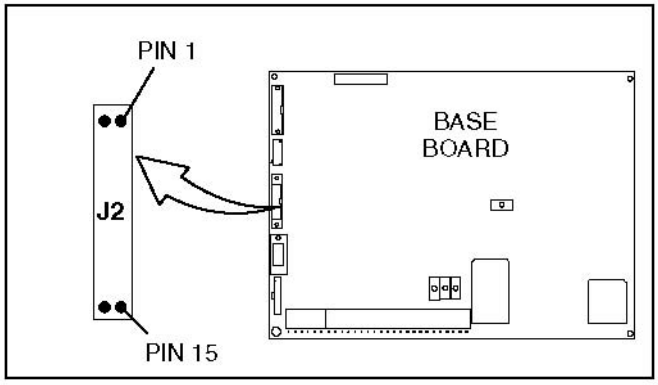


FIGURE 19. J2 LED/BARGRAPH CONNECTOR

TABLE 2. CONNECTOR J2

PIN	SIGNAL
1	MOSI
2, 4, 6, 16	GND
3	SCK
5	SEL_A
7	SEL_B
10, 14, 15	VCC
9	SEL_C
11	SEL_D
13	BAR_ENABLE

4.5 Connector J3

J3 connects to membrane buttons of front control panel assembly.

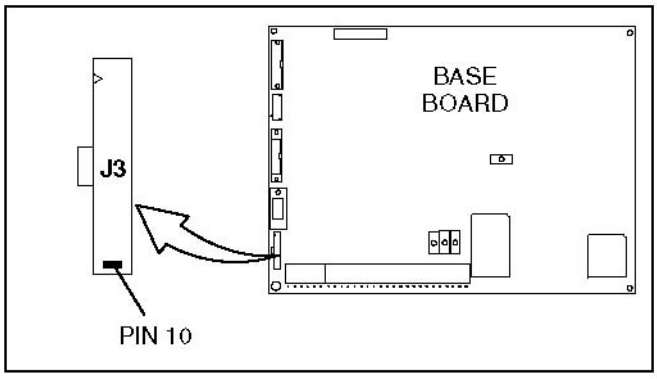


FIGURE 20. J3 MEMBRANE CONNECTOR

TABLE 3. CONNECTOR J3

PIN	SIGNAL

1	HOME MENU <<
2	PREVIOUS MENU <
3	UPPER LEFT
4	LOWER LEFT
5	UPPER RIGHT
6	LOWER RIGHT
7	FAULT ACK/RESET
8	PANEL LAMP
9	MANUAL RUN/STOP
10	COMMON (GND)

4.6 Connector J4

J4 connects to display menu of front control panel assembly.

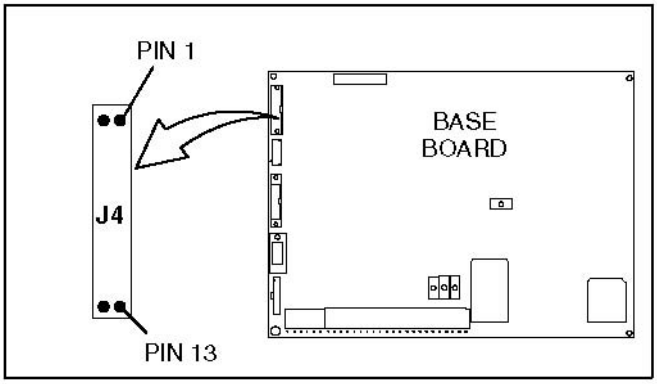


FIGURE 21. J4 DISPLAY MENU CONNECTOR

TABLE 4. CONNECTOR J4

PIN	SIGNAL
1	GND
2	VCC
3	N.U.
4	RS
5	R/W
6	ENABLE DISPLAY
7	D[0]
8	D[1]
9	D[2]
10	D[3]
11	D[4]
12	D[5]

13	D[6]
14	D[7]

4.7 Connector J7

J7 connects to the engine sensors, battery, starter, governor actuator and magnetic pickup.

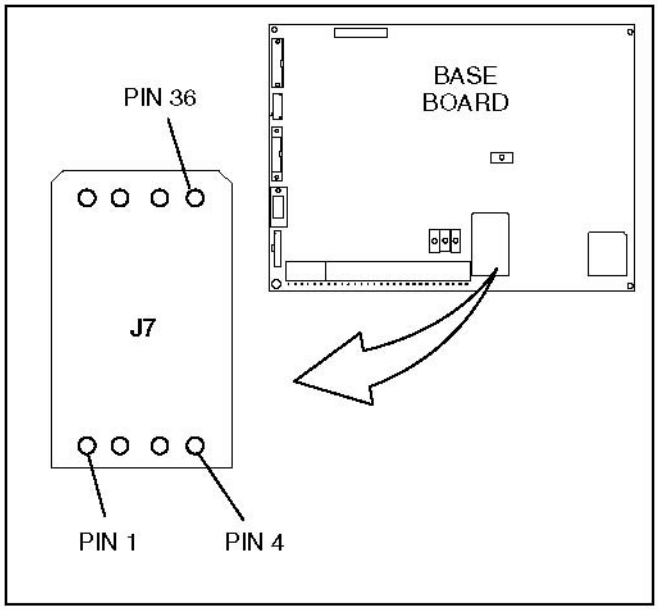


FIGURE 22. J7 ENGINE HARNESS CONNECTOR

TABLE 5. CONNECTOR J7

PIN	SIGNAL
5, 6, 7, 8	GND
1, 2, 3, 4	B+ IN
9 10	GEN SW B+ FUEL SOL -
11 12	CT1 CT1-COM
13 17 21	OIL PRESS OUT OIL PRESS COM OIL PRESS 5V
15 16	CT2 CT2-COM
18	ALT FLASHOUT
19 20	CT3 CT3-COM
23 27	GEN SW B+ START SOL B-

24 36 14	ACTUATOR + GND ACTUATOR SIG
25 29 33	MAG PICKUP+ MAG PICKUP- GND
30 34	COOLANT SNDER COOLANT SNDER COM
31 32 35	COOL LVL B+ COOL LVL RTN COOL LVL GND

4.8 Connector J8

J8 connects directly to the generator to monitor and control AC output of the genset.

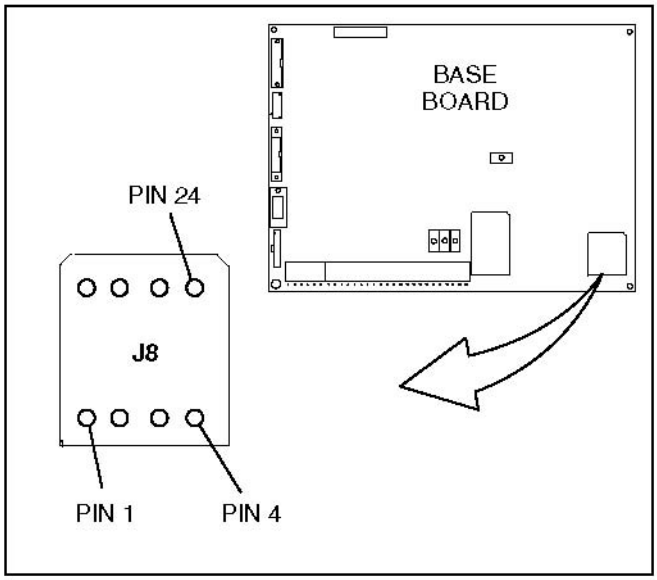


FIGURE 23. J8 AC GENERATOR CONNECTOR

TABLE 6. CONNECTOR J8

PIN	SIGNAL	COMMENTS
4 12 20 7	U1 (T1) V2 (T2) W3 (T3) N (T4)	Used for alternator voltage sensing and power factor angle sensing
13 5	FIELD + FIELD -	Excitation drive output
21 22 23	AC2 (PMG2) AC3 PMG3) AC4 (PMG4)	Used for excitation power (Shunt connection - pins 21 & 22 only)

TABLE 7. BASE BOARD FUSES

REFERENCE DESIGNATION	RATING	FUNCTION
F1	10A	Customer B+ (to TB1 customer terminal block)
F2	5A	Customer switched B+ (to TB1 customer terminal block)
F3	2A	Customer switched B+ (to T26 engine terminal block)
F4	5A	Base board power supply fuse
F5	2A	B+ supply to Power Transfer Control (PTC) module (optional) (PCB P/N 300-5381)
RS1 (Fuse/Auto Reset)	0.9A	B+ supply to Power Transfer Control (PTC) module (optional) (PCB P/N 327-1379)

4.9 TB1 Customer Connections

Customer monitor/control connections are attached to terminal board TB1. Optional equipment such as sensing devices used to monitor genset operation, remote start/stop switches and etc. are attached to this terminal. Refer to Customer Connections diagram in *Appendix A* for TB1 connections.

5 Troubleshooting

5.1 General

The generator set control continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will light a yellow Warning lamp or a red Shutdown lamp and display a message on the digital display panel.

5.2 Safety Considerations

⚠ WARNING

Troubleshooting procedures.

Many troubleshooting procedures present hazards that can result in severe personal injury or death.

Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review the safety precautions in Chapter 1 on page 1

⚠ WARNING

High voltage.

Contacting high voltage components can cause electrocution, resulting in severe personal injury or death.

Keep the output box covers in place during troubleshooting.

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

⚠ WARNING

Battery gases.

Ignition of explosive battery gases can cause severe personal injury or death.

Arching at battery terminals, a light switch or other equipment, flame, pilot lights, andsparks can ignite battery gases, that can cause servere personal injury or death.

Do not smoke or switch a trouble light ON or OFF near a battery. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface. Ventiate the battery area before working on or near a battery. Using an insulated wrench, disconnect the negative (-) cable first and reconnect it last.

⚠ WARNING

Accidental starting.

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

Prevent accidental starting by disconnecting the negative (−) cable from the battery terminal with an insulated wrench.

NOTICE

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

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

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

5.3 InPower Service Tool

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

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

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

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

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

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

5.4 Network Applications and Customer Inputs

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

5.5 Troubleshooting Procedures

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

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

NOTICE

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

This section contains the following information:

- How to troubleshoot a local/remote failure to crank problem when the control panel does not indicate any fault condition.
- How to troubleshoot engine problems that are not within the detectable range of the PC control.
- How to troubleshoot a Check Engine lamp fault for generator sets that contain the low emissions option.
- Descriptions of each status, warning, and shutdown code; warning and shutdown limits where applicable; and basic corrective actions, such as checking fluid levels, control reset functions, battery connections, etc.
- Detailed troubleshooting procedures. In the following list of troubleshooting procedures, the fault codes are arranged in numeric order.

NOTICE

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

NOTICE

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

5.6 Relay K1

Switched B+ relay K1 supplies switched B+ power to splice SP8. SP8 supplies switched B+ to the fuel solenoids, air fuel controller, and the oxygen sensor. K1 is part of the engine harness assembly.

5.7 Relay K4

Relay K4 is the Starter Pilot relay that is used to energize the starter solenoid. K4 is part of the genset harness assembly.

5.8 Relay K6

Relay K6 is the fuel burn-off relay that is used to energize the ignition coil. K6 is part of the genset harness.

5.9 Engine Lacks Power or Is Unstable (No Fault Message)

Reason: This indicates that the PCC has not received or recognized a generator set fault.

Effect: The engine is approaching a level at which unpredictable operation may occur.

1. **Possible Cause:** Current ambient conditions cause a derate, limiting power to less than the rated power.

   Corrective Action: Determine proper derates for ambient conditions. Refer to specification sheet for site derating factors.

2. **Possible Cause:** The engine air filter element is dirty.

   Corrective Action: Replace the air filter element.

3. **Possible Cause:** Check for exhaust restrictions.

   Corrective Action: See the Installation Manual.

4. **Possible Cause:** The gaseous fuel is of insufficient energy content or fuel pressure.

   Corrective Action: Check with the propane supplier or the gas utility to confirm the energy content of the gaseous fuel being used. Propane must have approximately 2500 BTU's per cubic foot and natural gas 1000 BTU's per cubic foot.

   Check the gas supply pressure (7.0 to 13.6 inches WC) and readjust it if necessary.

5. **Possible Cause:** LPG liquid converter frosts.

   Corrective Action: Check for low coolant and fill if necessary.

   Check for air in the cooling system and, if necessary, bleed the cooling system.

6. **Possible Cause:** Incorrect demand regulator adjustment.

   Corrective Action: Refer to *Initial Demand Regulator Adjustment*.

7. **Possible Cause:** Engine hunting at 90% to 100 % of full load.

   Corrective Action: Governor Gain misadjusted. Refer to *Governor/Regulator Setup Menu*.

   No Air/Fuel adjustment available (dual fuel gensets) - check K99 wiring. K99 relay, miswired, can cause genset hunting.

   Refer to *Initial Demand Regulator Adjustment*.

8. **Possible Cause:** Engine has preignition on LPG at high loads.

   Corrective Action: Check ignition timing wiring (single fuel gensets, Spec D & E only).

   Natural Gas: P11 to P10

   LPG: P11 to K1-

9. **Possible Cause:** Excessive crank time (seven seconds or more) before starting (NG or LPG vapor).

   Corrective Action: See the Installation Manual.

   Regulator may require adjustment. Refer to *Initial Demand Regulator Adjustment*.

10. **Possible Cause:** Problems with fuel trim valve (air fuel control).

    Corrective Action: See instructions for FC 1318.

11. **Possible Cause:** Failed HEGO sensor.

    Corrective Action: See instructions for failed HEGO sensor in FC 1318.

    Check to see if the hunting only occurs in closed-loop mode. Run the genset for at least three minutes. If the genset is still hunting, unplug the O2 sensor. If the hunting stops, the HEGO sensor is faulty, or the connection between the HEGO sensor and the fuel trim valve (air fuel control) is faulty.

12. **Possible Cause:** The engine is worn.

    Corrective Action: Service the engine according to the engine service manual.

5.10 Fault Code 121 - Speed Signal Lost

Lamp: Shut down

Corrective Action: This indicates that the PCC is not sensing the magnetic pickup signal.

- Restart and check RPM on the digital display.

1. **Possible Cause:** Loose or damaged magnetic pickup (MPU) wires/connector pins.

   Corrective Action: Inspect the wires/connector pins, and repair or replace as necessary.

2. **Possible Cause:** Engine died

   Corrective Action:

   a. Check ignition system.

   b. Check fuel supply.

3. **Possible Cause:** The magnetic pickup or harness could be bad.

   Corrective Action: To isolate the problem, reset the control and attempt to start the set in Idle mode (select Idle Mode − Enable menu).

   - If **1438** (Fail To Crank) is displayed, or if the engine starts, but then shuts down on **121** (Speed Signal Lost), the MPU sender could be bad. Remove the MPU connectors and check for 1.5 VAC (minimum) at the MPU while cranking.
     - If no output or less than 1.5 VAC, check for damage or debris. Also check for improper adjustment of the MPU. (Refer to *Section 6*.) If there is still no output, replace the MPU sender.
     - If the MPU output is OK, check for MPU voltage at P7−25 (MAG PICK+) to P7-29 (MAG PICK−) while cranking. If not OK, use continuity checks to isolate connectors/harness.
   - If the engine starts and idles, and does not display a fault, then there could be a frequency mismatch problem. Measure generator output frequency with a digital multimeter and compare to the frequency on the PCC display.
     - If they do match, multiply the frequency by 30 and compare this number to the RPM on the PCC display. If these are not the same, the MPU sender may be bad. Replace the MPU sender.
     - If the multimeter and PCC frequencies do not match, there may be a frequency sensing problem within the Base board.

5.11 Fault Code 135 - Oil Pressure Sensor High

Lamp: Warning

Corrective Action: Indicates that the control has sensed that the engine oil pressure sender signal is shorted high. Check sender/connectors/wires.

Effect: No engine protection for oil pressure during genset operation.

1. **Possible Cause:** Fault simulation was enabled with In-Power.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the oil pressure sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** The sensor connections could be bad.

   Corrective Action: Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

3. **Possible Cause:** The sensor could be bad.

   Corrective Action: Disconnect the oil pressure sensor leads, and connect an oil pressure sensor simulator to the harness. **"OIL PRESSURE SENSOR H" warning is displayed after the fault condition is sensed for 10 seconds.** If the control responds to the simulator, replace the sensor. If control does not respond, go to next step.

4. **Possible Cause:** The harness could be bad.

   Corrective Action: Remove connector P7 from Base board and connector from sensor. Check P7-13, 17 & 21 as follows:

   - Check for a short circuit from pin to pin (more than 200k ohms OK).
   - Check for an open circuit (10 ohms or less OK). Repair or replace as necessary.

5. **Possible Cause:** The pressure signal could be out of range.

   Corrective Action: With all connectors attached, check pressure signal (.5 to 4.5 VDC) at P7-13 (OP OUT) and P7-17 (OP COM).

5.12 Fault Code 143 - Pre-Low Oil Pressure Sensor

Lamp: Warning

Corrective Action: Indicates engine oil pressure has dropped to an unacceptable level. If the generator is powering critical loads and cannot be shut down, wait until the next shutdown period and then follow code **415** procedure.

Effect: Calibration-dependent. No action is taken by the PCC for code **143**. Engine will shut down for code **415**.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the oil pressure sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Low oil level. Clogged lines or filters.

   Corrective Action: Check oil level, lines, and filters. If the oil system is OK but the oil level is low, replenish.

3. **Possible Cause:** Sensor or oil pump could be bad. Or the generator set may be shutting down on another fault.

   Corrective Action: Disconnect the oil pressure sensor leads, and connect an oil pressure sensor simulator to the harness. If the control responds to the simulator, reconnect the sensor, disconnect the ACT− signal wire at the fuel pump actuator, and crank the engine. Check the oil pressure reading on the digital display.

   - If the display shows an acceptable oil pressure, the problem may not be in the oil or oil sensing system. The generator set may be shutting down on another fault (out of fuel, intermittent connector). Restart the generator set and monitor the PCC display panel for other faults.
   - If the display does not show an acceptable oil pressure, replace the sensor. If the PCC still doesn't display an oil pressure while cranking, the oil pump may be bad. Refer to the engine service manual. If the control does not respond to the simulator, go to the next step.

4. **Possible Cause:** Harness could be bad.

   Corrective Action: If the control does not respond to the simulator, the harness is defective. Check for +5 VDC at the sensor (lead marked E1-A). If there is no 5 VDC at the sensor:

   - Check for 5 VDC at P7-21.
   - If yes, the harness is defective and must be replaced. If there is 5 VDC at the sensor, use the sensor simulator to generate a signal to P7-13 (OP OUT) and P7-17 (OP COMM). If the pressure signal (.5 to 4.5 VDC) does not get to P7, isolate to the harness.

5.13 Fault Code 141 - Oil Pressure Sensor Low

Lamp: Warning

Corrective Action: Indicates that the control has sensed that the engine oil pressure sender signal is shorted low. Check sender/connectors/wires.

Effect: No engine protection for oil pressure during generator set operation.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the oil pressure sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** The sensor connections could be bad.

   Corrective Action: Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

3. **Possible Cause:** The sensor could be bad.

   Corrective Action: Disconnect the oil pressure sensor leads and connect an oil pressure sensor simulator to the harness. **"OIL PRESSURE SENSOR L" warning is displayed after the fault condition is sensed for 10 seconds.** If the control responds to the simulator, replace the sensor. If control does not respond, go to the next step.

4. **Possible Cause:** The harness could be defective.

Corrective Action: Remove connector P7 from base board and the connector from the sensor. Check P7-13, 17, and 21 as follows:

- Check for an open circuit (10 ohms or less is OK).
- Check for a short circuit to the engine block ground (more than 200k ohms is OK).
- Check for a short circuit from pin to pin (more than 200k ohms is OK). Repair or replace as necessary.

5. **Possible Cause:** The pressure signal could be out of range.

   Corrective Action: With all connectors attached, check pressure signal (.5 to 4.5 VDC) at P7-13 (OP OUT) and P7-17 (OP COM).

5.14 Fault Code 144 - Coolant Temperature Sensor High

Lamp: Warning

Corrective Action: Indicates that the control has sensed that the engine coolant temperature signal is shorted high. Check sender/connectors/wires.

Effect: No engine protection for coolant temperature during generator set operation. Possible white smoke.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides

2. **Possible Cause:** The sensor connections could be defective.

   Corrective Action: Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

3. **Possible Cause:** The sensor could be defective.

   Corrective Action: Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault. If the control responds to the simulator, replace the sensor. If the control does not respond, go to the next step.

4. **Possible Cause:** The harness could be defective.

   Corrective Action: Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).

   - If resistance is not the same, the harness is defective and must be replaced.

5.15 Fault Code 145 - Coolant Temperature Sensor Low

Lamp: Warning

Corrective Action: Indicates that the control has sensed that the engine coolant temperature signal is shorted low. Check sender/connectors/wires.

Effect: No engine protection for coolant temperature during generator set operation. Possible white smoke.

1. Fault simulation was enabled with InPower.

With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. The sensor connections could be defective.

   Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

3. The sensor could be defective.

   Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault. If the control responds to the simulator, replace the sensor. If the control does not respond, go to the next step.

4. The harness could be defective.

   a. Remove connector P7 from the base board and disconnect the sensor. Check pins P7-30 (IH20) and P7-34 (IH20 COM) for short circuit as follows:

      - Check for a short circuit to the engine block ground (more than 200k ohms is OK).
      - Check for a short circuit from pin to pin (more than 200k ohms is OK). Repair or replace as necessary.

   b. Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).

      - If resistance is not the same, the harness is defective and must be replaced.

5.16 Fault Code 146 - Pre-High Cool Temp

Lamp: Warning

Corrective Action: Indicates engine has begun to overheat (coolant temperature has risen to an unacceptable level).

If the generator set is powering non-critical and critical loads and cannot be shut down, use the following:

1. Reduce the load if possible by turning off non-critical loads.
2. Check air inlets and outlets and remove any obstructions to the airflow.

If the engine can be stopped, follow the fault code **151** procedure.

Effect: Calibration-dependent. No action is taken by the PCC for fault code **146**. Engine will shut down for fault code **151**.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Engine or sensor circuitry problem.

Corrective Action: Isolate to the engine or sensor circuitry. Check the sensor accuracy with a thermocouple or similar temperature probe.

- If the PCC ambient coolant temperature reading is accurate, the engine may be overheating. Refer to the engine service manual.
- If the PCC ambient coolant temperature reading is not accurate, go to the next step.

3. **Possible Cause:** The sensor could be defective.

   Corrective Action: Disconnect the sensor and connect a coolant temperature sensor simulator to the harness. If the control responds to the simulator, replace the sensor. If control does not respond, go to next the step.

4. **Possible Cause:** The harness could be defective.

   Corrective Action: Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).

   - If resistance is not the same, the harness is defective and must be replaced.

5.17 Fault Code 151 - High Coolant Temp

Lamp: Shutdown

Corrective Action: Indicates the engine has overheated (coolant temperature has risen above the shutdown trip point).

Allow the engine to cool down completely before proceeding with the following checks:

- Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.
- Check for obstructions to cooling airflow and correct as necessary.
- Check the fan belt and repair or tighten if necessary.
- Check the blower fan and circulation pumps on remote radiator installations.
- Reset the control and restart after locating and correcting the problem.

Effect: Calibration-dependent. No action is taken by the PCC for fault code **146**. Engine will shut down for fault code **151**.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Engine or sensor circuitry problem.

   Corrective Action: Isolate to the engine or sensor circuitry. Check the sensor accuracy with a thermocouple or similar temperature probe.

   - If the PCC ambient coolant temperature reading is accurate, the engine may be overheating. Refer to the engine service manual.
   - If the PCC ambient coolant temperature reading is not accurate, go to the next step.

3. **Possible Cause:** The sensor could be defective.

Corrective Action: Disconnect the sensor and connect a coolant temperature sensor simulator to the harness. If the control responds to the simulator, replace the sensor. If control does not respond, go to the next step.

4. **Possible Cause:** The harness could be defective.

   Corrective Action: Measure the resistance of the coolant sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).

   - If resistance is not the same, the harness is defective and must be replaced.

5.18 Fault Code 197 - Low Coolant Level

Lamp: Warning (Optional)

Corrective Action: Indicates engine coolant level has fallen below the warning trip point.

⚠ WARNING

Contact with a hot engine or hot coolant can result in serious burns. To avoid personal injury, allow the engine to cool down completely before proceeding.

Effect: No action is taken by the PCC for code **197**. Engine will shut down for code **235**.

1. The sensor or harness could be defective.

   If the coolant level is normal, isolate the source of the low coolant signal. (This is a ground signal.) Disconnect the signal lead at the sender and reset the control.

   a. If the **197/235** message drops out and does not reappear, replace the sender.

   b. If the **197/235** message reappears and remains after the control is reset, remove connector P7 from the base board and check continuity from P7-32 to ground. If there is continuity, replace the harness.

5.19 Fault Code 234 - Overspeed

Lamp: Shutdown

Corrective Action: Indicates the engine has exceeded normal operating speed. Possible causes are single step large block load removal or starting a very cold engine.

Effect: Engine will shut down.

1. **Possible Cause:** Cold engine (no coolant heaters).

   Corrective Action: Overspeed can occur when starting a very cold engine. Clear the fault and restart the generator set.

2. **Possible Cause:** Single step large block load removal.

   Corrective Action: Clear the fault and restart the generator set.

3. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

4. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.

5. **Possible Cause:** Monitor the engine RPM using InPower.

   Corrective Action: If the RPM is not correct, refer to fault code **121** for corrective action.

6. **Possible Cause:** Binding of the mixer throttle plate.

   Corrective Action: Mechanical binding of the throttle plate in the mixer. Refer to *Actuator/Fuel System Adjustments*.

5.20 Fault Code 235 - Low Coolant Level

Lamp: Shutdown

Corrective Action: Indicates engine coolant level has fallen below the shutdown trip point.

⚠ CAUTION
Allow engine to cool down completely before proceeding with the following checks to avoid personal injury or harm.

1. Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.
2. Reset control and restart after locating and correcting problem.

Effect: No action is taken by the PCC for code **197**. Engine will shut down for code **235**.

1. The sensor or harness could be bad.

   If the coolant level is normal, isolate the source of the low coolant signal. (This is a ground signal.) Disconnect the signal lead at the sender and reset the control.

   a. If the **197/235** message drops out and does not reappear, replace the sender.

   b. If the **197/235** message reappears and remains after control reset, remove connector P7 from Base board and check continuity from P7-32 to ground.

      - If there is continuity, replace the harness.

5.21 Fault Code 359 - Fail to Start

Lamp: Shutdown

Corrective Action: Indicates a possible fuel system problem. (Engine cranks but fails to start)

1. Check for a dirty or plugged air filter and replace if necessary.
2. Restricted fuel supply (e.g., closed fuel shutoff valve, low fuel pressure/supply, etc.)
3. Reset the control and restart after correcting the problem.

Effect: Engine will not start.

1. **Possible Cause:** The air cleaner is blocked.

   Corrective Action: Service as necessary.

2. **Possible Cause:** Restricted fuel supply.

   Corrective Action:

   a. Open any closed fuel shutoff valve. (Valves closed for maintenance or new installations may require several crank cycles to get fuel to the generator set.)

   b. Fill the propane supply tank. For natural gas fueled sets, check with the gas utility.

   c. Check fuel pressure at the regulator (refer to *Fuel Pressure*). High fuel pressure will prevent the solenoid from opening.

   d. Check the fuel solenoid (VDC present at K1+ lead during cranking). If not present, go to step 3.

   Dual Fuel Sets Only:

   e. Check relay K99. Refer to the wiring diagrams. (VDC present at K99-30 during cranking with natural gas supply to the engine.)

   f. Check pressure switch wiring. Propane − normally closed connected to common. Natural gas − normally open connected to common.

   g. Check pressure switch function (@ 3.5 inch H2O or less, should switch from natural gas to LPG).

   h. Check the S14 vacuum switch (optional) for proper operation.

3. **Possible Cause:** Problems with fuel trim valve (air fuel control).

   Corrective Action: Troubleshoot using the electronic service tool and Woodward L-Series Process Controller manual (available on the Woodward website).

NOTICE
The Woodward electronic service tool is just a diagnostic tool. You cannot change anything with it.

   a. Connect the interface harness (Cummins PN 0338−4987).

   b. Verify that the software version for the electronic service tool is 2.3 or greater. (The software is available on the Cummins software shelf and on the Woodward web site.)

   c. Launch Woordward software, and allow the engine to begin cranking.

NOTICE
The Woodward electronic service tool does not work unless the engine is cranking or running.

   d. At the overview screen, make sure that the fuel trim valve is in open-loop mode. (See **Figure 24** for reference.) Verify that the fuel trim valve is in open-loop mode and that the actual position of the valve is the same as or very close to the commanded position (66.3% for natural gas, 49.4% for liquid propane). If one or both of these is not right, verify the wiring to the HEGO sensor. See steps 5 and 6 for FC **1318**. If that is not the problem, remove the fuel trim valve, and check for obstructions. If there are none, replace the fuel trim valve.

4. **Possible Cause:** Switched B+ is not present at T26 terminal block due to:

   a. Fuse F10 of the engine harness assembly may be open.

b. Switched B+ relay K1 is defective.

Corrective Action: Isolate to harness, F10, or K1.

a. Remove F10 (engine harness) and check continuity. If open, replace the fuse with one of the same type and amp rating (20 Amps). If fuse reopens, check wiring continuity of the circuit.

b. Install a harness tool between the base board and the P7 connector. Attempt to start and check for B+ at P7-9 (GEN SW B+) and P7-10 (FUEL SOL−). (These are leads to K1 SW B+ relay).

- If B+ is present, relay K1 or the harness is defective. Go to next step.

c. Attempt to start and check for B+ IN (K1-1) and B+ OUT (K1-4).

- If there is no B+ IN, check for an open circuit.
- If there is B+ IN and not OUT, K1 is defective or the circuit to the K1 coil is open.

5. **Possible Cause:** The engine ignition system is malfunctioning. Refer to the wiring diagrams.

Corrective Action:

a. Check fuses F1 (15A), F2 (5A) and F3 (20A) located on Ford engine harness power block (mounted on skid near ICM).

b. Check the Ford engine harness ground lead connection. (A black/white stripe wire connects to the starter ground stud.)

c. Check B+ power connection of the Ford engine harness power lead (starter motor stud B1.)

d. Check for spark. (Remove a lead and connect to a spare spark plug).

e. Check the crank shaft position sensor (315 to 385 ohms).

f. Check the cam position sensor (315 to 385 ohms).

6. **Possible Cause:** Incorrect demand regulator adjustment.

Corrective Action: Refer to *Initial Demand Regulator Adjustment*.

7. **Possible Cause:** Actuator is inoperable because the harness or actuator is defective.

Corrective Action: Isolate to the harness or actuator.

a. Display “Governor Duty Cycle” menu. Attempt to start and check for duty cycle (approximately 20% to 40% from zero to full load). If the percentage of duty cycle is displayed before the shutdown, the harness or actuator is defective; go to step b. (Duty cycle displayed indicates the processor is functioning.)

b. Remove connector P7 from the base board and check wiring continuity of the actuator circuit. P7-24 (ACT +), P7-14 (ACT SIG) and P7-36 (GND) to the appropriate terminals of the governor actuator. Repair as necessary. If continuity is OK, go to step c.

c. Attempt to start and check for CNTL B+ at the terminal lead ACT + of the actuator (use ACT− for meter ground). If CNTL B+ is present, attempt to start and check for a pulse width modulated signal at pin 11 (ACT SIG) and pin 1 (ACT +) of the actuator. If ACT SIG is present, the actuator may be defective. Check actuator operation.

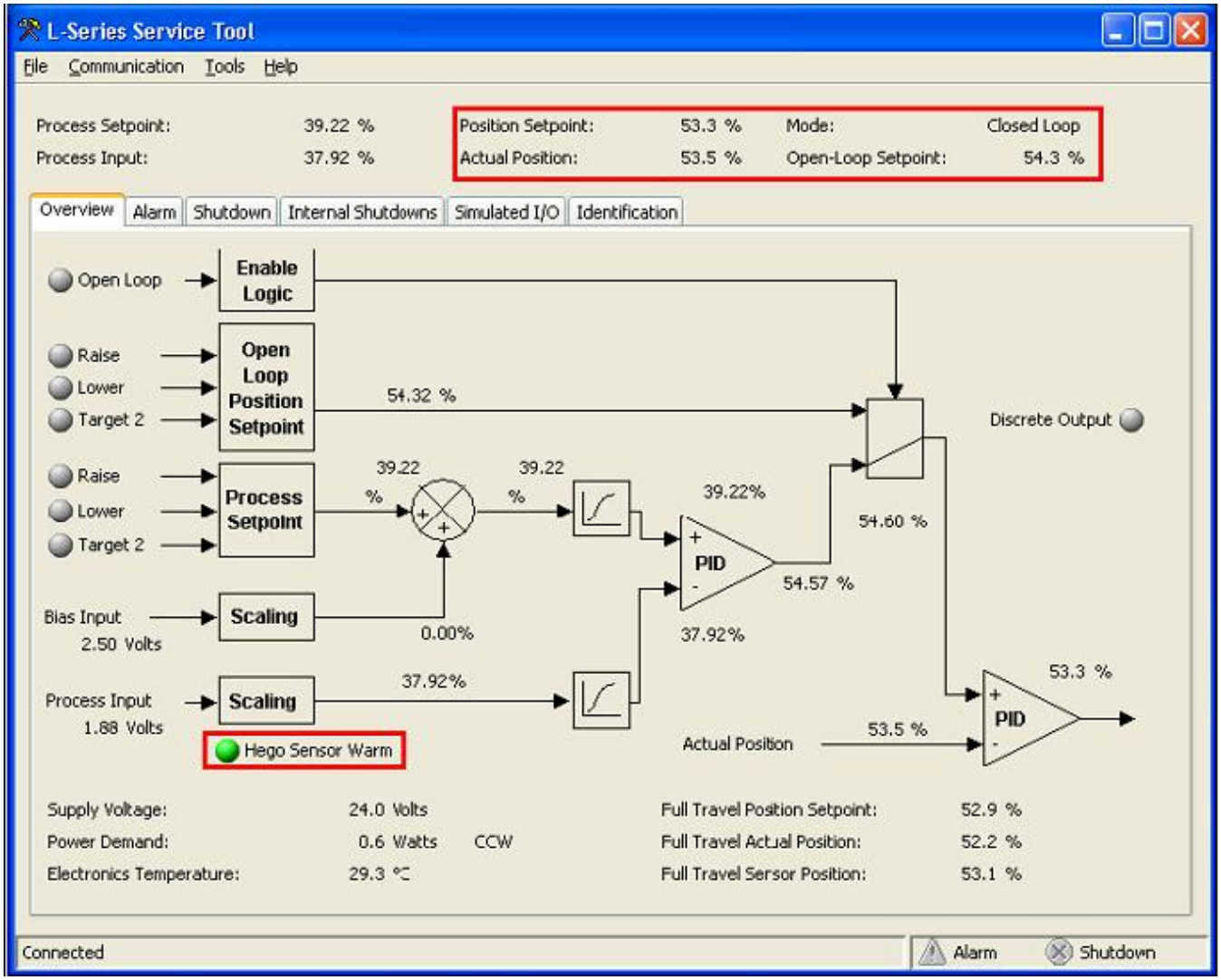


FIGURE 24. WOODWARD SOFTWARE, OVERVIEW SCREEN (EXAMPLE; FIELDS REFERENCED IN PROCEDURES ARE BOXED)

5.22 Fault Code 415 - Low Oil Pressure

Lamp: Shutdown

Corrective Action: Indicates the engine oil pressure has dropped below the shutdown trip point. Check the oil level, lines, and filters. If the oil system is OK but the oil level is low, replenish. Reset the control and restart.

Effect: Calibration-dependent. No action is taken by the PCC for code **143**. Engine will shut down for code **415**.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the oil pressure sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Low oil level. Clogged lines or filters.

