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Service Manual

MDKBH

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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SAFETY PRECAUTIONS

Thoroughly read the **OPERATOR'S MANUAL** before operating the genset. Safe operation and top performance can only be obtained when equipment is operated and maintained properly.

The following symbols in this manual alert you to potential hazards to the operator, service person and equipment.

⚠ DANGER alerts you to an immediate hazard that will result in severe personal injury or death.

⚠ WARNING alerts you to a hazard or unsafe practice that can result in severe personal injury or death.

⚠ CAUTION alerts you to a hazard or unsafe practice that can result in personal injury or equipment damage.

Electricity, fuel, exhaust, moving parts and batteries present hazards which can result in severe personal injury or death.

GENERAL PRECAUTIONS

- Keep children away from the genset.
- Do not use evaporative starting fluids. They are highly explosive.
- Do not step on the genset when entering or leaving the generator room. Parts can bend or break leading to electrical shorts or to fuel, coolant or exhaust leaks.
- To prevent accidental or remote starting while working on the genset, disconnect the negative (–) battery cable at the battery.
- Let the engine cool down before removing the coolant pressure cap or opening the coolant drain. Hot coolant under pressure can spray and cause severe burns.
- Keep the genset, drip pan and compartment clean. Oily rags can catch fire. Gear stowed in the compartment can restrict cooling.
- Make sure all fasteners are secure and properly torqued.

- Do not work on the genset when mentally or physically fatigued or after having consumed alcohol or drugs.
- You must be trained and experienced to make adjustments while the genset is running—hot, moving or electrically live parts can cause severe personal injury or death.
- Used engine oil has been identified by some U. S. state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or contact used oil or its vapors.
- Ethylene glycol, used as engine antifreeze, is toxic to humans and animals. Clean up spills and dispose of used engine coolant in accordance with local environmental regulations.
- 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)
- Genset installation and operation must comply with all applicable local, state and federal codes and regulations.

GENERATOR VOLTAGE IS DEADLY

- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- The genset must not be connected to shore power or to any other source of electrical power. Back-feed to shore power can cause electric shock resulting in severe personal injury or death and damage to equipment. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry, stand on a dry wooden platform or rubber insulating mat and use tools with insulated handles.

ENGINE EXHAUST IS DEADLY

- Never sleep in the boat while the genset is running unless the boat is equipped with properly working carbon monoxide detectors.

- The exhaust system must be installed in accordance with the genset Installation Manual and be free of leaks.
- Make sure the bilge is adequately ventilated with a power exhauster.
- Inspect for exhaust leaks every startup and after every eight hours of operation.
- For more information about carbon monoxide see American Boat and Yacht Council (ABYC) publication TH-22—*Educational Information About Carbon Monoxide*.

DIESEL FUEL IS COMBUSTIBLE

- Do not smoke or turn electrical switches ON or OFF where fuel fumes are present or in areas sharing ventilation with fuel tanks or equipment. Keep flames, sparks, pilot lights, arc-producing equipment and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.

GASOLINE IS FLAMMABLE AND EXPLOSIVE

- Because this genset is an *Ignition Protected* device, no substitutes are permitted for the parts listed in the *Critical Parts Index* of the genset Parts Catalog. They must be purchased from Onan and be installed in accordance with the genset Service Manual by

those who are trained and experienced in marine genset service.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses.
- Do not smoke.
- To reduce arcing when disconnecting or reconnecting battery cables, always disconnect the negative (–) battery cable first and reconnect it last.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

FLAMMABLE VAPOR CAN CAUSE A DIESEL ENGINE TO OVERSPEED

Flammable vapor can cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate a diesel-powered genset where a flammable vapor environment can be created by fuel spill, leak, etc.** The owners and operators of the genset are solely responsible for operating the genset safely.

POST THESE SAFETY PRECAUTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT

1. Introduction

ABOUT THIS MANUAL

This is the Service Manual for the generator sets (gensets) listed on the front cover. Each operator should study this manual carefully and observe all of its instructions and safety precautions. Keep this manual handy for ready reference.

