



# Operator Manual

Performance you rely on.™



## Generator Set with PowerCommand® 3200 Controller

DFEG (Spec A–B)

DFEH (Spec A–B)

DFEJ (Spec A–B)

DFEK (Spec A–B)

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**California**  
**Proposition 65 Warning**  
 Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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# IMPORTANT SAFETY INSTRUCTIONS

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

**Before operating the generator set (genset)**, read the Operator's Manual and become familiar with it 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.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

**⚠ DANGER** *This symbol warns of immediate hazards which will result in severe personal injury or death.*

**⚠ WARNING** *This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.*

**⚠ CAUTION** *This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.*

## FUEL AND FUMES ARE FLAMMABLE

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

- DO NOT fill fuel tanks while engine is running, unless 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 zinc coated or copper fuel lines with diesel fuel.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure 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.

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

## 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 battery charger from its AC source, then disconnect starting batteries, 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 adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

## 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 genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

## **ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH**

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

## **GENERAL SAFETY PRECAUTIONS**

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential 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.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breathe or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

**KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE**

# 1. Introduction

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## GENERAL

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

Each operator should read this manual before operating the set for the first time. A generator set (gen-set) must be operated and maintained properly if you are to expect safe, reliable and quiet operation. The manual includes a troubleshooting guide and a maintenance schedule.

The engine manual is included with the set. Where there is conflicting information, this manual takes precedence over the engine manual.

**⚠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 the safety precautions on page iii and carefully observe all instructions and precautions in this manual.*

## HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearest Cummins Power Generation distribu-

tor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

To contact your local Cummins Power Generation distributor in the United States or Canada, call 1-800-888-6626 (this automated service utilizes touch-tone phones only). By selecting Option 1 (press 1), you will be automatically connected to the distributor nearest you.

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

GENERATORS-ELECTRIC or  
ELECTRICAL PRODUCTS

For outside North America, call Cummins Power Generation, 1-763-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Cummins Power Generation using the fax number 1-763-574-8087.

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

### **⚠WARNING**

**INCORRECT SERVICE OR PARTS REPLACEMENT CAN RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE TRAINED AND EXPERIENCED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.**

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## 2. Specifications

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MODEL	DFEG, DFEH, DFEJ, DFEK
<b>Engine</b> Cummins Series	QSX15 (50/60 Hz)
<b>Generator Kw Rating</b>	See Genset Nameplate for rating information.
<b>Electrical System</b> Starting Voltage Battery Group Number CCA (minimum) Cold Soak @ 0°F (-18° C)	24 Volts DC Two, 12 Volt 8D 1400
<b>Cooling System</b> (Capacity Std. Raidiator) – Gal (L)	15.3 (58)
<b>Lubricating System</b> Oil Cap. w/Filters Oil Type*	26 Gallons (58 L)
* Refer to Cummins QSX15 Series Engine Operation and Maintenance Manual for lubricating oil recommendations/specifications.	

### FUEL CONSUMPTION (STANDBY/FULL LOAD/60HZ)

MODEL	DFEG	DFEH	DFEJ	DFEK
US gph (L/hr)	24.6 (93.2)	27.1 (102.7)	30.0 (113.7)	34.8 (131.9)



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# 3. Operation

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## GENERAL

The following describes the function and operation of the PowerCommand® Control 3200 (PCC). All indicators, control switches/buttons and graphical display are located on the face of the control panel as illustrated in Figure 3-1.

This section covers prestart checks, starting and stopping and operating the generator set. Each operator should read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set and the control panel. Refer to *Section 6* for operating recommendations.

## PRESTART CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation.

## Lubrication

Check the engine oil level. Keep the oil level near as possible to the dipstick high mark without overfilling.

## Coolant

Check the engine coolant level. Refer to Section 5.

## Fuel

Make sure the fuel tanks have sufficient fuel and that fuel system is primed. Check to make sure there are no leaks and that all fittings are tight.

## Exhaust

Check to make sure entire exhaust system is tight, that no combustible materials are near system, and gases are discharged away from building openings.

## **EXHAUST GAS IS DEADLY!**

***Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:***

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

***IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.***

***Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.***

## 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.

**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.

**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 remain on during Screen Saver mode, indicating that the operating software is active (Awake mode).

When a "Warning" signal is sensed by the PCC (for example, low coolant temp), 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.

**Sleep/Awake Mode:** In the Sleep mode, the control's operating software is inactive and the LEDs and the graphical display on the control panel are all

off. Sleep mode is a feature that is used to reduce battery power consumption when the control is in the Auto mode and is not being used.

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

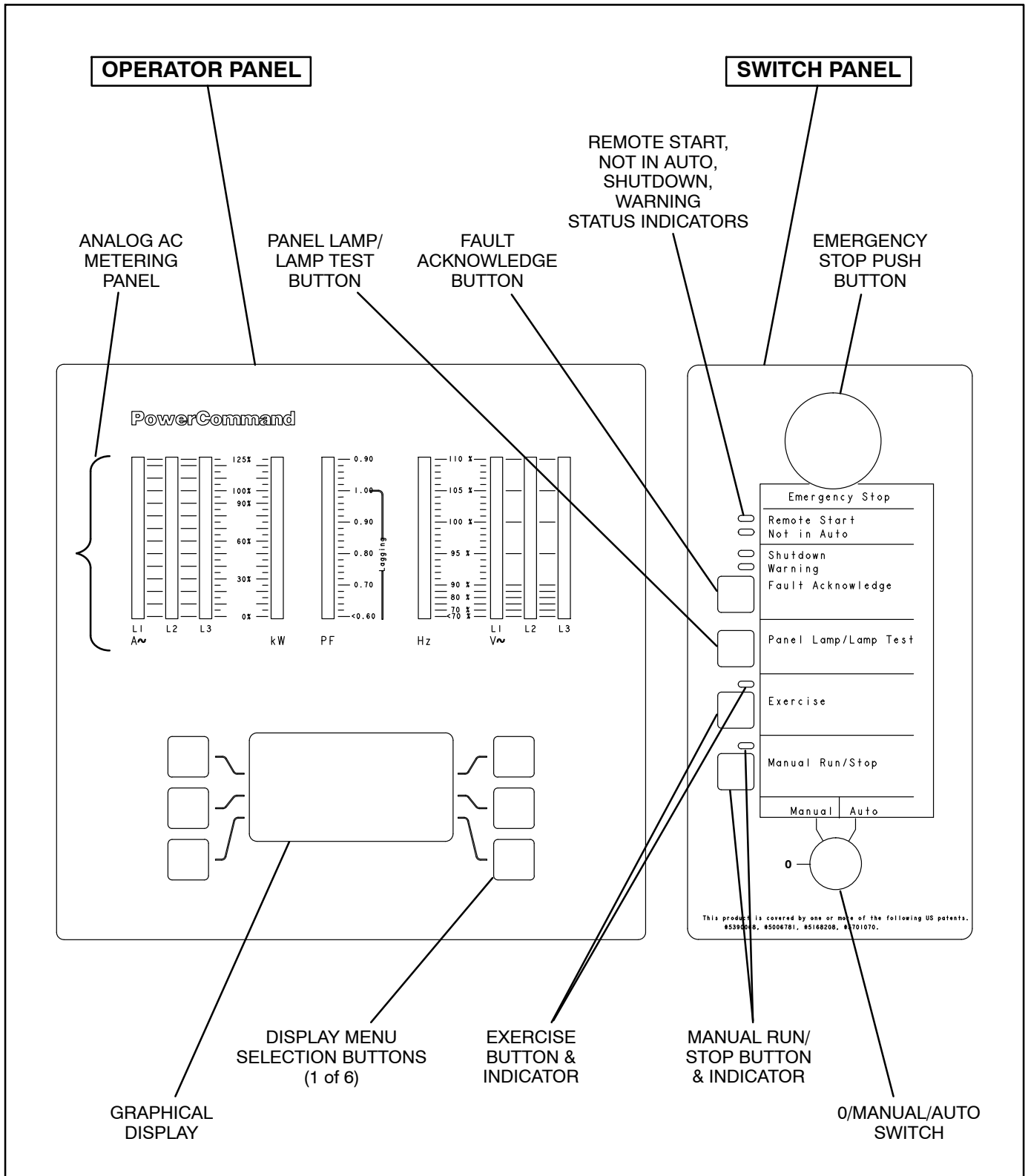
The operating software is initialized and the control panel LEDs and graphical display is turned on in response to one of the following:

- moving/pressing any control panel switch/button.
- a remote start input signal (generator set in Auto mode), or
- customer fault 2 or 3 only (shutdown or warning indicator is on).

To activate the control and view the menu display without starting the generator set, press any button on the control panel.

The InPower service tool is required to enable or disable the Sleep mode. When shipped from the factory, the Sleep mode is disabled. When disabled, the operating software will always remain active (Awake mode) when the control is in Auto mode.

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



**FIGURE 3-1. CONTROL PANEL ASSEMBLY (FULL-FEATURED)**

## CONTROL PANEL ASSEMBLY

The control panel assembly (Figure 3-1) consist of two panels, the *Operator Panel* and the *Switch Panel*. The control panel assembly can be mounted on the genset or in a freestanding cabinet located near the genset. In either location, the function of the control panel assembly switches and indicators remain the same.

Dependent on site requirements, the *Operator Panel* is either mounted on the control panel assembly (full-featured) as shown in Figure 3-1 or is contained in a separate enclosure and mounted remotely of the control panel assembly.

**The function of several buttons on the operator panel will vary dependent on the location of the operator panel (remote or local of the control panel assembly). If the function differs, it is noted as either “remote” or “local operator panel” in the button description.**

### Operator Panel

The operator panel contains the following components:

**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.

**Graphical Display:** The graphical display is capable of displaying up to 9-lines of data with approximately 27 characters per line. The display is used to view the 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/error codes, modes of operation (Figure 3-3) and system actions, such as Warning, Derate, Shutdown, etc.

**Display Menu Selection Buttons:** Six momentary buttons—three on each side of the graphical display window—are used to navigate through the system control menus and to adjust generator set parameters. The button is active when the message adjacent to the button is highlighted (displayed in inverse video).

### Switch Panel

The switch panel contains the following components:

**Emergency Stop Button:** Push the button in for emergency shutdown of the engine. If the engine is not running, pushing the button in will prevent the starting of the engine, regardless of the start signal source (local or remote).

To reset:

1. Pull the button out.
2. Move the 0/Manual/Auto switch to 0.
3. Press the front panel Fault Acknowledge button.
4. Select Manual or Auto, as required.

**Remote Start Indicator:** This green lamp is lit whenever the control is receiving a remote run signal. When flashing, indicates a load demand stop mode.

**Not in Auto Indicator:** This red lamp flashes continuously when the 0/Manual/Auto switch is not in the Auto position. (If in Auto position and lamp is flashing, service is required.)

**Shutdown Status Indicator:** This red lamp is lit whenever the control detects a shutdown condition. The generator set can not be started when this lamp is on. After the condition is corrected, shutdown indicators can be reset by turning the 0/Manual/Auto switch to the 0 position, and pressing the Fault Acknowledge button.

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 cool-down sequence). All other faults would allow the engine to run during the cool-down sequence before engine shutdown.

**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 genset operation.)

**Fault Acknowledge:** Press this button to acknowledge warning and shutdown messages after the fault has been corrected.

To acknowledge a Warning message, the 0/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 0/Manual/Auto switch must be in the 0 (off) position.

This button is also used to blink a fault code if the Shutdown or Warning Status Indicator is lit. (This function is used when the control does not contain a graphical display.) Refer to *Reading Fault Codes* in this section, which describes how to use this button for interpreting fault codes.

**Panel Lamp/Lamp Test Button:** Press this button to turn on or off the panel lamp. Press and hold down this button for three seconds or more to turn all control panel LEDs on to make sure all lamps illu-

minate. The illumination will shut off after releasing button.

**Exercise Button:** Press this button to initiate a pre-programmed exercise sequence. The 0/Manual/Auto switch is used in conjunction with this button to enable this function (refer to Exercise Start in this section).

**Manual Run/Stop Button:** This button starts and stops the set locally and will bypass Time Delay to Start and Stop sequences. The 0/Manual/Auto switch must be in the Manual position to enable this button.

**0/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. (Disables the use of the switch panel Manual Run/Stop button.)

0 (off) position prevents the starting of the set (local or remote). If moved to 0 during set operation, will cause an immediate engine shutdown (bypasses cool-down timers). This hot shutdown should be avoided, if possible, to help prolong the life of the engine. Hot shutdowns are logged by the system software.

## STARTING

The following headings cover the systems used to start the generator set. Figure 3-2 provides a flow chart for each of the four start/run/stop sequences.

Before starting the generator set, make sure that exhaust and fuel fittings are tight and that proper maintenance has been performed. See **Prestart Checks** in this section.

### Starting at Switch Panel (Manual Mode)

Move the 0/Manual/Auto switch to the Manual position and press the Manual Run/Stop button. This will activate the engine control system and the starting system. The starter will begin cranking, and after a few seconds the engine will start and the starter will disconnect.

In the Manual position, the control will not complete the time delay to start or time delay to stop (Figure 3-2), but will complete the warm-up at idle and cool-down at rated/idle.

When the coolant reaches operating temperature or the warm-up at idle time delay is reached (0 to 300 seconds), whichever occurs first, the generator set will ramp to rated speed and voltage.