Corrective Action: Check the oil level, lines, and filters. If the oil system is OK but oil level is low, replenish.

3. **Possible Cause:** Sensor or oil pump could be defective. Or the generator set may be shutting down on another fault.

   Corrective Action: Disconnect the oil pressure sensor leads, and connect an oil pressure sensor simulator to the harness. If the control responds to the simulator, reconnect the sensor, disconnect the ACT− signal wire at the fuel pump actuator, and crank the engine. Check the oil pressure reading on the digital display.

   - If the display shows an acceptable oil pressure, the problem may not be in the oil or the oil sensing system. The generator set may be shutting down on another fault (out of fuel, intermittent connector). Restart the generator set and monitor the PCC display panel for other faults.
   - If the display does not show an acceptable oil pressure, replace the sensor. If the PCC still doesn't display an oil pressure while cranking, the oil pump may be defective. Refer to the engine service manual. If the control does not respond to the simulator, go to the next step.

4. **Possible Cause:** The harness could be defective.

   Corrective Action: If the control does not respond to the simulator, the harness is defective. Check for +5 VDC at the sensor (lead marked E1-A). If there is no 5 VDC at the sensor:

   - Check for 5 VDC at P7-21.
   - If yes, the harness is defective. If there is 5 VDC at the sensor, use the sensor simulator to generate a signal to P7-13 (OP OUT) and P7-17 (OP COMM). If the pressure signal (.5 to 4.5 VDC) does not get to P7, isolate to the harness.

5.23 Fault Code 441 - Low Battery Voltage

Lamp: Warning

Corrective Action: Indicates battery voltage supply to the control is approaching a low level at which unpredictable operation will occur.

1. Discharged or defective battery. Check the battery charger fuse. Recharge or replace the battery.
2. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
3. Check battery wiring/calibration.
4. Check engine DC alternator. Replace the engine DC alternator if normal battery charging voltage is not obtained.
5. Check the battery charge voltage float level, if applicable (raise float level).

Effect: PCC voltage supply approaching level at which unpredictable operation may occur.

1. **Possible Cause:** Weak or discharged battery.

   Corrective Action: Recharge or replace the battery. The specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C).

2. **Possible Cause:** Low electrolyte level in the battery.

Corrective Action: Replenish electrolyte and recharge the battery.

3. **Possible Cause:** Battery connections loose or dirty.

   Corrective Action: Clean and tighten or replace the battery cable connectors and cables at the battery and at the generator set.

4. **Possible Cause:** Wrong battery voltage.

   Corrective Action: Verify that battery voltage 12 or 24 matches calibration.

5. **Possible Cause:** Insufficient battery charging voltage.

   Corrective Action: Adjust the charge rate of the battery charging circuit, according to manufacture's instructions.

6. **Possible Cause:** Engine DC alternator could be defective.

   Corrective Action: Replace the engine DC alternator if normal battery charging voltage (12 to 14 or 24 to 26 VDC) is not obtained.

7. **Possible Cause:** If the batteries are OK, the problem may be the harness.

   Corrective Action: Remove connector P7 from the base board and check battery voltage at P7−3 (B+) to P7-7 (GND) and P7-4 (B+) to P7-8 (GND).

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

5.24 Fault Code 442 - High Battery Voltage

Lamp: Warning

Corrective Action: Indicates the battery voltage supply to the control is approaching a high level at which damage to the control can occur. Check the float level on the battery charger, if applicable (lower float level). Check battery wiring/calibration.

Effect: PCC damage will occur.

1. **Possible Cause:** Excessive battery charging voltage.

   Corrective Action: Adjust the charge rate of the battery charging circuit according to manufacturer's instructions.

2. **Possible Cause:** Engine DC alternator could be defective.

   Corrective Action: Replace the engine DC alternator if normal battery charging voltage (12 to 14 VDC) is not obtained.

3. **Possible Cause:** Wrong battery voltage.

   Corrective Action: Verify that the battery voltage (12 VDC) matches the calibration.

5.25 Fault Code 1123 - Shutdown After Battle Short

Lamp: Warning

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

5.26 Fault Code 1124 - Delayed Shutdown

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

Lamp: Warning

Possible Causes:

1. A shutdown fault

5.27 Fault Code 1131 - Battle Short Active

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

Lamp: Warning

Possible Causes:

1. Battle short function enabled

5.28 Fault Codes 1311, 1312, and 1317 - Customer Input #1 - #3

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

Corrective Action: The nature of the fault is an optional customer selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, Low Starting Hydraulic Pressure, Low Starting Air Pressure, etc.

Each of the fault functions can be programmed (using the service tool), as follows:

- Enable/disable input (Default: enable)
- Status, Warning or Shutdown (Default: #1-None, #2 thru #4-Warning)
- Active closed or open (Default: closed [ground])
- Change the display name using up to 19 characters (Default: #1- Customer Fault 1, #2-Ground Fault, #3-Low Fuel)

Effect: Status, warning or shutdown

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

   Disconnect the signal lead from TB1 and reset the control.

   - CUST_IN1 − TB1-4
   - CUST_IN2 − TB1-5
   - CUST_IN3 − TB1-6

   If the message drops out, the external wiring has a short or open circuit, or the active input selection (closed/open) is not correct for customer input (use the service tool to check the selection).

5.29 Fault Code 1318 - Service Engine Fault

Lamp: Warning

Corrective Action: Indicates that emissions criteria might not be met due to one of the following:

- Engine running in an open loop,
- Lean mixture
- Rich mixture
- Failed fuel system component

Effect: No action is taken by the PCC. A Service Engine message appears on the control display.

1. **Possible Cause:** Intermittent fault.

   Corrective Action:

   a. Reset the control.

NOTICE
This fault must be cleared manually.

   b. Check for loose connections at the heated exhaust gas oxygen sensor and at the fuel trim valve (air fuel control).

NOTICE
Note: This fault is delayed for approximately three minutes upon start-up.

2. **Possible Cause:** Improper inlet supply pressure to the generator set at the demand regulator.

   Corrective Action: Verify supply pressure to the generator set at the demand regulator is 7−13.6 inches WC.

3. **Possible Cause:** Gas solenoid is not opening properly.

   Corrective Action: Verify proper operation of the gas solenoids.

4. **Possible Cause:** Problem with the fuel trim valve (air fuel control).

   Corrective Action:

   a. Troubleshoot using the electronic service tool and Woodward L-Series Process Controller manual (available on the Woodward website).

NOTICE
The Woodward electronic service tool is just a diagnostic tool. You cannot change anything with it.

   b. Connect the interface harness (Cummins PN 0338−4987).

   c. Verify that the software version for the electronic service tool is 2.3 or greater. (The software is available on the Cummins software shelf and on the Woodward web site.)

d. Launch the Woordward software and start the engine.

NOTICE
The Woodward electronic service tool does not work unless the engine is cranking or running.

e. At the overview screen, check whether the fuel trim valve is in open-loop or closed-loop mode.

If the fuel trim valve is in open-loop mode, verify that the HEGO sensor warm light is not on. Check the actual position of the valve and compare it to the commanded position. If these are not the same or very close, there may be a problem with the valve or an obstruction in the valve. Check the process setpoint, and compare it to the open-loop set point specified for the model and fuel type (66.3% for natural gas, 49.4% for propane).

If the fuel trim valve is in closed-loop mode, verify that the HEGO sensor warm light is on. If not, check the HEGO sensor and the wiring between the HEGO and the fuel trim valve. Otherwise, check the Alarms screens for the “At Max Position” or “At Minimum Position” alarms. (See **Figure 25** for reference.) If these alarms are active, it means that either there is too much or too little fuel going to the fuel trim valve. Verify the gas supply pressure, and adjust the demand regulator.

5. **Possible Cause:** No SW B+ to the HEGO sensor and the fuel control.

   Corrective Action:

   a. On the HEGO sensor, check for SW B+ at P20-D and GND at P20-C.

   b. On the fuel trim valve (air/fuel control), check for SW B+ at A20-1 and GND at A20-5.

   c. Check relay K1, fuse F1, and control fuse F3.

6. **Possible Cause:** No communication between the HEGO sensor and the fuel trim valve (air/fuel control).

   Corrective Action: Check for continuity between the HEGO sensor and the fuel trim valve as follows: P20-B to A20-8, P20-A to A20-3.

7. **Possible Cause:** Failed HEGO sensor.

   Corrective Action:

   a. Check the resistance between P20-C and P20-D. The resistance should be 2.1 + 0.4 Ohms at room temperature.

   b. Check the voltage between P20-A and P20-B after the sensor has warmed up while the engine is running. The voltage should be 0−1 V

8. **Possible Cause:** Wrong fuel selection.

   Corrective Action:

   a. Verify the fuel selection.

   b. If SW B+ is present at A20-11, it indicates propane fuel only.

9. **Possible Cause:** No communication between the generator set control and the fuel trim valve (air fuel control).

Corrective Action: Check for continuity between the fuel trim valve (A20-9) and the generator set control (TB1-7).

10. **Possible Cause:** Excessively high exhaust back pressure.

    Corrective Action: See the Installation Manual.

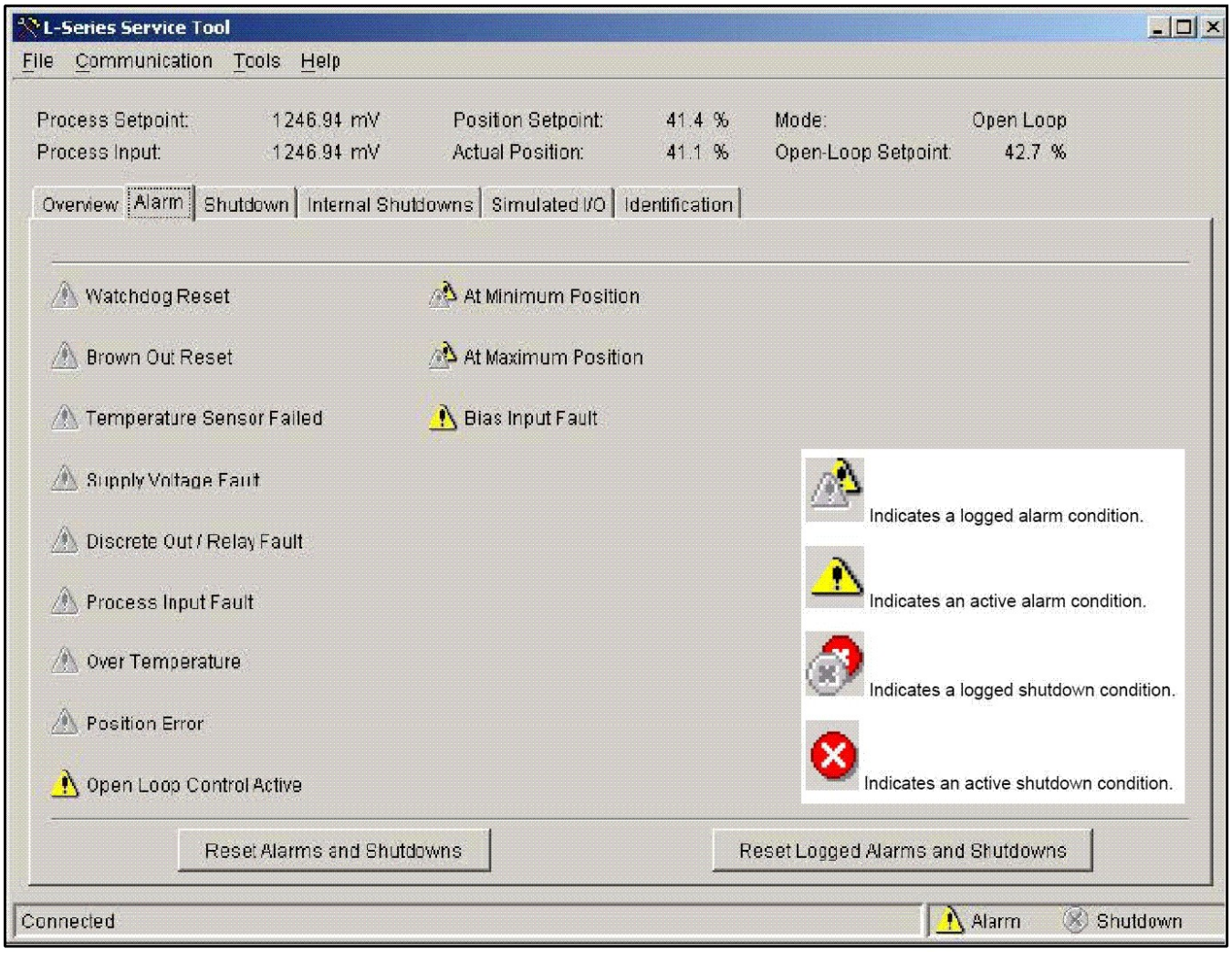


FIGURE 25. WOODWARD SOFTWARE, ALARM SCREEN (EXAMPLE)

5.30 Fault Code 1334 - Crit Scaler OR

Lamp: Shutdown

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

5.31 Fault Code 1335 - Non-Crit Scaler OR

Lamp: Warning

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

5.32 Fault Code 1416 - Fail to Shutdown

Logic :

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

Lamp: Warning

Possible Causes:.

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

5.33 Fault Code 1417 - Power Down Failure

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

Lamp: Warning

Possible Causes:

1. Possibility of the base board fault

5.34 Fault Code 1433 - Emergency Stop

Lamp: Shutdown

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

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

5.35 Fault Code 1434 - Remote Emergency Stop

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

Lamp: Shutdown

Possible Causes:

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

5.36 Fault Code 1435 - Low Coolant Temperature

Lamp: Warning - Generator set is not operating. This warning occurs when the engine coolant temperature is 70° F (21° C) or lower.

NOTICE

In applications where the ambient temperature falls below 40° F (4° C), Low Coolant Temp may be indicated even though the coolant heaters are operating.

Corrective Action: Indicates the engine coolant heater is not operating or is not circulating coolant. Check for the following conditions:

1. Coolant heater not connected to a power supply. Check for a blown fuse or a disconnected heater cord and correct as required.
2. Check for low coolant level and replenish if required. Look for possible coolant leakage points and repair as required.
3. Open heater element. Check current draw of the heater.

Coolant temperature must be below 70° F (default setting) for one minute to activate this warning and be above 70° F for five minutes before the warning can be cleared.

Effect: No action is taken by the PCC. The engine may not start due to slow cranking speed.

1. **Possible Cause:** Fault simulation was enabled with InPower.

   Corrective Action: With InPower, verify that the fault simulation is not enabled for the coolant sensor. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.

3. **Possible Cause:** The engine coolant heater could be defective. (Radiant heat should be felt with your hand held close to the outlet hose.)

   Corrective Action: Coolant heater not operating due to:

   - Coolant heater not connected to power. Check for a blown fuse or a disconnected heater cord and correct as required.
   - Low coolant level. Look for possible coolant leakage points and repair as required.
   - Defective heater element/thermostat. With the coolant heater removed from the engine and power disconnected, flush with cold tap water for two minutes to close the internal heater thermostat (opens at 100 °F and closes at 80 °F). Check resistance across the input power leads:

     a. Open − replace the coolant heater.

     b. Closed − coolant heater is OK (coil resistance of 10 to 60 ohms)

4. **Possible Cause:** The sensor connections could be defective.

   Corrective Action: Inspect the sensor and engine harness connector pins. Repair or replace as necessary.

5. **Possible Cause:** The sensor could be defective.

   Corrective Action: Disconnect the sensor and plug in a resistive sensor simulator to isolate the fault. If the control responds to the simulator, replace the sensor. If the control does not respond, the harness or base board is defective and must be replaced.

6. **Possible Cause:** The harness could be defective.

Corrective Action: Measure the resistance of the coolant temperature sensor and reconnect the harness to the sensor. Remove connector P7 from the base board and check resistance between pins P7-30 (IH20) and P7-34 (IH20 COM).

- If resistance is not the same, the harness is defective and must be replaced.

5.37 Fault Code 1438 - Fail to Crank

Lamp: Shutdown

Corrective Action: Indicates a possible fault with the control, speed sensing, or starting system. This indicates that the engine failed to crank after the PCC received a start signal.

Effect: Engine will not start.

1. **Possible Cause:** Starter is defective.

   Corrective Action: Reset the control. Attempt to start and test for B+ at the starter. If there is B+ at the starter, the starter could be defective. Test the starter (see the engine service manual). Replace the starter. If B+ is not present at the starter, go to the next step.

2. **Possible Cause:** Fuse F3 on the base board may be open.

   Corrective Action: Remove F3 and check continuity. If open, replace the fuse with one of the same type and amp rating (2 Amps).

   If F3 is OK, install a harness tool between the base board and the P7 connector. Attempt to start and check for B+ at P7-23 (GEN SW B+) and P7-27 (START SOL−). (These are leads to the K4 coil.)

   - If there is a B+ signal, the Start Pilot Relay K4 or starter circuitry is defective. Go to the next step.

3. **Possible Cause:** Start Pilot Relay K4 or starter circuitry could be defective.

   Corrective Action: Check for B+ IN at K4-1 (directly connected to battery B+). If not present, check for an open circuit. If there is B+ IN, attempt to start and test for B+ OUT at K4-4.

   - If there is no B+ OUT at K4-4, K4 is defective and must be replaced.
   - If there is B+ OUT at K4-4, check for an open circuit between K4-4 and the starter.

4. **Possible Cause:** The Emergency Stop switch or wiring is defective.

   Corrective Action: With the Emergency Stop push button not activated, remove connector P1 and check for continuity between P1-1 (ESTOP-NC1) and P1-2 (ESTOP-NC2). (If the circuit is open, the control will detect a local E-Stop condition but will not display the E-Stop condition.) If circuit is open, isolate to the Emergency Stop switch and wiring. If there is continuity, go to the next step.

5. **Possible Cause:** MPU/circuit is bad.

   Corrective Action: Refer to Fault Code **121** instructions.

5.38 Fault Code 1442 - Weak Battery

Lamp: Warning

Corrective Action: Indicates that during cranking, the battery voltage is at or below the weak battery warning trip point for a time greater than or equal to the weak battery set time. See code **441** for corrective action.

Effect: No action is taken by the PCC.

1. **Possible Cause:** Weak or discharged battery

   Corrective Action: Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C).

2. **Possible Cause:** Low electrolyte level in battery.

   Corrective Action: Replenish electrolyte and recharge battery.

3. **Possible Cause:** Battery connections loose or dirty.

   Corrective Action: Clean and tighten or replace the battery cable connectors and cables at the battery and the set.

4. **Possible Cause:** Insufficient battery charging voltage.

   Corrective Action: Adjust charge rate of battery charging circuit, according to manufacturers instructions.

5. **Possible Cause:** If the batteries are OK, the problem may be the harness.

   Corrective Action: Remove connector P7 from Base board. Check battery voltage at: P7-3 (CNTL) to P7-7 (GND) and P7-4 (CNTL) to P7-8 (GND) If voltage is not OK, repair defective harness.

5.39 Fault Code 1443 - Battery Failed

Lamp: Shutdown

Corrective Action: Dead battery - engine will not start. See code **441** for corrective action.

Effect: Engine will not start.

1. **Possible Cause:** Refer to code **1438**.

   Corrective Action: Refer to code **1438** instructions.

5.40 Fault Code 1444 - kW Overload

Lamp: Warning

Corrective Action: Indicates that generator output power exceeded 105% of genset rating. Check load and load lead connections.

Effect: No action taken by the PCC.

1. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.

2. **Possible Cause:** Short or overload.

   Corrective Action: Check the load and load cables. Repair if necessary. Check operation by disconnecting load and restarting generator set.

3. **Possible Cause:** Incorrect CTs or CT connections.

   Corrective Action: Check CTs and CT connections. Correct if necessary. Refer to *Current Transformer Installation*

4. **Possible Cause:** The problem may be the harness connections.

   Corrective Action: Remove connector P7 from Base board. Check continuity from P7 to CTs. P7-11 (CT1) to P7-12 (CT1-COM) P7-15 (CT2) to P7-16 (CT2-COM) P7-19 (CT3) to P7-20 (CT3-COM) Repair connections.

5.41 Fault Code 1445 - Short Circuit

Lamp: Shutdown

Corrective Action: Indicates that generator output current has exceeded 175% of rated. Check load and load lead connections. (Fault may not reset for several minutes.)

Effect: Engine will shut down.

1. **Possible Cause:** Refer to code **1444**.

   Corrective Action: Refer to code **1444**.

5.42 Fault Code 1446 - High AC Voltage

Lamp: Shutdown

Corrective Action: Indicates one or more of the phase voltages has exceeded 130% of nominal, or has exceeded 110% of nominal for 10 seconds.

Effect: Engine will shut down.

1. **Possible Cause:** Fault simulation was enabled with In-Power.

   Corrective Action: With InPower, verify that the related fault simulation is not enabled. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Single step large block load removal.

   Corrective Action: Clear fault and restart genset.

3. **Possible Cause:** Fault threshold is not set correctly with InPower

   Corrective Action: Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.

4. **Possible Cause:** Generator is bad.

   Corrective Action: Refer to *Generator/Base Board Isolation Procedure* to determine if the generator is causing the high AC voltage shutdown fault.

5.43 Fault Code 1447 - Low AC Voltage

Lamp: Shutdown

Corrective Action: Indicates that one or more of the phase voltages has dropped below 85% of nominal for 10 seconds.

Effect: Engine will shut down.

1. **Possible Cause:** Fault simulation was enabled with In-Power.

   Corrective Action: With InPower, verify that the related fault simulation is not enabled. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.

3. **Possible Cause:** Overload.

   Corrective Action: Check the load and correct any overload. Check operation by disconnecting load and restarting generator set.

4. **Possible Cause:** Improper connections have been made at the generator output terminals.

   Corrective Action: Reconnect according to the appropriate reconnection diagram.

5. **Possible Cause:** PMG or field wiring could be bad.

   Corrective Action: Check and repair the PMG or field wiring

6. **Possible Cause:** Shunt wiring connection could be incorrect.

   Corrective Action: Check that excitation inputs P8-21 and P8-22 are connected to the correct voltage. If misconnected to a high voltage, the AVR fault will shut down excitation and cause Low AC Voltage condition.

7. **Possible Cause:** The rotating rectifier assembly (diodes CR1 through CR6) is faulty.

   Corrective Action: Check each diode

8. **Possible Cause:** Loose connector.

   Corrective Action: Repair connections (P8).

5.44 Fault Code 1448 - Under Frequency

Lamp: Shutdown

Corrective Action: Indicates that engine speed has dropped below 90% of nominal for 10 seconds. Check fuel supply, intake air supply and load.

Effect: Generator set will shut down.

1. **Possible Cause:** Fault simulation was enabled with In-Power.

   Corrective Action: With InPower, verify that the related fault simulation is not enabled. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.

3. **Possible Cause:** Overload.

   Corrective Action: Check the load and correct any overload. Check operation by disconnecting load and restarting generator set.

4. **Possible Cause:** Fuel or air delivery problem.

   Corrective Action: Refer to *Fuel Systems.*

5. **Possible Cause:** Loose connector.

   Corrective Action: Repair connections (P8).

5.45 Fault Code 1449 - Over Frequency

Lamp: Warning

Corrective Action: Indicates frequency is 10% above base frequency for 20 seconds. Generator AC output frequency is high.

Effect: No action taken by the PCC.

1. **Possible Cause:** Fault simulation was enabled with In-Power.

   Corrective Action: With InPower, verify that the related fault simulation is not enabled. If you do not have InPower, remove battery power from the control to disable fault simulation overrides.

2. **Possible Cause:** Fault threshold is not set correctly with InPower.

   Corrective Action: Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.

3. **Possible Cause:** Fuel or air delivery problem.

   Corrective Action: Refer to *Fuel Systems.*

4. **Possible Cause:** Loose connector.

   Corrective Action: Repair connections (P7/P8).

5.46 Fault Code 1461 - Loss of Field

Lamp: Shutdown

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

5.47 Fault Code 1466 - Modem Failure

Lamp: Warning

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

5.48 Fault Code 1468 - Network Error

Lamp: Warning

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

5.49 Fault Code 1469 - Speed/Hz Match

Lamp: Shutdown

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

5.50 Fault Code 1471 - Over Current

Lamp: Warning

Corrective Action: Indicates that generator output current has exceeded 110% of rated for 60 seconds. Check load and load lead connections.

Effect: No action is taken by the PCC for code **1471**. Engine will shut down for code **1472**.

1. **Possible Cause:** Refer to code **1444**.

   Corrective Action: Refer to code **1444.**

5.51 Fault Code 1472 - Over Current

Lamp: Shutdown

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

5.52 Fault Codes 2323−2326 - Network Faults 5 through 8

Lamp: Shutdown, Warning, or none for status message

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

5.53 Fault Code 2335 - Excitation Fault

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

Lamp: Shutdown

Possible Causes:

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

5.54 Fault Code 2336 - Memory Error

Lamp: Shutdown

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

5.55 Fault Code 2341 - High Control Temperature

Lamp: Warning

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

5.56 Fault Code 2342 - Too Long in Idle

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

Lamp: Warning

Possible Causes:

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

5.57 Fault Code 2967 - Governor Fault

Lamp: Warning

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

5.58 Fault Code 2968 - AVR Fault

Lamp: Warning

Corrective Action: Indicates AVR hardware contains a fault condition.

5.59 Fault Code 2969 - LON Failure

Lamp: Warning

Corrective Action: Indicates no communications with the LonWorks board.

5.60 Fault Code 2972 - Field Overload

Logic:

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

Lamp: Shutdown

Possible Causes:

⚠ WARNING

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

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

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6 Control Adjustment and Service

6.1 General

This section contains circuit board removal and replacement procedures and adjustment procedures for the genset control.

This section also describes the function and operation of engine sensors, genset options, and other special features of the genset control system, such as, customer connection points, optional run relays, etc. Installation information is also provided for these items where necessary.

⚠ WARNING

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

⚠ WARNING

HAZARDOUS VOLTAGE. The PCC2100 control box must be opened only by technically qualified personnel. Voltages of up to 600 VAC are present in the PCC box. These voltages can cause electrical shock, resulting in personal injury.

6.2 Circuit Board Removal/Replacement

No special tools (other than a grounding wrist strap and InPower Service tool) are required to remove a circuit board from inside the control box. The InPower Service tool is required when replacing the Base board.

Before replacing the Base board, make sure that a capture file of the genset's parameter values has been created using InPower. (During genset installation, it was suggested that a capture file be made before and after changes were made to the genset operating parameters.)

After replacing the Base board, use the capture file as a template to write the previous settings to the new Base board software.

Refer to INPOWER User's Guide for specifics.

6.2.1 Circuit Board Removal Safety Precautions

To prevent circuit board damage due to electrostatic discharge (ESD), a grounding wrist strap must be worn when handling circuit boards or socket-mounted IC's. (The wrist strap **does not** provide a direct short to ground, but is typically rated at approximately 1 megohm to ground.)

Attach the clip to the chassis ground screw in the control box and place the strap around your wrist before handling a circuit board.

⚠ CAUTION

Electrostatic discharge will damage circuit boards. Always wear a grounding wrist strap when handling circuit boards or socket-mounted IC's.

Turn off or remove AC power from the battery charger and then remove the negative (-) battery cable from the set starting battery. This is to make sure that the set will not start while working on it and to avoid circuit board damage, caused by voltage spikes when removing and replacing circuit board connectors.

⚠ WARNING

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

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.

⚠ CAUTION

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

⚠ WARNING

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

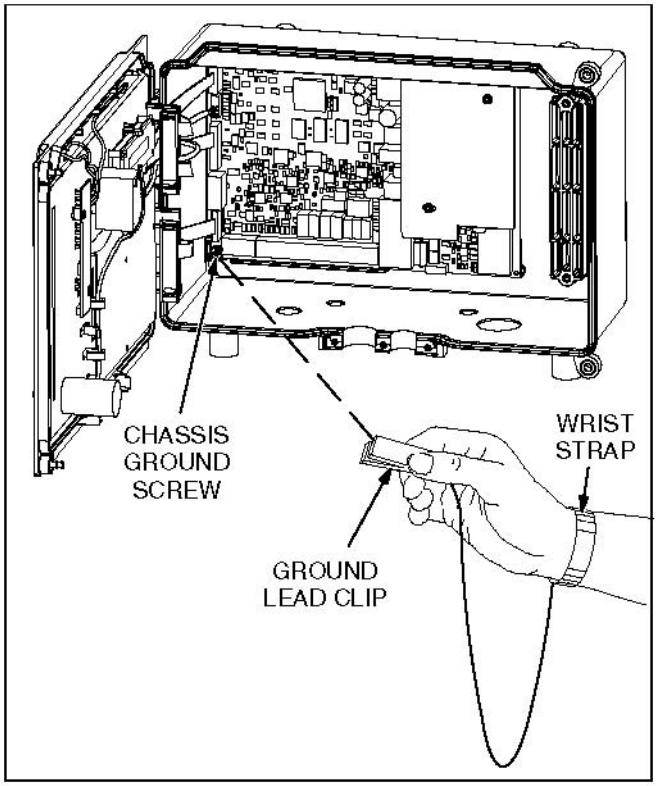


FIGURE 26. WRIST STRAP

6.3 Modifying Setup Submenus

The Setup submenus allow you to adjust system parameters.

There are three setup menus that are selectable from the Setup Main Menu:

- Crank/Idle Setup Menu
- Governor/Regulator Setup Menu
- Power Transfer Setup Menu

These three menus are intended for qualified service personnel only. For this reason, a three-digit access code (password) must be entered before you can proceed to those menus.

⚠ CAUTION
Improper adjustment of the control can cause equipment malfunction or damage. Adjustment must be performed by technically qualified personnel only.

6.4 Password Submenu

Figure 27 on page 84 shows a block representation of the Setup Main menu. If you press the button next to the word “Setup" in the display, the Setup Password submenu is displayed. Use of Setup menus is restricted to service personnel.

Press the Previous Main Menu button to return to Main Menu 3. Press the Home button to return to Main Menu 1.

Password submenu: If you enter the correct password, the Setup Main Menu is displayed. When the Password submenu is displayed, the first numeric character (0) is flashing. The access code for your PCC is: **574**. To enter the password:

1. Press the button next to the + symbol until the value reads “5."
2. Press the button next to the → symbol to move to the next numeric character.
3. Press the button next to the + symbol until the value reads “7."
4. Press the button next to the → symbol to move to the next numeric character.
5. Press the button next to the + symbol until the value reads “4."
6. After you have completed entering the password, press the button next to the M symbol. The Setup Main Menu is displayed.

If a wrong number is entered into any of the numeric character fields, use the buttons next to the ↓ and ↑ symbols until the correct value is entered.

If the wrong character field is selected, use the buttons next to the ← and → symbols to move to the character field you wish to change.

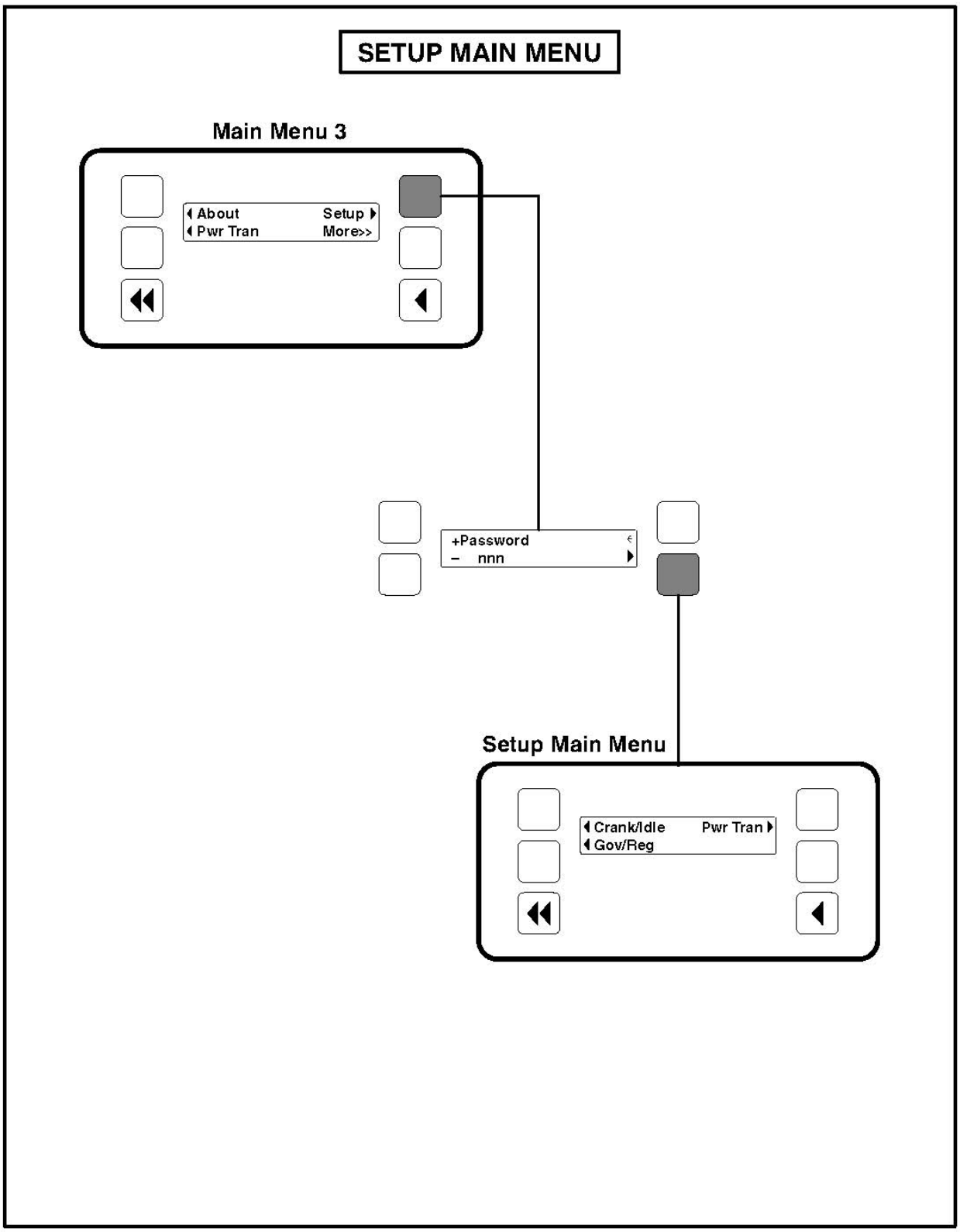


FIGURE 27. SETUP MAIN MENU

6.5 Crank/Idle Setup Menu

Figure 28 on page 86 shows a block representation of the Crank/Idle Setup menu. If you press the button next to the word “Crank/Idle" in the display, the first Crank/Idle Setup submenu is displayed.

As shown in the diagram, the Crank/Idle menu has five submenus. Each submenu includes a parameter or value that can be changed.

Press the buttons next to the ↓ and ↑ symbols in the graphical display to navigate between the menus. Press the Previous Main Menu button to return to the Setup Main Menu. Press the Previous Main Menu button again to return to Main Menu 3. Press the Home button to return to Main Menu 1.

Adjusting Values/Parameters:

1. Press the button next to the ► symbol in the display until the + and - symbols are displayed.
2. If necessary, press the button next to the ← or → symbols to move to the numeric character you wish to change.
3. Press the button next to the + symbol to increase the value or select parameter; press the button next to the - symbol to decrease the value or select parameter.
4. After adjusting values/selecting parameters, pressing the ► symbol results in the changes being saved. (When adjusting values, make sure the cursor is on the last numeric character before pressing the ► symbol).
5. If the Home button or Previous Main Menu button is pressed before pressing the ► symbol, the changes are not saved.

Cycle Crank submenu: Cycle Crank can be enabled or disabled (default = Disable).

Number of Crank Attempts submenu: This value can be adjusted from 2 to 7 attempts (default = 3 attempts).

Crank Time submenu: This value can be adjusted from 2 to 20 seconds (default = 15 seconds).