Operation, Periodic Maintenance and Troubleshooting provide the instructions necessary for operating the genset and maintaining it at top performance. The owner is responsible for performing maintenance in accordance with the PERIODIC MAINTENANCE SCHEDULE (p. 4-1). This manual also includes genset specifications, information on how to obtain service, and information regarding compliance with emissions regulations.

⚠ WARNING *This genset is not a life support system. It can stop without warning. Children, persons with physical or mental limitations, and pets could suffer personal injury or death. A personal attendant, redundant power or alarm system must be used if genset operation is critical.*

See the Parts Manual for part identification numbers and required quantities. Genuine Onan® replacement parts are recommended for best results.

⚠ WARNING *Because this genset is an Ignition Protected Device, no substitutes are permitted for the parts listed in the Critical Parts Index of the genset Parts Catalog. They must be purchased from Onan and be installed in accordance with the genset Service Manual by those who are trained and experienced in marine genset service.*

⚠ WARNING *Improper service or replacement of parts can lead to severe personal injury or death and to damage to equipment and property. Service personnel must be qualified to perform electrical and mechanical service.*

MODEL IDENTIFICATION

Be ready to provide the genset model and serial numbers on the nameplate when contacting Onan for parts, service and product information. Figure 1-1 illustrates the nameplate and its location on the side of the control box.

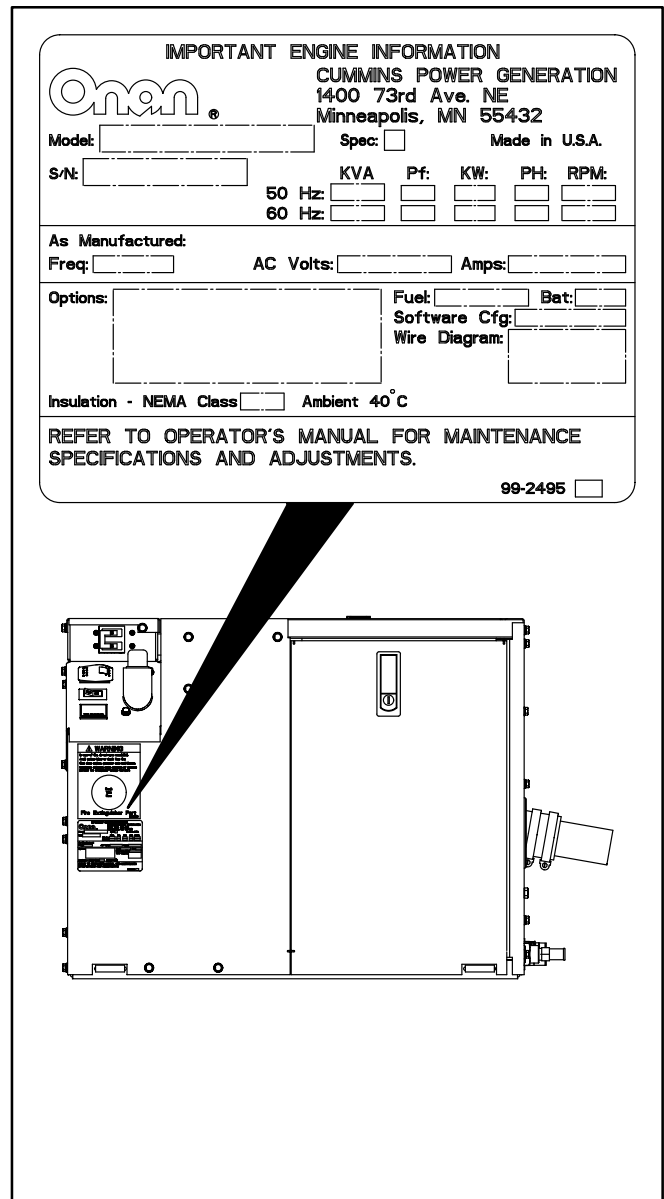


FIGURE 1-1. TYPICAL NAMEPLATE

EMISSIONS LABEL

The engine has a label on the air intake (Figure 1-2) which states compliance with applicable EPA and California emissions regulations.