If the engine does not start, the starter will disengage after a specified period of time and the control will indicate an overcrank shutdown.

The generator set can be configured for a number of starting cycles (1 to 7) and duration of crank and rest periods. Default setting is for 3 start cycles composed of 15 seconds of cranking, and 15 seconds of rest.

**The InPower service tool is required to change the number of crank cycles, and the crank and rest times. Contact an authorized service center for assistance.**

To clear a Fail To Start shutdown, place the 0/Manual/Auto switch in the 0 position and press the Fault Acknowledge button. Wait two or more minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt, refer to the *Troubleshooting* section.

### Starting at Remote Operator Panel (Auto Mode)

When the operator panel is mounted remotely of the control panel assembly, the Start button of the Control submenu can also be used to start the generator set. The function of this Start button is identical to the Starting from Remote Location (non-emergency sequence, Figure 3-2). Refer to Control Submenu (page 3-15) for additional information.

**The 0/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.**

### Starting from Remote Location (Switch or Device) (Auto Mode)

Place the 0/Manual/Auto switch in the Auto position. This allows the generator set to be started from a remote switch or device (e.g., transfer switch).

There are two start modes that are selectable for the remote start input, one for non-emergency start and the other for emergency start. Figure 3-2 illustrates how the start/run/stop sequence differs between the two modes.

In response to the remote run signal, the control lights the Remote Start indicator and initiates the starting sequence described in the previous heading (*Starting at Switch Panel*), except for the following:

In the Auto position, the control will complete the Time Delay To Start (0 to 300 seconds) for a non-emergency start signal and the Time Delay To Stop (0 to 600 seconds) for either a emergency or non-emergency start signal (see Figure 3-2).

**Refer to Adjust submenu in this section to change the time delay settings.**

When the generator set is operating in the Remote Start mode, removing the Remote Start command does not shut off the engine if the load is more than 10 per cent, 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.

## Exercise Start

Press and hold down the Exercise button and move the 0/Manual/Auto switch from Auto to Manual and back to Auto or from Manual to Auto.

This will activate the engine control system to complete a pre-programmed exercise sequence. The sequence (Figure 3-2) will vary accordingly to the settings/selections of the system control parameters.

**The InPower service tool is required to modify these parameters. Contact an authorized service center for assistance.**

The exercise sequence may include running at idle speed, ramping to rated speed, running for a predetermined period of time and timed shutdown. During the exercise operation, the LED lamp adjacent to the Exercise button will light. To manually stop the exercise operation before completion, press the Exercise button. The set will complete its normal cool-down sequence. The control will indicate that the set is in a cool-down mode by flashing the exercise LED.

All exercise functions are disabled when a remote start signal is received by the control.

## Cold Starting with Loads

In accordance with NFPA 110, Cummins Power Generation recommends installing diesel standby generator sets (life safety systems) equipped with engine jacket water coolant heaters in locations where the minimum ambient temperature is above 40°F (4°C). NFPA also requires that the engine jacket water coolant be maintained at a minimum of 90°F (32°C) and for most applications, accept the emergency load in 10 seconds or less. Although most generator sets will start in temperatures down to -25°F (-32°C) when equipped with engine jacket water coolant heaters, it might take more than 10 seconds to warm the engine up before a load can be

applied when ambient temperatures are below 40°F (4°C).

The **Engine Cold (Code 1435)** message, in conjunction with illumination of the Warning LED, is provided to meet the requirements of NFPA 110. The engine cold sensing logic initiates a warning when the engine jacket water coolant temperature falls below 70°F (21°C). In applications where the ambient temperature falls below 40°F (4°C), a cold engine may be indicated even though the coolant heaters are connected and functioning properly. Under these conditions, although the generator set may start, it may not be able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions may be necessary to warm the engine before applying a load.

## RUNNING AT IDLE (MANUAL)

**The Run At Idle mode is selectable only when the operator panel is mounted on the control panel assembly.**

The run mode can be set to Rated or Idle with the set running or not running. To manually select the engine idle function, the 0/Manual/Auto switch must be in the Manual position. Once selected and the set is manually started, the control will limit the engine idle time to 10 minutes. When the 10 minute idle cycle is complete, the genset will ramp to rated speed.

To activate the idle function, refer to page 3-15.

When the engine idle function is enabled, the control automatically sets lower oil pressure warning and shutdown trip points to reflect the lower operating speed. When the engine idle function is removed and the set reverts to normal operating speed, the control automatically resets oil pressure warning and shutdown trip points to the normal settings.



## STOPPING

### Emergency Stop (Code 1434)

The emergency stop button is located on the upper right side of control panel (Figure 3-1). Push the button in for emergency stop. The red Shutdown status LED will light, and the graphical display message will be: “EMERGENCY STOP  
1434 – SHUTDOWN”

To reset:

1. Pull the button out.
2. Move the 0/Manual/Auto switch to 0.
3. Press the front panel Fault Acknowledge button.
4. Select Manual or Auto, as required.

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

### Stopping at Switch Panel (Manual Mode)

If the set was started at the switch panel (0/Manual/Auto switch in the Manual position), pressing the Manual Run/Stop button will cause the set to complete its normal (Local Start) shutdown sequence (Figure 3-2).

The preset cool-down time (at rated speed) can vary dependent on the kW output. That is, if prior to shutdown, the kW is 10% or less of rated, the control software considers this output as cool-down and will subtract this time from the preset cool-down timer.

The set will stop after the Cool-down At Idle Timer (0 to 10 minutes) has timed out. (If necessary, the set will continue to run after time-out until coolant reaches normal operating temperature.)

Moving the 0/Manual/Auto switch to the 0 position will cause an immediate engine shutdown (bypass Cool-down At Idle) and display a Cool-down Interrupted Warning message. This hot shutdown should be avoided, if possible, to help prolong the

reliability of the engine. Hot shutdowns are logged in the system software.

### Stopping at Remote Operator Panel (Auto Mode)

When the operator panel is mounted remotely of the control panel assembly, the Stop button of the Control submenu can also be used to stop the generator set (0/Manual/Auto switch in the Auto position).

The function of this Stop button is identical to the Stopping from Remote Location (non-emergency sequence, Figure 3-2). Refer to Control Submenu (page 3-15) for additional information.

**The 0/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.**

### Stopping from Remote Location (Switch or Device) (Auto Mode)

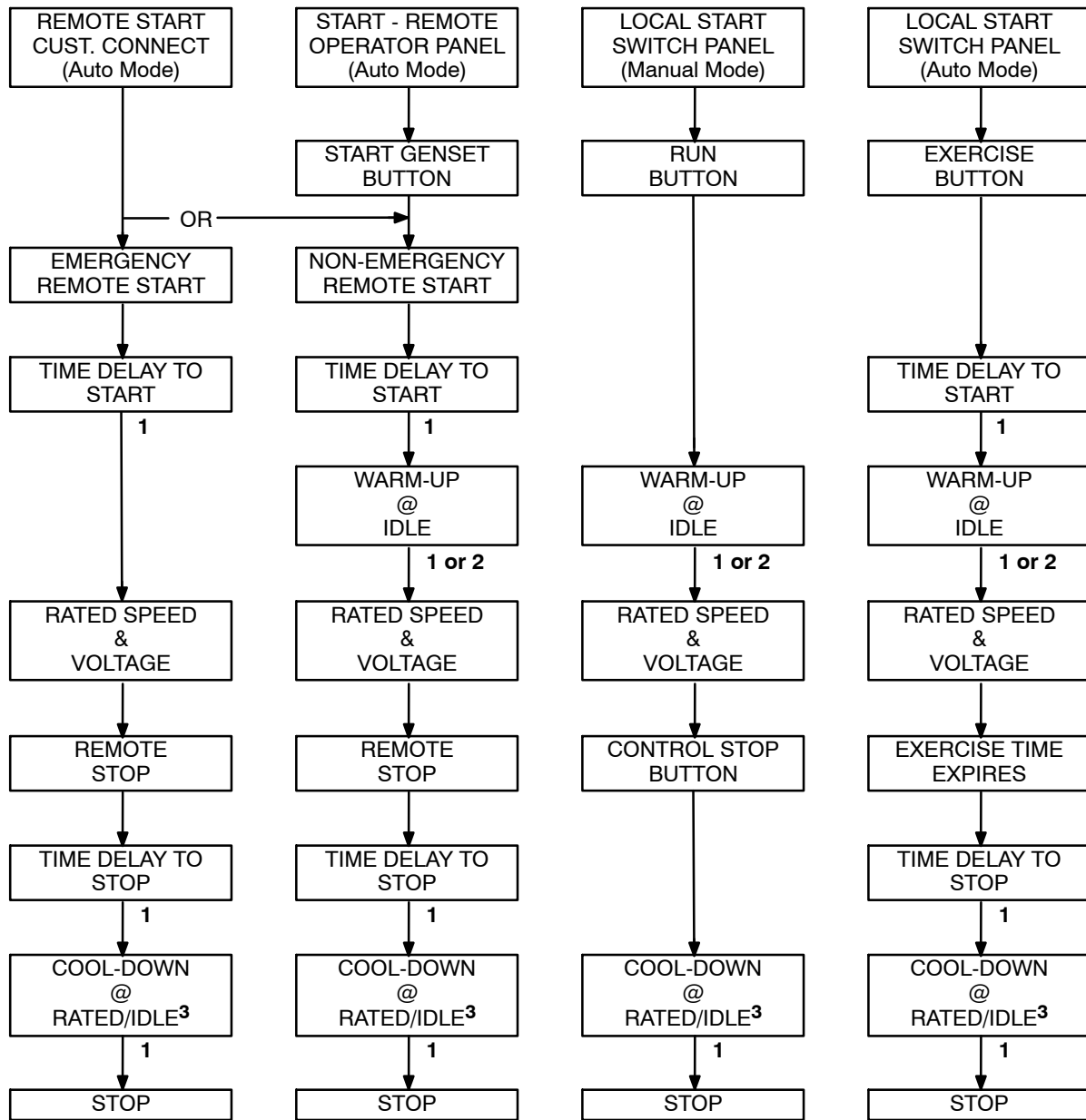
If the control receives a remote stop signal (0/Manual/Auto switch in the Auto position), the set will complete its normal shutdown sequence.

There are two start modes that are selectable for the remote start input, one for non-emergency start and the other for emergency start. Figure 3-2 illustrates how the start/run/stop sequence differs between the two modes. Note that the stop sequence is the same for either mode.

The set will stop after completing the following cool-down sequence:

- Time Delay To Stop (0 to 300 seconds)
- Cool-down At Idle (0 to 10 minutes) or longer, if necessary, to obtain normal operating temperature before shutdown.

**Refer to Adjust submenu in this section to change the Time Delay To Stop setting. The InPower service tool is required to modify the Cool-down At Idle. Contact an authorized service center for assistance.**



**NOTES:**

1. Timer expires.
2. Coolant temperature reaches operating level.
3. Cool-down can be at rated speed and/or idle with different time-outs for each.

**FIGURE 3-2. NORMAL START/RUN/STOP SEQUENCES**

## MENU DISPLAY AND SWITCHES

Figure 3-3 shows the graphical display and the menu selection buttons.

**Graphical Display:** The graphical display is capable of displaying up to 9-lines of data with approximately 27 characters per line. The display is used to view the menus of the menu-driven operating system. Refer to the menu trees later in this section. The display is also used to show the following system information:

- *State Line* – modes of operation, such as Stopped, Time Delay To Start, Warm Up At Idle, etc. (see Figure 3-2), and paralleling operations, such as Standby, Dead BUS Close, Synchronize, etc.
- *Action Line* – system actions, such as Warning, Derate, Shutdown Cool-down and Shutdown, and fault codes.

- *Description Line* – Fault code/status messages.

**Menu Buttons:** Six momentary buttons—three on each side of the graphical display window—are used to navigate through the system control menus and to adjust generator set parameters. The button is active when the message or symbol adjacent to the switch is highlighted (displayed in inverse video). The displayed message or symbol indicates the function of the button.

In the graphical display, the “▼” symbol indicates that selecting the adjacent button causes the operating program to go to the next menu display—as shown in the menu diagrams.

In the graphical display, the “▲” symbol indicates that selecting the adjacent button causes the operating program to go back to the previous menu display.

In the graphical display, the “⏪” symbol indicates that selecting the adjacent button causes the operating program to go back to Main Menu A (Figure 3-5).