Rest Time submenu: This value can be adjusted from 7 to 40 seconds (default = 15 seconds).

Idle Speed Adjust submenu: This value can be adjusted from 700 to 1100 RPM (default = 800 RPM).

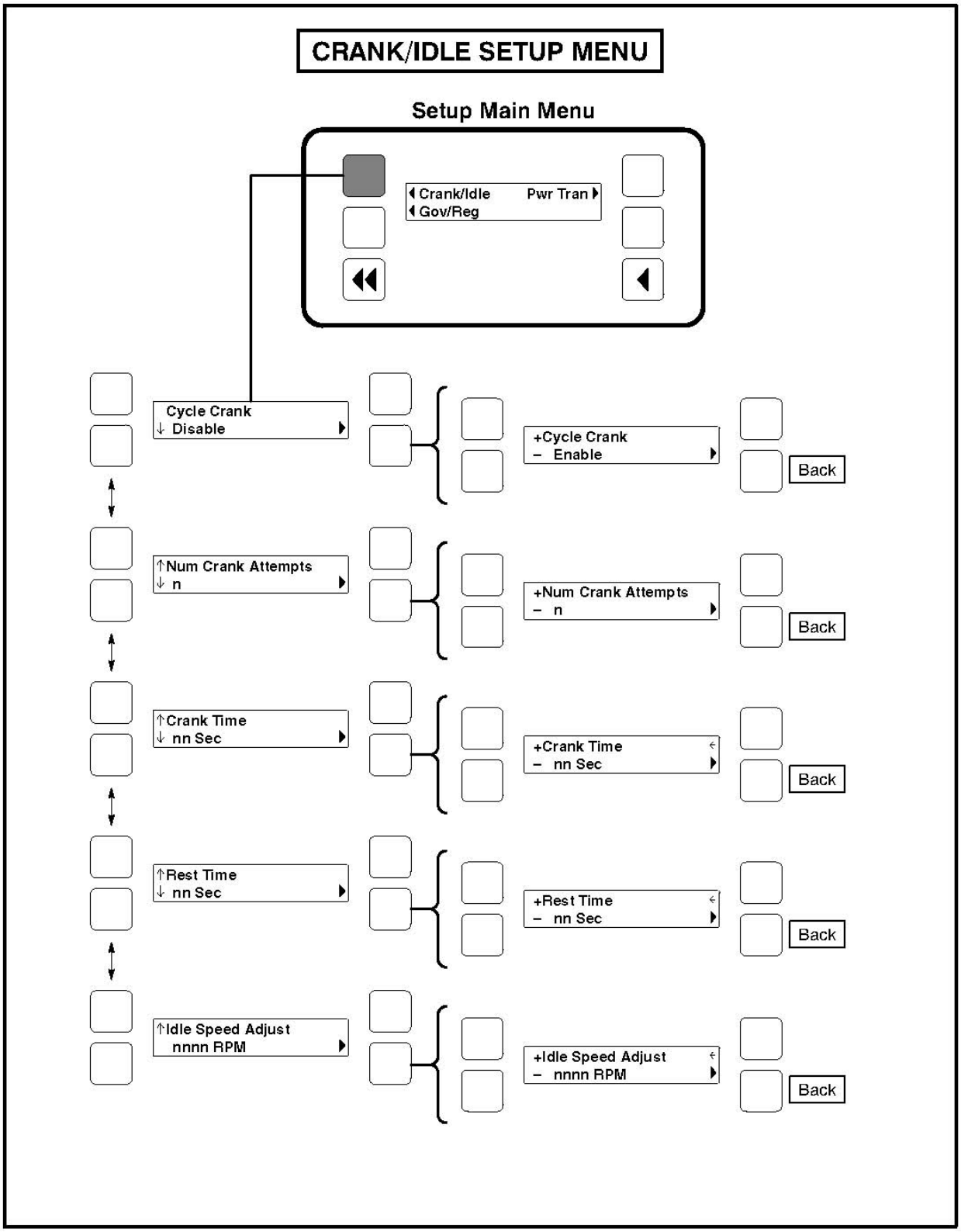


FIGURE 28. CRANK/IDLE SETUP MENU

6.6 Governor/Regulator Setup Menu

Figure 29 on page 89 shows a block representation of the Governor/Regulator Setup menu. If you press the button next to the word “Gov/Reg" in the display, the first Governor/Regulator Setup submenu is displayed.

The GOV/REG menu values will display “100%". The expression “100%" represents the factory setting (default value) for the selected set. When increasing or decreasing the value, you are increasing or decreasing from the factory default value. (For example, entering “200%" will double the value; “50%" will decrease the value by one half.)

Default values are preset by the factory. Due to site variables, the default values may need to be adjusted to attain peak performance.

As shown in the diagram, the Gov/Reg menu has five submenus. Each submenu includes a parameter or value that can be changed.

⚠ CAUTION
Improper adjustment of the PowerCommand control can cause equipment malfunction or damage. Adjustment must be performed by technically qualified personnel only.

Press the buttons next to the ↓ and ↑ symbols in the graphical display to navigate between the menus. Press the Previous Main Menu button to return to the Setup Main Menu. Press the Previous Main Menu button again to return to Main Menu 3. Press the Home button to return to Main Menu 1.

Adjusting Values/Parameters:

1. Press the button next to the ► symbol in the display until the + and - symbols are displayed.
2. If necessary, press the button next to the ← or → symbols to move to the numeric character you wish to change.
3. Press the button next to the + symbol to increase the value or select parameter; press the button next to the - symbol to decrease the value or select parameter.
4. After adjusting values/selecting parameters, pressing the ► symbol results in the changes being saved. (When adjusting values, make sure the cursor is on the last numeric character before pressing the ► symbol).
5. If the Home button or Previous Main Menu button is pressed before pressing the ► symbol, the changes are not saved.

Voltage Configuration submenu: The phase, voltage, and wire fields can simultaneously be adjusted. If phase = 1, the line-to-line voltage can be 200, 220, 230, or 240 volts with 3 wires. If phase = 3, the line-to-line voltage can be 190, 200, 208, 220, 230, 240, 380, 416, 440, 460, or 600 volts with either 3 or 4 wires. The default = 3Ph 208V 4W.

Alternator Frequency submenu: This value can either be 50 or 60 Hz (default = 60 Hz).

Regulator Gain Adjustment submenu: This value can be adjusted from 5 to 1000 percent (default = 100 percent).

If the gain adjustment is set too high, output voltage will be unstable. If gain is set too low, the output voltage will respond sluggishly to changes in load - overshoot may result.

Governor Ramp Time submenu: This value can be adjusted from 0 to 30 seconds (default = 0 seconds).

This adjustment sets the time for the engine to ramp to full operating speed. This adjustment applies only to set start up and does not affect the transient response.

Governor Gain Adjustment submenu: This value can be adjusted from 5 to 1000 percent (default = 100 percent).

If the gain adjustment is set too high, engine speed will “hunt" or oscillate. If gain is set too low, the engine will respond too slowly to changes in load - overspeed may result.

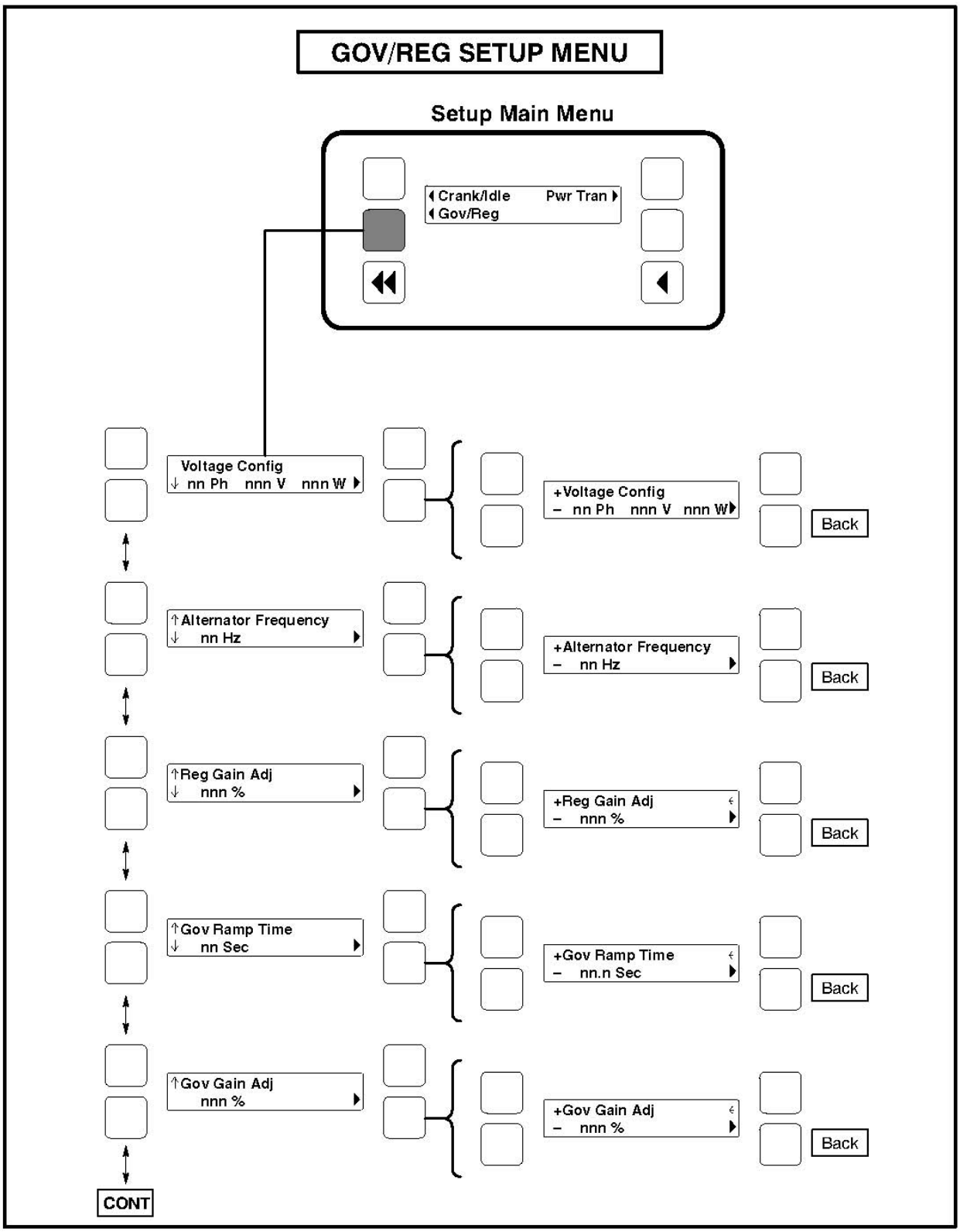


FIGURE 29. GOVERNOR/REGULATOR SETUP MENU

6.7 Governor/Regulator Setup Menu (Continued...)

Speed Droop Mode submenu: Selects between Isochronous and Droop kW Sharing droop modes (default = Isochronous).

Speed Droop Percent submenu): This value can be adjusted from 0 to 10 percent (default = 5%). This adjustment sets the amount of speed droop for a full standby/prime rated kW load.

Voltage Droop Mode submenu: Select between Constant and Droop kVAR Sharing Droop modes (default = Constant).

Voltage Droop Percent submenu: This value can be adjusted from 0 to 10 percent (default = 4%). This adjustment sets the amount of voltage droop for a 0.8 pf full standby rated load.

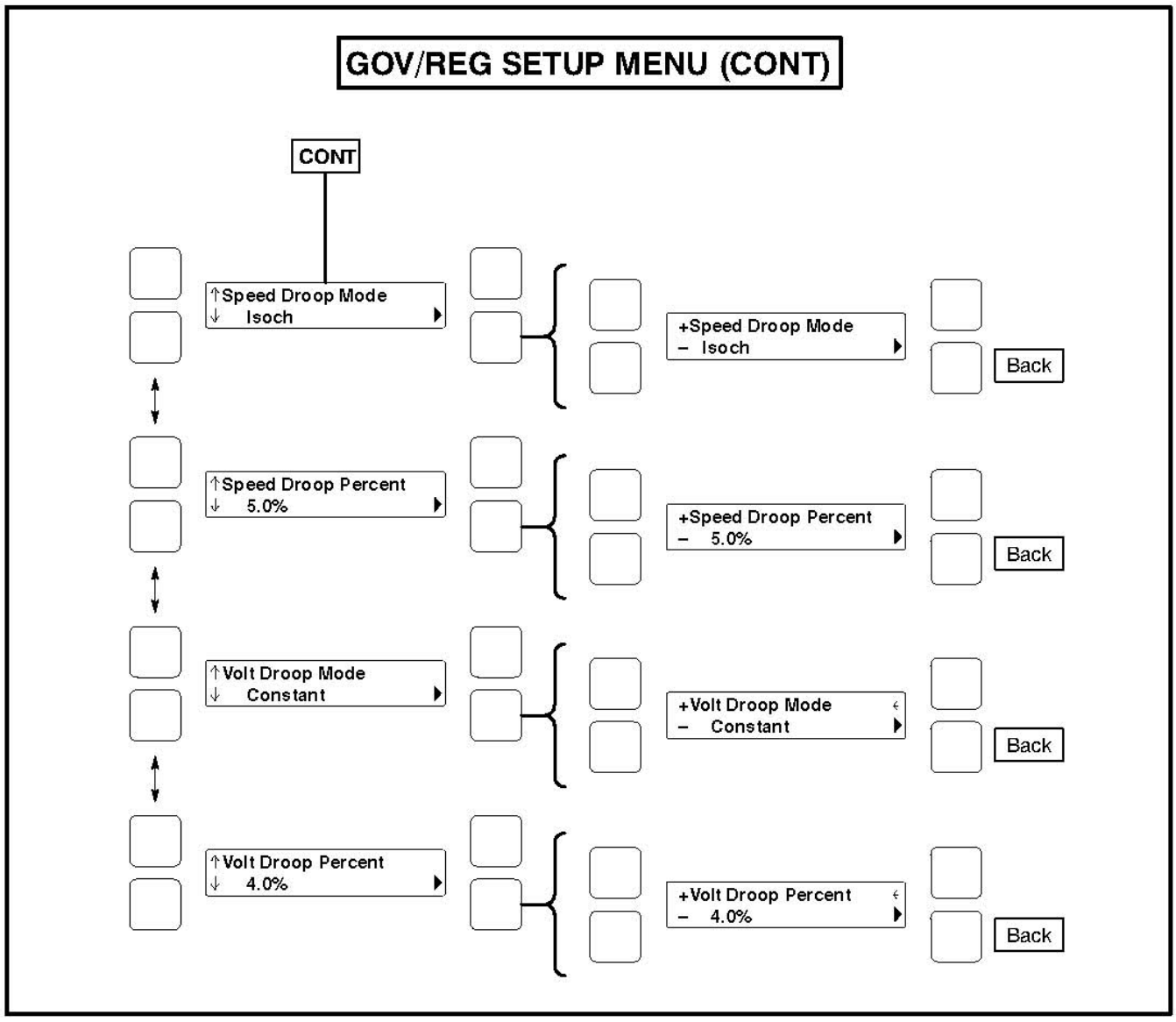


FIGURE 30. GOVERNOR/REGULATOR SETUP MENU (CONT)

6.8 PCC Control Panel Box Components (Standard/Optional)

The PCC control panel box contains components that provide connection points for remote control and monitor options. The control panel box can be equipped with one or more of the following components.

6.8.1 Network Communications Module (Optional)

The Network Communications Module (NCM) provides an interface for data from the genset to other modules on the network. It communicates with the PCC 2100 baseboard providing complete monitoring and control of the genset. Refer to the *PowerCommand Network Installation and Operator's Manual (900-0529)* for instructions on network wiring and network software information.

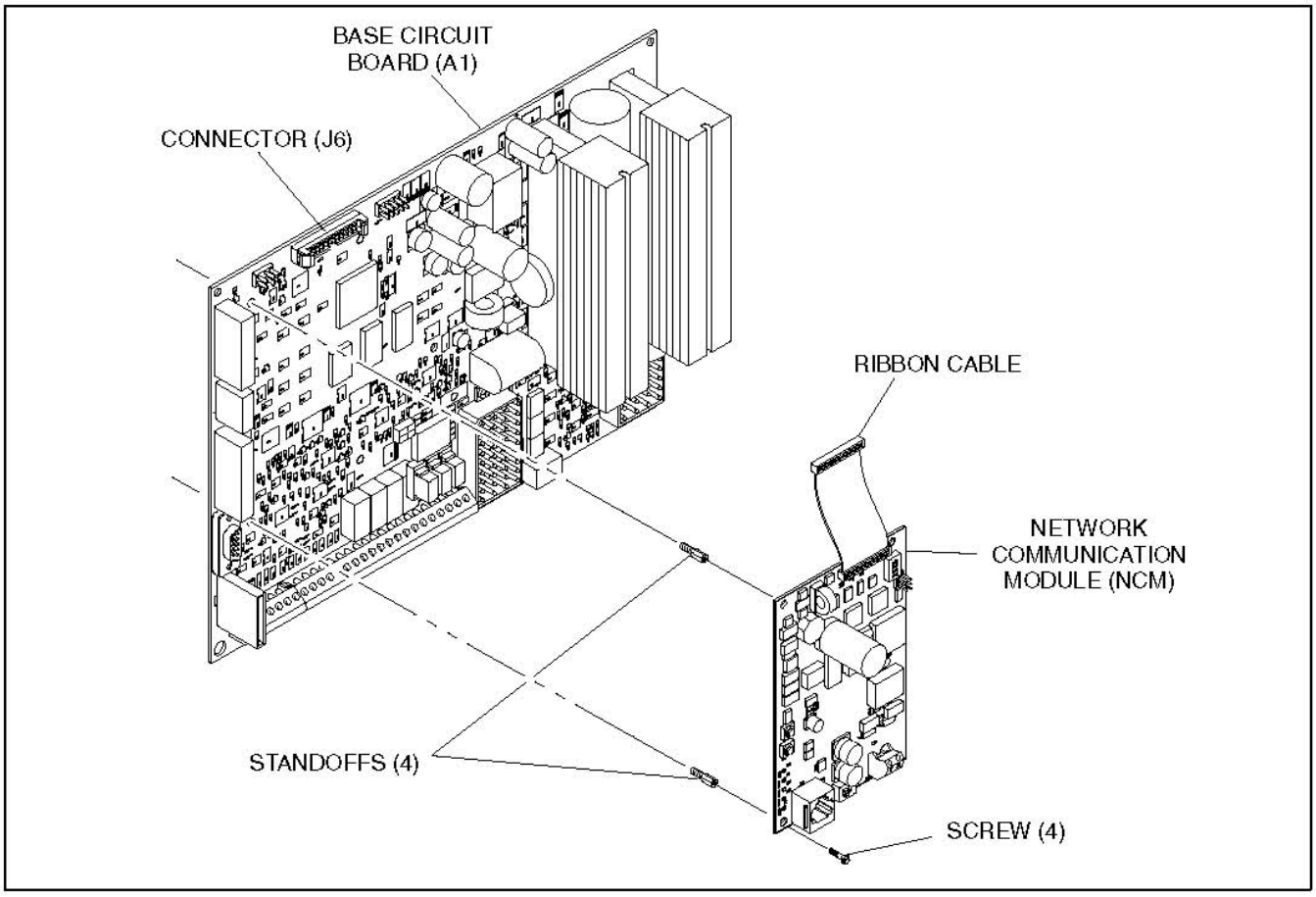


FIGURE 31. NETWORK COMMUNICATION MODULE

6.8.2 TB1 Customer Inputs

Refer to wiring diagrams for typical connections to TB1.

Remote Start: When the O/Manual/ Auto switch is in the Auto position, grounding this input initiates the engine cranking and start sequence. This circuit must be opened to permit resetting a shutdown condition with the Reset input.

Remote Emergency Stop: Grounding this input causes an immediate shutdown. Emergency stop must be reset at the front panel.

Remote Reset: When the O/Manual/ Auto switch is in the Auto position and the remote start switch is open, grounding this input resets any warning and shutdown fault (except Emergency Stop, which must be reset at the genset front panel.)

Customer Fault Inputs 1 through 3: Grounding any one of these inputs activates the corresponding warning or shutdown sequence.

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

The nature of the fault is an optional customer selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, Low Starting Hydraulic Pressure, Low Starting Air Pressure, etc.

Each of the four fault functions can be programmed (using InPower), as follows:

- Enable/disable input. Default setting:

  Enable **1** through **3**

- Status, Warning or Shutdown. Default setting:

  1 - None

  2 thru **3** - Warning

- Active closed or open. Default setting:

  Closed [ground] **1** through **3**

- Change display name using up to 19 characters. Default setting:

  1 - Customer Fault 1

  2 - Ground Fault

  3 - Low Fuel

6.8.3 TB1 Customer Outputs

Refer to Page 9-11 for typical connections to TB1.

Customer Outputs 1 through 4: One set of normally open (NO) contacts, rated for 2 amps at 30 VDC for each of the four output signals. The relays can be used to control small devices and indicator lamps.

The nature of the customer output signal (contacts closed) is an optional customer selection. Example outputs: Genset running, common warning, common fault, load shed, ready to load, etc.

Each relay can be independently programmed (using InPower) to energize as follows.

- Enable/disable output. Default setting:

  Enable **1** through **4**

- Status, Warning or Shutdown. Default setting:

  1 - Common warning

  2 - Common shutdown

  3 - Not in Auto

  4 - Ready to Load

The customer outputs can also be connected to three control relays (optional) to operate larger equipment, such as, fans, pumps and motorized air dampers. Refer to *Control Relays* in this section for additional information.

B+: This is a fused 10 amp, 12/24 volt output. (Fuse F1 is located on Base board.) Two terminals (TB1-16 and -17) are connected to this 10 amp circuit.

B+ Switched: This is a fused 5 amp, 12/24 volt switched output. This output is activated when the control receives a run command. (Fuse F2 is located on Base board.)

6.8.4 Control Relays (K10, K11, K12) (Optional)

⚠ CAUTION

Damage to the Base board can occur if the voltage suppressors (Figure 32) are not installed across relay coils (A1/A2) before connecting genset battery cables.

The three optional control relays are rail mounted inside the control panel box. Each relay is a 4-pole relay with 2 poles normally open and two poles normally closed.

These relays (**Figure 32**) are used to control auxiliary equipment, such as fans, pumps and motorized air dampers. Energizing of the relays is user definable (refer to *TB1 Customer Outputs* in this section for customizing information.)

The contacts are rated at 10 amps at 600 VAC.

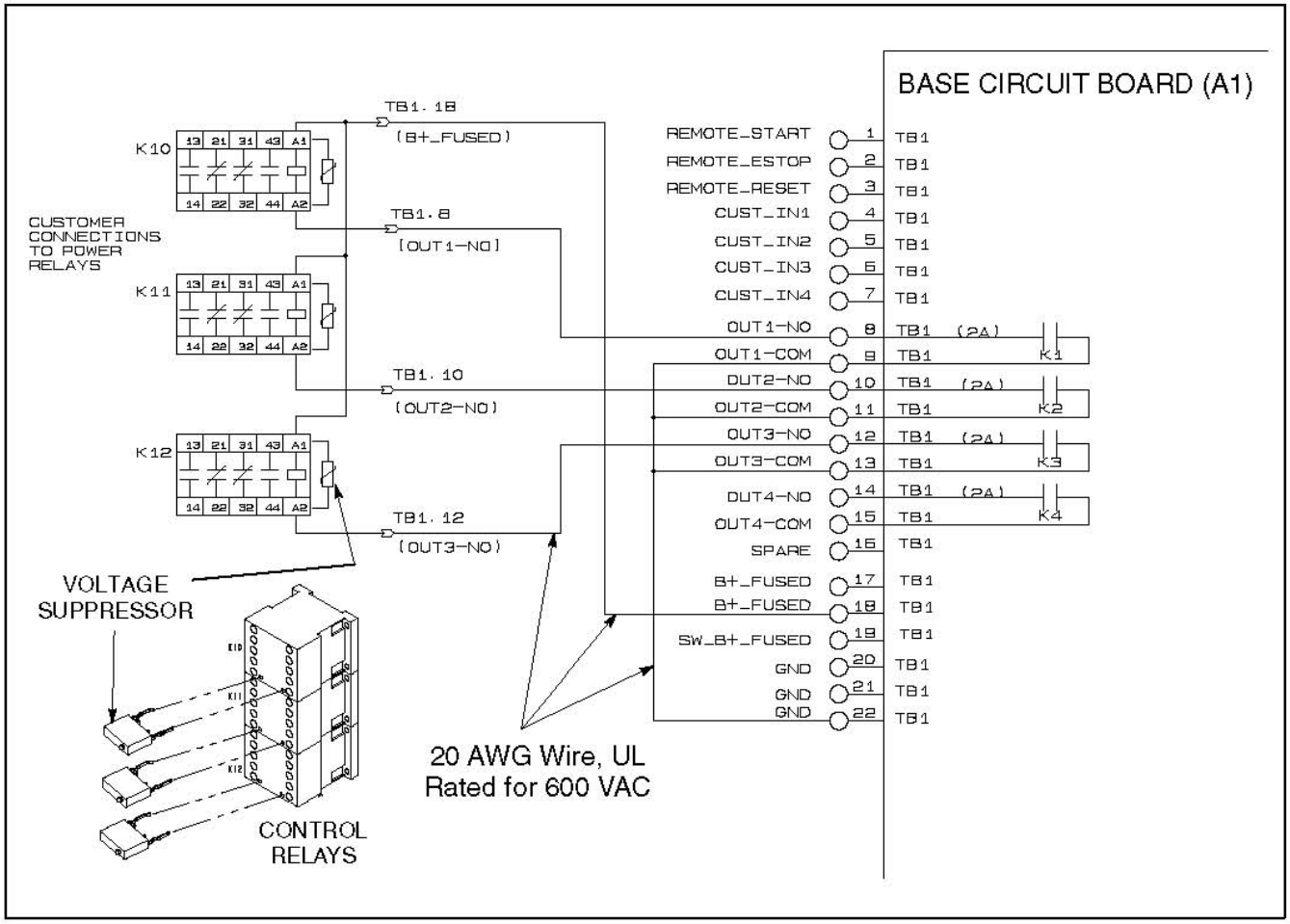


FIGURE 32. OPTIONAL CONTROL RELAYS (K10, K11, K12)

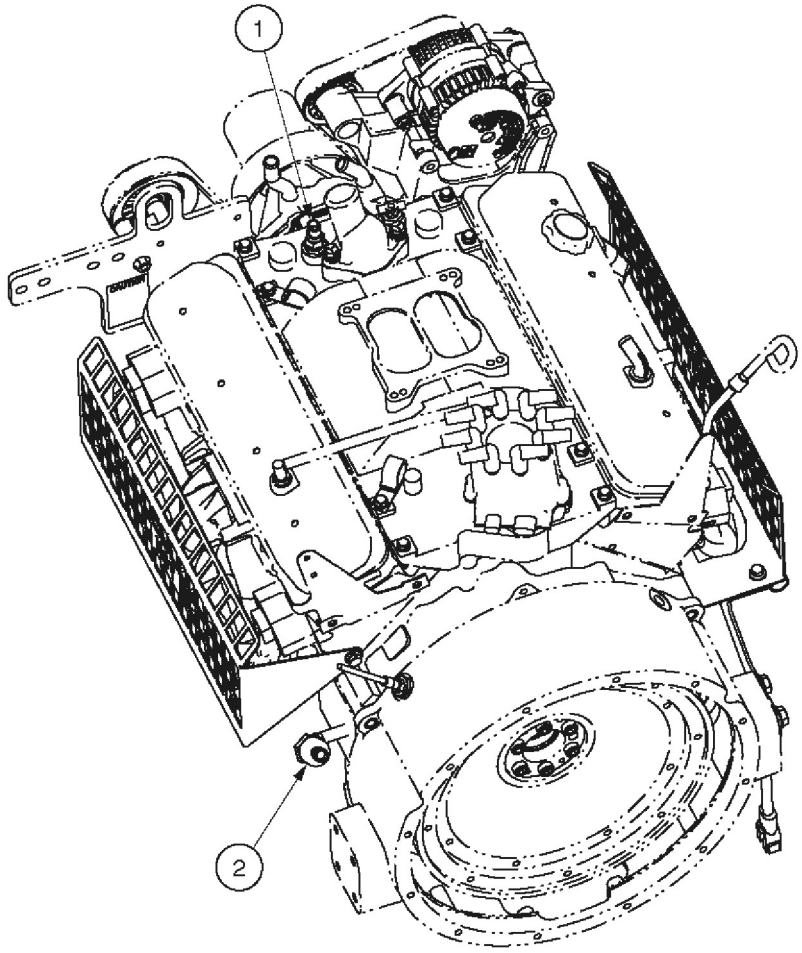
6.9 Engine Sensors

Figure 33 shows the locations of the coolant temperature and oil pressure senders to which the PCC responds for the engine.

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

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

The low coolant level switch functions by closing the circuit to the engine chassis ground (battery negative [**–**]). The low coolant level switch is not shown in Figure 33; this switch is located near the top of the radiator.



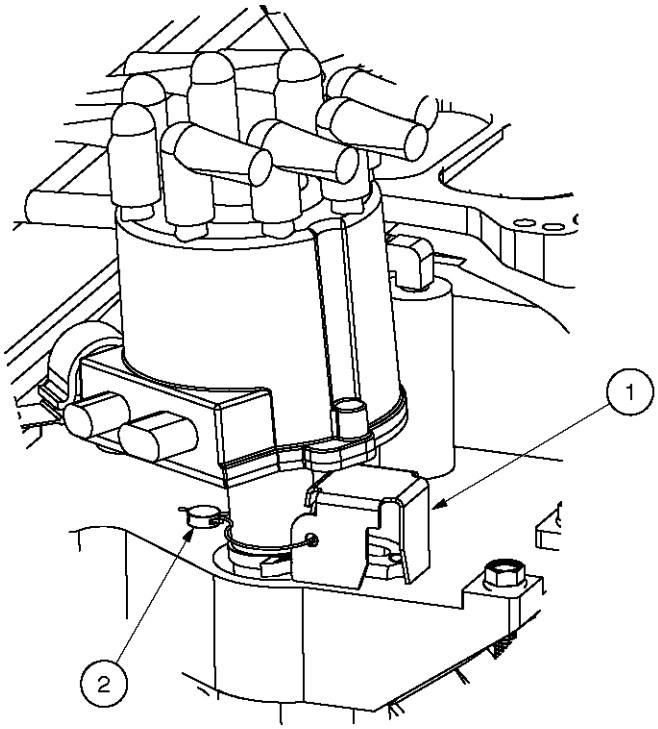
No.	Description	No.	Description
1	Temperature Sensor	2	Oil Pressure Sender

FIGURE 33. ENGINE SENSOR LOCATIONS

6.10 Distributor

Sealing the distributor (**Figure 34**) must be done after setting the engine timing. To seal the distributor,

1. Place the bolt cover over the bolt
2. Thread the wire-lock sealing wire through the two holes in the cover, under the distribution hold-down clamp, and around the distribution shaft.
3. Insert the wire through one of the holes in the seal and pull tight against the shaft of the distributor and crimp the seal using the sealing tool with embossed die. The crimp must be tight enough so wire cannot be pulled out and the initials "CPGF" are readable.



No.	Description	No	Description
1	Bolt Cover	2	Wire-Lock Sealing Wire

FIGURE 34. DISTRIBUTOR

6.11 Magnetic Speed Pickup Unit (MPU) Installation

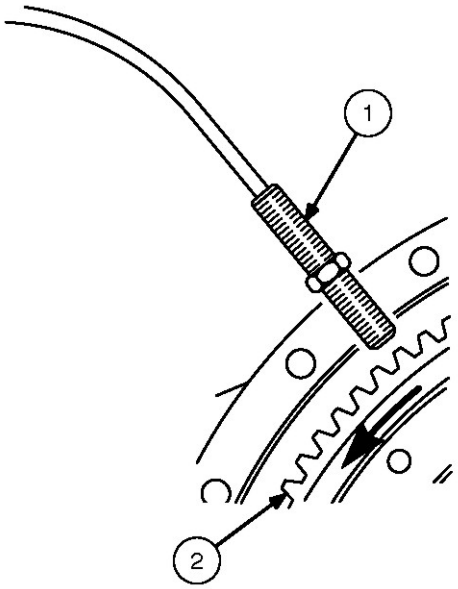
Measure the resistance of the magnetic speed pickup (MPU). Replace the MPU if the resistance is over 1,000 ohms.

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

NOTICE

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

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



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

FIGURE 35. MPU SENSOR

6.12 Current Transformer (CT) Installation

Current transformers (CTs) are required on gensets that contain AC meters. The CTs must be installed as noted in the following *CT Installation Requirements*. Improper installation of CTs will cause a “1459 Reverse Power" shutdown error.

Refer to the Reconnection Diagram to identify the output leads/phase that must be routed through each CT, and also appropriate transformer post selection for meter sensing leads. The transformers are labeled CT1, CT2 and CT3 on the reconnection wiring diagram. (The Reconnection Diagram is located on the upper side cover of the control housing.)

6.13 CT Installation Requirements

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

B. CT1 - U load leads (A phase)

CT2 - V load leads (B phase)

CT3 - W load leads (C phase)

C. Route the appropriate leads through each CT.

- 6 lead generator sets - generator output leads are routed through the CT's.
- 12 lead generator sets - load wires are routed through the CTs.

D. Reconnectable gensets (12 leads) have dual secondary CTs (3 pins). The CT secondary wire marked 1 is connected to pin 1 of the CT. CT secondary wire marked 2/3 is connected to pin 2 for high voltage gensets or to pin 3 for low voltage gensets. (Refer to Reconnection Diagram.)

Non-reconnectable gensets (6 leads) have single secondary CTs (2 pins).

7 Servicing the Generator

7.1 Testing the Generator

These tests can be performed without removing the generator. Before starting tests, disconnect the negative (−) cable from the battery to make sure the engine will not start while performing these tests.

⚠ WARNING

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

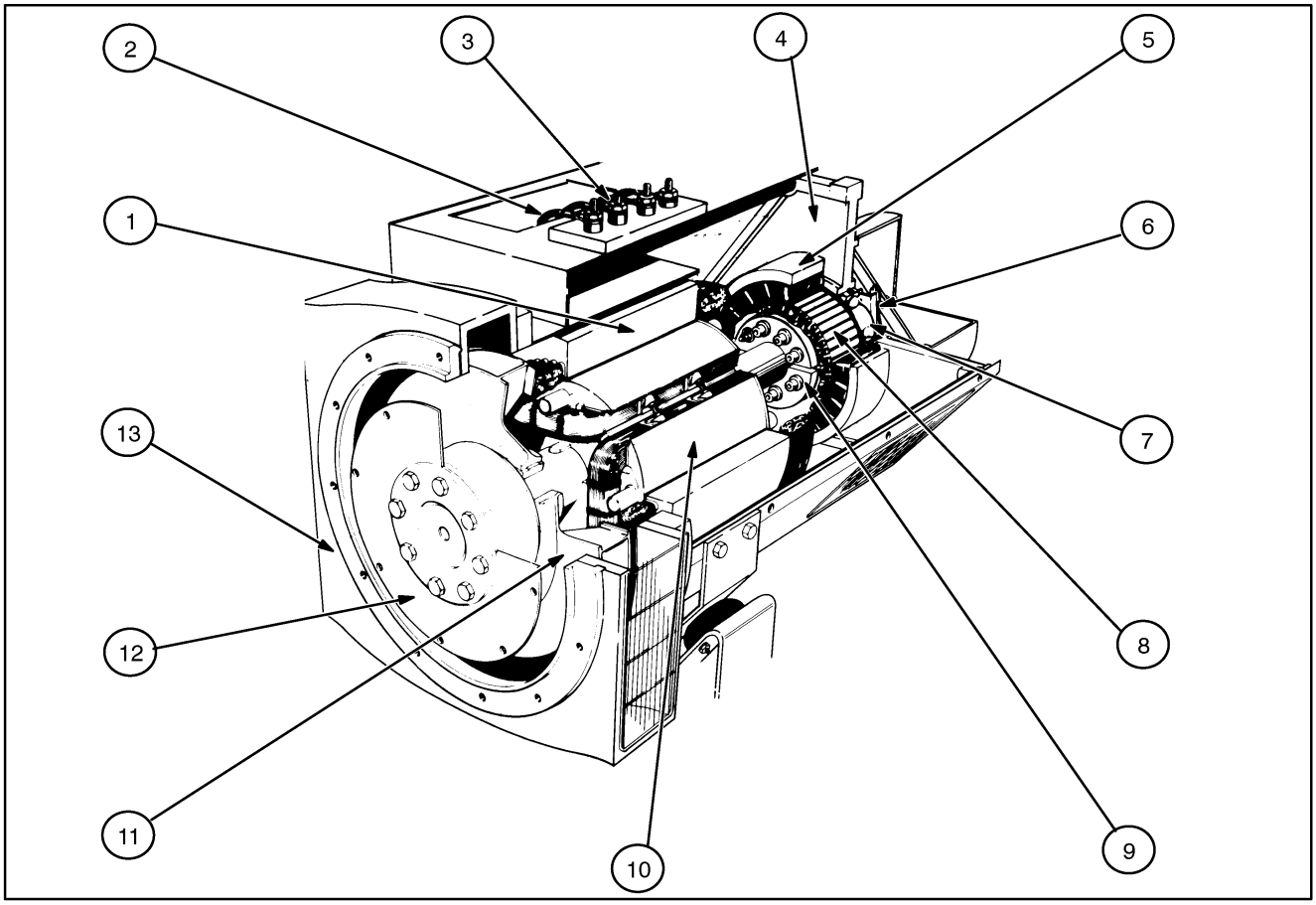
Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (−) cable first and reconnect last.

⚠ CAUTION

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

⚠ WARNING

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



NO	DESCRIPTION	NO	DESCRIPTION
1	Main Stator	8	Exciter Rotor
2	Stator Leads	9	Rotating Rectifier Assembly
3	Output Terminals	10	Main Rotor (Generator Field)
4	End Plate	11	Cooling Bowler
5	Exciter Stator	12	Drive Discs
6	PMG Assembly	13	Generator Adapter Casting
7	Rotor Shaft Bearing		

FIGURE 36. GENERATOR

7.2 Generator/Base Board Isolation Procedure

The following procedure is used to determine if the generator or the control Base board is causing a high AC voltage shutdown fault.

1. Throw the line circuit breaker **OFF** and shut down the set.

⚠ CAUTION

This test involves unregulated excitation of the generator. To prevent damage to the generator due to overcurrent, make sure that all loads have been disconnected from the power output terminals of the generator and that all faults have been cleared.

⚠ WARNING

HAZARDOUS VOLTAGE. Touching uninsulated parts inside the control housing and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching hazardous voltage parts.

Stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.

2. Remove the side access cover of the control housing to access the exciter stator leads (**X** and **XX**). Disconnect the **X** and **XX** leads from the AC harness (quick connect type connectors).
3. Prepare to measure output voltage across the generator terminals while the set is running.
4. Bring two jumpers from a 12 volt battery for connection to the excitor stator **X** (Field +) and **XX** (Field -) leads.

   Connect the jumper from the positive (**+**) post of the battery to the **X** lead. Be prepared to connect the jumper from the negative (**-**) post of the battery to the **XX** lead. If one of the 12 volt cranking batteries is used, bring the jumpers from the battery connected on the grounded side of the system to avoid inadvertently imposing 24 volts on the system.
5. Check polarity again. Polarity must be correct or this test will be inconclusive because the induced and residual magnetic polarities in the exciter stator will be opposed.

   Genset may shut down on a fault condition within 5 to 15 seconds due to the excitor stator leads being disconnected from the Base board. Clear fault and start genset to check next phase.
6. Start the set and connect the jumper from the battery negative (**-**) terminal to the **XX** lead.
7. The generator circuitry is probably okay if rated output voltage or higher is obtained and the voltages for all phases are balanced when the exciter is powered by a 12 volt battery. Refer to *Section 4* to troubleshoot the PCC control circuitry. (Normal excitation voltage ranges from approximately 10 VDC at no-load to approximately 40 VDC at full-load.)
8. If the voltages are unbalanced, troubleshoot the main stator first. If the voltages are uniformly low, troubleshoot the exciter and field circuits first.

7.2.1 Exciter Stator

Testing Winding Resistance: Measure winding resistance with a Wheatstone bridge or digital ohmmeter. Replace the stator if winding resistance is not as specified by **Table 8 on page 107**.

Testing Winding Insulation Resistance: Disconnect the exciter stator leads **X** and **XX** from their connectors in the AC harness and isolate them from ground. Using an ohmmeter, measure resistance between either lead and the stator laminations. Replace the stator if insulation resistance is less than 1 megohm (1,000,000 ohms)

Flashing the Field (Self-Excited Generators Only): If necessary, flash the exciter field before or after installation. Apply 110 to 220 VAC for one to two seconds to the **X** and **XX** leads of the exciter stator. **The generator must be shut down, the Base board disconnected, a diode used to establish correct polarity and a 3 amp fuse to prevent over-excitation.** See the diagram.

Alternatively, while the set is running and disconnected from all loads, apply a 12 VDC battery for one to two seconds as shown in the diagram. **Polarity must be correct: + to X, - to XX**.

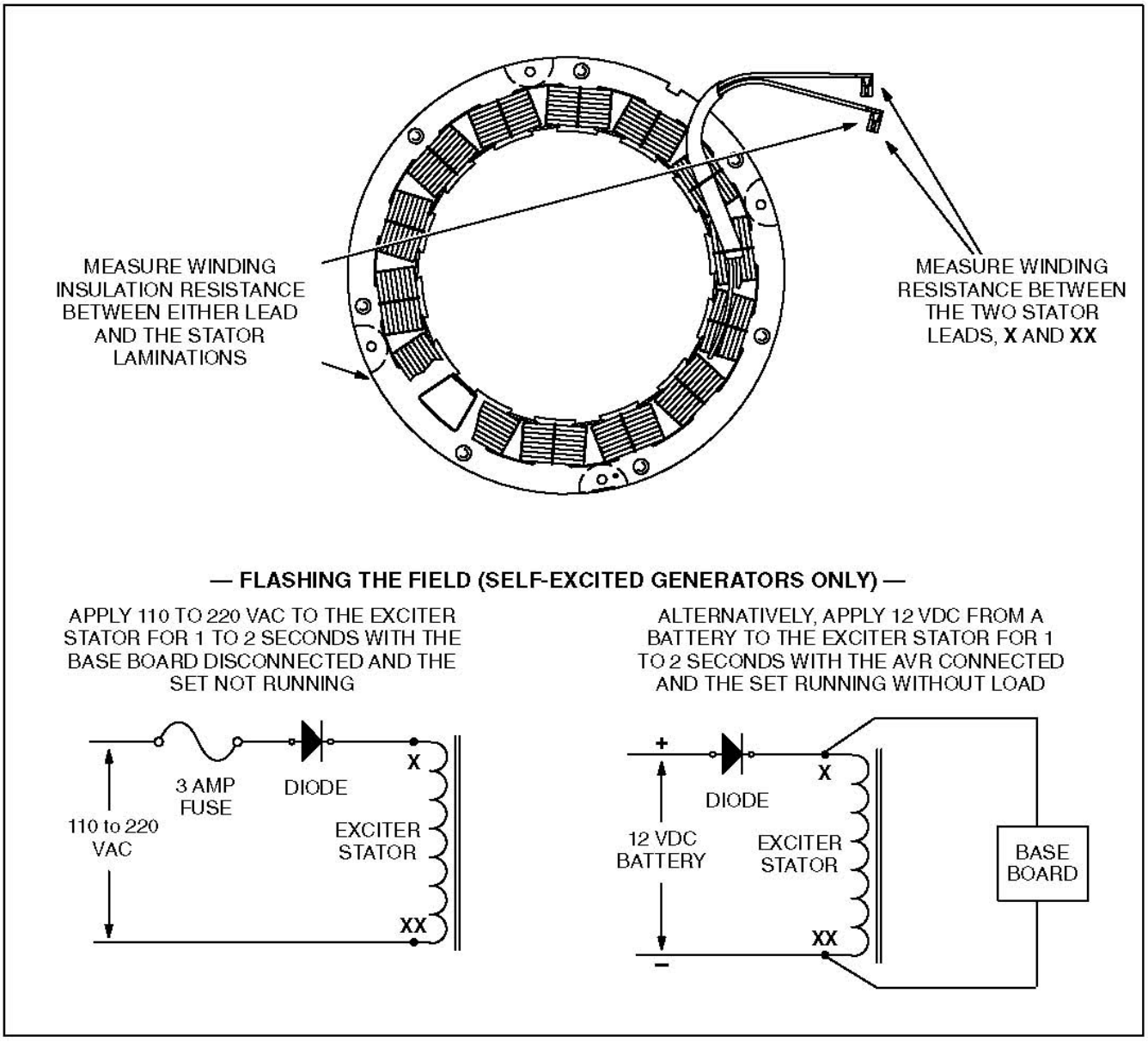


FIGURE 37. TESTING AND FLASHING THE EXCITER STATOR

7.2.2 Exciter Rectifier Bridge (Rotating Rectifier Assembly)

The exciter rectifier bridge is mounted on the exciter rotor, inboard, facing the main rotor. It consists of a positive plate and a negative plate, split diametrically. Each carries three diodes, three terminal posts for connecting exciter rotor leads to the diode pigtails and a terminal for the main rotor (generator field) lead. A surge suppresser is connected across the two plates to prevent transient voltages that could damage the diodes.

Testing Diodes: Disconnect the diode pigtails from the terminal posts. Using an ohmmeter, measure electrical resistance between each diode pigtail and the plate on which the diode is mounted. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the diode.

Replacing Diodes: Make sure the replacement diode is of the correct polarity. Disconnect the pigtail from the terminal post and unscrew the old diode. Apply heat-sink compound under the head of the diode. Make sure the compound does not get on the threads. Torque the diodes to 36 to 42 in-lbs (4 to 4.8 Nm) and the pigtail terminals to 24 in-lbs (2.7 Nm) when reassembling.

Surge Suppresser Testing and Replacement: Remove the suppresser. Replace the suppresser if it appears to have overheated or if ohmmeter readings indicate less than infinite resistance (end of scale) in both directions. Torque the terminals to 24 in-lbs (2.7 Nm) when reassembling.

⚠ CAUTION
Layers of dust can cause diodes to overheat and fail. Brush dust off regularly.

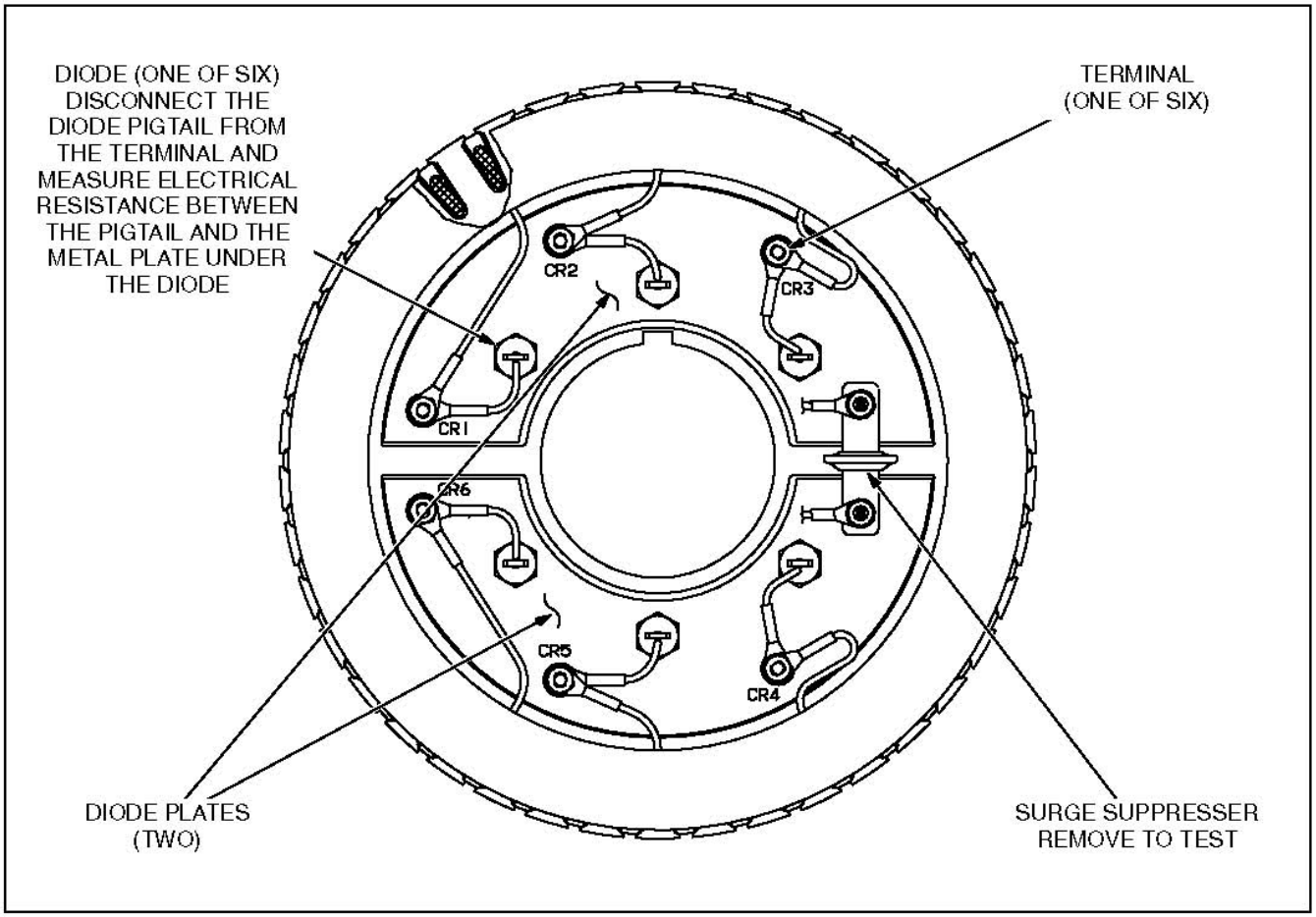


FIGURE 38. TESTING THE ROTATING RECTIFIER ASSEMBLY

7.2.3 Exciter Rotor

Testing Winding Resistance: Disconnect the six rotor winding leads from the terminal posts on the rectifier assembly. With a Wheatstone bridge, measure electrical resistance across each pair of rotor windings: **U** (CR1 or CR4) and **V** (CR2 or CR5), **V** (CR2 or CR5) and **W** (CR3 or CR6), **W** (CR3 or CR6) and **U** (CR1 or CR4). See the winding schematic. Replace the whole rotor shaft assembly if the resistance of any winding is not as specified in Table 8 on page 107.

Testing Winding Insulation Resistance: Using an ohmmeter, measure the resistance between any rotor winding lead or the terminal to which it is connected and the rotor laminations. Replace the whole rotor shaft assembly if insulation resistance is less than 1 megohm.

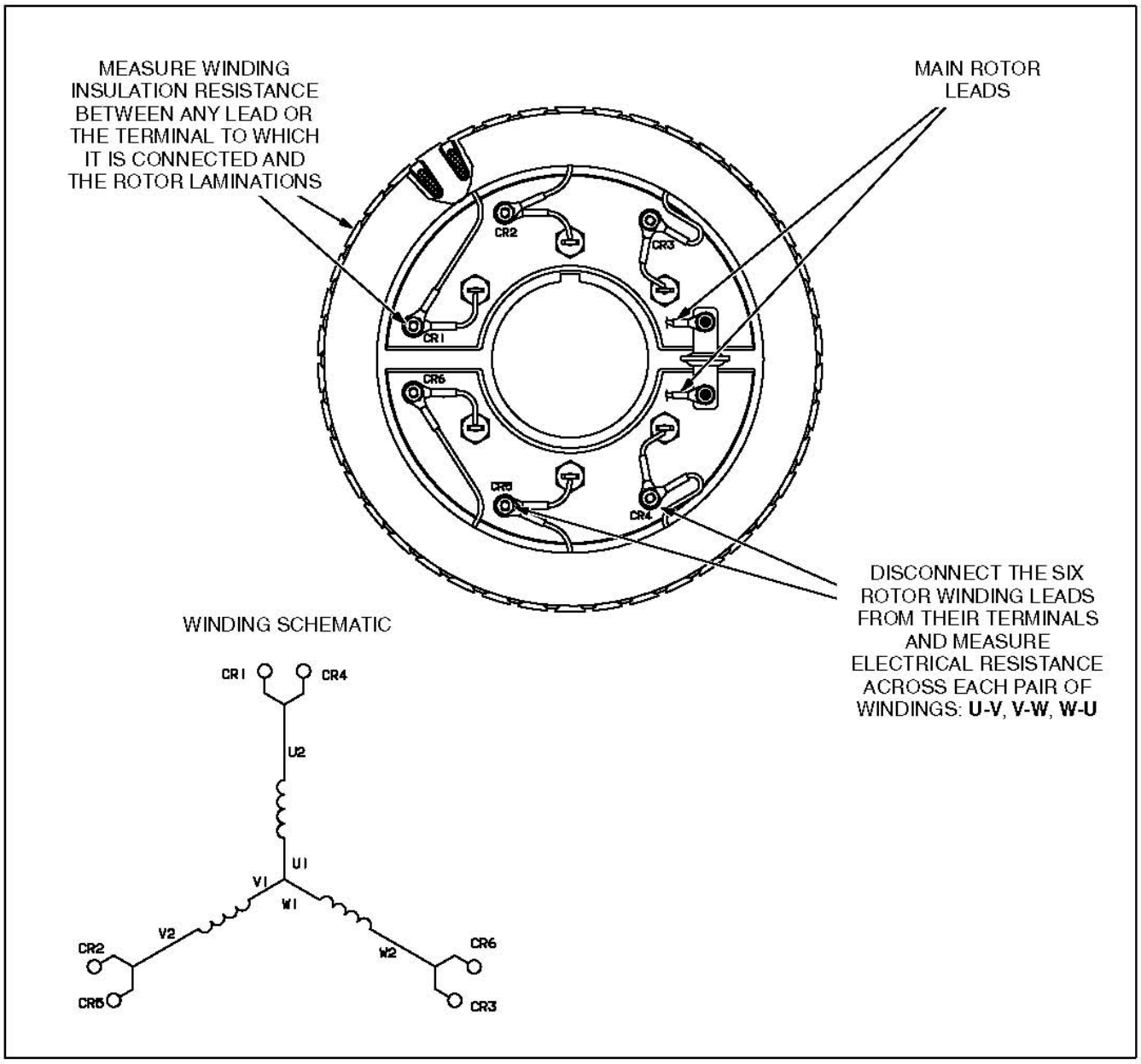


FIGURE 39. TESTING THE EXCITER ROTOR

7.2.4 Main Rotor (Generator Field)

Testing Winding Resistance: Disconnect the two leads of the main rotor from the terminals on the rotating rectifier assembly. See **Figure 40 on page 106**. Measure electrical resistance between the two leads with a Wheatstone bridge or digital ohmmeter. Replace the rotor if the resistance is not as specified in **Table 8 on page 107**. Connect the rotor leads and torque the terminals to 24 in-lbs (2.7 Nm) when reassembling.

Testing Winding Insulation Resistance: Using an ohmmeter, measure the resistance between either lead of the main rotor windings, or the terminal to which it is connected, and the main rotor laminations. Replace the rotor if insulation resistance is less than 1 megohm.

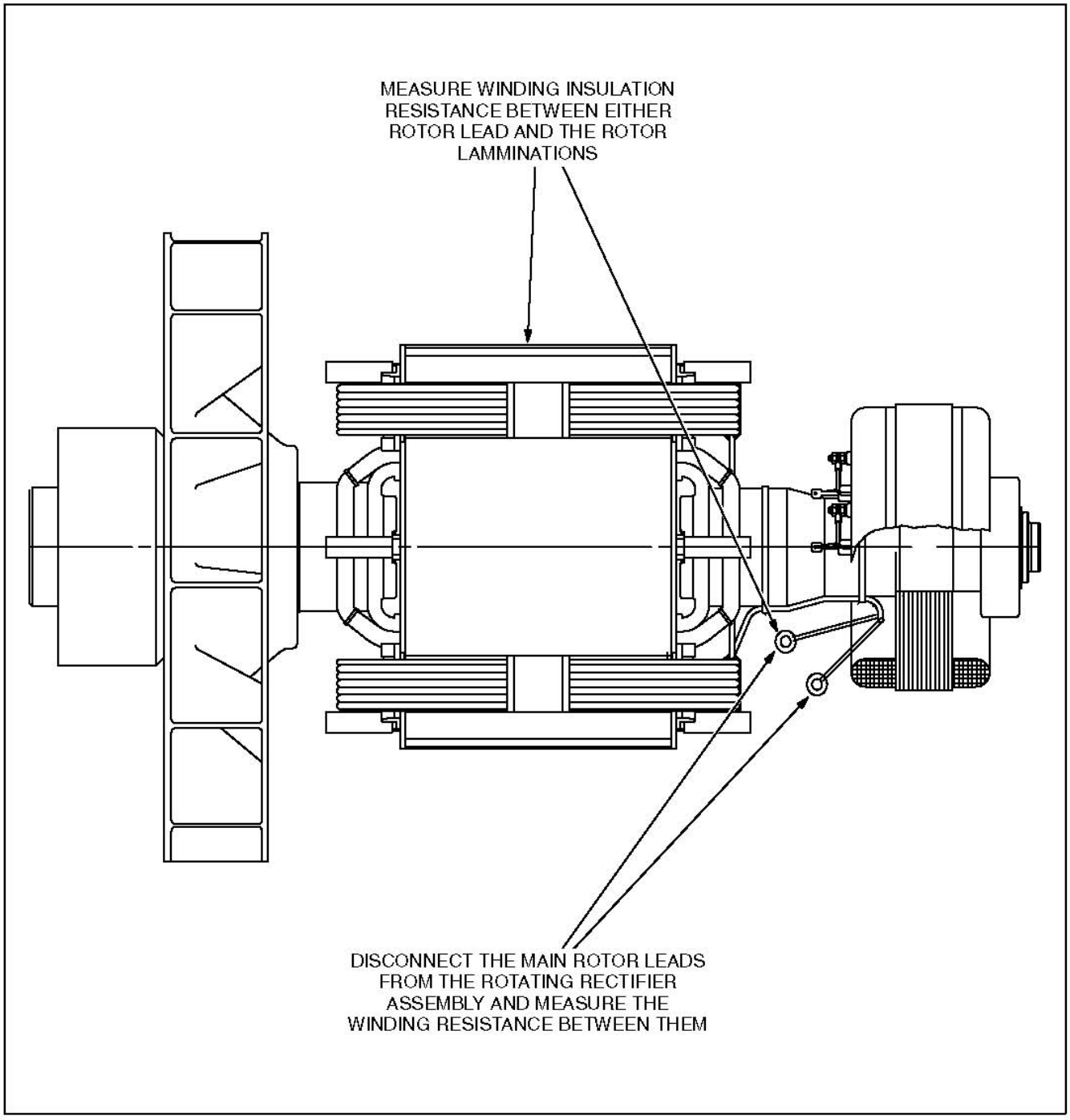


FIGURE 40. TESTING THE MAIN ROTOR

7.2.5 Main Stator

Testing Winding Resistance: Measure electrical resistance across each pair of stator leads (U1-U2, U5-U6, VI-V2, V5-V6, W1-W2 and W5-W6) with a Wheatstone bridge or ohmmeter having at least 0.001 ohm precision. Replace the stator if the resistance of any winding is not as specified in **Table 8 on page 107**.

Alternatively, winding resistance can be measured line-to-line at the generator terminals (U-V, V-W, W-U) on “star" connected generators. On a 600 volt generator, line-to-line resistance should be twice the table value (two winding elements in series). On a “series star" connected generator, line-to-line resistance should be four times the table value (four winding elements in series). On a “parallel star" connected generator, line-to-line resistance should be the same as the table value (two sets of two winding elements in series). Single phase only windings can be measured at W-V and should be twice the table value.

Testing Winding Insulation Resistance: Disconnect all stator leads and winding taps from their respective terminals and make sure the ends do not touch the generator frame. Using an ohmmeter, measure electrical resistance between any stator lead and the stator laminations. Replace the stator if insulation resistance is less than 1 megohm.

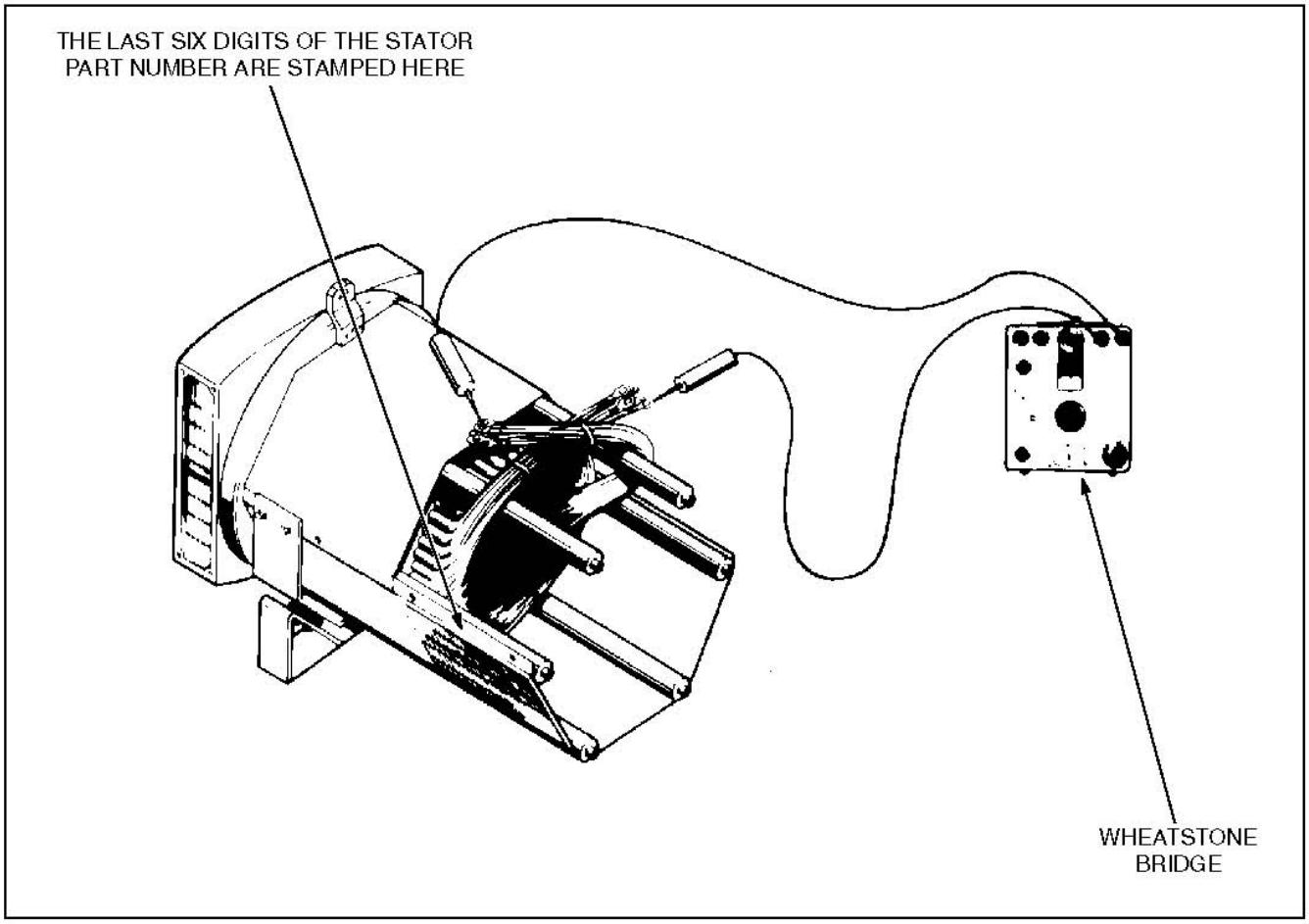


FIGURE 41. TESTING THE GENERATOR STATOR

TABLE 8. GENERATOR WINDING RESISTANCES

MAIN STATOR PART NUMBER***	MAIN STATOR (OHMS*)	MAIN ROTOR (OHMS**)	EXCITER STATOR (OHMS**)	EXCITER ROTOR (OHMS*)
220-4447-06	0.0561-0.0620	0.57	20.3	0.167
220-4447-07	0.0466-0.0515	0.64	20.3	0.167
220-4447-08	0.0371-0.0410	0.67	19.5	0.180
220-4447-09	0.0228-0.0252	0.80	19.5	0.180

MAIN STATOR PART NUMBER***	MAIN STATOR (OHMS*)	MAIN ROTOR (OHMS**)	EXCITER STATOR (OHMS**)	EXCITER ROTOR (OHMS*)
220-4447-10	0.0181-0.0200	0.93	19.5	0.180
220-4447-11	0.0860-0.0950	0.57	20.3	0.167
220-4447-12	0.0613-0.0677	0.64	20.3	0.167
220-4447-13	0.0480-0.0530	0.67	19.5	0.180
220-4447-14	0.0309-0.0341	0.80	19.5	0.180
220-4447-15	0.0261-0.0289	0.93	19.5	0.180
220-4447-16	0.0561-0.0620	0.57	20.3	0.167
220-4447-17	0.0428-0.0473	0.64	20.3	0.167
220-4447-18	0.0333-0.0368	0.67	19.5	0.180
220-4447-19	0.0228-0.0252	0.80	19.5	0.180
220-4447-20	0.0171-0.0189	0.93	19.5	0.180
220-4447-26	0.1354-0.1496	0.57	20.3	0.167
220-4447-27	0.0960-0.1050	0.64	20.3	0.167
220-4447-28	0.0713-0.0788	0.67	19.5	0.180
220-4447-29	0.0485-0.0536	0.80	19.5	0.180
220-4447-30	0.0404-0.0446	0.93	19.5	0.180
220-4448-07	0.0209-0.0231	1.11	19.5	0.180
220-4448-08	0.0162-0.0179	1.20	19.5	0.180
220-4448-09	0.0143-0.0158	1.31	19.5	0.210
220-4448-10	0.0095-0.0105	1.50	19.5	0.210
220-4448-11	0.0076-0.0084	1.66	19.5	0.210
220-4448-12	0.0066-0.0072	1.80	19.5	0.210
220-4448-13	0.0260-0.0310	1.11	19.5	0.180
220-4448-14	0.0214-0.0236	1.20	19.5	0.180
220-4448-15	0.0147-0.0163	1.31	19.5	0.210
220-4448-16	0.0114-0.0126	1.50	19.5	0.210
220-4448-17	0.0100-0.0110	1.66	19.5	0.210
220-4448-18	0.0071-0.0079	1.80	19.5	0.210
220-4448-19	0.0204-0.0226	1.11	19.5	0.180
220-4448-20	0.0152-0.0168	1.20	19.5	0.180
220-4448-21	0.0105-0.0116	1.31	19.5	0.210
220-4448-22	0.0090-0.0100	1.50	19.5	0.210
220-4448-23	0.0076-0.0084	1.66	19.5	0.210
220-4448-24	0.0062-0.0068	1.80	19.5	0.210
220-4448-31	0.0413-0.0457	1.11	19.5	0.180
220-4448-32	0.0229-0.0331	1.20	19.5	0.180
220-4448-33	0.0238-0.0263	1.31	19.5	0.210

MAIN STATOR PART NUMBER***	MAIN STATOR (OHMS*)	MAIN ROTOR (OHMS**)	EXCITER STATOR (OHMS**)	EXCITER ROTOR (OHMS*)
220-4448-34	0.0181-0.0200	1.50	19.5	0.210
220-4448-35	0.0124-0.0137	1.66	19.5	0.210
220-4448-36	0.0133-0.0147	1.80	19.5	0.210
220-4448-37	0.0085-0.0095	2.05	19.5	0.210
220-4448-38	0.0095-0.0105	2.05	19.5	0.210
220-4448-39	0.0074-0.0082	2.05	19.5	0.210
220-4448-40	0.0066-0.0074	2.05	19.5	0.210
220-4448-41	0.0065-0.0073	2.05	19.5	0.210
220-4448-42	0.0131-0.0145	2.05	19.5	0.210

* - These values are approximate, plus or minus 10 percent at 68° F (20° C).
** - These values are approximate, plus or minus 10 percent at 77° F (25° C).
*** - See **Figure 41 on page 107** for the location of the stator part number.

7.3 Generator Dissambly

The generator is heavy. You will need an assistant and a hoist of sufficient capacity to remove and service the generator.

⚠ WARNING

Accidentally dropping the generator can damage it and cause severe personal injury and death. The hoist, straps and chains must have sufficient capacity and be attached properly so that the load cannot shift.

Before starting, disconnect the negative (−) cable from the battery to make sure the set will not start while working on it.

⚠ WARNING

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

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (−) cable first and reconnect last.

⚠ CAUTION

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

⚠ WARNING

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

7.3.1 Removing The Generator Control Housing

1. Disconnect the line cables and conduit. For reconnections later, make sure each cable is clearly marked to indicate the correct terminal.
2. Disconnect the remote control wiring and conduit. For reconnections later, make sure each wire is clearly marked to indicate the correct terminal.
3. Disconnect all engine wiring harness connections in the generator control and output boxes. For reconnections later, make sure each wire is clearly marked to indicate the correct terminal.
4. Disconnect all generator control leads (winding taps) from connections in the output box. For reconnections later, make sure each wire is clearly marked to indicate the correct terminal.
5. If the set has a mounted line circuit breaker, disconnect the cables to the circuit breaker. For reconnections later, make sure each cable is clearly marked to indicate the correct terminal.
6. Attach a hoist to the generator output box, loosen the mounting bolts on the sides of the generator and remove the box.