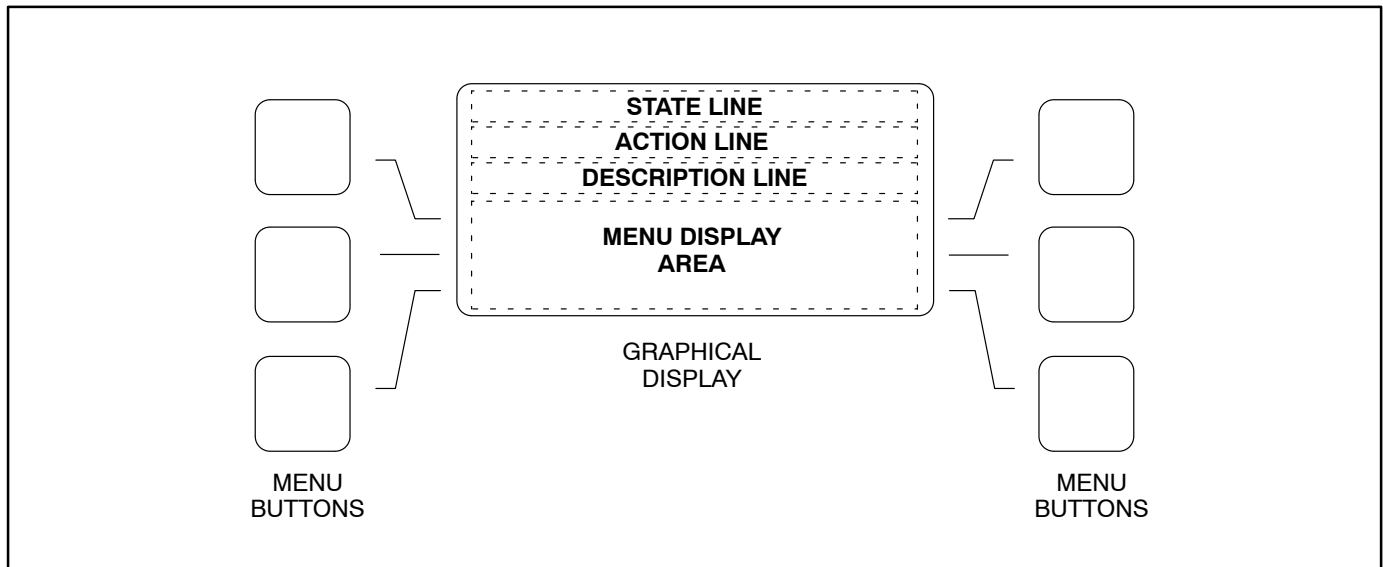


FIGURE 3-3. GRAPHICAL DISPLAY AND MENU SELECTION BUTTONS

## MENU UNITS SELECTION

During any control panel operation, you can change how units are displayed by pressing the two lower menu buttons (one on each side of display). When pressing these two buttons simultaneously, the units submenus will appear (Figure 3-4). After selecting the desired units, press the **ENTER** button in this submenu to change and save the selections.

**Use the + button to select the desired option for each field. Use the arrow (→) button to move to the next field. Selected field is highlighted.**

**Local/Remote Field:** This selection must be set to **Local** when the graphical display is mounted on the generator set front control panel or **Remote** when mounted remotely of the generator set.

The Local/Remote selection determines which buttons in the Control submenu (page 3-15) are active (displayed).

**Temp:** Used to select ° F or ° C for temperature readings.

**Pressure Fluid:** Used to select PSI, KPA, BAR or IN for pressure readings.

**Pressure Gas:** Used to select INHG or MMHG for pressure readings.

**Flow Air:** Used to select CFM or CMM for air flow readings.

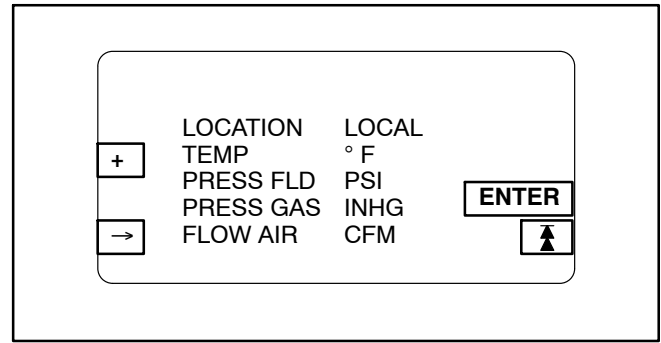


FIGURE 3-4. UNITS SUBMENU

## MAIN MENU



Figure 3-5 shows the main menus (Menu A and Menu B) of the system control. The two main menus are used to divide the system submenus into major categories, such as, Engine Data, Alternator Data, Control, etc.

To view system data, simply press the appropriate menu button to select the category. After pressing the desired menu button, refer to the page number shown in Figure 3-5 for detailed information related to the selected category.

**Adjust Button:** The Adjust submenu is intended for qualified site personnel only. Note that a password may be assigned to allow only authorized operators to modify this data. (Password is not required if not assigned.)



**Setup Button:** The Setup submenu is described in the *Service* manual and is intended for qualified service personnel only. For this reason, a password must be entered before this data can be modified.

The “Adjust” and “Setup” submenus can be viewed, but not modified without entering the correct passwords.

**\_/\_ Button:** (Paralleling applications only). Used to open and close the generator set circuit breaker (CB). The symbol indicates if the CB is opened or closed. Opened , push to close. Closed , push to open.

With the control panel **0/Manual/Auto** switch in the **Auto** position, the opening and closing of the CB is controlled by the control system software. The CB symbol will indicate an open or closed CB, but the button will be inactive when the control is in Auto.

In the **Manual** position, the CB can only be closed by using this button. When manually closed and the CB opens, it must be closed again by using this button. To close the CB, press and hold the button until the symbol indicates a closed CB. (CB close will occur only when setup conditions allow – dead bus or generator synchronized with bus.)

In the following figures, the boxed/highlighted field indicates that the adjacent menu button is active. Also, the submenus are shown in the order in which they are displayed when scrolling up  or down .

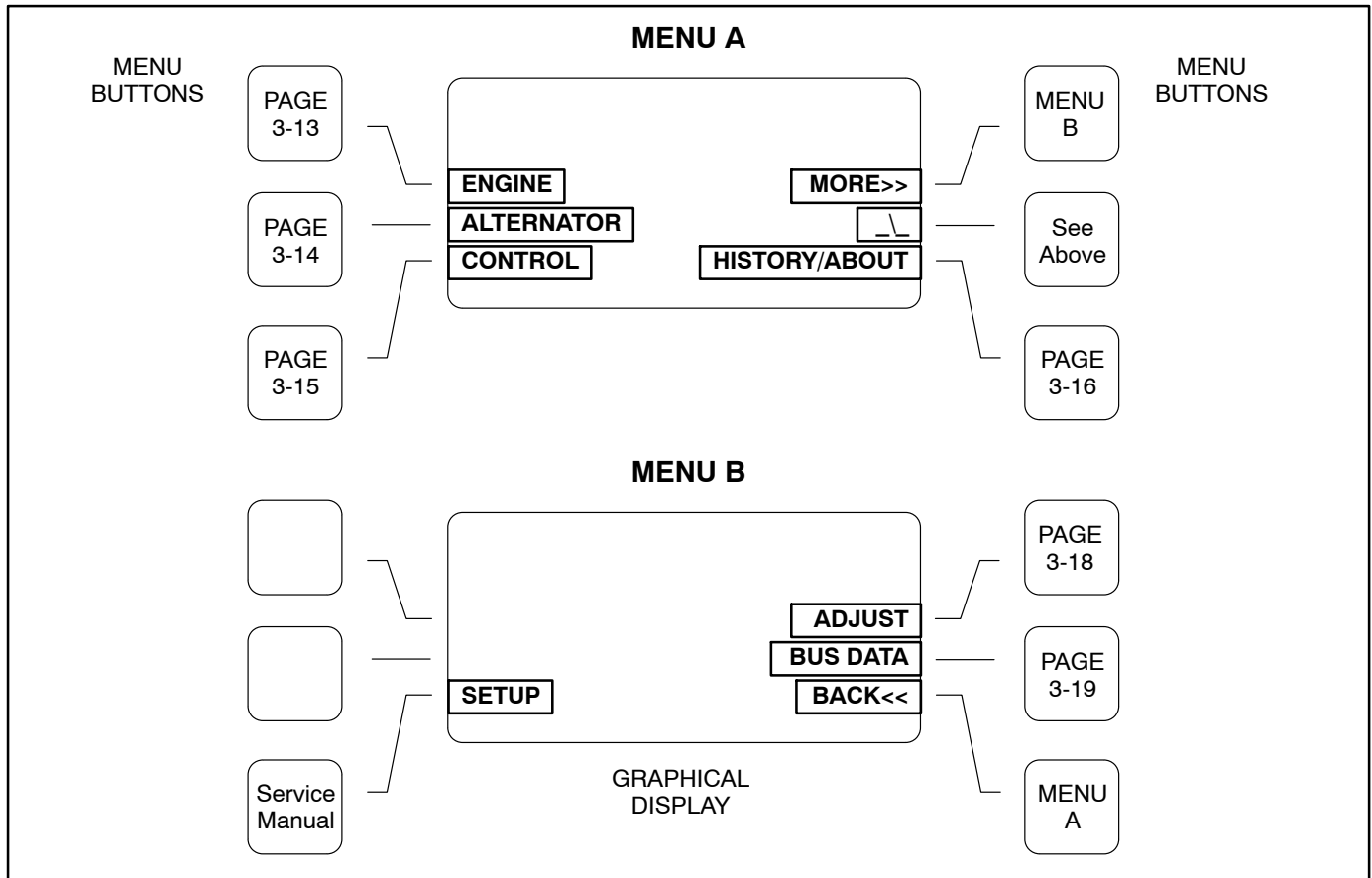
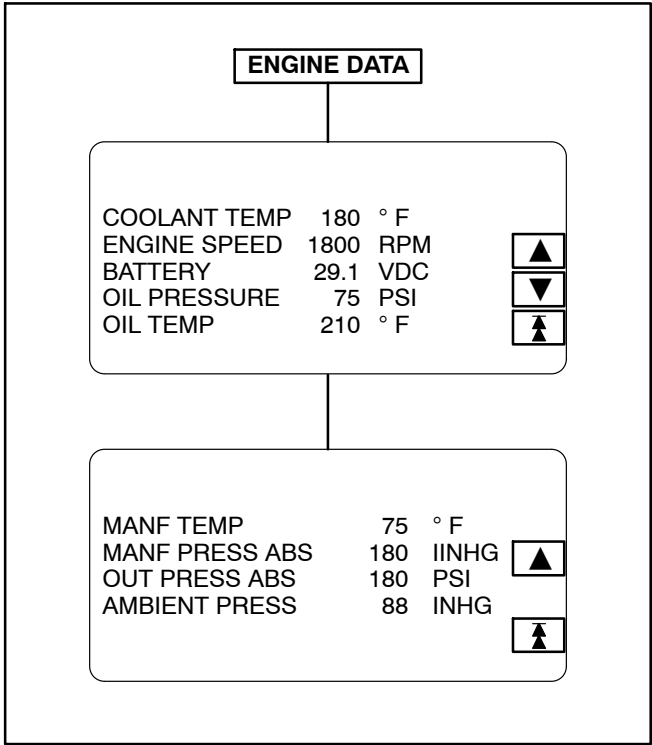


FIGURE 3-5. SYSTEM CONTROL MAIN MENUS A AND B

# ENGINE DATA SUBMENUS

If you press the "ENGINE DATA" button in Menu A, the Engine Data submenus will appear (Figure 3-6).

The first submenu displays general information that applies to all gensets (coolant temp, oil pressure, etc.) The data in the remaining submenu(s) will vary according to the type and number of sensors provided with the engine.



**FIGURE 3-6. ENGINE SUBMENUS**

## ALTERNATOR DATA SUBMENUS

If you press the “ALTERNATOR DATA” button in Menu A, the Alternator Data submenus will appear (Figure 3-7).

**Voltage L-L and L-N:** Indicates voltage Line-to-Line and Line-to-Neutral. Note that the Line-to-Neutral column will not be displayed for a 3 phase/3 wire system. Accuracy 1%.

The voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.

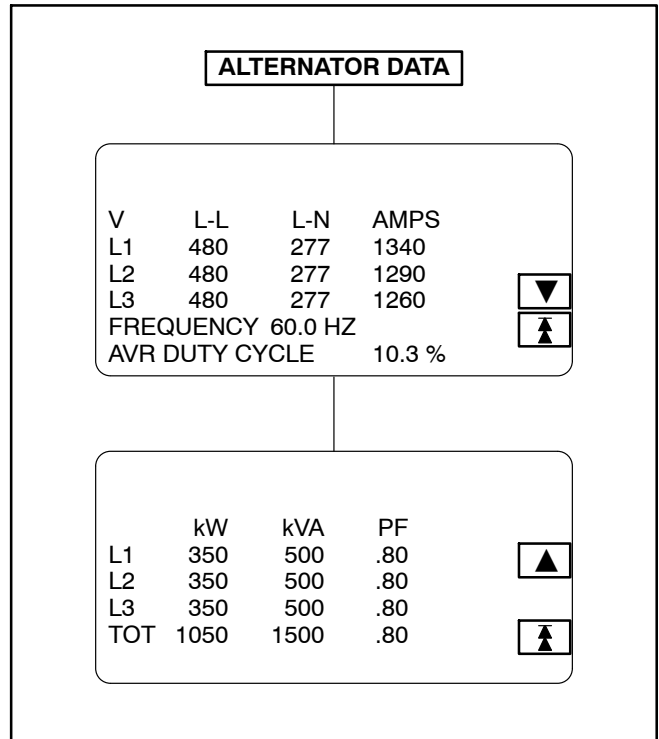
**Amps:** All phases. Accuracy 1%.

**Frequency:** Generator set output frequency.

**AVR DUTY CYCLE:** Displays voltage regulator (drive) level in percentage of maximum.

**kW, kVA and PF:** Displays generator set kW and kVA output (average and individual phase, and direction of flow) and power factor with leading/lagging indication. Accuracy 5%.

The PF reading will contain an asterisk if the power factor is leading (for example, \*.30).



**FIGURE 3-7. ALTERNATOR DATA SUBMENUS**

## CONTROL SUBMENU

If you press the “CONTROL” button in Menu A, the Control submenu will appear (Figure 3-8).

### Local CONTROL Submenu Function

When the operator panel is mounted on the control panel assembly, the Run Mode Idle/Rated button is active (displayed). Note in Figure 3-8 that this button is not displayed in remote applications.

The shaded area in Figure 3-8 displays the selected/active mode of operation, either IDLE or RATED.

**Run Mode Idle/Run At Rated Button:** Refer to Page 3-7 for a complete description of the Run At Idle mode.

### Remote CONTROL Submenu Functions

When the operator panel (Figure 3-1) is mounted remotely of the control panel assembly, the menu buttons in the Control submenu are used to perform the following remote operations. (To activate these menu buttons for remote/local use, refer to page 3-11.)

**The 0/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.**

**Remote START or STOP Button:** This button is used to start and stop the generator set when the operator panel is mounted in a remote location. For additional information refer to Starting at Remote Operator Panel (page 3-6) and Stopping at Remote Operator Panel (page 3-8).

When the generator set is operating, **Stop** will be displayed for this button and **Start** will be displayed when not operating.

**Fault Acknowledge Button:** Used to reset inactive Warning messages, not Shutdown messages.

### Local/Remote CONTROL Submenu Function

**Bargraph Test:** The function of this button remains the same and is not dependent on operator panel location. This button sequentially lights the LEDs to test the bar graph display.

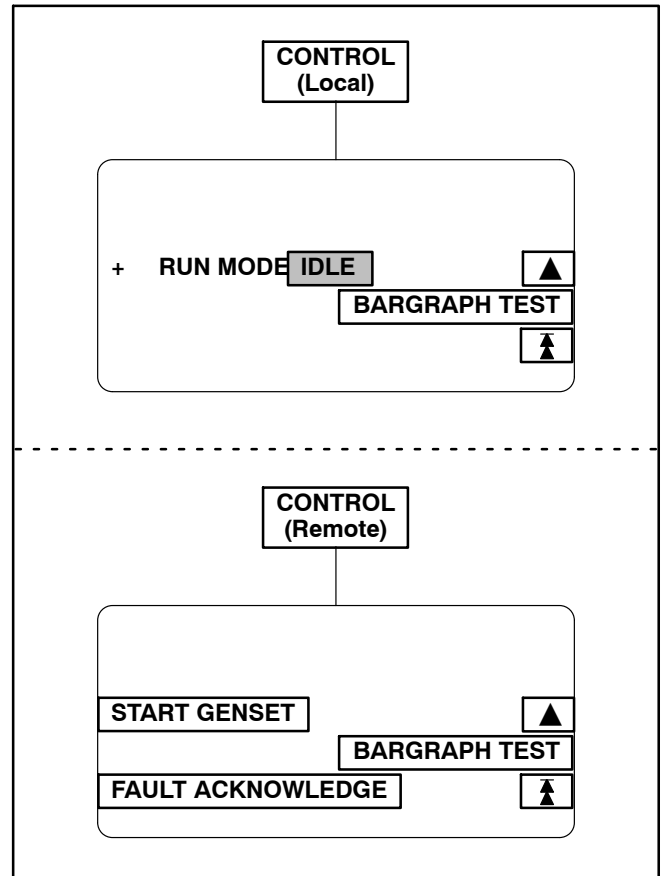


FIGURE 3-8. CONTROL SUBMENU



## HISTORY/ABOUT SUBMENUS

If you press the “HISTORY/ABOUT” button in Menu A, the History/About submenus will appear (Figure 3-9).

**HISTORY:** The control maintains a data log of the number of engine starts and number of operating hours for the engine and control, and the megawatt and maximum torque hours of the generator set. This information is stored in non-volatile memory and will not be deleted due to loss of battery power.

**ABOUT:** The About submenus provide the following generator set information.

- Genset model and wattage (kW/MW)
- Output voltage and WYE, DELTA or SINGLE
- Frequency 50 or 60 Hz
- Rating: Standby, Prime or Base
- Version level of the controller and panel operating software.

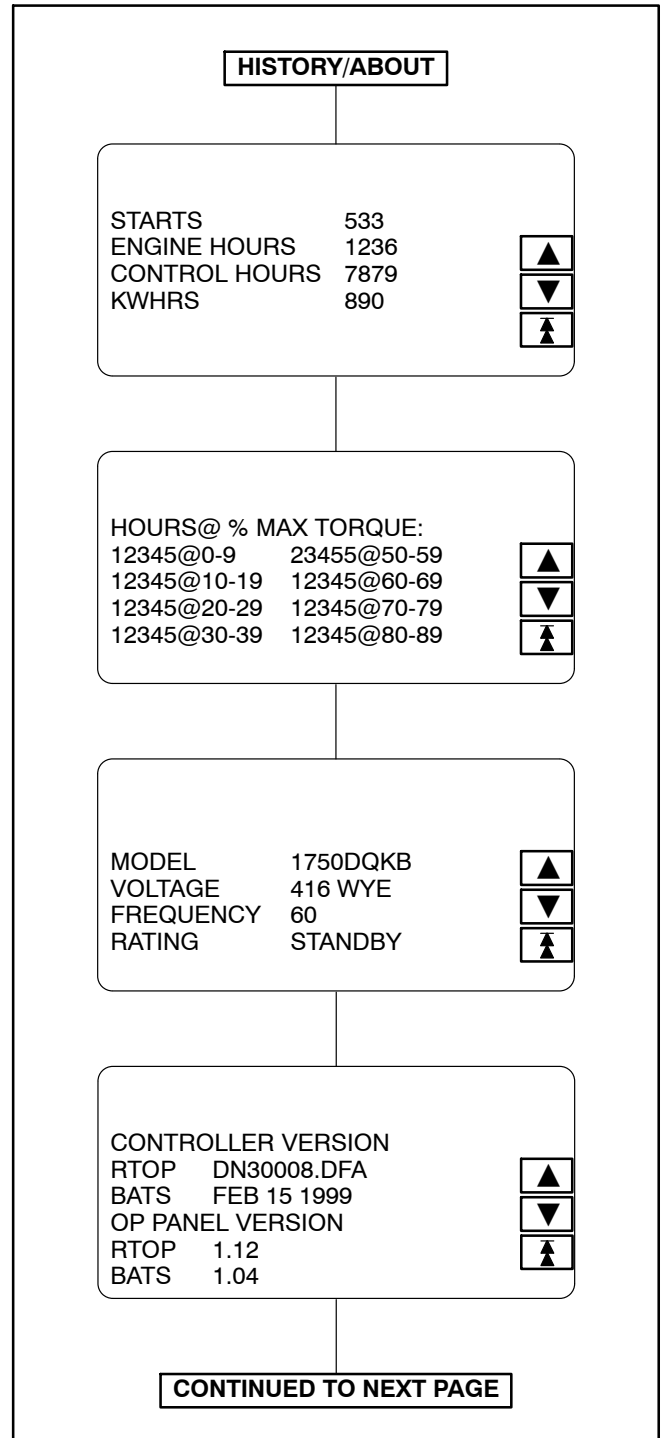


FIGURE 3-9. HISTORY/ABOUT SUBMENUS

## HISTORY/ABOUT SUBMENU (CONT.)

**FAULT HISTORY:** The control maintains a data log of all fault conditions as they occur, and time stamps them with the control and engine operating hours.

Up to 32 (unacknowledged) fault codes can be stored in control panel memory. After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log that maintains a fault code history. (The InPower service tool is required to view this data log.)

The *Fault History* display line: 1 of 24 indicates that 24 faults are recorded and that the most recent fault (1) detected by the controller is displayed.

The *Occurrences* display line: In this example, 5 indicates that this is the fifth occurrence of this fault. (The InPower service tool is required to review the last four faults of this code.)

**The Occurrences number is incremented for each new occurrence of the same fault. The controller must detect that the original sensed fault is corrected before it will increment the occurrence number for that fault.**

For example, when a Low Oil Pressure fault is detected, the controller will increment the Occurrences number by 1. This fault will remain active until the controller detects that the fault is corrected. An active fault will prevent the controller from incrementing the Occurrences number each time the engine is started. When the controller detects that the oil pressure is normal the fault will become inactive, allowing the occurrences number to be incremented for the next detected Low Oil Pressure fault.

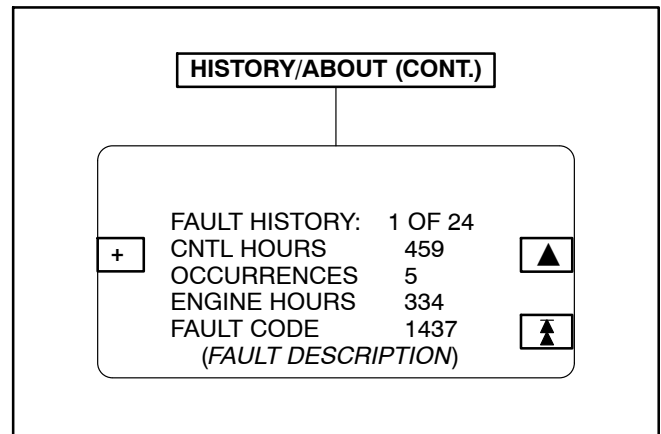


FIGURE 3-9. HISTORY/ABOUT SUBMENU (CONT.)

## ADJUST SUBMENU

If you press the “ADJUST” button in Menu B, the Adjust submenu will appear (Figure 3-10).

The Adjust submenu is intended for qualified service personnel and site personnel only and may require a **USER** password. If a password is required, the **USER** password menu will appear when you try to modify the Adjust submenu. (Refer to *PASSWORD Menu* in this section to enter password.)

Changes are automatically saved when you exit this menu.

**Use the + and - buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Selected field is highlighted.**

**VOLTAGE:** Used to adjust the output voltage  $\pm 5\%$ .

**FREQUENCY:** Used to adjust the frequency  $\pm 3$  Hz.

**START DELAY:** This delay applies only to remote starting in the Auto mode. The Start Delay adjustment range is 0 to 300 seconds.

**STOP DELAY:** This delay applies only to remote stopping in the Auto mode. The Stop Delay adjustment range is 0 to 600 seconds.

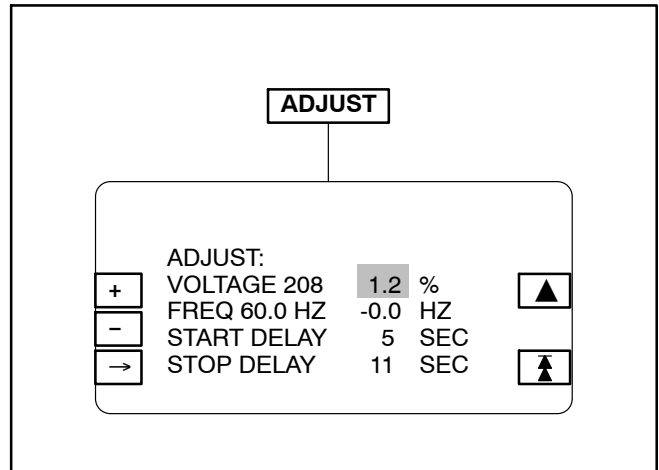


FIGURE 3-10. ADJUST SUBMENU

## BUS DATA SUBMENU

If you press the “BUS DATA” button in Menu B, the Bus Data submenu will appear (Figure 3-11). This menu is displayed in paralleling applications only.

**BUS DATA STATUS LINE:** The top line of the graphical display is used to indicate the following BUS DATA status:



- STANDBY
- DEAD BUS CLOSE: Indicates first genset in system to close to bus.
- SYNCHRONIZE: Genset is synchronizing to bus.
- LOAD SHARE: Genset has closed to bus and is sharing load with other gensets in system.
- LOAD GOVERN: Genset closed to bus in parallel with utility (mains).

**BUS Voltage L-L:** The BUS voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.

**BUS/GEN HZ:** BUS/GEN hertz.

**BUS/GEN SYNC STATUS:** The bottom line of the graphical display is used to indicate the following BUS/GEN Sync status:

- NOT SYNCHRONIZING: Genset is in service mode that does not allow auto sync feature.
- SYNCHRONIZING: Genset is synchronizing to bus.
- READY TO CLOSE: In manual mode, push circuit breaker close button to close breaker.

**Button:** (Paralleling applications only). Used to open and close the generator set circuit breaker (CB). The symbol indicates if the CB is opened or closed. Opened , push to close. Closed , push to open.

With the control panel **0/Manual/Auto** switch in the **Auto** position, the opening and closing of the CB is controlled by the control system software. The CB symbol will indicate an open or closed CB, but the button will be inactive when the control is in **Auto**.

In the **Manual** position, the CB must be closed by this button. When manually closed and the CB opens, it must be closed again by using this button. To close the CB, press and hold the button until the symbol indicates a closed CB. (CB close will occur only when setup conditions allow – dead bus or generator synchronized with bus.)