7.3.2 Withdrawing The Generator From The Set

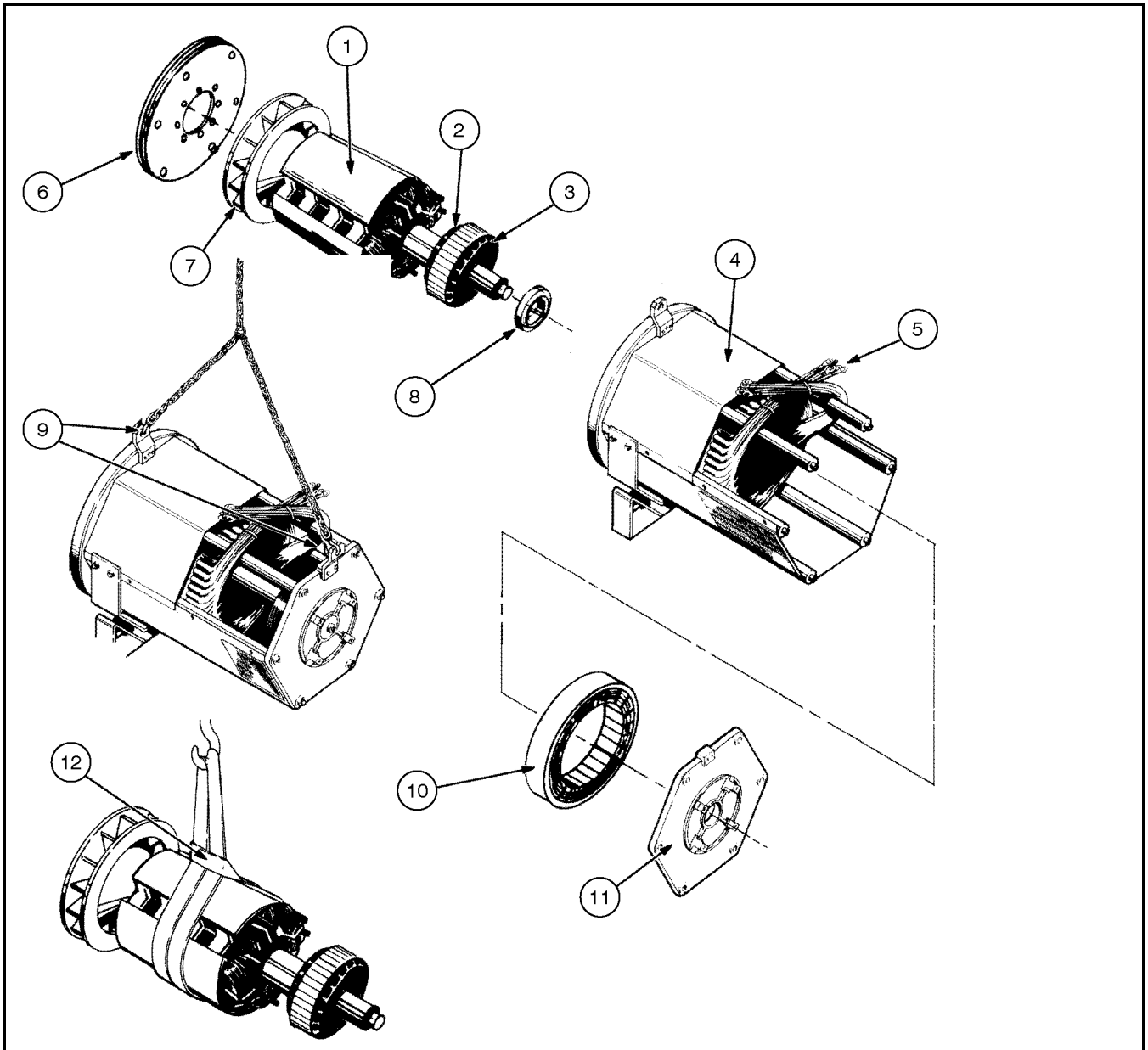
⚠ CAUTION
Do not use fan blade to bar over engine. That can damage blades and cause property damage and personal injury.

1. The rotor will be carried inside the stator when the generator is withdrawn from the engine. Bar the engine until one of the four poles of the rotor points straight down so that the rotor will rest on the face of the pole when the generator is withdrawn.

⚠ CAUTION
The rotor can be damaged if it rests on the edges of the winding slot between two poles.

2. Attach lifting eyes and a hoist of sufficient capacity (Figure 42 on page 111).
3. Take up hoist slack and remove the two through bolts securing the generator to the rubber isolation mounts.
4. Raise the generator end approximately one inch (12 mm) and securely block the engine under the flywheel housing. Lower the generator slightly so that the blocks carry most of the weight.
5. Remove the bolts securing the generator drive discs to the flywheel.
6. Loosen all the bolts securing the generator adapter casting to the flywheel housing. Adjust the hoist to carry the full weight of the generator, remove the bolts and pull the generator away.

⚠ CAUTION
Never withdraw the generator leaving the rotor to hang by the drive discs. The weight of the rotor will damage the drive discs.



NO	DESCRIPTION	NO	DESCRIPTION
1	Main Rotor	7	Cooling Bowler
2	Rotating Diode Assembly	8	Main Rotor Bearing
3	Exciter Rotor	9	Generator Lift Points
4	Stator	10	Exciter Stator
5	Stator Leads	11	End Plate
6	Drive Discs	12	Cinch Strap Around the Middle of the Rotor Core to Lift

FIGURE 42. GENERATOR ASSEMBLY

7.4 Generator Reassembly

Reassembling is the reverse of disassembling. Note the following.

1. Apply force to the inner race of the rotor bearing when pressing it onto the shaft, otherwise, it will be damaged. Be sure to secure the retaining clip.
2. The drive disc-to-rotor bolts should be torqued to 190 ft-lbs (257 Nm).
3. The drive disc-to-flywheel bolts should be torqued to 50 ft-lbs (67 Nm).
4. The exciter stator mounting screws should be torqued to 7 ft-lbs (10 Nm).
5. The generator end plate mounting bolts should be torqued to 25 ft-lbs (34 Nm).
6. Make sure the rubber O-ring is in place in the bearing bore in the generator endplate.
7. The generator mounting bracket bolts should be torqued to 65 ft-lbs (88 Nm) if M12 or 35 ft-lbs (47 Nm) if M10.
8. The generator-to-adaptor bolts should be torqued to 40 ft-lbs (55 Nm).
9. The adaptor-to-engine bolts should be torqued to 35 ft-lbs (48 Nm).
10. Reconnect the generator as required.

7.5 Servicing the PMG

The following is applicable if the generator is equipped with a PMG (permanent magnet) exciter.

7.5.1 Disassembling the PMG

1. Disconnect the negative (−) cable from the battery to make sure the set will not start while working on it.

⚠ WARNING

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

Ventilate battery area before working on or near battery—Wear goggles—Stop generator set and disconnect charger before disconnecting battery cables—Disconnect negative (−) cable first and reconnect last.

⚠ WARNING

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

⚠ CAUTION

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

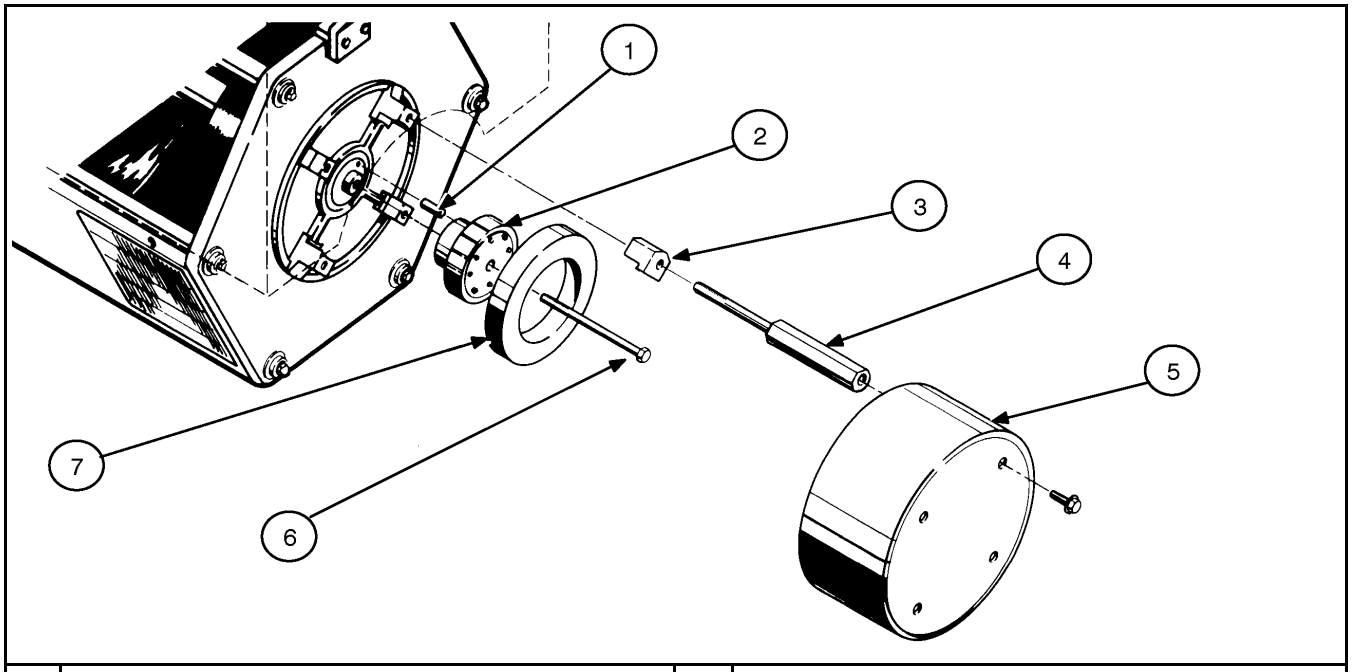
2. Remove the PMG cover and disconnect the leads at the connector.
3. Remove the bolts and clamps that secure the PMG stator to the generator frame and carefully pull away the stator.

NOTICE
The rotor is magnetic and will attract the stator. Hold the stator firmly so that the windings are not damaged by striking the stator support lugs.

4. Remove the rotor center bolt and pull away the rotor. The rotor is magnetic and will attract iron filings. Put it in a clean plastic bag until it is remounted. Do not take it apart or it will lose its magnetism. Also, if the dowel pin in the end of the shaft is loose, stow it in a safe place until it is time to reassemble the PMG.

7.5.2 Reassembling the PMG

Reassembling is the reverse of disassembling. Torque the rotor center bolt to 40 ft-lbs (54 Nm). The stator leads must be at 12 o'clock.



NO	DESCRIPTION	NO	DESCRIPTION
1	Dowel Pin	5	Cover
2	PMG Rotor	6	PMG Rotor Through Bolt
3	PMG Stator	7	PMG Stator
4	Spacer Bolt		

FIGURE 43. GENERATOR ASSEMBLY

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8 Fuel System Adjustments

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

8.1 Fuel System Components

The generator set may be equipped for natural gas or propane or both, with automatic changeover. Each fuel has two shutoff solenoid valves and a demand pressure regulator valve. Generator sets for liquid withdrawal of propane are equipped with two shutoff solenoid valves and a converter that vaporizes the fuel with hot engine coolant.

A generator set equipped for natural gas and propane has a gas mixer that serves both fuels. A fuel pressure switch to detect loss of natural gas pressure (primary fuel) is provided for automatic changeover to propane while the engine is running.

8.1.1 Gaseous and Combination Fuel Systems

Mixer side: The regulator used are demand type regulators which control gas flow by responding to pressure changes in the intake system. When the engine is cranking or running, a partial vacuum is created in the fuel line to the mixer, which opens the regulator permitting fuel to flow to the mixer. When the engine is running, fuel pressure on the mixer side is reduced to slightly less than atmospheric and is maintained at this level by the regulator during no-load to full load operation.

With the engine stopped, fuel is sealed off within the regulator as well as in the solenoid valve.

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

For propane vapor and natural gas, the maximum permissible fuel supply pressure is 13.6 inches WC (3.4 kPa) and the minimum is 7 inches WC (1.7 kPa).

8.1.2 Fuel System Operation

During normal operation, the engine fuel/air ratio is determined by the fuel trim valve operating in conjunction with the oxygen sensor and the air/fuel control module. Your authorized Cummins Power Generation distributor can monitor fuel system/oxygen sensor operation using the L-series service tool.

8.2 Actuator/Fuel System Adjustments

The actuator is controlled/governed by the PCC control and requires no mechanical adjustments. Electronic governor submenus are provided to allow adjustment of the governor software settings (refer to *Electronic Governor Submenus*).

8.2.1 Actuator Adjustments

To verify if the actuator motor is operating, remove the small shaft cover. The shaft should rotate 20 degrees or more when cranking. If no rotation is seen, check wiring before replacing the actuator or the base board of the PCC (refer to the wiring diagrams provided with the generator set).

8.2.2 Fuel System

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

⚠ WARNING

Gaseous fuel.

Gaseous fuels are flammable and explosive and can cause severe personal injury or death.

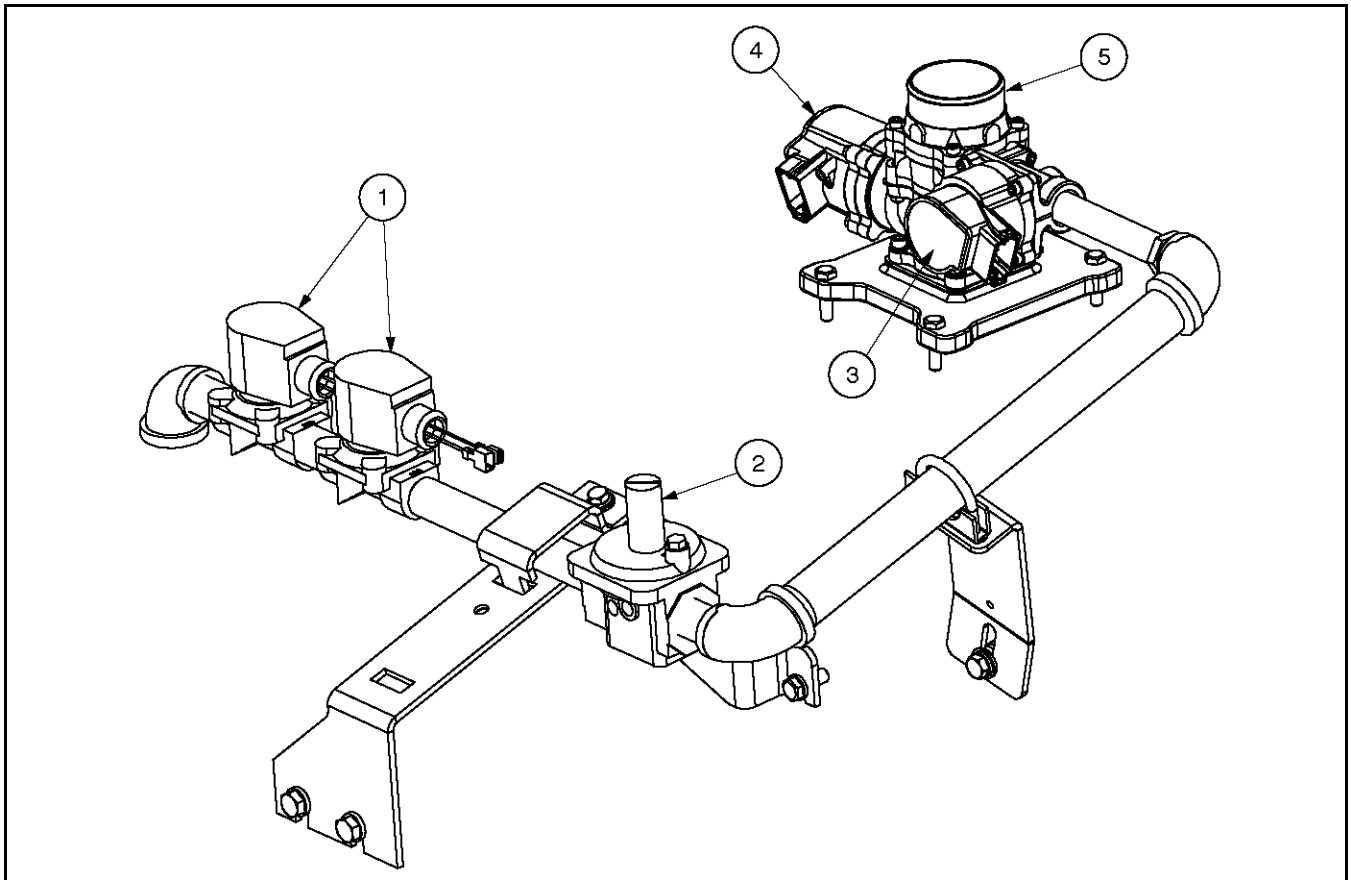
Do not allow cigarettes, flame, pilot lights, arcing switches or equipment in area or areas sharing ventilation. Keep a type ABC fire extinguisher handy.

NOTICE

Natural gas is lighter than air, and will tend to gather under hoods. Propane is heavier than air, and will tend to gather in sumps or low areas. NFPA Standard No. 58 requires all persons handling and operating propane to be trained in proper handling and operating procedures.

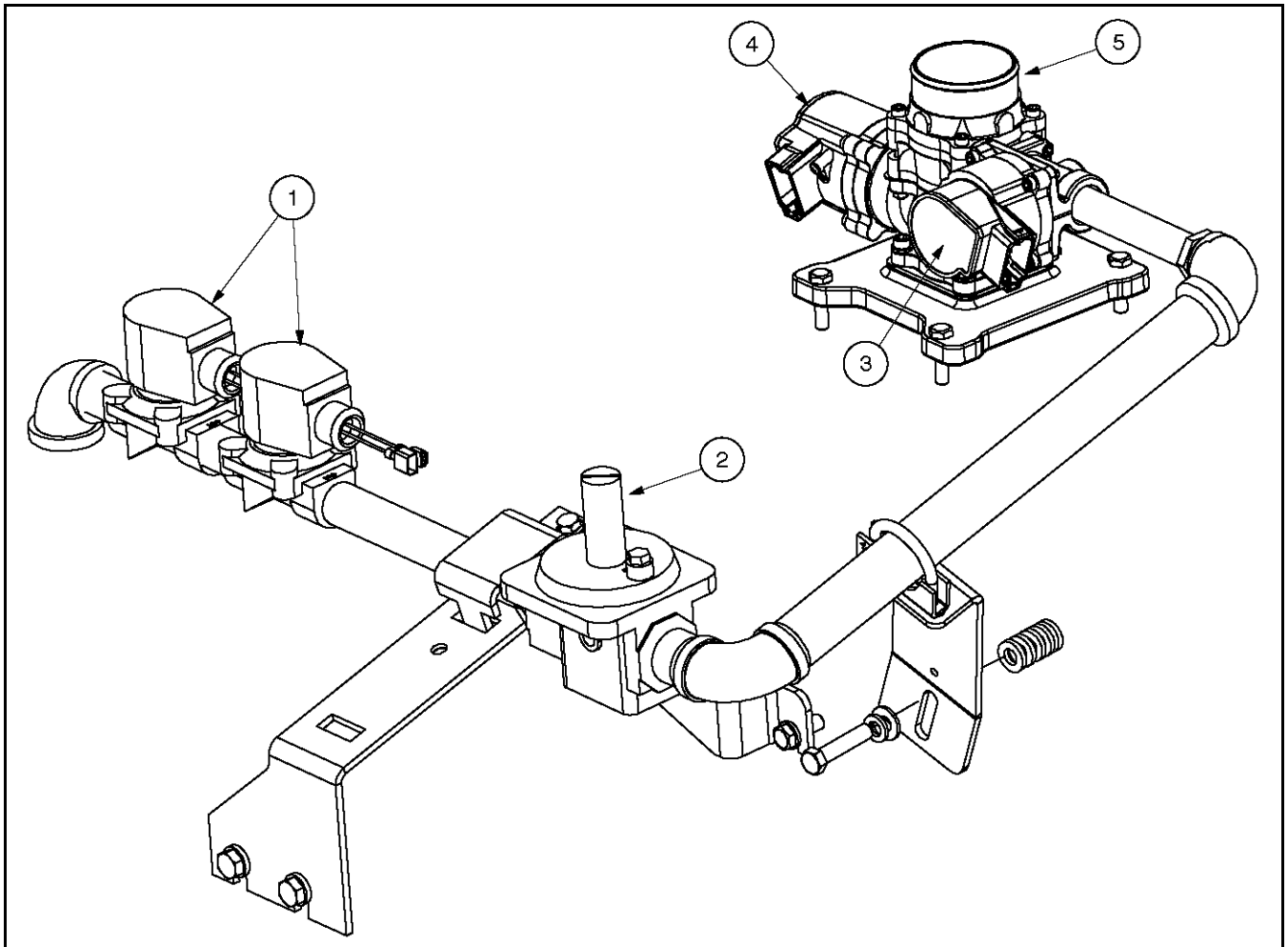
NOTICE

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



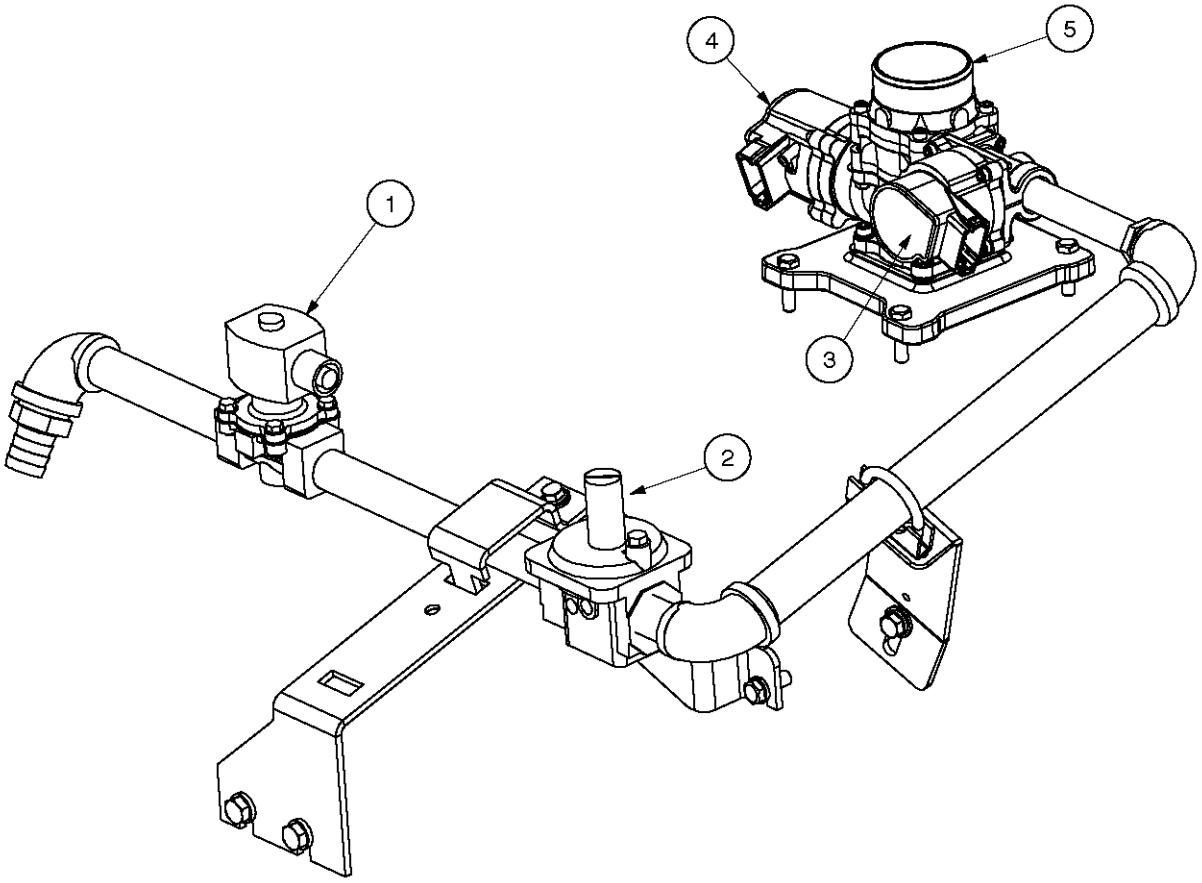
No.	Description	No.	Description
1	Solenoid Valve	4	Governor Actuator
2	Pressure Regulator	5	Fuel Mixer
3	Fuel Control		

FIGURE 44. PROPANE VAPOR FUEL SYSTEM



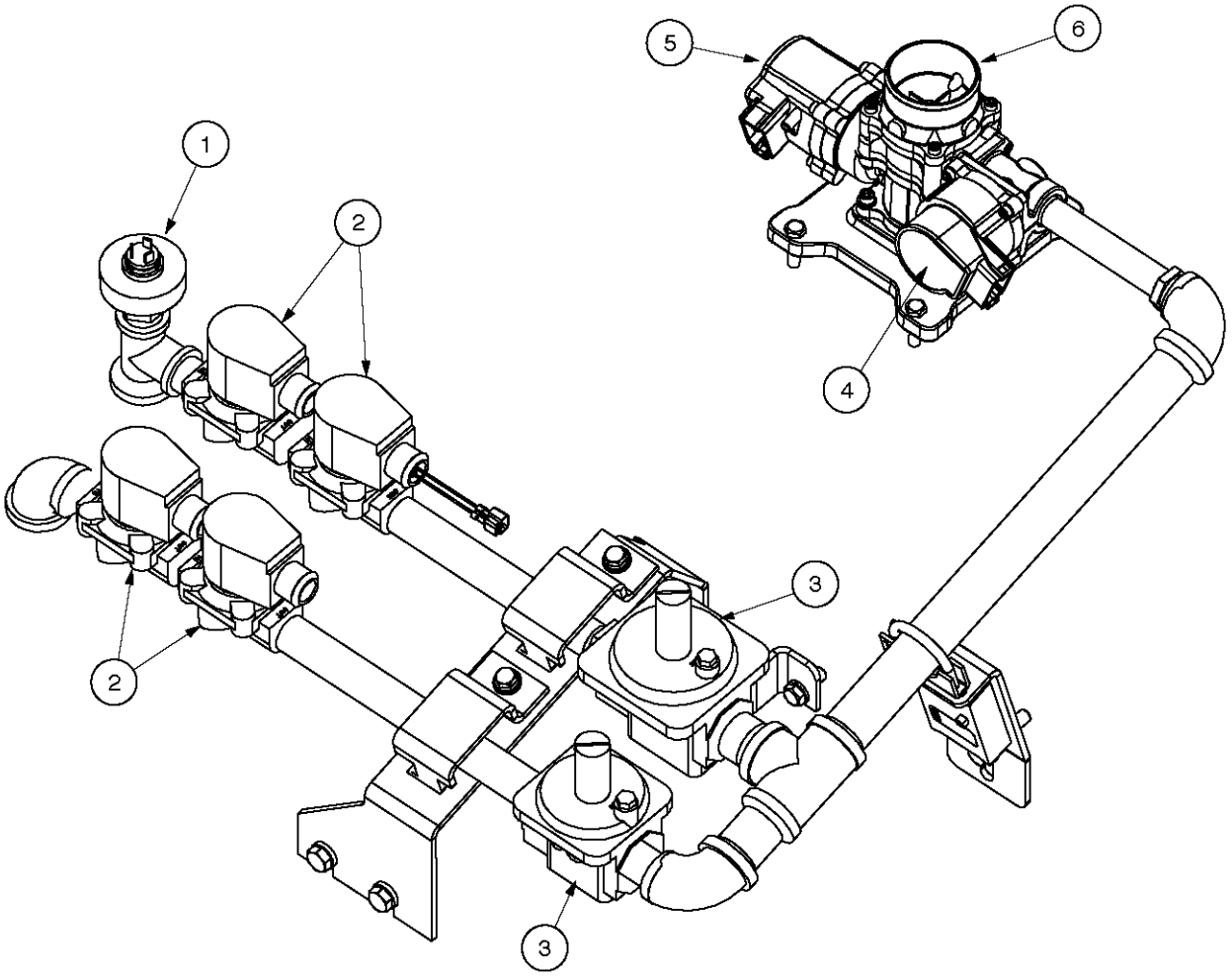
No.	Description	No.	Description
1	Solenoid Valve	4	Governor Actuator
2	Pressure Regulator	5	Fuel Mixer
3	Fuel Control		

FIGURE 45. NATURAL GAS FUEL SYSTEM



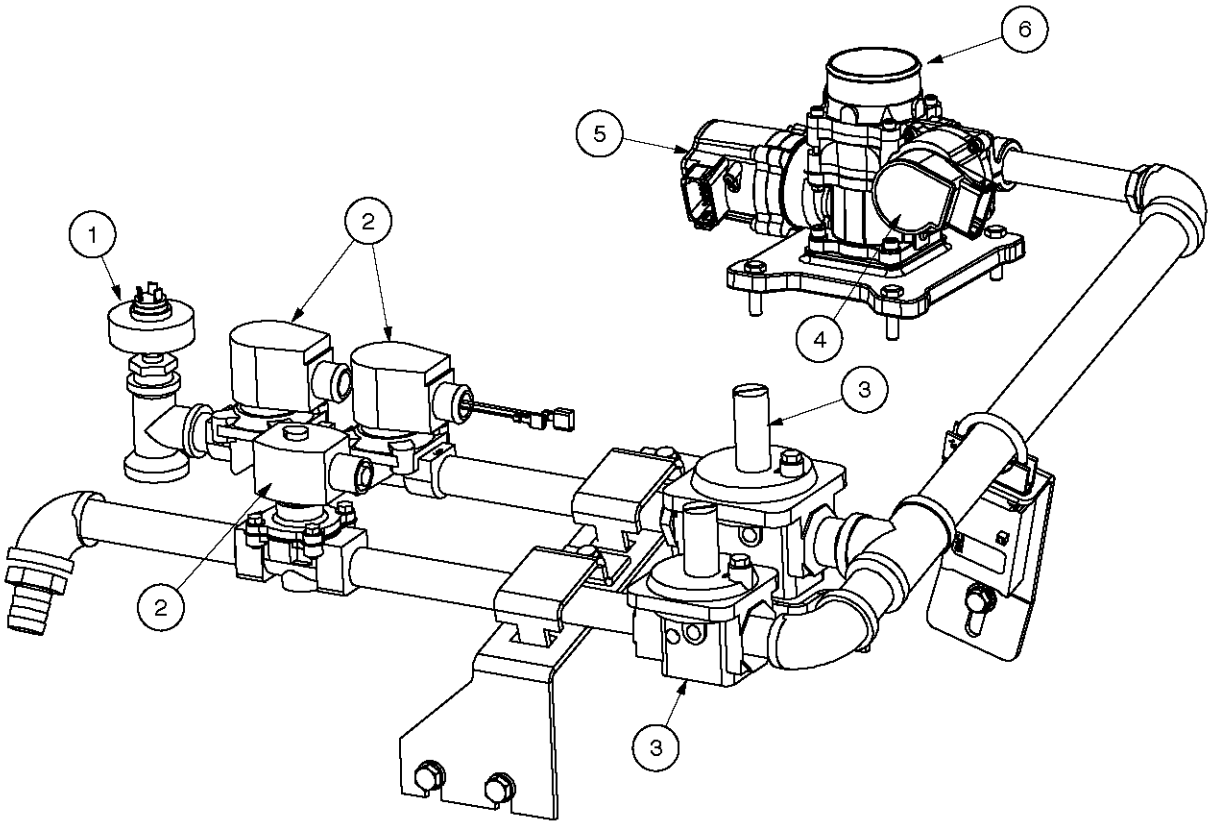
No.	Description	No.	Description
1	Solenoid Valve	4	Governor Actuator
2	Pressure Regulator	5	Fuel Mixer
3	Fuel Control		

FIGURE 46. LIQUID PROPANE FUEL SYSTEM



No.	Description	No.	Description
1	Low Pressure Switch	4	Fuel Control
2	Solenoid Valve	5	Governor Actuator
3	Pressure Regulator	6	Fuel Mixer

FIGURE 47. DUAL FUEL NATURAL GAS AND PROPANE VAPOR FUEL SYSTEM



No.	Description	No.	Description
1	Low Pressure Switch	4	Fuel Control
2	Solenoid Valve	5	Governor Actuator
3	Pressure Regulator	6	Fuel Mixer

FIGURE 48. DUAL FUEL NATURAL GAS AND LIQUID PROPANE FUEL SYSTEM

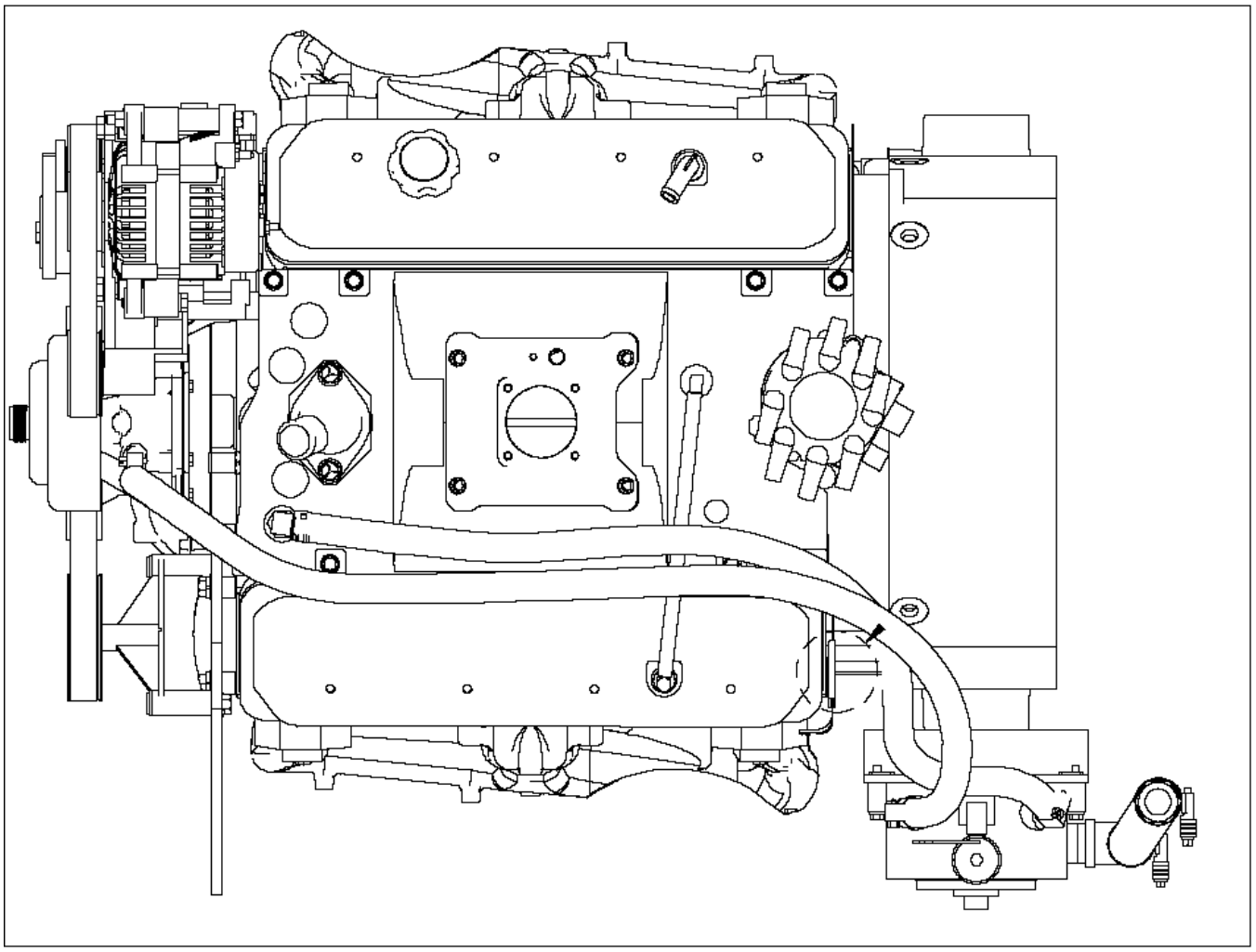


FIGURE 49. VAPORIZER INSTALLED ON GENERATOR SET

8.3 Fuel Mixture Adjustments

If the engine starts hard, misfires under high load, or has poor response to transient loads, the air-fuel mixture could be too lean. If the engine hunts at no-load, the air-fuel mixture could be too rich. ***Always use an Air-Fuel Ratio Meter set to the LAMBDA reading to make adjustments.***

Make adjustments as follows:

1. Check for recommended gas supply pressure (7 to 13.6 inch WC).
2. Check operation of fuel shut-off solenoids.
3. Disconnect the factory installed O2 sensor (The 1318 fault will go on with the oxygen sensor disconnected).
4. Insert the air-fuel mixture test probe into the exhaust port, or exhaust pipe outlet if using tailpipe adaptor
5. Start the engine and let it warm up under no load. Start with natural gas if the generator set is equipped for dual fuel.

NOTICE
LAMBDA of 1.0 is stoichiometric; less then 1.0 is rich; greater then 1.0 is lean.

6. Apply 10% load. Check LAMBDA on the Air-Fuel Ratio Meter. Set LAMBDA to read between 0.94 and 1.02 by adjusting the demand regulator. On the demand regulator, turn the adjusting screw clockwise to decrease LAMBDA (richer) or counter-clockwise to increase LAMBDA (leaner)

   Due to variations in site conditions, some generator sets might be outside the range of 0.94 and 1.02.