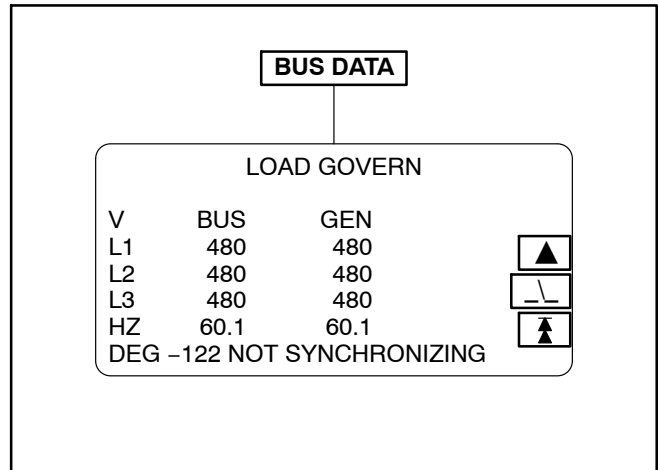


FIGURE 3-11. BUS DATA SUBMENU

## PASSWORD Menu

When viewing the Adjust submenu, pressing either the + or – button will display the Password menu (Figure 3-12) if a **User** password is assigned to this field. After entering the correct password, the system will allow you to modify the submenu. To prevent unauthorized adjustment, the entered password is valid for only 10 minutes after the last button is pressed.

**Application Password is intended only for qualified service personnel to allow adjustment of Setup submenu parameters.**

To enter the password:

1. Display Adjust submenu.
2. Press either the + or – button within the displayed submenu. The Password menu appears. (Adjustment is allowed if Password menu does not appear.)
3. Press the + and – button to select the first character of the **User** password (A–Z or 0–9).
4. Press the → button to select the next character field. Selected character field is highlighted.
5. Repeat steps 3 and 4 to enter remaining password characters.
6. Press the **Enter** button after entering the password. The Adjust submenu will reappear.
7. Exit Adjust submenu to save changes.

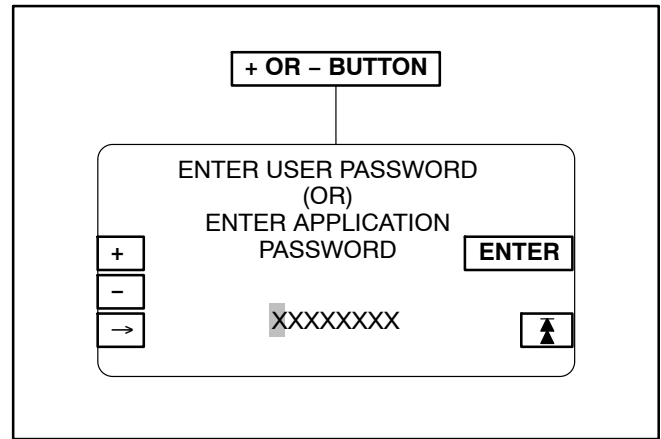


FIGURE 3-12. PASSWORD MENU

# 4. Troubleshooting

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## GENERAL

The genset 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 graphical display panel.

In the event of an engine shutdown fault (red Shutdown lamp), the control will stop the engine immediately; an alternator shutdown fault, the engine will stop after the cool-down timer has timed out. If the generator set is stopped for this reason, the operator can restart the set after making adjustments or corrections. This section lists the warning and shutdown codes/messages (Table 4-1), and suggests troubleshooting procedures (Table 4-2).

Displayed error codes that are not listed in Table 4-2 will require an authorized service representative to correct the fault. Contact an authorized service center for assistance.

## SAFETY CONSIDERATIONS

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

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

**⚠WARNING** *Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch 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.*

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

1. Move the O/Manual/Auto switch on the control panel to the O (off) position.
2. Turn off or remove AC power from the battery charger.
3. Remove the negative (-) battery cable from the generator set starting battery.

## STATUS INDICATORS

**Not In Auto Indicator:** This red lamp flashes continuously when the O/Manual/Auto switch is not in the Auto position (Figure 4-1).

**Shutdown Status Indicator:** This red lamp is lit whenever the control detects a shutdown condition. After the condition is corrected, the shutdown indicator can be reset by turning the O/Manual/Auto switch to the O position, and pressing the Fault Acknowledge button. The generator set can not be started when this lamp is on.

**Warning Status Indicator:** This yellow lamp is lit whenever the control detects a warning condition. After the condition is corrected, the warning indicator can be reset by pressing the Fault Acknowledge button. (It is **not** necessary to stop the generator set if the fault becomes inactive during genset operation.)

## READING FAULT CODES

If the genset contains the optional graphical display and a fault occurs, the fault code/message will be displayed in the display Description Line (Figure 4-1). If the control does not contain the graphical display, the fault code is read from the Warning and Shutdown status indicators.

After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log to maintain a fault code history. The InPower service tool is required to view this data log.

**Reading Fault Codes Using Graphical Display (Optional):** The top three lines of the graphical display contain the following control information in the order described:

- *State Line* – modes of operation, such as Stopped, Time Delay To Start, Warm Up At Idle, etc. (see Figure 3-2), and paralleling operations, such as Standby, Dead BUS Close, Synchronize, etc.
- *Action Line* – system actions, such as Warning, Derate, Shutdown Cool-down and Shutdown, and fault codes.
- *Description Line* – Fault code messages.

Refer to *History/About Submenus* in *Section 3*, which describes how to view fault codes using graphical display.

**Reading Fault Codes Using Warning/Shutdown Indicators:** If the Warning or Shutdown status indicator is lit, press and hold the Fault Acknowledge button and release after one second or more. After one second, the Shutdown lamp will begin to blink the active fault code(s) as follows.

The Warning lamp is used to indicate the start of a new code. The Warning lamp will remain on for 2 seconds, followed by the Shutdown lamp blinking the fault code. This sequence occurs three times for

each code. The fourth flash of the Warning lamp indicates the beginning of the second fault code.

There are distinct pauses between repetitions of the code blink transmissions of the Shutdown lamp.

A three digit fault code is indicated by three sets of blinks separated by a two second pause. The first set corresponds to the hundreds position, the second to the tens position and the third to the ones digit. Example for Code No. 213:

### Shutdown LED:

*blink-blink-pause-blink-pause-blink-blink-blink*

### Warning LED:

*blink (2 seconds)*

The light will display the fault codes (active or inactive) in succession, starting with the most recent. Up to 32 (unacknowledged) fault codes can be stored in control panel memory.

To return the control to the most recent fault code, press and release the Fault Acknowledge button (less than one second) and repeat procedure.

When the fault code is acknowledged and the fault condition is corrected, the fault code will be removed from the LED fault log.

## LINE CIRCUIT BREAKER (OPTIONAL)

The optional line circuit breaker mounts on the generator output box. If the load exceeds the generator current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator.

## CONTROL AND DIAGNOSTICS VIA NETWORK OR PC (LAPTOP)

See your authorized Onan dealer regarding software, hardware and network requirements for control and diagnostics via network or PC.

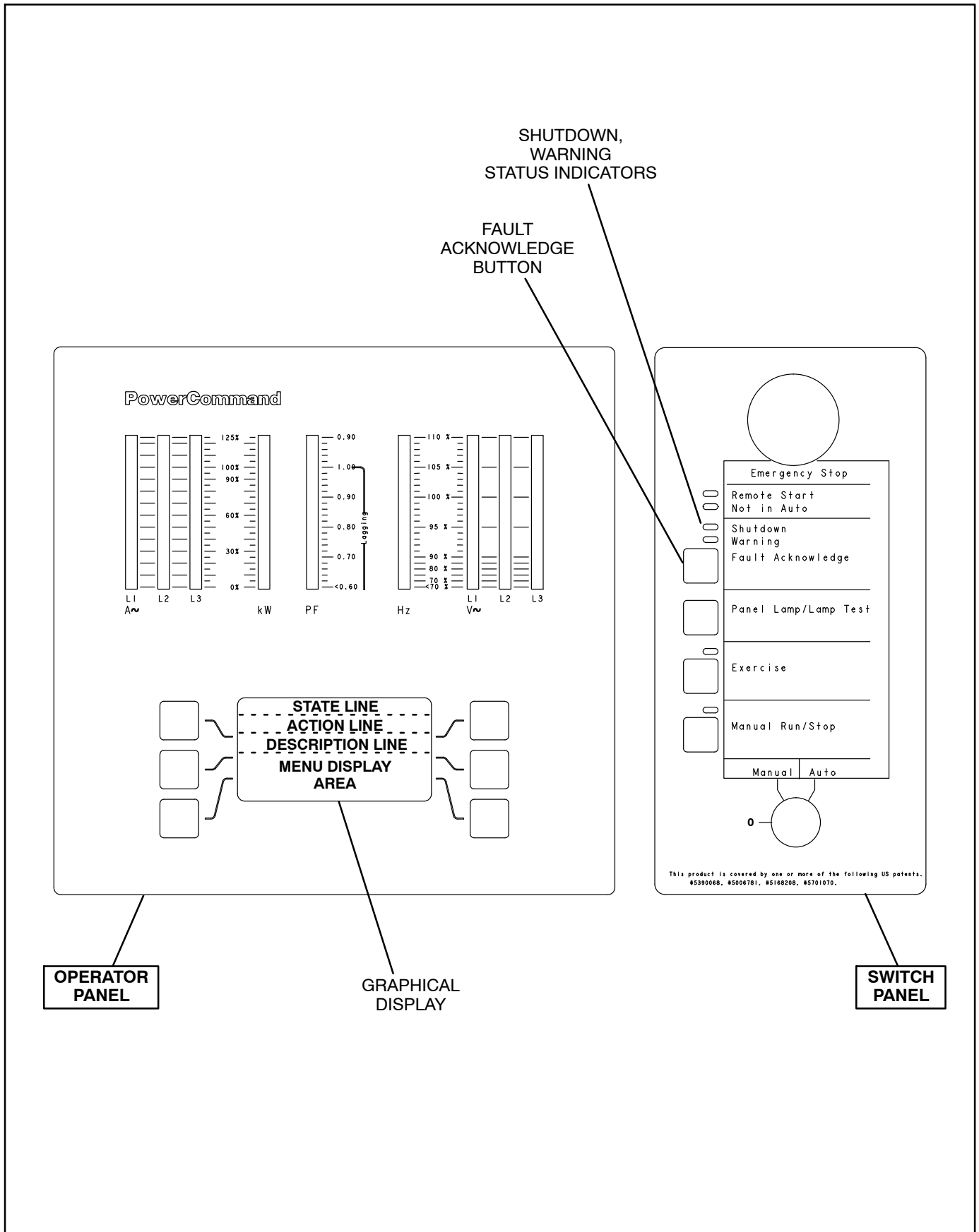


FIGURE 4-1. FRONT CONTROL PANEL (FULL-FEATURED)



## FAULT CODES

Table 4-1 lists the fault codes that can be displayed for all genset models that use this control. For this reason, some of the codes in this table will not apply to your genset model. Also note that there are gaps in the code numbers. These gaps are provided for future updates (new genset models).

The fault codes have been divided into four categories to help you determine what corrective action to take for safe operation of the generator set. Use Table 4-1 to find the category (CAT) and fault description for all codes.

**Category A Fault Codes:** Pertain to engine or alternator shutdown faults that require immediate repair by qualified service personnel (generator set non-operational). Control prevents the generator set from being restarted.

**Category B Fault Codes:** Consist of faults that can affect genset performance or cause **engine, alternator, or connected equipment damage**. Operate only when generator set is powering critical loads and cannot be shut down. Requires repair by qualified service personnel.

**Category C Fault Codes:** Consist of faults that do not affect generator set performance but require qualified service personnel to repair. These codes indicate a defective sensor or harness, leaving no engine protection. (Engine damage can occur without detection.) **Continued operation may void generator set warranty if damage occurs that relates to fault condition.**

**Category D Fault Codes:** Consist of faults that are repairable by site personnel. Service will be required by qualified service personnel if site personnel cannot resolve the problem after taking the corrective actions suggested in Table 4-2.

**TABLE 4-1. FAULT CODES**

CAT	CODE	LAMP	DISPLAYED MESSAGE
A	111	Shtdn	Internal ECM error
A	112	Shtdn	Actuator not responding
B	113	Wrng	Actuator sensor fault
A	115	Shtdn	No speed signal
A	116	Shtdn	Time press sensor high
A	117	Shtdn	Time press sensor low
B	118	Wrng	Pump press sensor high
B	119	Wrng	Pump press sensor low
C	121	Wrng	No engine speed signal
B	122	Wrng	Manifold air press sensor
B	123	Wrng	Manifold air press sensor
C	135	Wrng	Oil pressure sensor
C	141	Wrng	Oil pressure sensor
B	143	Wrng	Low oil pressure
C	144	Wrng	Coolant temperature sensor
C	145	Wrng	Coolant temperature sensor
D	146	Wrng	High coolant temp warning
C	151	Shtdn	High coolant temp alarm
D	152	Wrng	Low coolant temp
C	153	Wrng	Manifold air temp sensor
C	154	Wrng	Manifold air temp sensor
A	155	Shtdn	Manifold air temp alarm
D	197	Wrng	Coolant level warning
C	212	Wrng	Oil temperature sensor
C	213	Wrng	Oil temperature sensor
A	214	Shtdn	High oil temperature
C	221	Wrng	Air pressure sensor
C	222	Wrng	Air pressure sensor
A	228	Shtdn	Low coolant pressure
C	231	Wrng	Coolant pressure sensor
C	232	Wrng	Coolant pressure sensor
A	233	Wrng	Coolant pressure warning
A	234	Shtdn	Overspeed
D	235	Shtdn	Coolant level alarm
A	236	Shtdn	Position sensor
D	253	Shtdn	Oil level alarm

CAT	CODE	LAMP	DISPLAYED MESSAGE
A	254	Shtdn	Fuel shutoff valve
C	259	Wrng	Fuel shutoff valve
C	261	Wrng	Fuel temperature sensor
C	263	Wrng	Fuel temperature sensor
C	265	Wrng	Fuel temperature sensor
A	266	Shtdn	Fuel temperature
B	316	Wrng	Fuel supply pump
B	318	Wrng	Fuel supply pump
D	326	Wrng	Oil level warning
B	343	Wrng	Internal ECM error
D	359	Wrng	Engine failed to start
A	378	Wrng	Fueling actuator #1
A	379	Wrng	Fueling actuator #1
A	394	Wrng	Fueling actuator #1
A	395	Wrng	Fueling actuator #1
A	396	Wrng	Fueling actuator #2
A	397	Wrng	Fueling actuator #2
A	398	Wrng	Fueling actuator #2
A	399	Wrng	Fueling actuator #2
B	415	Shtdn	Low oil pressure alarm
B	421	Wrng	High oil temperature
B	423	Wrng	Fuel timing
D	441	Wrng	Low battery voltage
D	442	Wrng	High battery voltage
B	449	Wrng	High fuel supply pressure
B	451	Wrng	Fuel rail pressure sensor
B	452	Wrng	Fuel rail pressure sensor
A	455	Shtdn	Fuel control valve sensor
B	467	Wrng	Timing rail act sensor
B	468	Wrng	Fuel rail actuator sensor
D	471	Wrng	Low oil level
B	482	Wrng	High fuel supply pressure
B	488	Wrng	High intake manifold temp
C	498	Wrng	Oil level sensor
C	499	Wrng	Oil level sensor
A	514	Shtdn	Fuel control valve

**TABLE 4-1. FAULT CODES (CONT.)**

CAT	CODE	LAMP	DISPLAYED MESSAGE
B	546	Wrng	Fuel pressure sensor
B	547	Wrng	Fuel pressure sensor
B	554	Wrng	Fuel rail pressure sensor
B	555	Wrng	Blowby pressure
A	556	Shtdn	Blowby pressure
A	586	Shtdn	Run/Stop switch
A	587	Shtdn	Run/Stop switch
D	611	Wrng	Engine hot
D	688	Shtdn	High oil level alarm
B	689	Wrng	Crank shaft sensor
B	719	Wrng	Blowby pressure sensor
B	729	Wrng	Blowby pressure sensor
B	731	Wrng	Cam/Crank Misalignment
B	778	Wrng	Camshaft sensor
NA	1311	Shtdn/ Wrng	Customer input #1
NA	1312	Shtdn/ Wrng	Customer input #2
NA	1313	Shtdn/ Wrng	Network Fault 1
NA	1314	Shtdn/ Wrng	Network Fault 2
NA	1315	Shtdn/ Wrng	Network Fault 3
NA	1316	Shtdn/ Wrng	Network Fault 4
NA	1317	Shtdn/ Wrng	Customer input #3
NA	1318	Shtdn/ Wrng	Customer input #4
B	1319	Wrng	High alternator temp
C	1321	Wrng	Common warning driver
A	1322	Shtdn	Load gov kW setpoint oor hi
A	1323	Shtdn	Load gov kW setpoint oor lo
B	1324	Wrng	Load gov kVAR oor hi
B	1325	Wrng	Load gov kVAR oor lo
B	1326	Wrng	Backup starter disconnect
A	1327	Shtdn	Load gov kW analog oor
D	1328	Wrng	Genset CB tripped

CAT	CODE	LAMP	DISPLAYED MESSAGE
B	1329	Wrng	AVR DC power failure
A	1331	Shtdn	AVR driver shorted
A	1332	Shtdn	Manual switch oor lo
A	1333	Shtdn	Manual switch oor hi
A	1334	Shtdn	Critical scaler oor
B	1335	Wrng	Non critical scaler oor
NA	1336	Shtdn	Cooldown complete
NA	1337	None	Network wink
NA	1341	Shtdn	Load demand stop
A	1342	Shtdn	Slot 0 card
A	1343	Shtdn	Slot 1 card
A	1344	Shtdn	Slot 2 card
A	1345	Shtdn	Slot 3 card
A	1346	Shtdn	Slot 4 incorrect
A	1347	Shtdn	Slot 5 card
A	1348	Shtdn	Slot 6 card
A	1349	Shtdn	Slot 7 card
C	1351	Wrng	Slot 4 / network enabled
C	1414	Wrng	Run relay contact
C	1415	Wrng	Run relay driver
D	1416	Wrng	Fail to shutdown
D	1417	Wrng	Power down error
B	1419	Wrng	Fuel rail driver
B	1421	Wrng	Timing rail driver #1
B	1422	Wrng	Timing rail driver #2
C	1424	Wrng	High side driver
C	1427	Wrng	Overspeed relay driver
C	1428	Wrng	LOP shutdown relay driver
D	1433	Shtdn	Emergency stop – local
D	1434	Shtdn	Emergency stop – remote
D	1435	Wrng	Engine cold
B	1436	Wrng	PT fuel system drivers
A	1437	Shtdn	E-stop path fuse blown
D	1438	Wrng	Fail to crank
D	1439	Wrng	Fuel level low in day
D	1441	Wrng	Fuel level low in main

**NA**– Indicates non-critical operational status of generator set, external faults, or customer fault inputs. May require repair by qualified service personnel.

**TABLE 4-1. FAULT CODES (CONT.)**

CAT	CODE	LAMP	DISPLAYED MESSAGE
D	1442	Wrng	Battery is weak
D	1443	Wrng	Battery is dead
B	1444	Wrng	kW overload
A	1445	Shtdn	Alternator short circuit
A	1446	Shtdn	AC output voltage is high
A	1447	Shtdn	AC output voltage is low
A	1448	Shtdn	AC output frequency low
A	1449	Wrng	AC output frequency high
B	1451	Wrng	Gen/Bus voltage differ
A	1452	Shtdn	Gen CB failed to close
A	1453	Shtdn	Gen CB failed to open
C	1454	Wrng	Gen CB position contact
A	1455	Shtdn	Util CB contact
NA	1456	Wrng	Bus out of range
NA	1457	Wrng	Fail to synchronize
NA	1458	Wrng	Phase rotation
A	1459	Shtdn	Reverse kW
A	1461	Shtdn	Loss of field
B	1462	Wrng	High ground current
NA	1463	None	Not in Auto
NA	1464	None	Load dump
NA	1465	None	Ready to load
C	1466	Wrng	Modem failure
C	1467	Wrng	Unable to connect modem
C	1468	Wrng	Network error
B	1471	Wrng	High current
A	1472	Shtdn	Overcurrent

CAT	CODE	LAMP	DISPLAYED MESSAGE
A	1473	Shtdn	Watchdog failure
A	1474	Shtdn	Software version mismatch
C	1475	Wrng	First start backup
C	1476	Wrng	LonWorks card
C	1477	Wrng	Crank relay contact
C	1478	Wrng	Crank relay driver
A	1481	Shtdn	AVR driver open
NA	1483	None	Common alarm status
A	1485	Shtdn	EFC driver shorted
A	1486	Shtdn	EFC driver open
C	1487	Wrng	Auto acknowledge driver
C	1488	Wrng	Warning LED driver
C	1489	Wrng	Shutdown LED driver
C	1491	Wrng	Ready to load relay driver
C	1492	Wrng	Load dump relay driver
C	1493	Wrng	Display control driver
C	1494	Wrng	Modem power relay driver
C	1495	Wrng	Common shutdown2 driver
C	1496	Wrng	Auto mode relay driver
C	1497	Wrng	Manual run LED driver
C	1498	Wrng	Exercise run LED driver
C	1499	Wrng	Remote start LED driver
C	2111	Wrng	Aftercooler temp sensor
C	2112	Wrng	Aftercooler temp sensor
B	2113	Wrng	High aftercooler temp
A	2114	Shtdn	High aftercooler temp

**NA**– Indicates non-critical operational status of generator set, external faults, or customer fault inputs. May require repair by qualified service personnel.

**TABLE 4-2. WARNING AND SHUTDOWN CODES**

<p><b>⚠WARNING</b> <i>Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and mechanical hazards should perform service procedures. Review safety precautions.</i></p>	
<b>SYMPTOM</b>	<b>CORRECTIVE ACTION</b>
<p>CODE: <b>146</b> LAMP: <b>Warning</b> MESSAGE: <b>HIGH COOLANT TEMP WARNING</b></p>	<p>Indicates engine has begun to overheat and engine coolant temperature has risen to an unacceptable level. If generator is powering non-critical and critical loads and cannot be shut down, use the following:</p> <ol style="list-style-type: none"> <li>Reduce load if possible by turning off non-critical loads.</li> <li>Check air inlets and outlets and remove any obstructions to airflow.</li> </ol> <p>If engine can be stopped, follow <b>151 High Coolant Temp Alarm</b> procedure.</p>
<p>CODE: <b>151</b> LAMP: <b>Shutdown</b> MESSAGE: <b>HIGH COOLANT TEMP ALARM</b></p>	<p>Indicates engine has overheated (engine coolant temperature has risen above the shutdown trip point or the coolant level is low. Allow engine to cool down completely before proceeding with the following checks:</p> <ol style="list-style-type: none"> <li>Check jacket water coolant level and replenish if low. Look for coolant leakage and repair if necessary.</li> <li>Check for obstructions to cooling airflow and correct as necessary.</li> <li>Check fan belt and repair if necessary.</li> <li>Reset control and restart after locating and correcting problem.</li> </ol>
<p>CODE: <b>152</b> LAMP: <b>Warning</b> MESSAGE: <b>LOW COOLANT TEMP</b></p>	<p>Indicates engine coolant heater is not operating or is not circulating coolant. Set is in standby mode but is not operating. Warning occurs when engine jacket water coolant temperature is 70° F (21° C) or lower.</p> <p><b>NOTE: 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.</b></p> <p>Check for the following conditions:</p> <ol style="list-style-type: none"> <li>Coolant heater not connected to power supply. Check for blown fuse or disconnected heater cord and correct as required.</li> <li>Check for low jacket water coolant level and replenish if required. Look for possible coolant leakage points and repair as required.</li> </ol>
<p>CODE: <b>197</b> LAMP: <b>Warning</b> MESSAGE: <b>COOLANT LEVEL WARNING</b></p>	<p>Indicates engine coolant level has fallen to an unacceptable level. If generator is powering critical loads and cannot be shut down, wait until next shutdown period, then follow <b>235 Coolant Level Alarm</b> procedure. If engine can be stopped, follow <b>235</b> procedure.</p>
<p>CODE: <b>235</b> LAMP: <b>Shutdown</b> MESSAGE: <b>COOLANT LEVEL ALARM</b></p>	<p>Indicates engine coolant level has fallen below the alarm trip point. Allow engine to cool down completely before proceeding.</p> <ol style="list-style-type: none"> <li>Check jacket water coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.</li> <li>Reset control and restart after locating and correcting problem.</li> </ol>

**TABLE 4-2. WARNING AND SHUTDOWN CODES (CONT.)**

<p><b>⚠WARNING</b> <i>Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and mechanical hazards should perform service procedures. Review safety precautions.</i></p>	
<b>SYMPTOM</b>	<b>CORRECTIVE ACTION</b>
<p>CODE: <b>359</b>                      LAMP: <b>Warning</b>                      MESSAGE:  <b>ENGINE FAILED TO START</b></p>	<p>Indicates possible fault with control or starting system. Check for the following conditions:</p> <ol style="list-style-type: none"> <li>Poor battery cable connections. Clean the battery cable terminals and tighten all connections.</li> <li>Discharged or defective battery. Recharge or replace the battery.</li> </ol>
<p>CODE: <b>441</b>                      LAMP: <b>Warning</b>                      MESSAGE:  <b>LOW BATTERY VOLTAGE</b></p>	<p>Indicates battery voltage is below 24 VDC.</p> <ol style="list-style-type: none"> <li>Discharged or defective battery. Check the battery charger fuse. Recharge or replace the battery.</li> <li>Poor battery cable connections. Clean the battery cable terminals and tighten all connections.</li> <li>Check engine DC alternator. Replace engine DC alternator if normal battery charging voltage (24 to 26 VDC) is not obtained.</li> <li>Check float level if applicable (raise float level).</li> </ol>
<p>CODE: <b>442</b>                      LAMP: <b>Warning</b>                      MESSAGE:  <b>HIGH BATTERY VOLTAGE</b></p>	<p>Indicates battery voltage exceeds 32 VDC.</p> <p>Check float level on battery charger if applicable (lower float level).</p> <p>Check engine DC alternator. Replace engine DC alternator if normal battery charging voltage (24 to 26 VDC) is not obtained.</p>
<p>CODE: <b>611</b>                      LAMP: <b>Warning</b>                      MESSAGE:  <b>ENGINE HOT</b></p>	<p>Indicates that an engine hot shut down has occurred (cool-down timers were bypassed). This condition will occur when the engine coolant temperature is above the normal operating level and the operator presses the Emergency Switch or moves the 0/Manual/Auto switch to the 0 (Off) position. This type of shutdown should be avoided. Can cause possible loss of performance and engine damage.</p>
<p>CODE: <b>1311 through 1318</b>                      LAMP: <b>Shutdown/Warning</b>                      MESSAGE:  <b>Customer Defined Fault</b></p>	<p>When any one of these customer defined inputs is detected by the control, the corresponding fault message is displayed. The nature of the fault is an optional customer selection. These fault functions can be programmed to initiate a shutdown or warning as indicated by the Warning or Shutdown lamp.</p> <p>Note: Customer fault messages are editable. The message displayed for the code shown (1311 through 1318) is determined by the customer.</p>
<p>CODE: <b>1416</b>                      LAMP: <b>Warning</b>                      MESSAGE:  <b>FAIL TO SHUTDOWN</b></p>	<p>Status – indicates that the “Fault Bypass” mode is enabled. This mode is primarily used by service personnel for troubleshooting purposes. In this mode the generator set ignores the majority of system shutdown faults.</p>