7. Connect the O2 sensor and wait 3 minutes for the oxygen sensor to warm up.
8. Reset the service engine fault (code 1318), and wait 3.5 minutes. If fault code 1318 becomes active again, see fault code 1318 in the Troubleshooting section.

8.4 Demand Regulator

The table below provides the approximate initial settings for the demand regulators used in the fuel system. If the regulator is not properly adjusted, the generator set may not start, there may be excessive crank time before starting, or it may lack power.

After initial adjustment of the regulator and the generator set does not start, turn the adjustment screw clockwise 1/2 turn and retry. Repeat until the engine starts and then fine tune fuel system adjustments. Refer to **Section 8.2 on page 115** in this section.

TABLE 9. INITIAL DEMAND REGULATOR ADJUSTMENT (DISTANCE FROM THE TOP OF THE REGULATOR TO THE TOP OF THE SET SCREW)

MODEL/HZ	NG	LPG VAPOR	LPG LIQUID
60 HZ	15.3 mm	13.2 mm	13.9 mm
50 HZ	14.5 mm	12.8 mm	13.9 mm

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9 Exhaust System

9.1 Overview

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

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

9.2 Oxygen Sensor

During normal operation, the oxygen sensor monitors the oxygen content of the exhaust gases and sends a voltage signal to the ECM. The ECM monitors this voltage and, depending on the value of the received signal, adjusts The DEPR for rich or lean conditions. The oxygen sensor has a heating element incorporated into the sensor to aid in the warmup to the proper operating temperature and to maintain that temperature.

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

Proper operation of the oxygen sensor depends on three conditions:

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

Your authorized Cummins Power Generation distributor can monitor fuel system/oxygen sensor operation using the L-series service tool.

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10 Manufacturing Facilities

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

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Appendix A. Wiring Diagrams

Table of Contents

Note: This section contains basic (generic) wiring diagrams and schematics for the controller and generator set.

UC GENERATORS

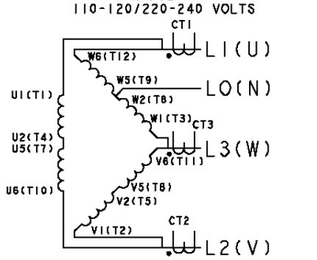
3 PHASE RECONNECTABLE, 12 LEAD

-01

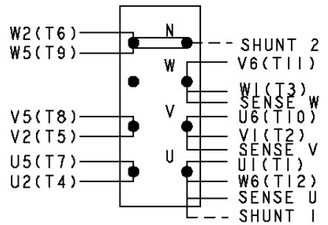
CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X3

* RANGE *
110-120/220-240 VOLTS



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



FEATURE CODE	VOLTAGE	50HZ	60HZ	
		WINDING 11	WINDING 11	WINDING 14
R028	110/220	X	-	X
R071	115/230	X	-	X
R105	120/240	X	X	X

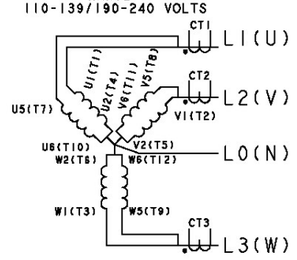
NOTE: SENSE LEAD N IS NOT USED. TAPE END AND TIE BACK.

-02

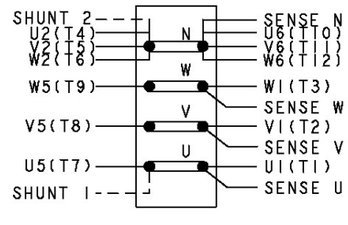
CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X3

* RANGE *
110-139/190-240 VOLTS



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



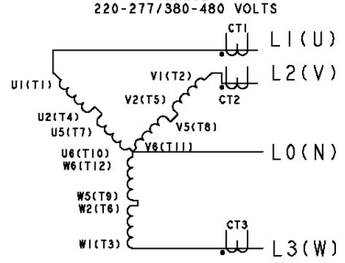
FEATURE CODE	VOLTAGE	50HZ	60HZ	
		WINDING 11	WINDING 11	WINDING 14
R004	110/190	X	-	X
R050	115/200	X	-	X
R098	120/208	X	X	X
R020	127/220	X	X	-
R067	139/240	-	X	-

-03

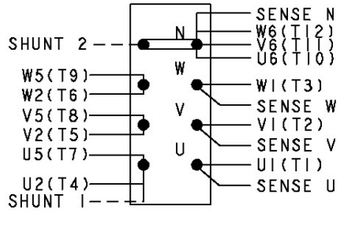
CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X2

* RANGE *
220-277/380-480 VOLTS



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



FEATURE CODE	VOLTAGE	50HZ	60HZ	
		WINDING 11	WINDING 11	WINDING 14
R099	220/380	X	-	X
R029	230/400	X	-	X
R003	240/416	X	X	X
R023	255/440	X	X	-
R002	277/480	-	X	-

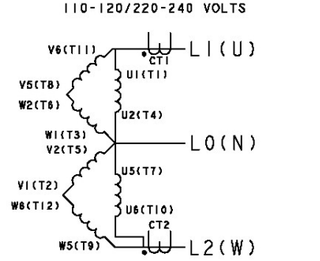
1 PHASE RECONNECTABLE, 12 LEAD

-04

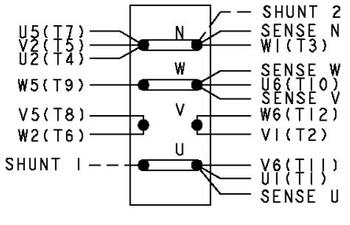
CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X3

* RANGE *
110-120/220-240 VOLTS



DOUBLE DELTA
1 PHASE 3 WIRE
OUTPUT TERMINALS
U,W, CENTER TAP N.



FEATURE CODE	VOLTAGE	50HZ		60HZ			
		WINDING 11		WINDING 11		WINDING 14	
		2/3 OUTPUT	FULL OUTPUT	2/3 OUTPUT	FULL OUTPUT	2/3 OUTPUT	FULL OUTPUT
R046	110/220	X	X	-	-	X	-
R041	115/230	X	X	-	-	X	-
R104	120/240	X	X	X	X	X	-

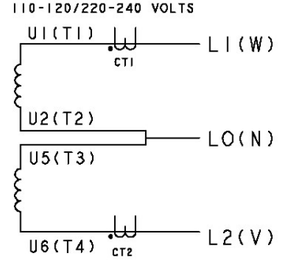
1 PHASE NON-RECONNECTABLE, 4 LEAD

-05

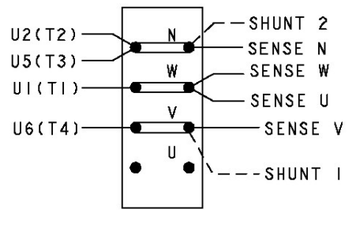
CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X3

* RANGE *
110-120/220-240 VOLTS



1 PHASE 3 WIRE
OUTPUT TERMINALS
W, V, CENTER TAP N



FEATURE CODE	VOLTAGE	50HZ	60HZ
		-	WINDING 6
R046	110/220	-	X
R041	115/230	-	X
R104	120/240	-	X

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS SHIPPED WITH THE GENERATOR SET.

NOTES:

1. UVW PHASE SEQUENCE WITH C.W. ROTATION FACING DRIVE END.
2. WHEN RECONNECTING GENERATOR LEADS, BOLTS SHOULD BE TORQUED AT 22 0942 FT-LBS.

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Sheet 1 of 2, Dated January 2004

FIGURE 50. AC RECONNECT WIRING DIAGRAM (SHEET 1 OF 2)

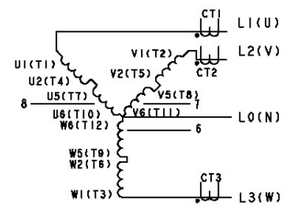
THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS SHIPPED WITH THE GENERATOR SET.

UC GENERATORS

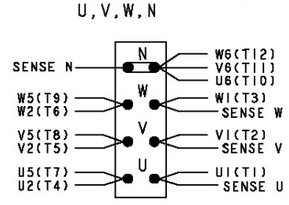
3 PHASE RECONNECTABLE

CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X2



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



NOTE: FOR SHUNT OPERATION, CONNECT AC HARNESS LEADS:
PMG2 TO GENERATOR TAP LEAD 8
PMG3 TO GENERATOR TAP LEAD 7

PMG4 NOT CONNECTED
TAPE & TIE BACK PMG4 AND LEAD 6

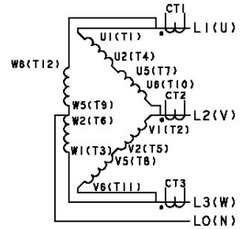
-06

FEATURE CODE	VOLTAGE	50HZ	60HZ
R114	600	-	X

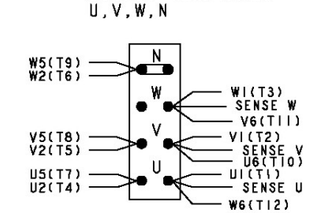
3 PHASE NON-RECONNECTABLE

CURRENT TRANSFORMER SECONDARY CONNECTION

X1 X2



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



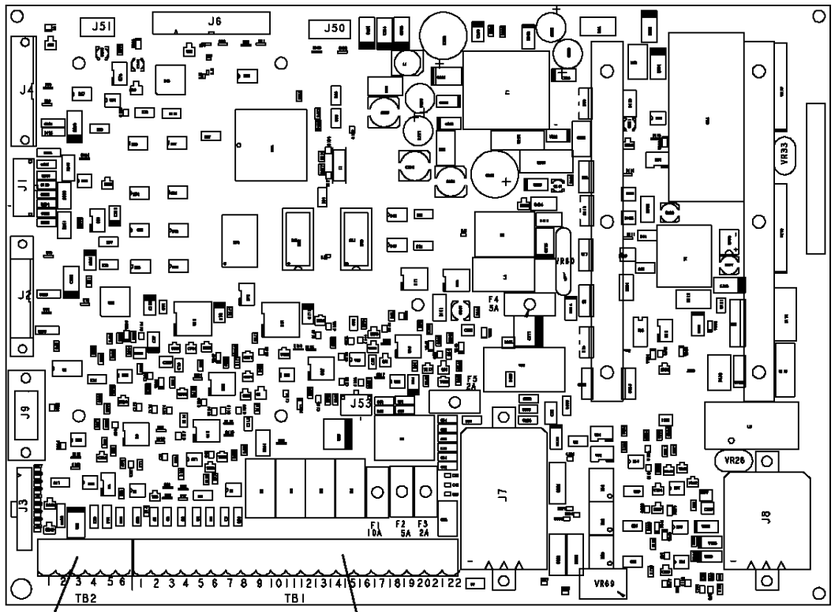
NOTES:
1. SENSE LEAD N IS NOT USED.
   TAPE END AND TIE BACK.
2. PMG MUST BE USED.
   SHUNT NOT ALLOWED

-07

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

No. 630-2404, Revision D
Sheet 2 of 2, Dated January 2004

FIGURE 51. AC RECONNECT WIRING DIAGRAM (SHEET 2 OF 2)



TB2

1	RS485+	TO REMOTE UTILITY VOLTAGE SENSING MODULE. SEE OPERATOR'S MANUAL FOR CABLE TYPE.
2	RS485-	
3	PTC B+	
4	PTC GND	
5	PTC STATUS	
6	COM	

DEFAULT SETTING

TB1-CUSTOMER FAULTS:
1 CUSTOMER FAULT 1
2 GROUND FAULT
3 LOW FUEL

TB-1CUSTOMER RELAYS:
1 COMMON WARNING
2 COMMON SHUTDOWN
3 NOT IN AUTO
4 READY TO LOAD

TB1

1	REMOTE START	APPLY GROUND TO ACTIVATE
2	REMOTE E-STOP	
3	REMOTE RESET	
4	CUSTOMER FAULT 1	
5	CUSTOMER FAULT 2	
6	CUSTOMER FAULT 3	
7	CUSTOMER FAULT 4	
8	CUSTOMER RELAY 1	RATED 2A @ 30VDC (MAX)
9	COM	
10	CUSTOMER RELAY 2	
11	COM	
12	CUSTOMER RELAY 3	
13	COM	
14	CUSTOMER RELAY 4	
15	COM	
16	(NOT USED)	
17	B+ FUSED OUT	10A FUSED
18	B+ FUSED OUT	
19	SWITCHED B+	5A FUSED
20	GND	
21	GND	
22	GND	

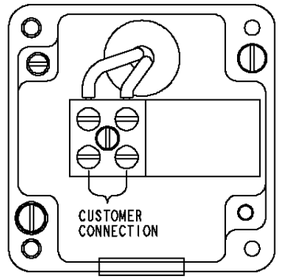
TERMINAL/WIRE SPECIFICATION

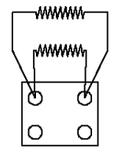
1) TORQUE TERMINALS TO 4.4 IN/LBS (0.5 Nm)
2) WIRE SIZE, 30-12 AWG (0.14-2.5MM) (TB1)
3) WIRE TYPE, USE 60°C RATED MINIMUM, COPPRER WIRE (TB1)
4) TERMINAL SCREWS ARE SLOTTED (0.6MM)
5. USE FLAT-BLADED SCREWDRIVER WITH 2.5MM BLADE
6) STRIP WIRE LENGTH TO 6.0MM

VOLTAGE SUPPRESSORS MUST BE INSTALLED BEFORE POWER IS APPLIED TO THE CONTROL OR GENSET TO PREVENT DAMAGE TO BASE BOARD

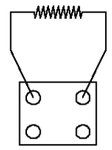
THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS SHIPPED WITH THE GENERATOR SET.

ALTERNATOR HEATER





DUAL HEATER



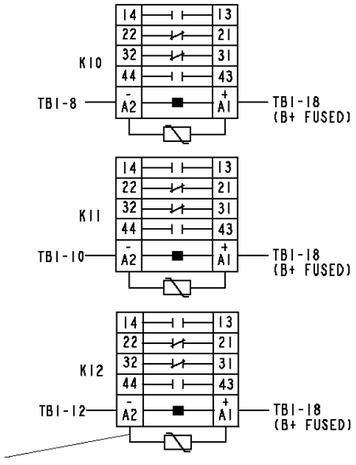
SINGLE HEATER

TERMINAL/WIRE SPECIFICATIONS

1. USE 60°C RATED MINIMUM COPPER WIRE.
2. WIRE SIZE: #12 - 18 AWG .
3. TORQUE TO 7.7 IN-Lb (0.9 Nm)
4. STRIP WIRE TO 0.32 INCHES (8.0 mm).
5. USE SLOTTED SCREWDRIVER WITH 3.0 mm BLADE
6. TERMINALS RATED AT 150V/20A AND 300V/10A.

HEATER RATING	
100 WATT	110 -125VAC 220 -260VAC
150 WATT	110 -125VAC 220 -260VAC
300 WATT	110 -125VAC 220 -260VAC

CUSTOMER RELAYS



TERMINAL/WIRE SPECIFICATIONS

1) NORMALLY OPEN (NO) TERMINALS: 13,14 43,44
NORMALLY CLOSED (NC) TERMINALS: 21,22 31,32
2) TORQUE TERMINALS TO 7 INCH LBS (0.8Nm)
3) WIRE SIZE 1-18 AWG MIN (0.75MM²)
2-14 AWG MAX (2.5MM²)
1-12 AWG MAX (4.0MM²)
4) USE 60°C RATED MINUMUM, COPPER WIRE, 600VAC
5) TERMINAL SCREWS ARE PHIL SLOT
6) USE SLOTTED SCREWDRIVER WITH 5.0 MM BLADE OR NO. 2 PHILIPS
7) CONTACT RATINGS: 600VAC, 10 AMPS MAX
8) STRIP WIRE LENGTH TO 7.0 MM

No. 620-0247, Revision C
Sheet 1 of 1, Dated June 2004

FIGURE 52. CUSTOMER CONNECTIONS

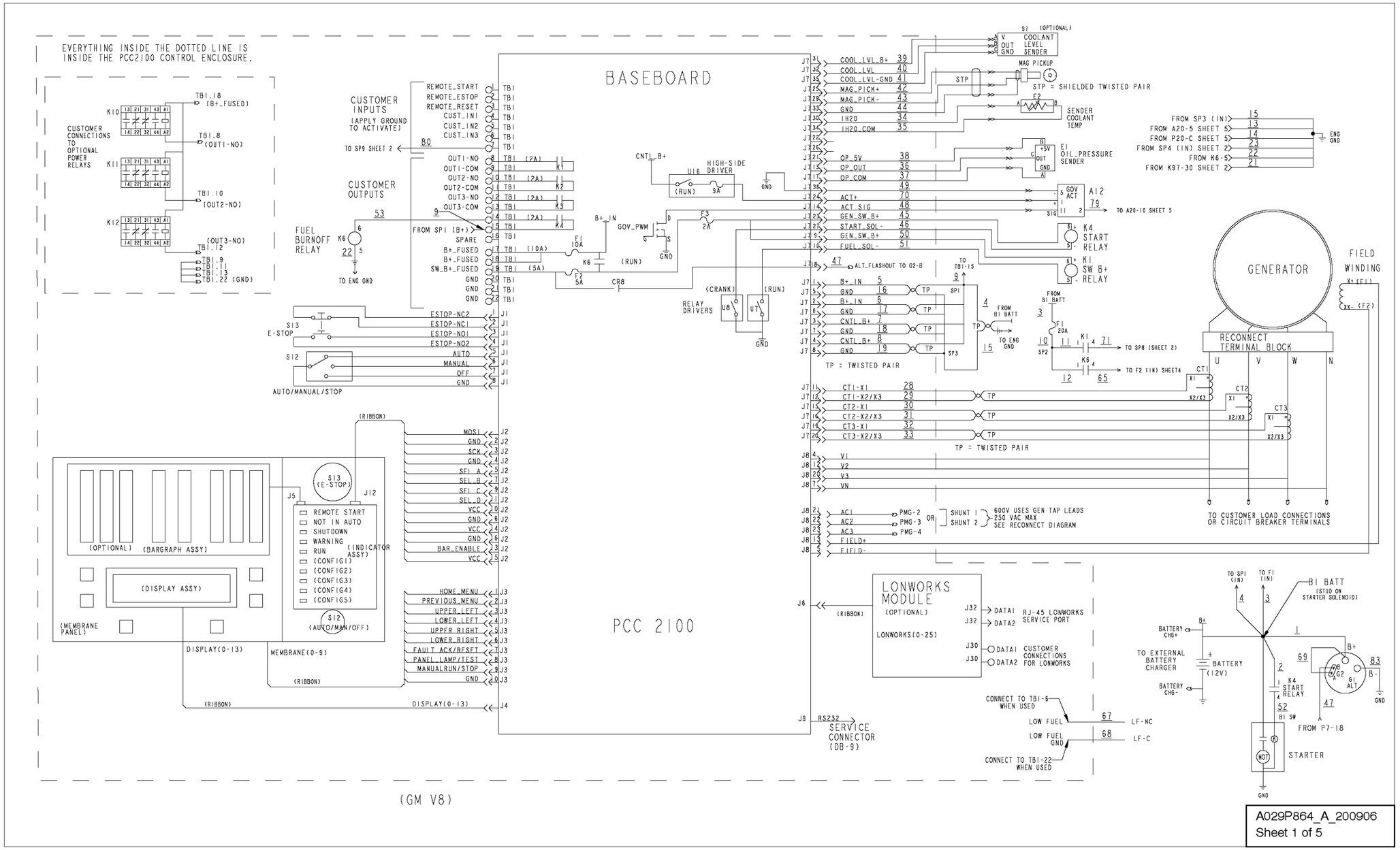


FIGURE 53. WIRING DIAGRAM - GENERATOR RECONNECT (SHEET 1 OF 5)

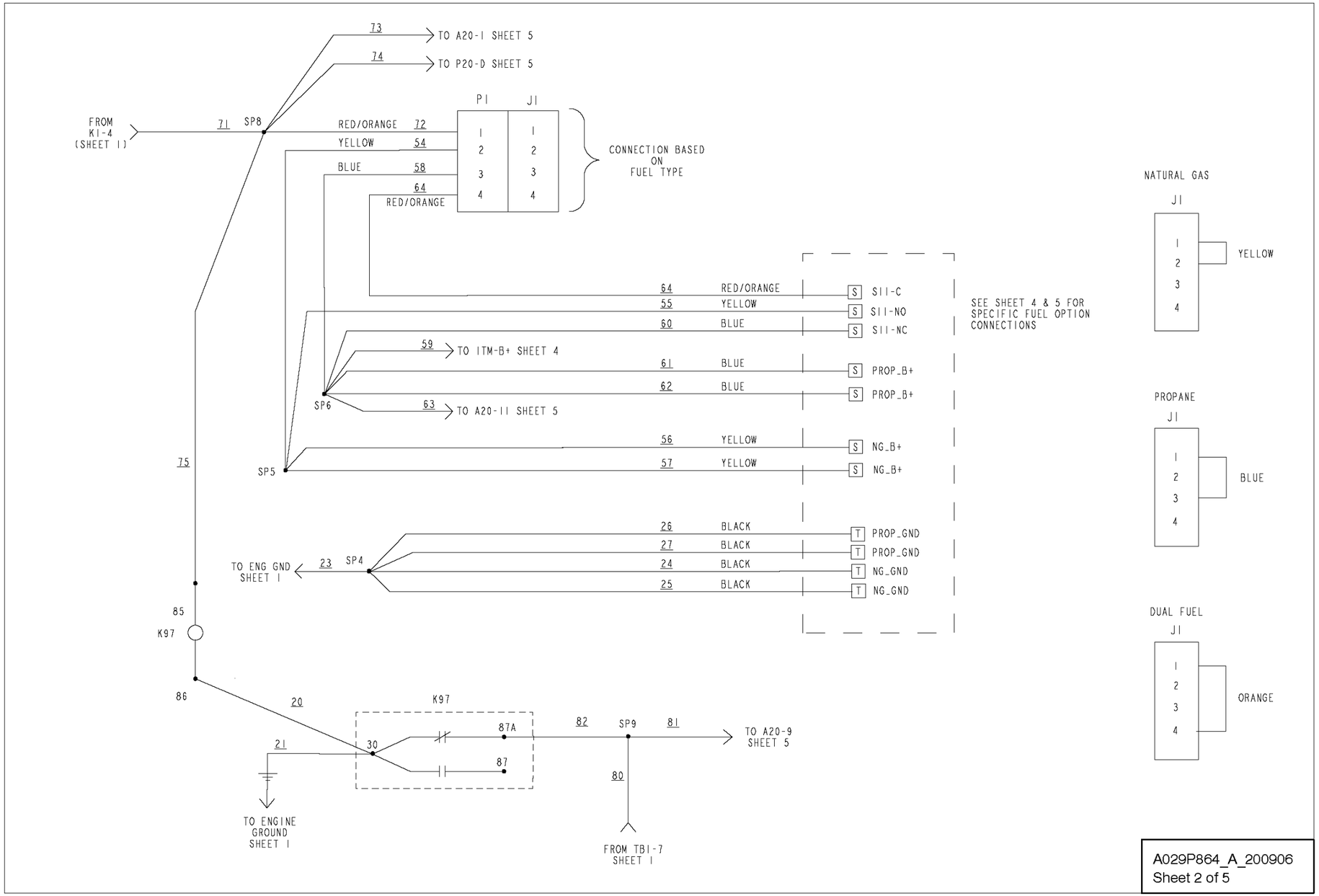


FIGURE 54. WIRING DIAGRAM (SHEET 2 OF 5)

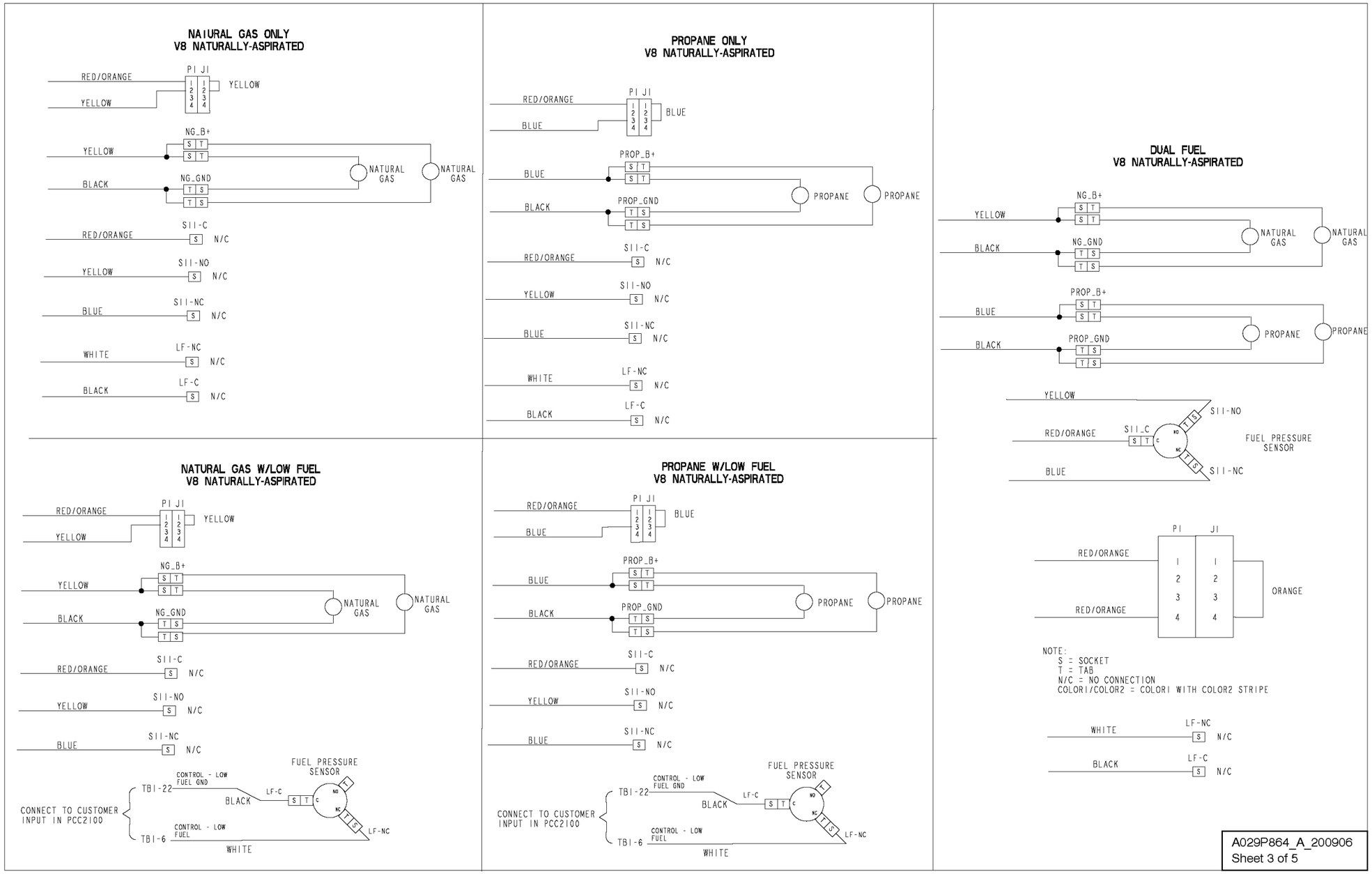


FIGURE 55. WIRING DIAGRAM (SHEET 3 OF 5)

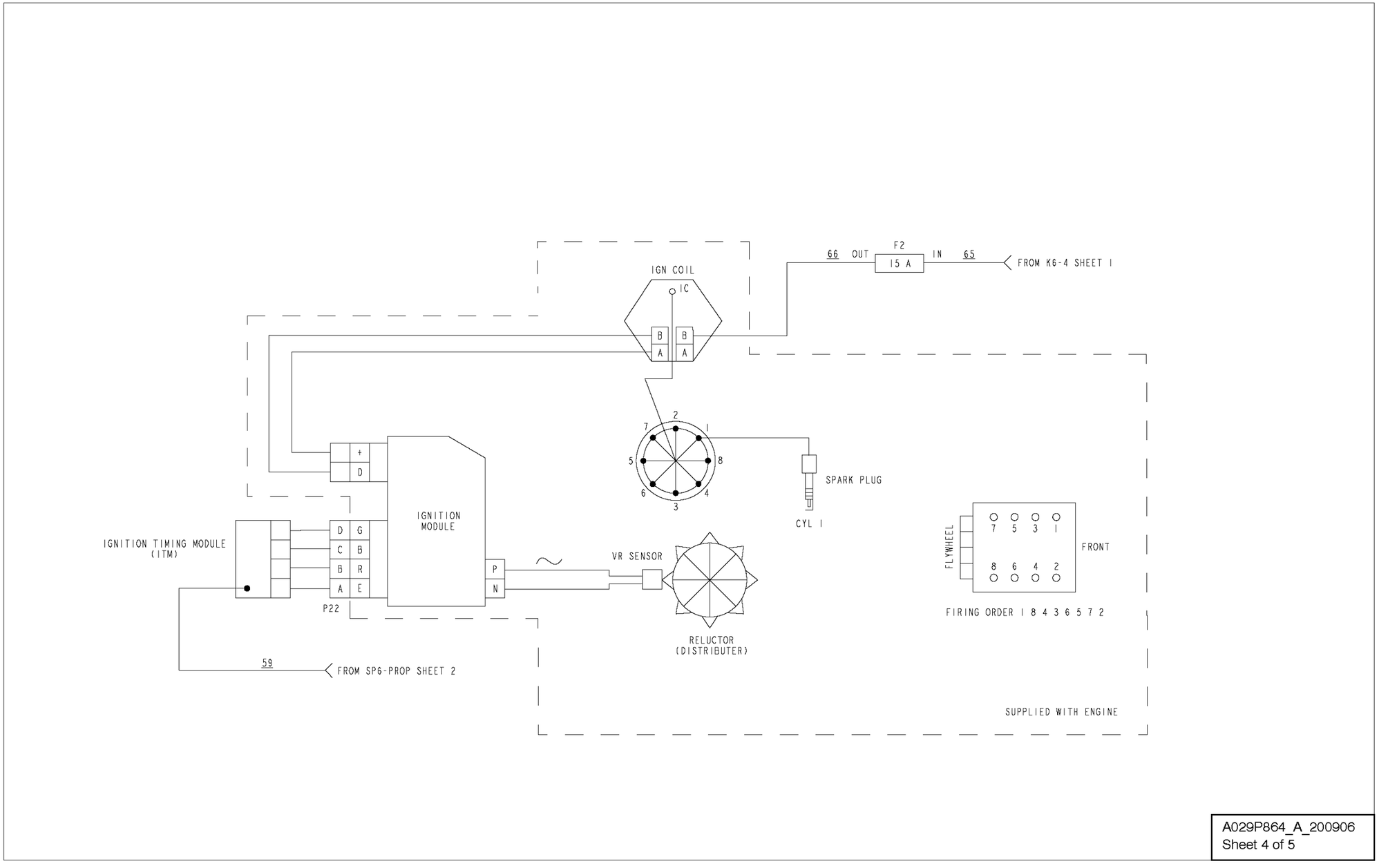


FIGURE 56. WIRING DIAGRAM (SHEET 4 OF 5)

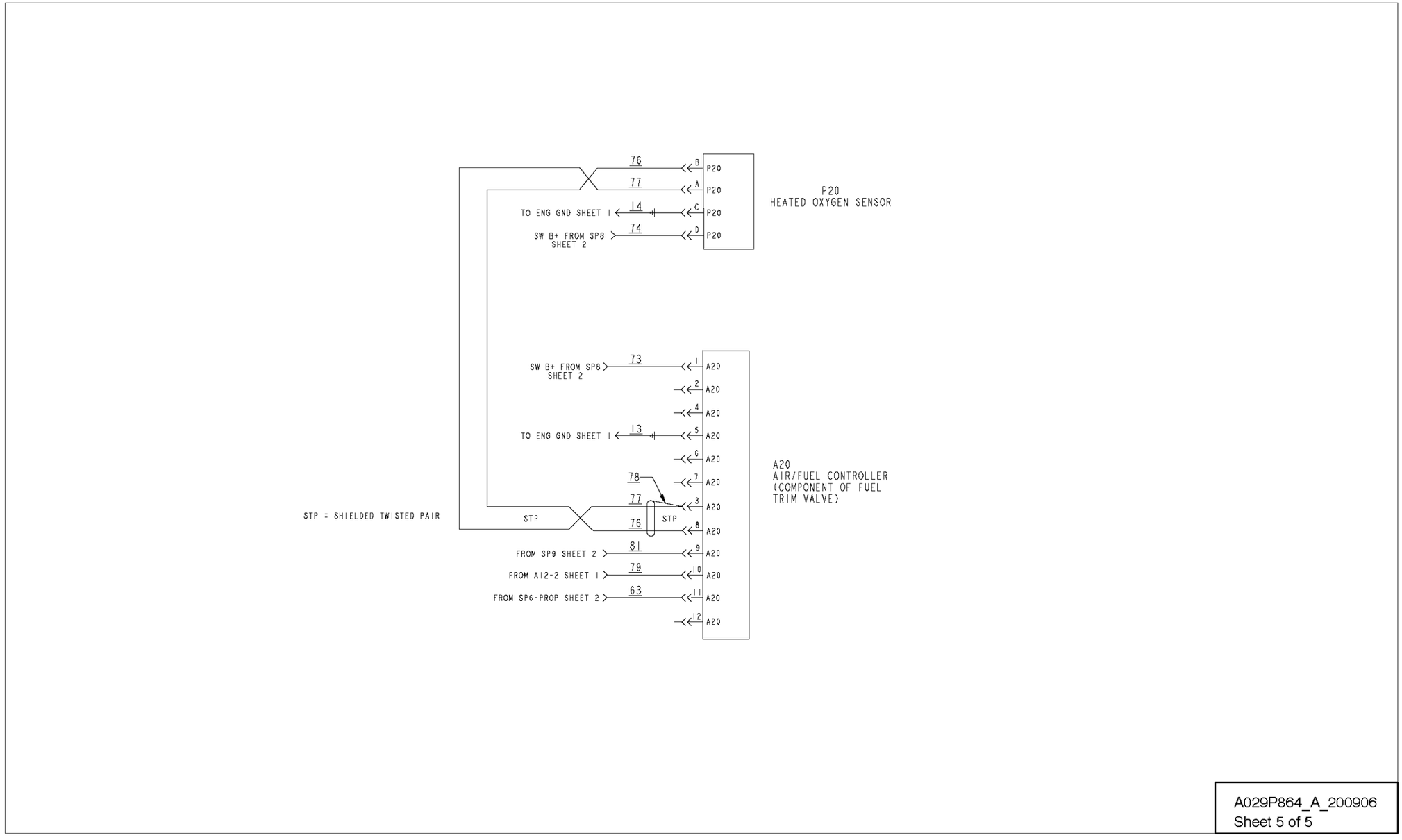
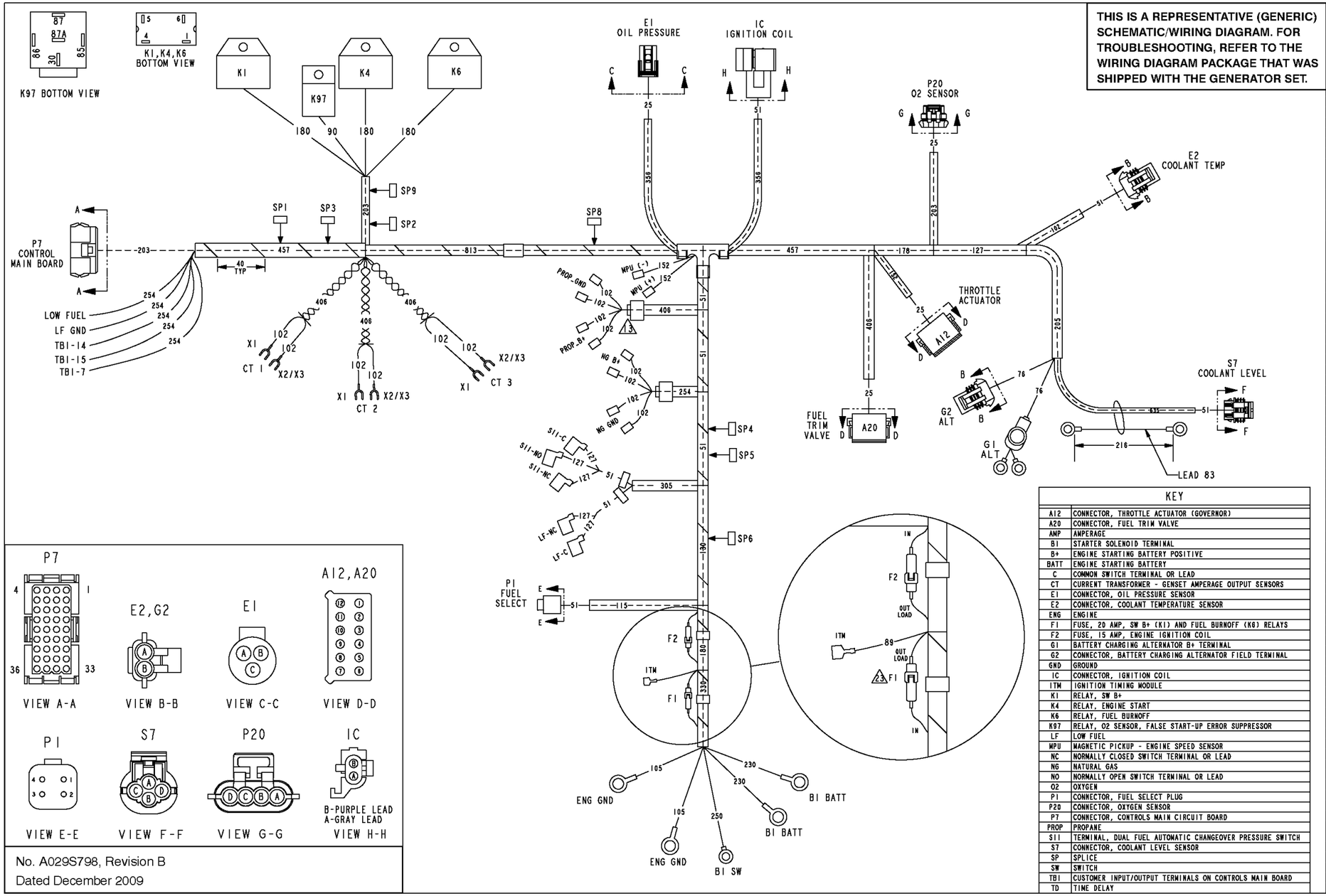