**TABLE 4-2. WARNING AND SHUTDOWN CODES (CONT.)**

<p><b>⚠WARNING</b> <i>Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and mechanical hazards should perform service procedures. Review safety precautions.</i></p>	
<b>SYMPTOM</b>	<b>CORRECTIVE ACTION</b>
<p>CODE: <b>1417</b> LAMP: <b>Warning</b> MESSAGE: <b>POWER DOWN ERROR</b></p>	<p>Indicates that the control can not power down due to some unknown condition. Possible drain on battery. Contact an authorized service center for service.</p>
<p>CODE: <b>1433 / 1434</b> LAMP: <b>Shutdown</b> MESSAGE: <b>EMERGENCY STOP – LOCAL / EMERGENCY STOP – REMOTE</b></p>	<p>Indicates local or remote Emergency Stop. Emergency Stop shutdown status can be reset only at the local control panel. To reset the local/remote Emergency Stop button: Pull the button out. Move the O/Manual/Auto switch to O (Off). Press the front panel Fault Acknowledge button. Select Manual or Auto, as required.</p>
<p>CODE: <b>1438</b> LAMP: <b>Warning</b> MESSAGE: <b>FAIL TO CRANK</b></p>	<p>Indicates possible fault with control or starting system. Check for the following conditions:</p> <ol style="list-style-type: none"> <li>a. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.</li> <li>b. Discharged or defective battery. Recharge or replace the battery.</li> </ol>
<p>CODE: <b>1439</b> LAMP: <b>Warning</b> MESSAGE: <b>FUEL LEVEL LOW IN DAY</b></p>	<p>Indicates fuel supply is running low. Check fuel supply and replenish as required.</p>
<p>CODE: <b>1441</b> LAMP: <b>Warning</b> MESSAGE: <b>FUEL LEVEL LOW IN MAIN</b></p>	<p>Indicates fuel supply is running low. Check fuel supply and replenish as required.</p>
<p>CODE: <b>1442</b> LAMP: <b>Warning</b> MESSAGE: <b>BATTERY IS WEAK</b></p>	<p>Indicates battery voltage drops below 14.4 volts for two seconds during starting. Discharged or defective battery. See Warning message <b>441 Low Battery Voltage</b>.</p>
<p>CODE: <b>1443</b> LAMP: <b>Warning</b> MESSAGE: <b>BATTERY IS DEAD</b></p>	<p>Indicates battery has dropped below genset operating range (3.5 volts when cranking) to power the starter and the control circuitry. See Warning message <b>441 Low Battery Voltage</b>.</p>

# 5. Maintenance

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## GENERAL

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. The table below covers the recommended service intervals for a generator set on STANDBY service. If the set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to weather

- Exposure to salt water
- Exposure to dust, sand or other airborne contaminants

Consult with an authorized distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use Table 5-1 to determine the maintenance required and then refer to the sections that follow for the correct service procedures. Also refer to Cummins *QSX15 Series Engines Operation and Maintenance Manual*.



**TABLE 5-1. PERIODIC MAINTENANCE SCHEDULE**

MAINTENANCE ITEMS	SERVICE TIME				
	See Engine Schdl.	Daily or after 8 Hours	Monthly or after 100 Hours	6 Months or after 250 Hours	Yearly or after 500 Hours
General set inspection	X <sup>1</sup>	X <sup>2</sup>			
Check engine oil level		X			
Check coolant level		X			
Check coolant heater(s)		X			
Check battery charging system			X		
Check all hardware (fittings, clamps, fasteners, etc.)			X		
Check battery electrolyte level			X		
Check generator air outlet			X		
Check radiator hoses for wear and cracks				X	
Test generator insulation resistance					X <sup>4</sup>
Check drive belt	X <sup>1</sup>				
Check air cleaner (replace as necessary)	X <sup>1</sup>				
Drain fuel filter(s)	X <sup>1</sup>				
Check anti-freeze and DCA concentration	X <sup>1</sup>				
Change engine oil and filter	X <sup>1</sup>				
Change water coolant filter	X <sup>1</sup>				
Clean crankcase breather	X <sup>1</sup>				
Change fuel filter	X <sup>1</sup>				
Clean cooling systems	X <sup>1</sup>				

X<sup>1</sup> - Refer to Cummins QSX15 Series Engine Operation and Maintenance Manual for maintenance interval and/or procedure.

X<sup>2</sup> - Check for oil, fuel, cooling and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately.

X<sup>3</sup> - Visually check belt for evidence of wear or slippage. Replace if hard or brittle.

X<sup>4</sup> - This procedure should be followed periodically throughout the life of the generator set, or if the generator has set idle for a period of time with no generator heaters used. Contact your authorized service center.

## GENERAL INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected for continued safe operation.

### Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler, and exhaust pipe. Check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the generator set and have leaks corrected immediately.

**⚠WARNING** *Inhalation of exhaust gases can result in severe personal injury or death. Be sure deadly exhaust gas is piped outside and away from any windows, doors, vents or other inlets to building and not allowed to accumulate in inhabitable areas.*

### Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, have them corrected immediately.

**⚠WARNING** *Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, arcing switch or equipment, pilot light, or other igniter near the fuel system or in areas sharing ventilation.*

### AC Electric System

Check the following while the generator set is operating.

**Frequency:** The generator frequency should be stable and the reading should be the same as the nameplate.

**AC Voltage:** At no load, the line-to-line voltage(s) should be the same as the set nameplate rating.

**AC Ammeter:** At no load, the current readings should be zero. With a load applied, each line current should be about the same.

**Panel Lamps:** Press and hold down the Panel Lamp/Lamp Test button on the control panel. All indicator lamps should light. Verify that all lamps are on and then release the button. Contact an authorized service center if any lamps are burned out.

### DC Electrical System

Check the terminals on the batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Refer to **BATTERIES** later in this section for cleaning and safety precautions.

### Engine

Monitor fluid levels and oil pressure and coolant temperatures frequently. Most engine problems give an early warning. Look and listen for changes in engine performance, sound, or appearance that can indicate service or repair is needed. Some engine changes to look for are as follows:

- Misfire
- Vibration
- Unusual noises
- Sudden changes in engine operating temperatures or pressures
- Excessive exhaust smoke
- Loss of power
- An increase in oil consumption
- An increase in fuel consumption
- Fuel, oil, or coolant leaks.

## GENERATOR SET MAINTENANCE (Battery Disconnected)

**⚠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 before beginning maintenance procedures.*

When performing the following maintenance procedures, make certain the generator set cannot be accidentally restarted as follows:

1. Move the O/Manual/Auto switch on the control panel to the O (off) position.
2. Turn off or remove AC power from the battery charger.
3. Remove the negative (-) battery cable from the generator set starting battery.

### **Mechanical Inspection**

With the generator set stopped, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately.

## LUBRICATION SYSTEM

Gensets are shipped filled with the correct type and quantity of oil. Be sure to check oil level before initial start.

### Oil API Classification

Refer to the Cummins *QSX15 Series Engines Operation and Maintenance Manual* for lubricating oil classification.

### Oil Viscosity

Refer to the Cummins *QSX15 Series Engines Operation and Maintenance Manual* for lubricating oil recommendations/specifications.

### Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance Table. The dipstick (Figure 5-1) is stamped with high and low marks to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 15 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

**⚠WARNING** *Crankcase pressure can blow out hot oil and cause severe burns. Do NOT check oil while the generator set is operating.*

Keep the oil level as near as possible to the high mark on the dipstick but never above it. Remove the oil fill cap and add oil of the same API viscosity and brand when necessary. Install the oil fill cap after adding oil.

**⚠CAUTION** *Do not operate the engine with the oil level below the low mark or above the high mark. Overfilling can cause foaming or aeration of the oil while operation below the low mark may cause loss of oil pressure.*

### Oil and Filter Change

Refer to the Cummins *QSX15 Series Engines Operation and Maintenance Manual* for maintenance interval and procedure.

**⚠WARNING** *State or federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Do not contact oil or breath vapors. Use rubber gloves and wash exposed skin.*

*Used oil and filters must be disposed of properly to avoid environmental damage and clean-up liability. Check all federal, state and local regulations for disposal requirements.*

## FUEL SYSTEM

Refer to the Cummins *QSX15 Series Engines Operation and Maintenance Manual* for fuel recommendations and fuel system maintenance, such as, draining of the fuel-water separator and fuel filter replacement interval and procedure.

### Fuel Handling Precautions

**⚠WARNING** *Ignition of fuel can cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, arc, spark, pilot light, or other igniter near the fuel system.*

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the

engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the day-time. At night, cool air tends to lower the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and tend to form condensation.

Condensation (water) can cause clogging of fuel filters with the sulphur in the fuel forms acid which can corrode and damage engine parts.

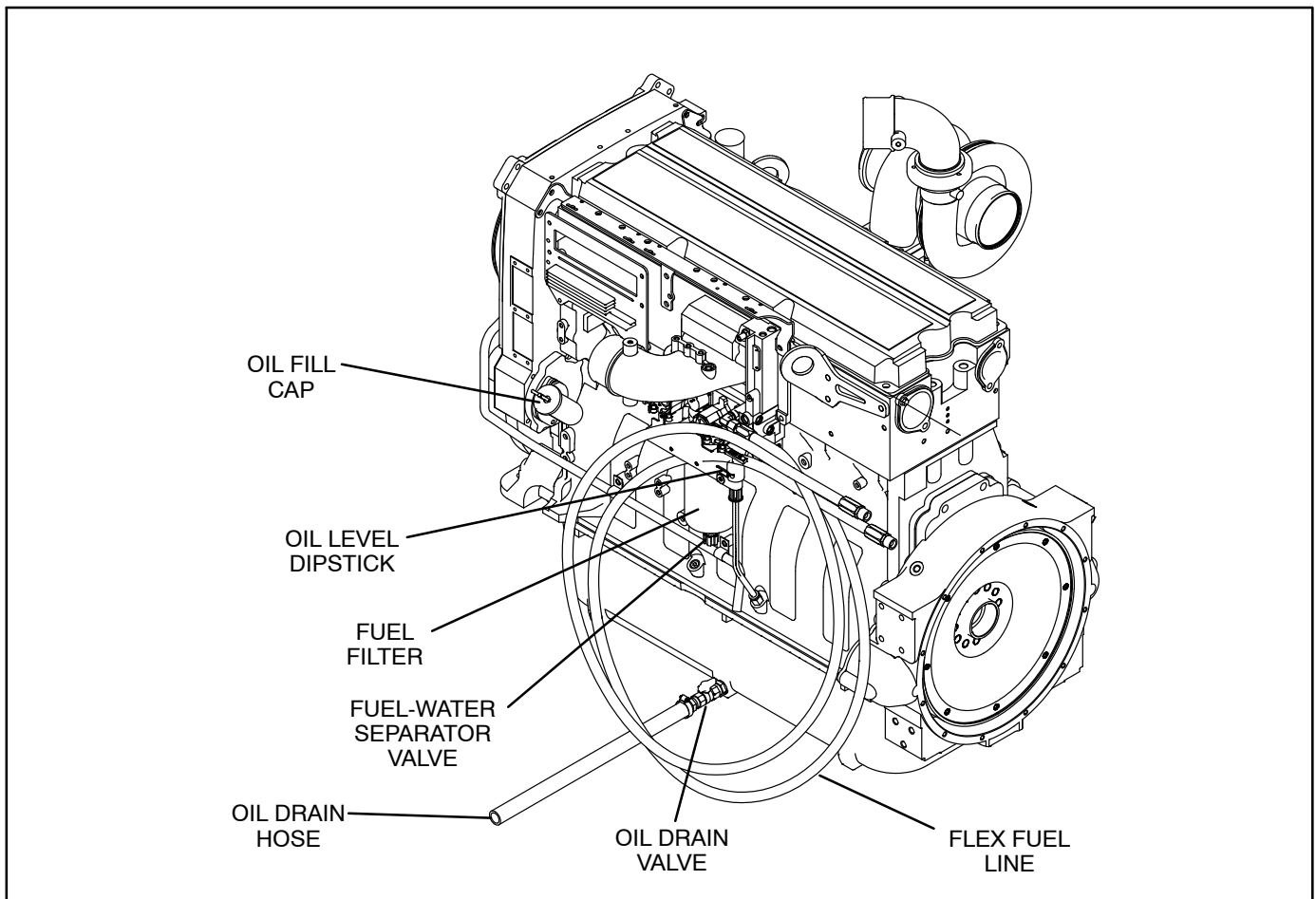


FIGURE 5-1. LUBRICATION AND FUEL COMPONENTS

## COOLANT SYSTEM

**⚠ CAUTION** *The heater must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.*

**⚠ CAUTION** *Remove AC power to the heater before disconnecting battery cables. Heater will run continuously without DC power and can overheat and damage heater.*

**⚠ CAUTION** *Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 120° F (50° C) before adding coolant.*

## Coolant Level

Check the coolant level during shutdown periods at the intervals specified in the Maintenance Table. A sight glass is provided on the radiator of the engine water cooling system (Figure 5-2).

The coolant level should be approximately in the middle of the sight glass, with the coolant temperature at 120° F (50° C) or lower. Refer to the Cummins Cummins QSX15 Series Engines Operation and Maintenance Manual for coolant recommendations/specifications.

**⚠ WARNING** *Contact with hot coolant can result in serious burns. Allow cooling system to cool before releasing pressure and removing jacket water radiator cap or LTA expansion tank cap.*

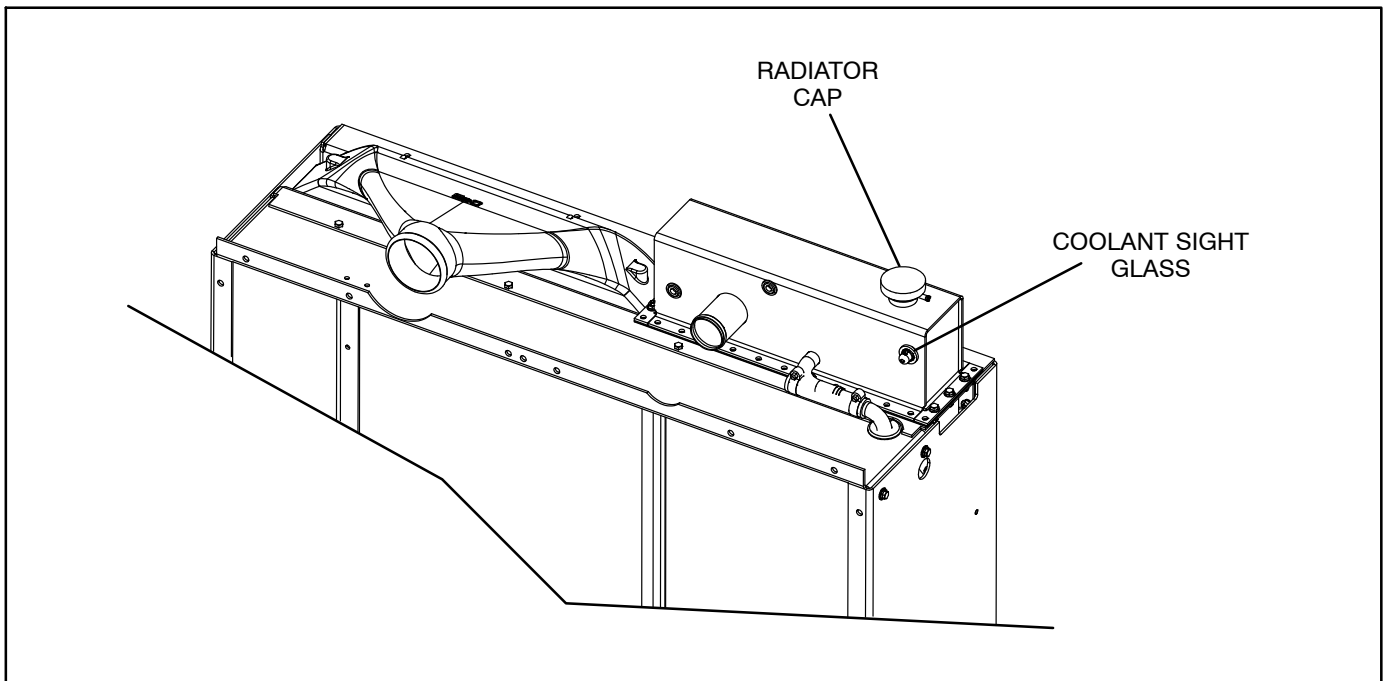


FIGURE 5-2. COOLING SYSTEM SIGHT GLASS/FILL LOCATIONS

## Cooling System Maintenance

Refer to the Cummins *QSX15 Series Engines Operation and Maintenance Manual* for all cooling system maintenance, such as, coolant requirements, filling of the engine cooling system, coolant filter replacement and flushing and cleaning.

An on/off valve is provided to prevent coolant leakage while changing the coolant filter. With the valve in the **ON** position, the coolant flows through the filter. In the **OFF** position, the coolant does not flow through the filter.

Make sure coolant shut off valve is in the **ON** position before operating the generator set.

If engine coolant heater(s) is installed in the water cooling system, disconnect heater(s) from power source before performing cooling system maintenance.

**⚠ CAUTION** *The heater element will burn out if engine coolant is removed with heater connected to power source.*

**⚠ CAUTION** *The heater element will burn out if power is connected before it is filled with coolant or if undiluted antifreeze solution is used for coolant. Before connecting power, fill the engine with coolant and run it for a while to circulate coolant through the heater.*

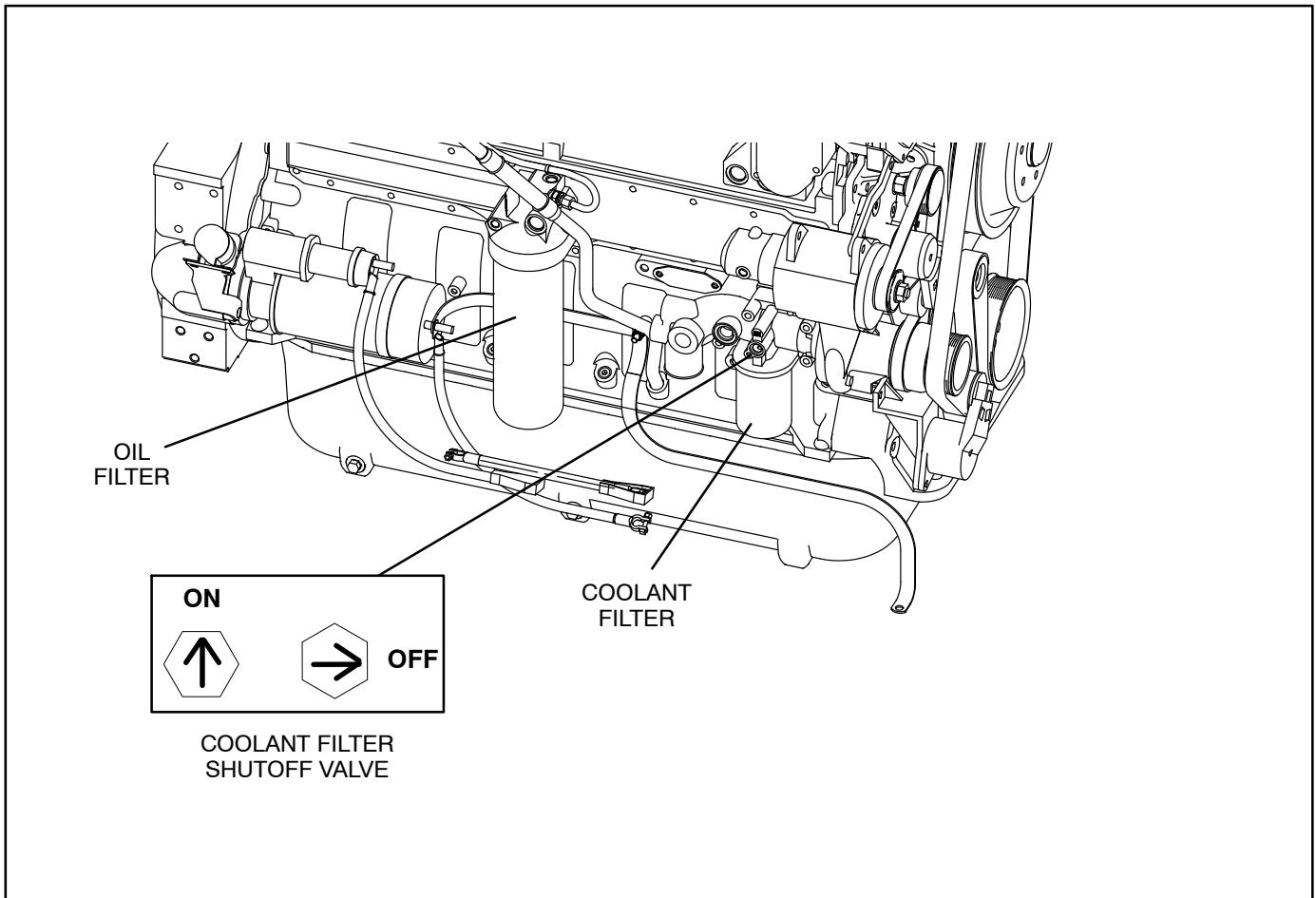


FIGURE 5-3. COOLANT AND LUBRICATION COMPONENTS

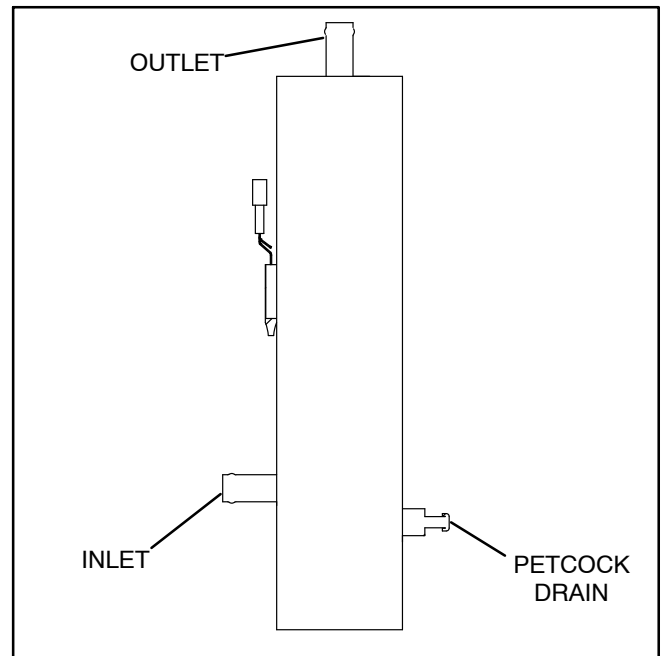
## Coolant Heater

Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet hose (see Figure 5-4). *Do not touch outlet hose* – if heater is operational, radiant heat should be felt with hand held close to outlet hose.

**⚠WARNING** *Contact with cooling system or engine can result in serious burns. Do not touch cooling system or engine during genset maintenance until they are cool.*

## Heat Exchanger Plugs

Check the zinc plugs in the heat exchanger and replace if they are eroded to less than half their original length. The frequency of replacement is dependent on the chemical reaction that occurs when the plugs are in contact with the raw water.



**FIGURE 5-4. COOLANT HEATER**



## BATTERIES

**⚠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.*

Check the condition of the starting batteries at the interval specified in the Maintenance Table. To prevent dangerous arcing, always disconnect the negative ground cable from the battery before working on any part of the electrical system or the engine. Disregard the sections On Checking Specific Gravity and Checking Electrolyte Level if using a “maintenance-free” battery.

### Cleaning Batteries

**⚠WARNING** *Electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. Do not get the substance in your eyes or contact with skin. Wear goggles and protective, rubber gloves and apron when servicing batteries.*

*In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN.*

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with a solution consisting of 1/4 pound of baking soda added to 1 quart of water. (This solution is also used for washing down spilled electrolyte.)

Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery and surrounding areas with clean water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

### Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every ten degrees the electrolyte temperature is above 80° F (27° C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

### Checking Electrolyte Level

**⚠CAUTION** *Do not add water in freezing weather unless the engine will run long enough (two to three hours) to assure a thorough mixing of water and electrolyte.*

Check the level of the electrolyte (acid and water solution) in the batteries at least every 200 hours of operation.

Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

### Battery Replacement

Always replace the starting battery with the same number and type (vented, lead acid). Properly dispose of battery in accordance with local environmental agency requirements.

**⚠WARNING** *Electrolyte or explosion of battery can cause severe personal injury or death. Do not mutilate or burn the battery in a fire for disposal.*

*Damage to case will release electrolyte which is harmful to the skin and eyes and is also toxic. Burning of battery may cause an explosion.*

# 6. Operating Recommendations

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## **NO-LOAD OPERATION**

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a load bank of at least 30 percent of nameplate rating.

## **EXERCISE PERIOD**

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting.

Exercise the generator set at least once a month for a minimum of 30 minutes, under not less than 30 percent of the nameplate rating.

## **LOW OPERATING TEMPERATURE**

Use a coolant heater if a separate source of power is available. The optional heater available from Onan will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

## **HIGH OPERATING TEMPERATURE**

Refer to the genset nameplate for the maximum ambient operating temperature, if applicable.

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