FIGURE 57. WIRING DIAGRAM (SHEET 5 OF 5)



KEY	
A12	CONNECTOR, THROTTLE ACTUATOR (GOVERNOR)
A20	CONNECTOR, FUEL TRIM VALVE
AMP	AMPERAGE
BI	STARTER SOLENOID TERMINAL
B+	ENGINE STARTING BATTERY POSITIVE
BATT	ENGINE STARTING BATTERY
C	COMMON SWITCH TERMINAL OR LEAD
CT	CURRENT TRANSFORMER - GENSET AMPERAGE OUTPUT SENSORS
EI	CONNECTOR, OIL PRESSURE SENSOR
E2	CONNECTOR, COOLANT TEMPERATURE SENSOR
ENG	ENGINE
FI	FUSE, 20 AMP, SW B+ (K1) AND FUEL BURNOFF (K6) RELAYS
F2	FUSE, 15 AMP, ENGINE IGNITION COIL
GI	BATTERY CHARGING ALTERNATOR B+ TERMINAL
G2	CONNECTOR, BATTERY CHARGING ALTERNATOR FIELD TERMINAL
GND	GROUND
IC	CONNECTOR, IGNITION COIL
ITM	IGNITION TIMING MODULE
K1	RELAY, SW B+
K4	RELAY, ENGINE START
K6	RELAY, FUEL BURNOFF
K97	RELAY, O2 SENSOR, FALSE START-UP ERROR SUPPRESSOR
LF	LOW FUEL
MPU	MAGNETIC PICKUP - ENGINE SPEED SENSOR
NC	NORMALLY CLOSED SWITCH TERMINAL OR LEAD
NG	NATURAL GAS
NO	NORMALLY OPEN SWITCH TERMINAL OR LEAD
O2	OXYGEN
PI	CONNECTOR, FUEL SELECT PLUG
P20	CONNECTOR, OXYGEN SENSOR
P7	CONNECTOR, CONTROLS MAIN CIRCUIT BOARD
PROP	PROPANE
SII	TERMINAL, DUAL FUEL AUTOMATIC CHANGEOVER PRESSURE SWITCH
S7	CONNECTOR, COOLANT LEVEL SENSOR
SP	SPLICE
SW	SWITCH
TBI	CUSTOMER INPUT/OUTPUT TERMINALS ON CONTROLS MAIN BOARD
TD	TIME DELAY

LEAD TABULATION		
FROM	TO	WIRE COLOR
BI BATT	GI-B+	RED
	K4-1	RED
BI BATT	FI (IN)	RED
	TBI-15	RED
	SP1 (IN)	RED
P7-1	SP1 (OUT)	RED
P7-2		RED
P7-3		RED
P7-4		RED
FI (OUT)	SP2 (IN)	RED
K1-1	SP2 (OUT)	RED
K6-1		RED
ENG GND	A20-5	BLACK
	P20-C	BLACK
	SP3 (IN)	BLACK
P7-5	SP3 (OUT)	BLACK
P7-6		BLACK
P7-7		BLACK
P7-8		BLACK
K97-86	K97-30	BLACK
		BLACK
ENG GND	K6-5	BLACK
	SP4 (IN)	BLACK
NG_GND	SP4 (OUT)	BLACK
NG_GND		BLACK
PROP_GND		BLACK
PROP_GND		BLACK
P7-11	CT 1X1	PINK
P7-12	CT1 X2/X3	GRAY
P7-15	CT2 X1	PURPLE
P7-16	CT2 X2/X3	GRAY
P7-19	CT3 X1	ORANGE
P7-20	CT3 X2/X3	GRAY
P7-30	E2-A	WHITE
P7-34	E2-B	WHITE
P7-13	E1-C	WHITE
P7-17	E1-A	WHITE
P7-21	E1-B	WHITE
P7-31	S7-C	RED
P7-32	S7-D	WHITE
P7-35	S7-B	BLACK
P7-25	MPU (+)	RED
P7-29	MPU (-)	BLACK
P7-33	MPU (SHIELD)	SHIELD
P7-23	K4-6	WHITE
P7-27	K4-5	WHITE
P7-18	G2-B	RED/ORANGE
P7-14	A12-11	WHITE
P7-36	A12-5	BLACK
P7-9	K1-6	WHITE
P7-10	K1-5	WHITE
BI SW	K4-4	BROWN
TBI-14	K6-6	WHITE
PI-2	SP5 (IN)	YELLOW
SII-NO		YELLOW
NG_B+	SP5 (OUT)	YELLOW
NG_B+		YELLOW
PI-3	SP6 (IN)	BLUE
ITM B+		BLUE
SII-NC	SP6 (OUT)	BLUE
PROP-B+		BLUE
PROP-B+		BLUE
A20-11		BLUE
PI-4	SII-C	RED/ORANGE
K6-4	F2 (IN)	WHITE
F2 (OUT)	IC-B	WHITE
LOW-FUEL	LF-NC	WHITE
LF-GND	LF-C	BLACK
GI-B+	G2-A	RED
P7-24	A12-1	RED/ORANGE
K1-4	SP8 (IN)	RED/ORANGE
PI-1	SP8 (OUT)	RED/ORANGE
A20-1		RED/ORANGE
P20-D		RED/ORANGE
K97-85		RED/ORANGE
A20-8	P20-B	BLACK
A20-3	P20-A	WHITE
	-	SHIELD
A20-10	A12-2	WHITE
TBI-7	SP9 (IN)	WHITE
A20-9	SP9 (OUT)	WHITE
K97-87A		WHITE
GI-B-	GND	BLACK

FIGURE 58. GENSET WIRING HARNESS

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A.0 Outline Drawings

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Appendix B. Outline Drawings

Table of Contents

B.0 Outline Drawings

See the applicable outline drawing in **Appendix B on page 143** to check for installation details such as:

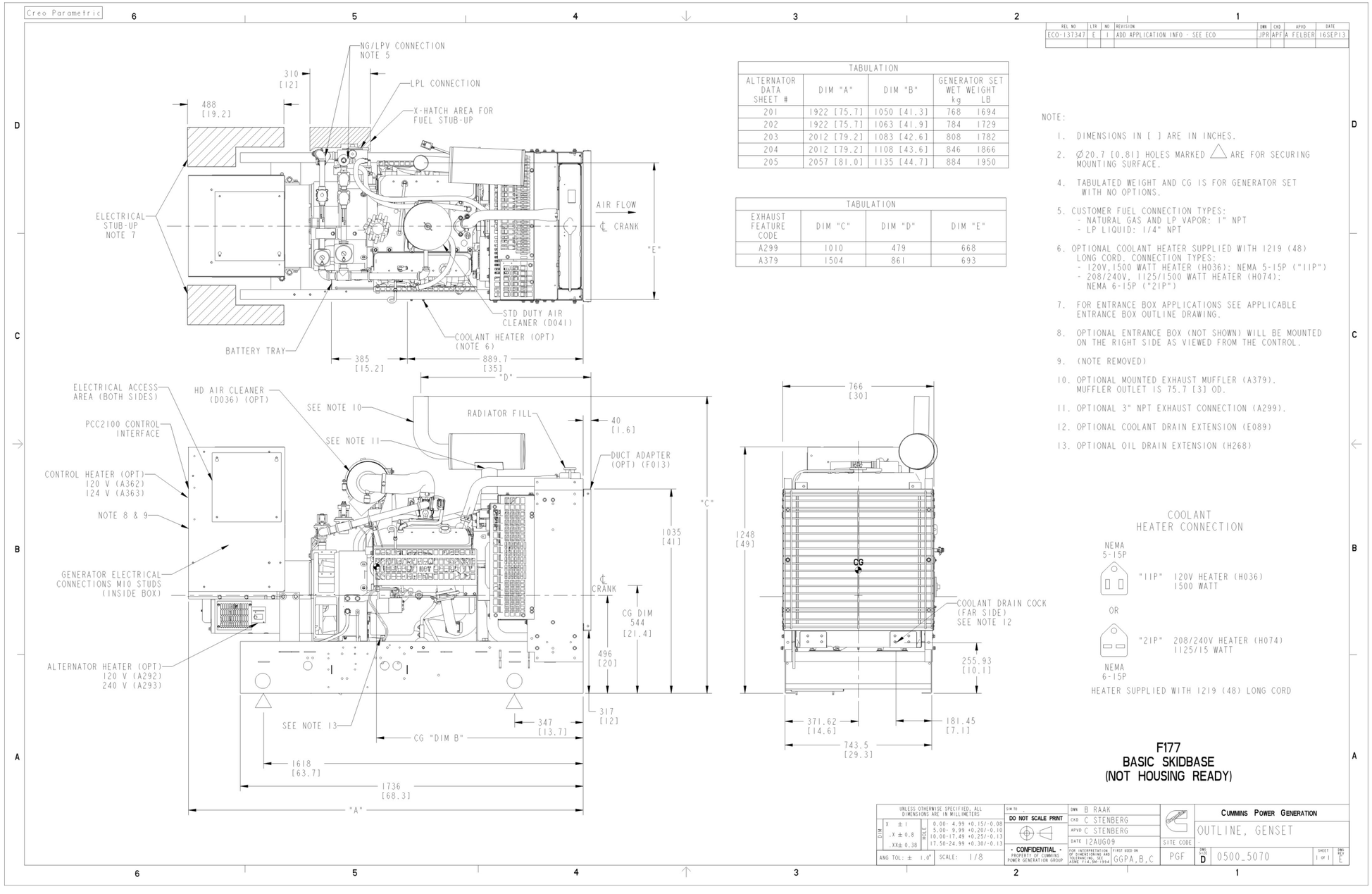
- mounting bolt hole locations
- connection points (fuel, battery, raw water, exhaust, remote control, AC output)
- sizes and types of fittings
- overall dimensions

See your Cummins Onan Distributor for large-scale copies of the applicable drawings.

⚠ WARNING

Improper installation can result in severe personal injury, death, and equipment damage. The installer must be qualified to perform installation of electrical and mechanical equipment.

B.1 Outline Drawing 0500-5070 (F177)



TABULATION			
ALTERNATOR DATA SHEET #	DIM "A"	DIM "B"	GENERATOR SET WET WEIGHT kg LB
201	1922 [75.7]	1050 [41.3]	768 1694
202	1922 [75.7]	1063 [41.9]	784 1729
203	2012 [79.2]	1083 [42.6]	808 1782
204	2012 [79.2]	1108 [43.6]	846 1866
205	2057 [81.0]	1135 [44.7]	884 1950

TABULATION			
EXHAUST FEATURE CODE	DIM "C"	DIM "D"	DIM "E"
A299	1010	479	668
A379	1504	861	693

REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-137347	E	1	ADD APPLICATION INFO - SEE ECO	JPR	APF	A FELBER	16SEP13

NOTE:

1. DIMENSIONS IN [ ] ARE IN INCHES.
2. Ø20.7 [0.81] HOLES MARKED △ ARE FOR SECURING MOUNTING SURFACE.
4. TABULATED WEIGHT AND CG IS FOR GENERATOR SET WITH NO OPTIONS.
5. CUSTOMER FUEL CONNECTION TYPES:
   - NATURAL GAS AND LP VAPOR: 1" NPT
   - LP LIQUID: 1/4" NPT
6. OPTIONAL COOLANT HEATER SUPPLIED WITH 1219 (48) LONG CORD. CONNECTION TYPES:
   - 120V,1500 WATT HEATER (H036): NEMA 5-15P ("11P")
   - 208/240V, 1125/1500 WATT HEATER (H074): NEMA 6-15P ("21P")
7. FOR ENTRANCE BOX APPLICATIONS SEE APPLICABLE ENTRANCE BOX OUTLINE DRAWING.
8. OPTIONAL ENTRANCE BOX (NOT SHOWN) WILL BE MOUNTED ON THE RIGHT SIDE AS VIEWED FROM THE CONTROL.
9. (NOTE REMOVED)
10. OPTIONAL MOUNTED EXHAUST MUFFLER (A379). MUFFLER OUTLET IS 75.7 [3] OD.
11. OPTIONAL 3" NPT EXHAUST CONNECTION (A299).
12. OPTIONAL COOLANT DRAIN EXTENSION (E089)
13. OPTIONAL OIL DRAIN EXTENSION (H268)

COOLANT HEATER CONNECTION

NEMA 5-15P
"11P" 120V HEATER (H036) 1500 WATT
OR
"21P" 208/240V HEATER (H074) 1125/15 WATT
NEMA 6-15P

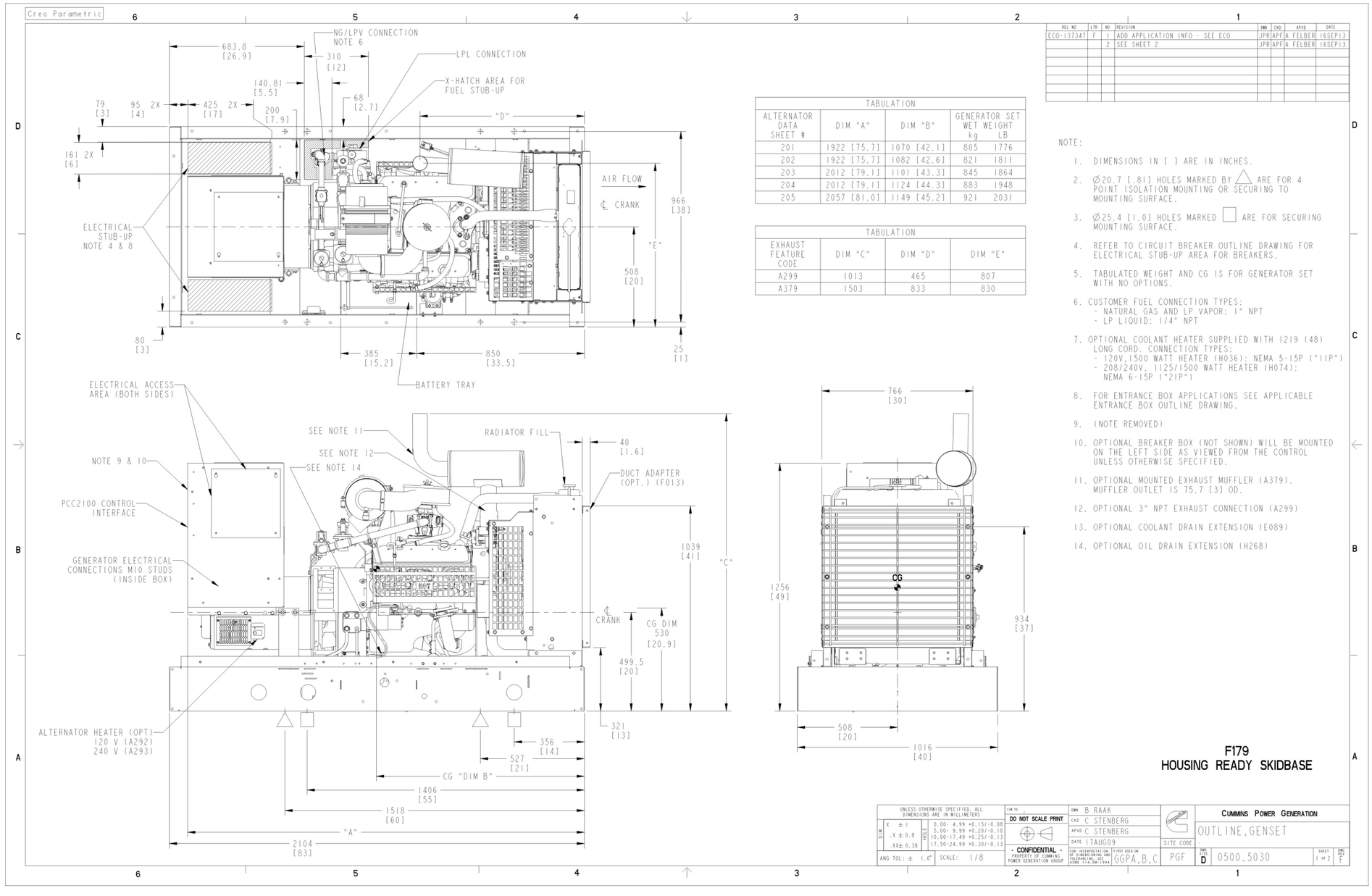
HEATER SUPPLIED WITH 1219 (48) LONG CORD

F177
BASIC SKIDBASE
(NOT HOUSING READY)

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS
DIM X ±1 .X ±0.8 .XX± 0.38
HOLE 0.00- 4.99 +0.15/-0.08 5.00- 9.99 +0.20/-0.10 10.00-17.49 +0.25/-0.13 17.50-24.99 +0.30/-0.13
ANG. TOL: ± 1.0° SCALE: 1/8
SIM TO .
DO NOT SCALE PRINT
- CONFIDENTIAL - PROPERTY OF CUMMINS POWER GENERATION GROUP
DWN B RAAK
CKD C STENBERG
APVD C STENBERG
DATE 12AUG09
FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
FIRST USED ON GGPA,B,C
CUMMINS POWER GENERATION
OUTLINE, GENSET
SITE CODE PGF
SIZE D 0500_5070 SHEET 1 OF 1 DWG REV E

FIGURE 59. OUTLINE DRAWING (0500-5070)

B.2 Outline Drawing 0500-5030 (F179)



TABULATION				
ALTERNATOR DATA SHEET #	DIM "A"	DIM "B"	GENERATOR SET WET WEIGHT kg	LB
201	1922 [75.7]	1070 [42.1]	805	1776
202	1922 [75.7]	1082 [42.6]	821	1811
203	2012 [79.1]	1101 [43.3]	845	1864
204	2012 [79.1]	1124 [44.3]	883	1948
205	2057 [81.0]	1149 [45.2]	921	2031

TABULATION			
EXHAUST FEATURE CODE	DIM "C"	DIM "D"	DIM "E"
A299	1013	465	807
A379	1503	833	830

REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-137347	F	1	ADD APPLICATION INFO - SEE ECO	JPR	APP'A	FELBER	16SEP13
		2	SEE SHEET 2	JPR	APP'A	FELBER	16SEP13

NOTE:

1. DIMENSIONS IN [ ] ARE IN INCHES.
2. Ø20.7 [.81] HOLES MARKED BY △ ARE FOR 4 POINT ISOLATION MOUNTING OR SECURING TO MOUNTING SURFACE.
3. Ø25.4 [1.0] HOLES MARKED □ ARE FOR SECURING MOUNTING SURFACE.
4. REFER TO CIRCUIT BREAKER OUTLINE DRAWING FOR ELECTRICAL STUB-UP AREA FOR BREAKERS.
5. TABULATED WEIGHT AND CG IS FOR GENERATOR SET WITH NO OPTIONS.
6. CUSTOMER FUEL CONNECTION TYPES:
   - NATURAL GAS AND LP VAPOR: 1" NPT
   - LP LIQUID: 1/4" NPT
7. OPTIONAL COOLANT HEATER SUPPLIED WITH 1219 (48) LONG CORD. CONNECTION TYPES:
   - 120V,1500 WATT HEATER (H036): NEMA 5-15P ("11P")
   - 208/240V, 1125/1500 WATT HEATER (H074): NEMA 6-15P ("21P")
8. FOR ENTRANCE BOX APPLICATIONS SEE APPLICABLE ENTRANCE BOX OUTLINE DRAWING.
9. (NOTE REMOVED)
10. OPTIONAL BREAKER BOX (NOT SHOWN) WILL BE MOUNTED ON THE LEFT SIDE AS VIEWED FROM THE CONTROL UNLESS OTHERWISE SPECIFIED.
11. OPTIONAL MOUNTED EXHAUST MUFFLER (A379). MUFFLER OUTLET IS 75.7 [3] OD.
12. OPTIONAL 3" NPT EXHAUST CONNECTION (A299)
13. OPTIONAL COOLANT DRAIN EXTENSION (E089)
14. OPTIONAL OIL DRAIN EXTENSION (H268)

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS
DIM: X ± 1; .X ± 0.8; XX± 0.38
HOLE: 0.00- 4.99 +0.15/-0.08; 5.00- 9.99 +0.20/-0.10; 10.00-17.49 +0.25/-0.13; 17.50-24.99 +0.30/-0.13
ANG TOL: ± 1.0° SCALE: 1/8
SIM TO . DO NOT SCALE PRINT
- CONFIDENTIAL - PROPERTY OF CUMMINS POWER GENERATION GROUP
FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
FIRST USED ON GGPA,B,C
DWN B RAAK
CKD C STENBERG
APVD C STENBERG
DATE 17AUG09
SITE CODE PGF
CUMMINS POWER GENERATION
OUTLINE,GENSET
DWG SIZE D
0500_5030
SHEET 1 of 2
DWG REV F

FIGURE 60. OUTLINE DRAWING (0500-5030 SHEET 1)

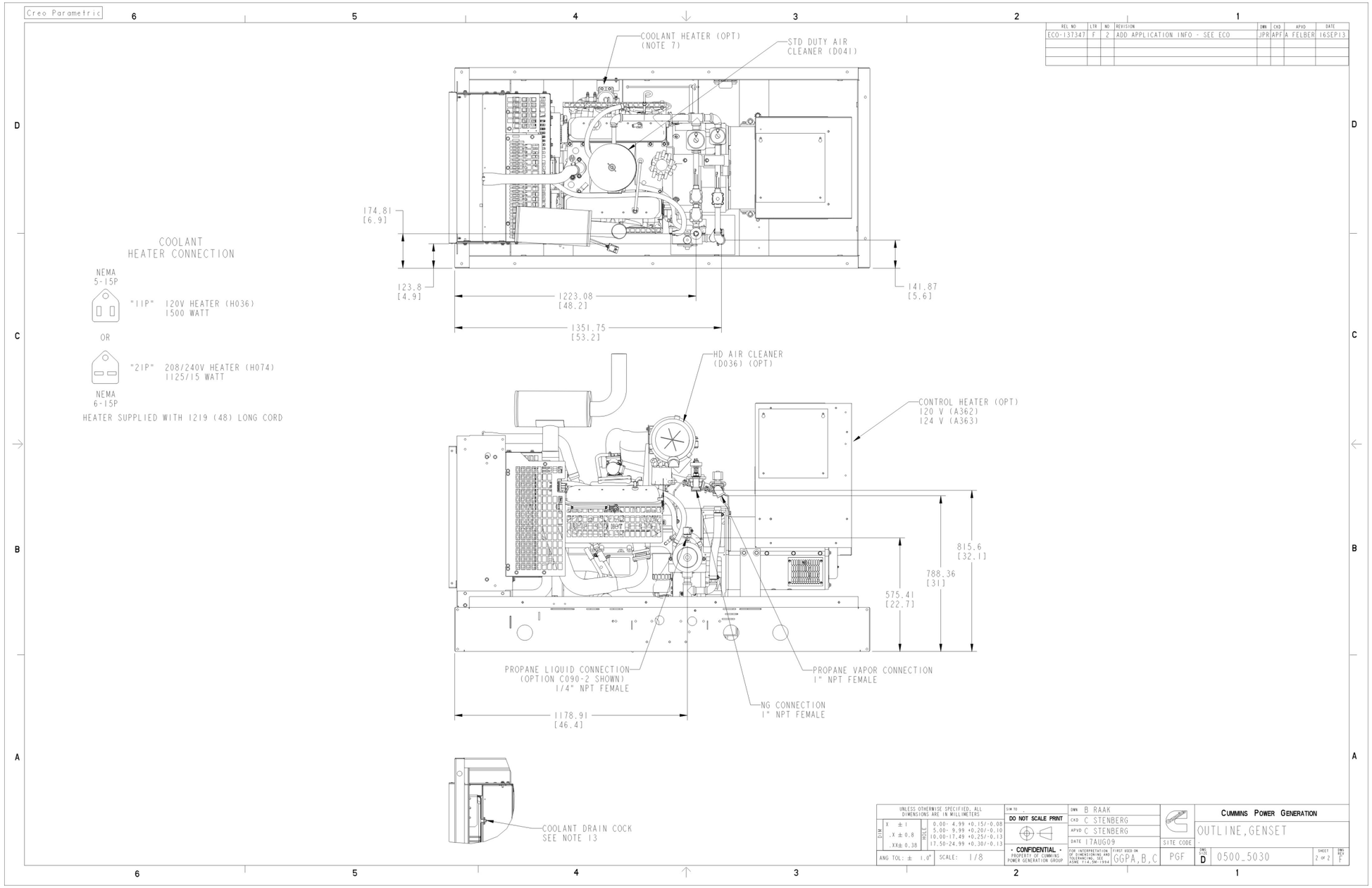
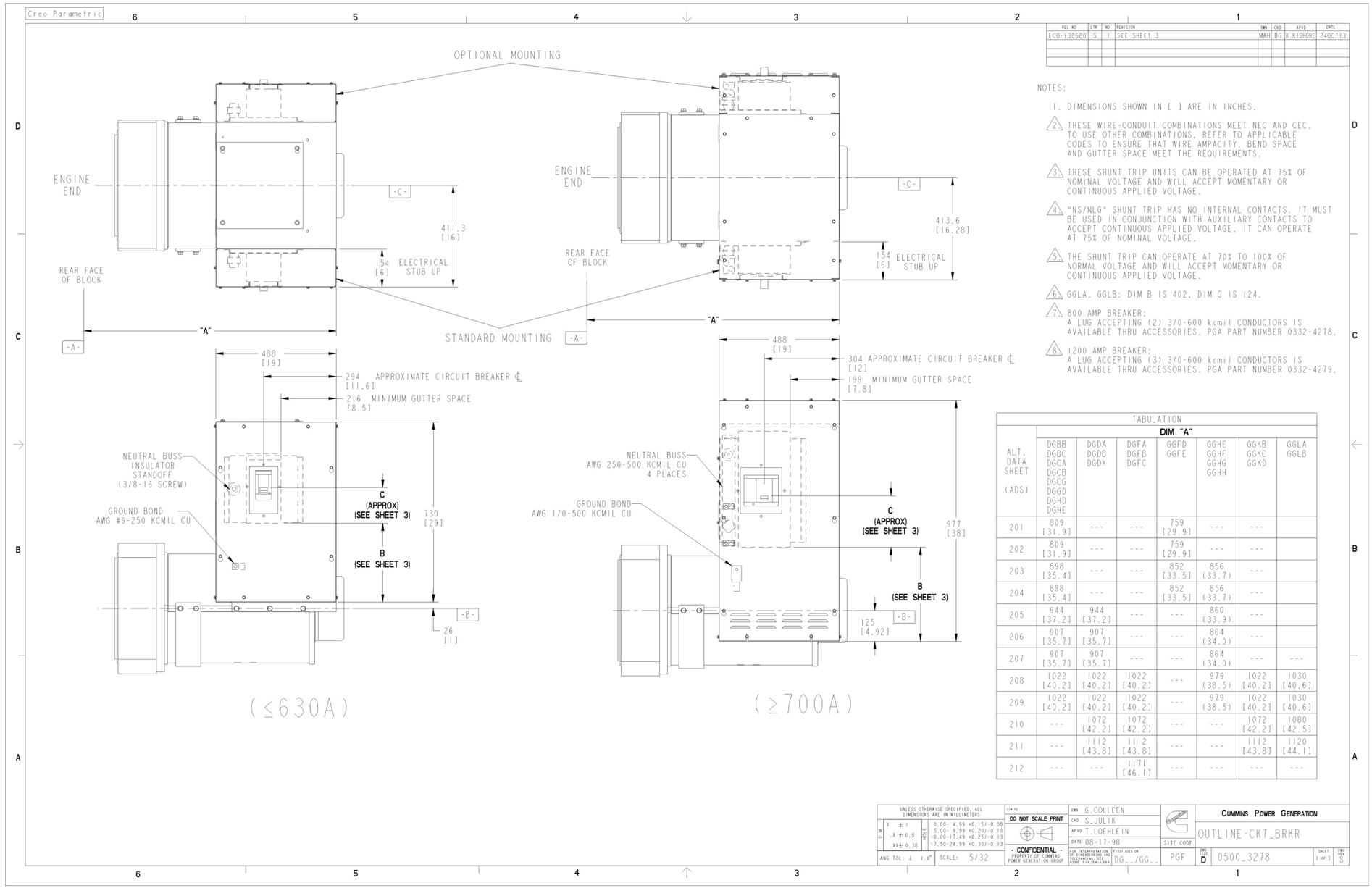


FIGURE 61. OUTLINE DRAWING (0500-5030 SHEET 2)

B.3 Outline Drawing 0500-3278 (Circuit Breaker)



REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-138680	S	1	SEE SHEET 3	MAH	BG	K.KISHORE	24OCT13

NOTES:

1. DIMENSIONS SHOWN IN [ ] ARE IN INCHES.
2. THESE WIRE-CONDUIT COMBINATIONS MEET NEC AND CEC. TO USE OTHER COMBINATIONS, REFER TO APPLICABLE CODES TO ENSURE THAT WIRE AMPACITY, BEND SPACE AND GUTTER SPACE MEET THE REQUIREMENTS.
3. THESE SHUNT TRIP UNITS CAN BE OPERATED AT 75% OF NOMINAL VOLTAGE AND WILL ACCEPT MOMENTARY OR CONTINUOUS APPLIED VOLTAGE.
4. "NS/NLG" SHUNT TRIP HAS NO INTERNAL CONTACTS. IT MUST BE USED IN CONJUNCTION WITH AUXILIARY CONTACTS TO ACCEPT CONTINUOUS APPLIED VOLTAGE. IT CAN OPERATE AT 75% OF NOMINAL VOLTAGE.
5. THE SHUNT TRIP CAN OPERATE AT 70% TO 100% OF NORMAL VOLTAGE AND WILL ACCEPT MOMENTARY OR CONTINUOUS APPLIED VOLTAGE.
6. GGLA, GGLB: DIM B IS 402, DIM C IS 124.
7. 800 AMP BREAKER: A LUG ACCEPTING (2) 3/0-600 kcmil CONDUCTORS IS AVAILABLE THRU ACCESSORIES. PGA PART NUMBER 0332-4278.
8. 1200 AMP BREAKER: A LUG ACCEPTING (3) 3/0-600 kcmil CONDUCTORS IS AVAILABLE THRU ACCESSORIES. PGA PART NUMBER 0332-4279.

TABULATION

ALT. DATA SHEET (ADS)	DIM "A" DGBB DGBC DGCA DGCB DGCG DGGD DGHD DGHE	DGDA DGDB DGDK	DGFA DGFB DGFC	GGFD GGFE	GGHE GGHF GGHG GGHH	GGKB GGKC GGKD	GGLA GGLB
201	809 [31.9]	---	---	759 [29.9]	---	---	
202	809 [31.9]	---	---	759 [29.9]	---	---	
203	898 [35.4]	---	---	852 [33.5]	856 (33.7)	---	
204	898 [35.4]	---	---	852 [33.5]	856 (33.7)	---	
205	944 [37.2]	944 [37.2]	---	---	860 (33.9)	---	
206	907 [35.7]	907 [35.7]	---	---	864 (34.0)	---	
207	907 [35.7]	907 [35.7]	---	---	864 (34.0)	---	---
208	1022 [40.2]	1022 [40.2]	1022 [40.2]	---	979 (38.5)	1022 [40.2]	1030 [40.6]
209	1022 [40.2]	1022 [40.2]	1022 [40.2]	---	979 (38.5)	1022 [40.2]	1030 [40.6]
210	---	1072 [42.2]	1072 [42.2]	---	---	1072 [42.2]	1080 [42.5]
211	---	1112 [43.8]	1112 [43.8]	---	---	1112 [43.8]	1120 [44.1]
212	---	---	1171 [46.1]	---	---	---	---

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN MILLIMETERS
DIM: X ±1, .X ±0.8, .XX± 0.38
HOLE: 0.00~4.99 +0.15/-0.08; 5.00~9.99 +0.20/-0.10; 10.00~17.49 +0.25/-0.13; 17.50~24.99 +0.30/-0.13
ANG TOL: ± 1.0° SCALE: 5/32
SIM TO: DO NOT SCALE PRINT
- CONFIDENTIAL - PROPERTY OF CUMMINS POWER GENERATION GROUP
FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5M-1994 FIRST USED ON DG__/GG__
DWN G_COLLEEN
CAD S_JULIK
APVD T_LOEHLEIN
DATE 08-17-98
CUMMINS POWER GENERATION
OUTLINE-CKT_BRKR
SITE CODE PGF
DWG SIZE D 0500_3278 SHEET 1 of 3 DWG REV S

FIGURE 62. OUTLINE CIRCUIT BREAKER (0500-3278 SHEET 1)

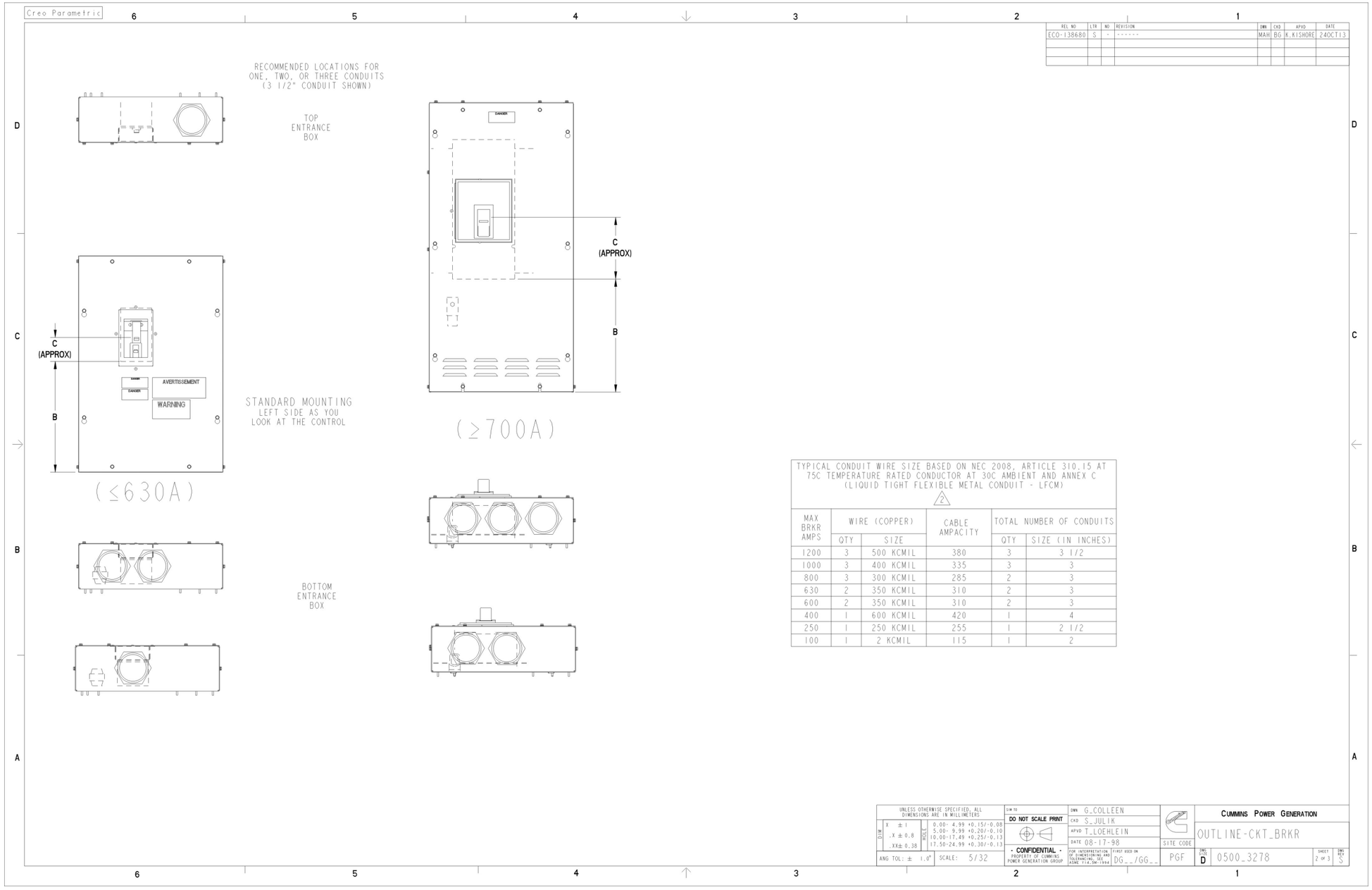


FIGURE 63. OUTLINE CIRCUIT BREAKER (0500-3278 SHEET 2)

Creo Parametric

REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-138680	S	1	ZONE C5: CHANGE 400 AMP WIRE RANGE	MAH	BG	K.KISHORE	24OCT13
		2	ZONE C5: CHANGE 600 AMP WIRE RANGE	MAH	BG	K.KISHORE	24OCT13

UL/IEC LUGS						ACCESSORY SPECIFICATIONS			
LUG	FRAME	MAX AMPS	WIRE RANGE COPPER	DIM B	DIM C	ACCESSORY DESCRIPTION	CONTACT RATING	INRUSH CURRENT	CONNECTION TYPE
	NSF 600/690V	15-60A	#14-10 AWG (SOLID COND. ONLY)	383 [15]	105 [4.1]	12 VDC SHUNT TRIP	-	10A 4	COMPRESSION TERMINALS #20-16 AWG OR SMALLER TORQUE: 10 LB-IN
		70-250A	2/0-250 KCMIL			1 EA. FORM C 1 AUX CONTACT + 1 TRIP ALARM	6A AT 690 VAC 2.5A AT 48 VDC, 0.3A AT 250 VDC	-	
	NSJ/NLG 600/690V	400A 3 OR 4 POLE	#2-600 KCMIL (NSJ/NLG)	329 [13]	176 [6.9]	12 VDC SHUNT TRIP	-	10A 4	COMPRESSION TERMINALS #20-16 AWG OR SMALLER TORQUE: 10 LB-IN
		600A 3-POLE 630A 4-POLE	2/0-350 KCMIL (NSJ) 2/0-500 KCMIL (NLG)			1 EA. FORM C 1 AUX CONTACT + 1 TRIP ALARM	6A AT 690 VAC 2.5A AT 48 VDC, 0.3A AT 250 VDC	-	
	CK 600/660V	800A 3-POLE 800A 4-POLE 1200A 3-POLE 1250A 4-POLE	3/0-500 KCMIL	382 [15]	230 [9]	12 VDC SHUNT TRIP	-	3.8A 3	COMPRESSION TERMINALS FOR 1 OR 2 #18-14 AWG. TORQUE: 12 LB-IN
						1 EA. FORM C 1 AUX CONTACT + 1 TRIP ALARM	5A AT 480 VAC, 3A AT 600 VAC 0.5A AT 125VDC, 0.25A AT 250VDC	-	
	KDL 240V	250A	#3-250 KCMIL	374 [14.7]	105 [4.1]	NONE AVAILABLE			
	QDL 240V	250A	#4-300 KCMIL	374 [14.7]	81 [3.2]	NONE AVAILABLE			
	Q4 240V	400A	#1-600 KCMIL	315 [12.4]	176 [6.9]	NONE AVAILABLE			
7	P	800A 3-POLE	3/0-500 KCMIL	448 [17.6]	177 [7]	12 VDC SHUNT TRIP	-	200VA 5	COMPRESSION TERMINALS FOR 1 OR 2 #18-16 AWG. TORQUE: 10 LB-IN
						1 EA. FORM C 4 AUX CONTACTS + 1 TRIP ALARM	6A AT 240 VAC, 6A AT 480 VAC, 3A AT 600 VAC, 2.5A AT 48 VDC, 0.8A AT 125 VDC, 0.3A AT 250 VDC	-	
8	P	1200A 3-POLE	3/0-500 KCMIL	407 [16] 6	220 [8.7] 6	12 VDC SHUNT TRIP	-	200VA 5	COMPRESSION TERMINALS FOR 1 OR 2 #18-16 AWG. TORQUE: 10 LB-IN
						1 EA. FORM C 4 AUX CONTACTS + 1 TRIP ALARM	6A AT 240 VAC, 6A AT 480 VAC, 3A AT 600 VAC, 2.5A AT 48 VDC, 0.8A AT 125 VDC, 0.3A AT 250 VDC	-	
	H	15-150	(1) #14-3/0 AWG	393 [15.5]	95 [3.8]	12 VDC SHUNT TRIP	COIL BURDEN < 5W	10A	COMPRESSION TERMINALS #14-#10 AWG, 50 LB-IN #8-3/0, 120 LB-IN
	J	175	(1) 1/0-4/0 AWG	383 [15]	105 [4.1]	1 EA FORM C 1 AUX CONTACT + 1 TRIP ALARM	MIN LOAD = 10 ma WITH 24V DC: 48 2.5A, 125 0.8A, 250 0.3A; AC: 240 6.0A, 480 6.0A, 600 3.0A	-	COMPRESSION TERMINALS 3/0-350 KCMIL 225 LB-IN
		200-250	(1) 3/0-350 kcmil						

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS
DIM: X ±1, .X ±0.8, .XX± 0.38
DEC: 0.00-4.99 +0.15/-0.08; 5.00-9.99 +0.20/-0.10; 10.00-17.49 +0.25/-0.13; 17.50-24.99 +0.30/-0.13
ANG TOL: ± 1.0° SCALE: 5/32
SHR TO: DO NOT SCALE PRINT
- CONFIDENTIAL - PROPERTY OF CUMMINS POWER GENERATION GROUP
DWN G_COLLEEN; CKD S_JULIK; APVD T_LOEHLEIN; DATE 08-17-98
FOR INTERPRETATION OF DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
FIRST USED ON DG__/GG__
CUMMINS POWER GENERATION
SITE CODE PGF
DWG SIZE D 0500_3278 SHEET 3 OF 3 DWG REV S
OUTLINE-CKT_BRKR

FIGURE 64. OUTLINE CIRCUIT BREAKER (0500-3278 SHEET 3)

B.4 GGHE/GGHF Enclosure Outline Drawing 0500-4814 (F217)

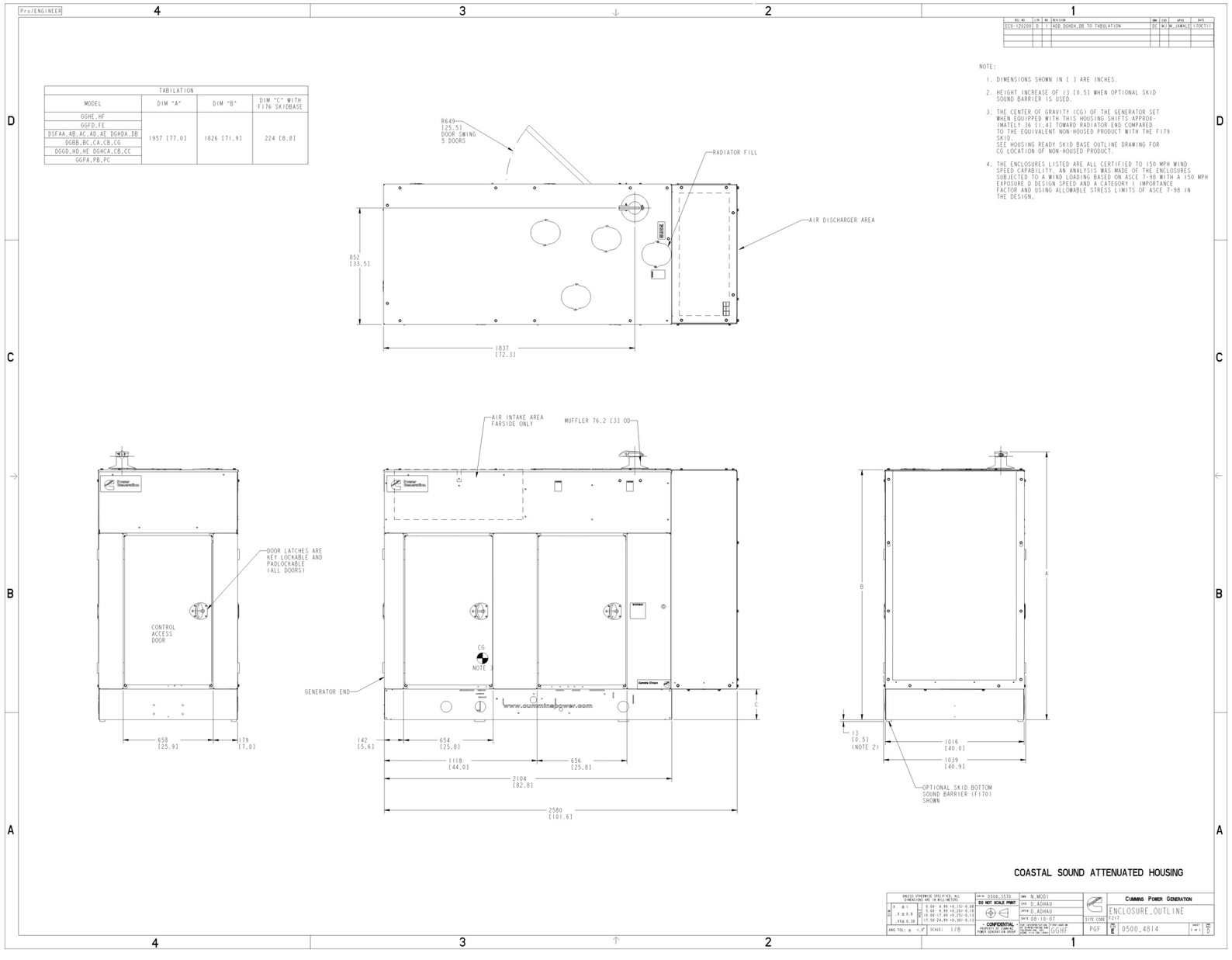


FIGURE 65. OUTLINE DRAWING (0500-4814)

B.5 GGHE/GGHF Enclosure Outline Drawing 0500-4813 (F216)

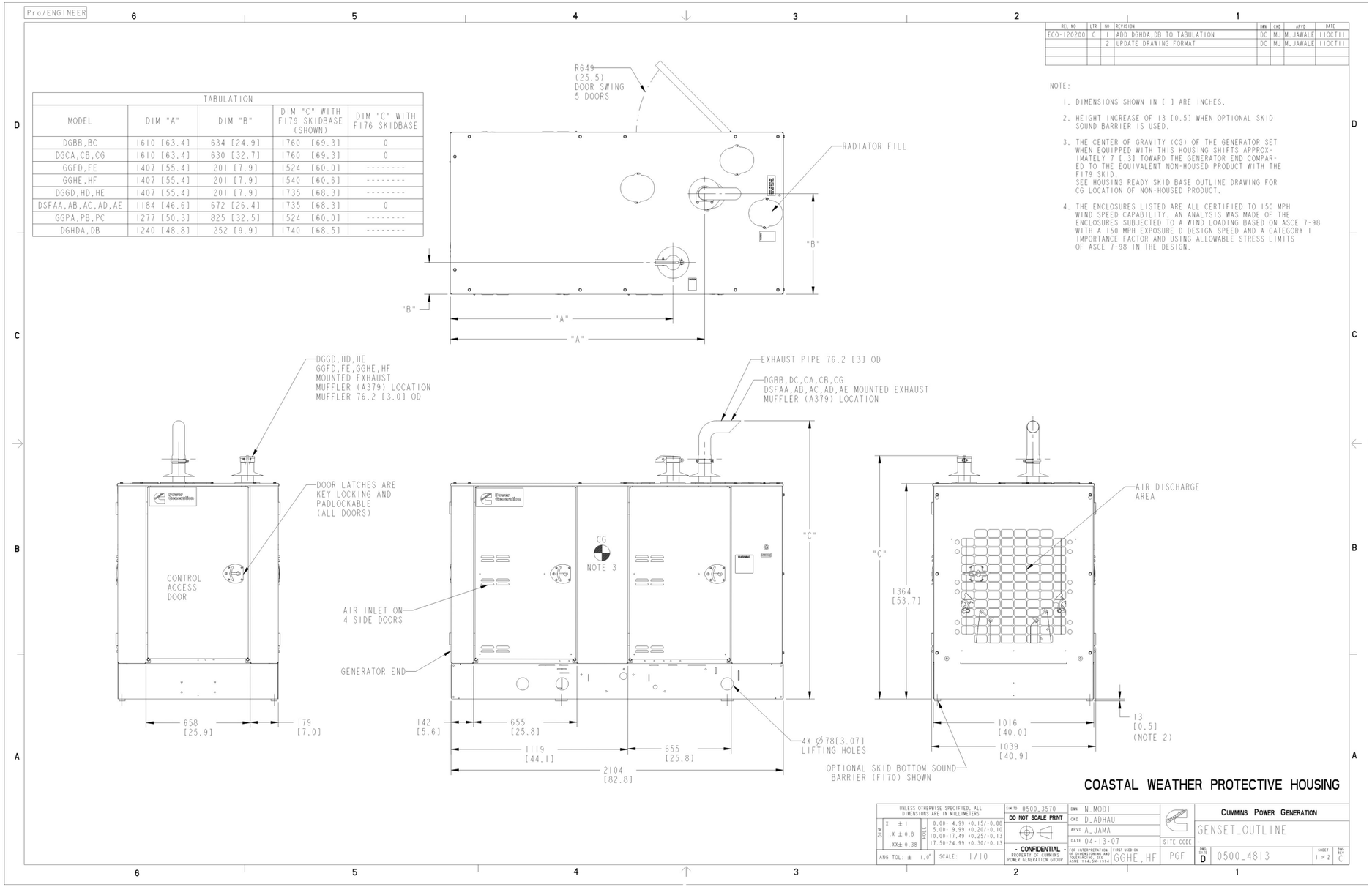


FIGURE 66. OUTLINE DRAWING (0500-4813 SHEET 1)

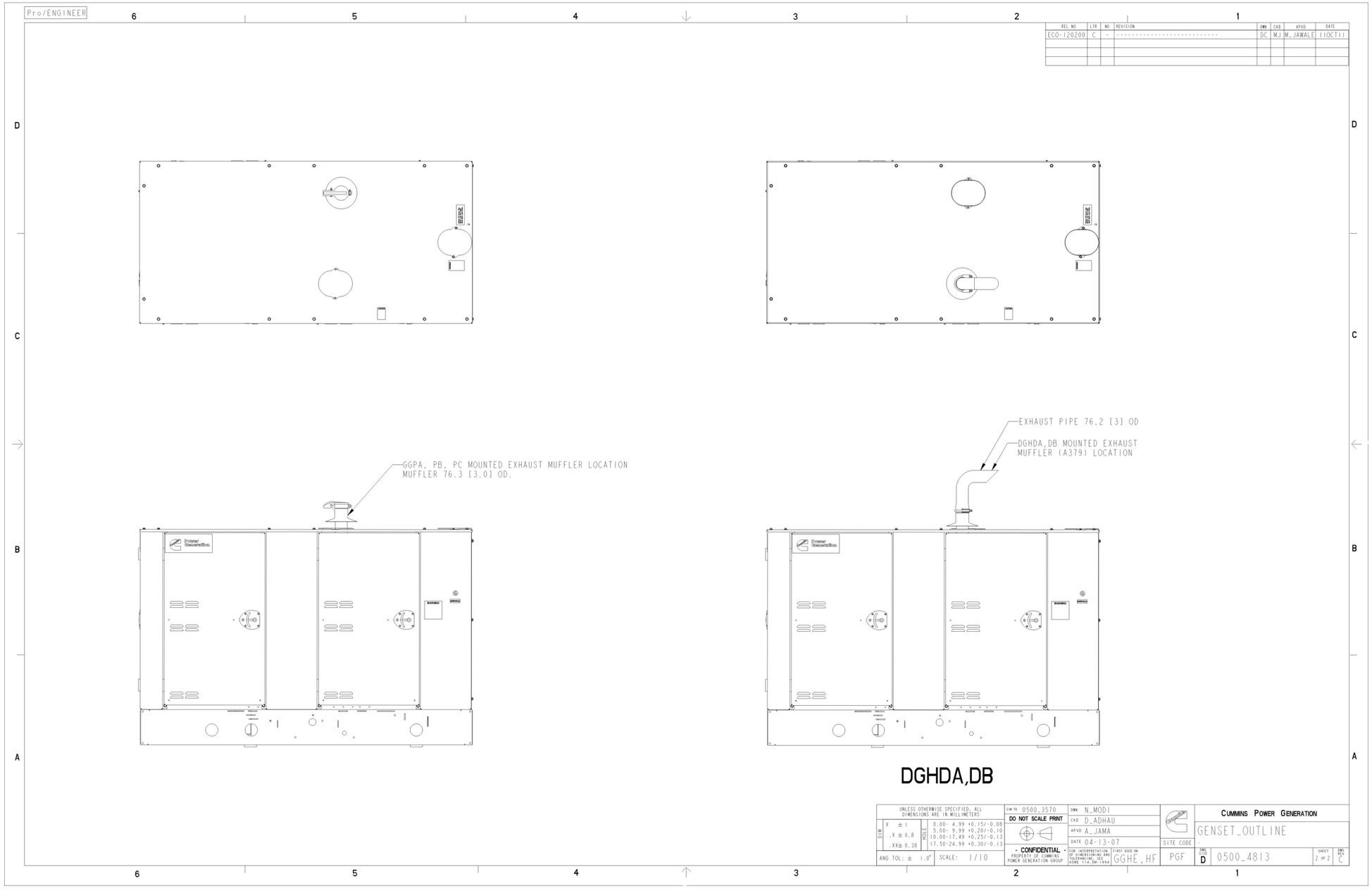


FIGURE 67. OUTLINE DRAWING (0500-4813 SHEET 2)

B.6 GGHE/GGHF Enclosure Outline Drawing 0500-3171 (F182)

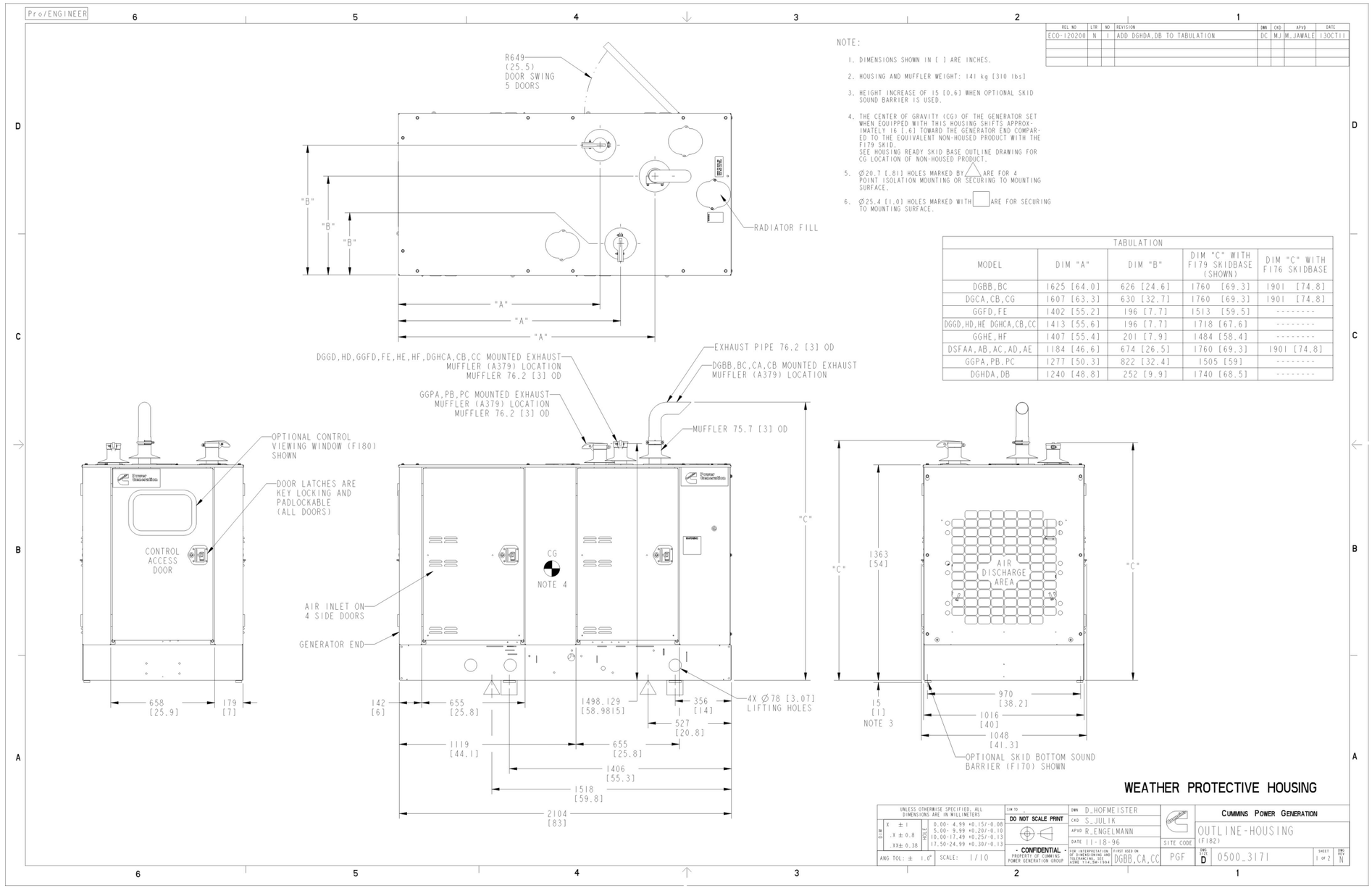


FIGURE 68. OUTLINE DRAWING (500-3171) SHEET 1

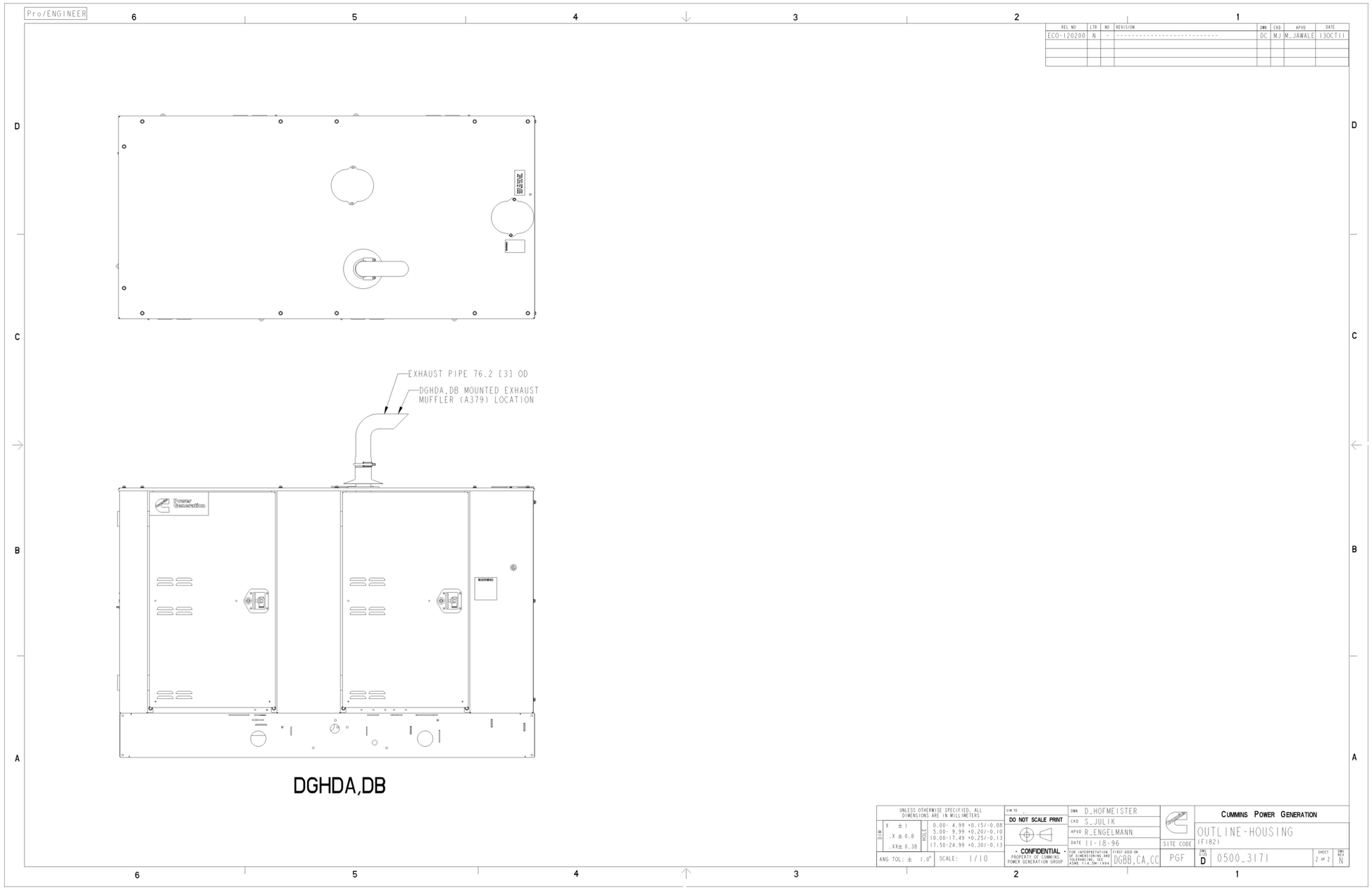


FIGURE 69. OUTLINE DRAWING (500-3171) SHEET 2

B.7 GGHE/GGHF Enclosure Outline Drawing 0500-3167 (F173)

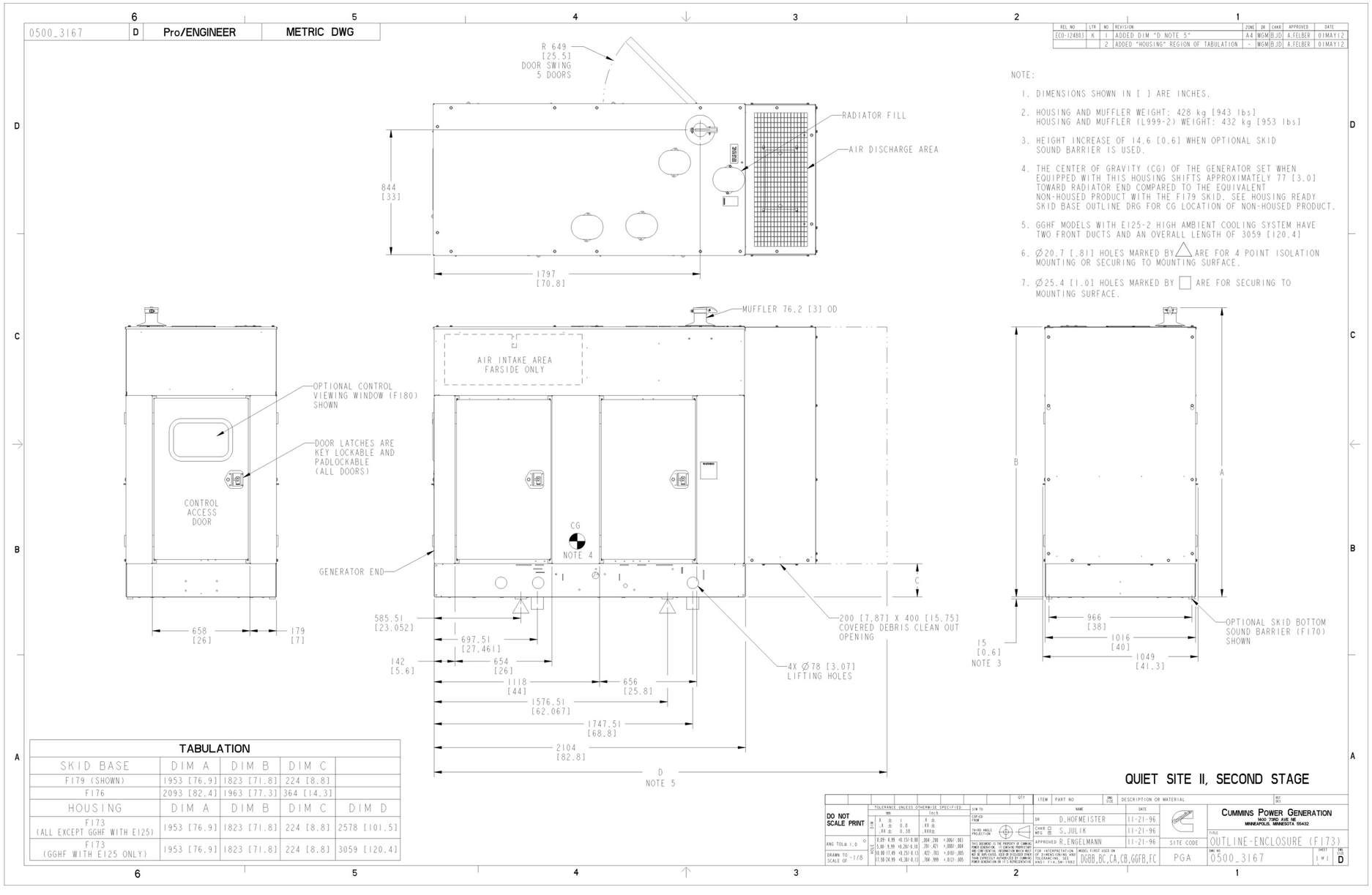


FIGURE 70. OUTLINE DRAWING (0500-3167)

B.8 GGHE/GGHF Enclosure Outline Drawing 0500-3211 (F172)

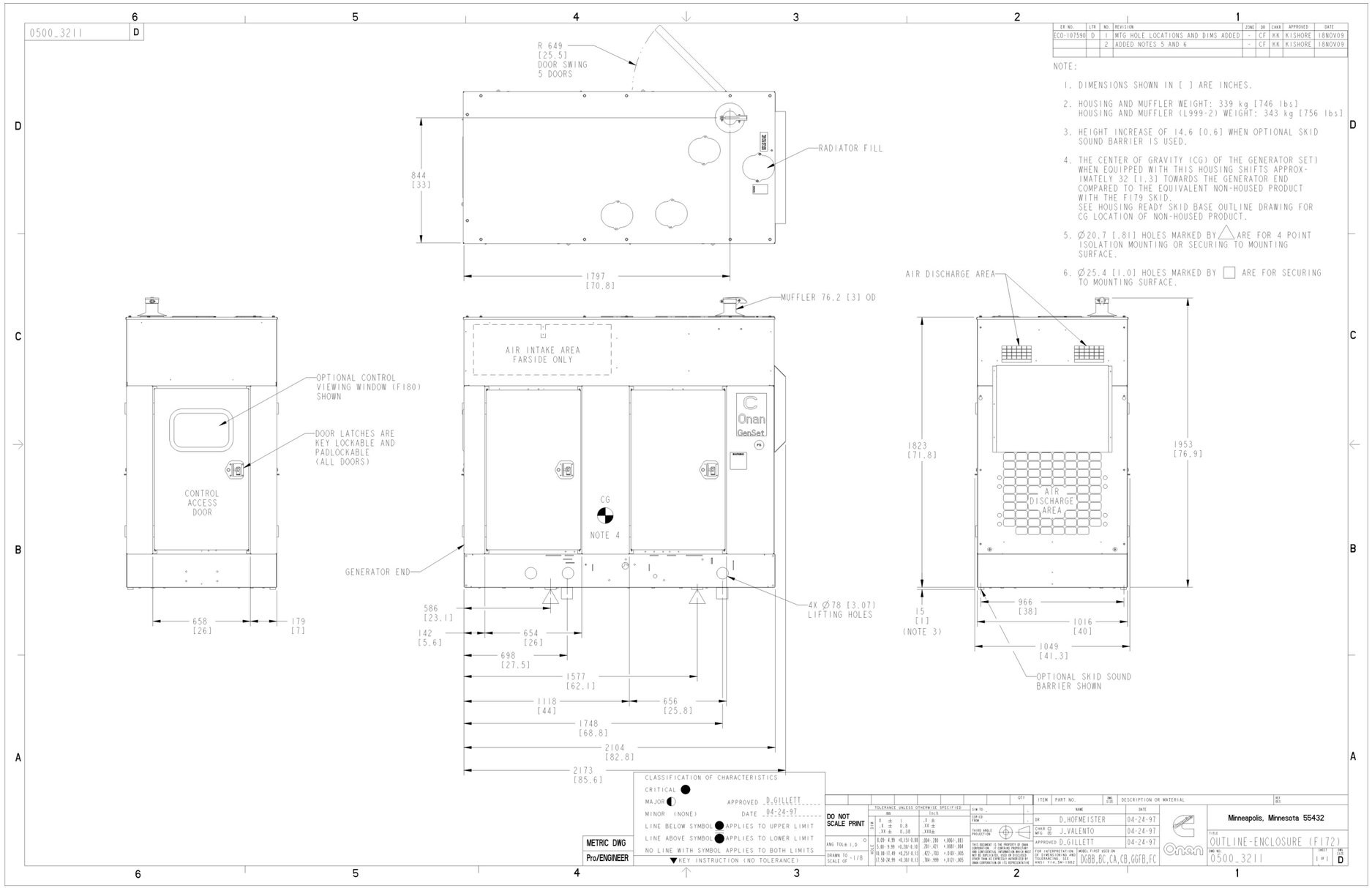


FIGURE 71. OUTLINE DRAWING (0500-3211)

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