California users of this genset should be aware that unauthorized modifications or replacement of fuel, exhaust, air intake, or speed control system components that affect engine emissions are prohibited. Unauthorized modification, removal or replacement of the engine label is prohibited.

You should carefully review Operator (Owner), Installation and other manuals and information you received with your genset. If you are unsure that the installation, use, maintenance or service of your genset is authorized, you should seek assistance from an approved Onan dealer.

California genset users may use Table 1-1 as an aid in locating information about the California Air Resources Board requirements for emissions control.

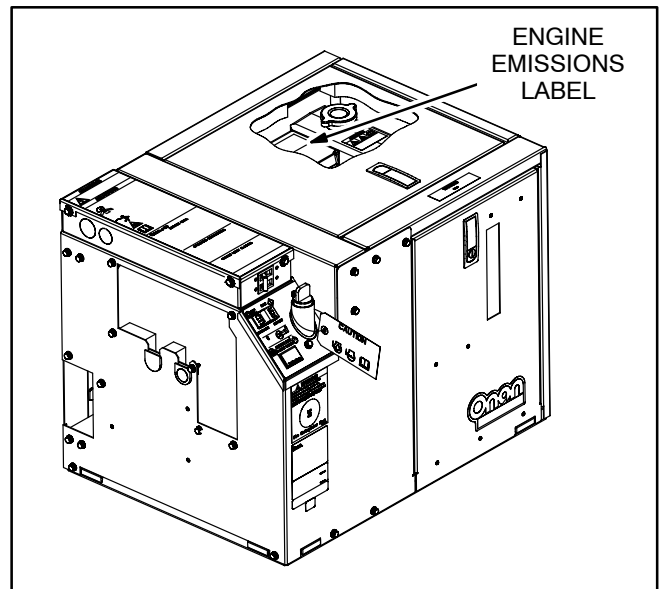


FIGURE 1-2. EMISSIONS LABEL

TABLE 1-1. EMISSIONS CONTROL INFORMATION

Emissions Warranty Information	The California emissions control warranty statement is located in the same packet of information as this manual when the genset is shipped from the factory.
Engine Fuel Requirements	The engine is certified to operate on diesel fuel. See FUEL RECOMMENDATIONS (p. 3-1).
Engine Lubricating Oil Requirements	See ENGINE OIL RECOMMENDATIONS (p. 3-1).
Engine Adjustments	High Idle Speed. This is a service procedure requiring trained personnel and proper tools. See the Service Manual.
Engine Emission Control System	The engine emission control system consists of engine design and precision manufacture. (IFI)

2. Control Panels

LOCAL CONTROL PANEL

Refer to Figure 2-1.

Control Switch

Starting: Push and Hold **START** to preheat, crank and start the genset. The *green* status lamp comes on when the genset is running. (Preheat is the period of time prior to engine cranking when the glow plugs preheat the combustion chambers. The time is automatically varied by the genset controller on the basis of engine temperature.)

Stopping: Push and Release **STOP (Prime)** to stop the genset.

Priming: Push and Hold **STOP (Prime)** to prime the fuel system (amber lamp comes on in 2 seconds to indicate priming).

Status Lamps

The control switch has two status lamps. The *amber* status lamp comes on during priming, blinks rapidly during cranking and goes out when the engine is up to speed. If the genset shuts down abnormally, this lamp will slowly blink a numerical code to indicate the cause of shutdown. See *Troubleshooting* (Section 11). The *green* status lamp comes on to indicate that the genset is running.

Emergency Stop Switch

In an emergency push the switch to **OFF**. Push it to **ON** after all necessary repairs to the genset and connected equipment have been made.

Line Circuit Breaker

The line circuit breaker protects the AC power leads connected to the genset from overloads and equipment short circuits.

Hour Meter

The hour meter records genset operating time in hours. It cannot be reset.

REMOTE CONTROL PANELS

Remote Control

The boat may be equipped with several remote control stations having *e-Series* Digital Displays (p. 2-2) or control switches with status lamps.

Boat Monitoring System

The boat may be equipped to monitor genset operation on an integrated monitoring system using an SAE J1939 or SmartCraft™ network protocol.

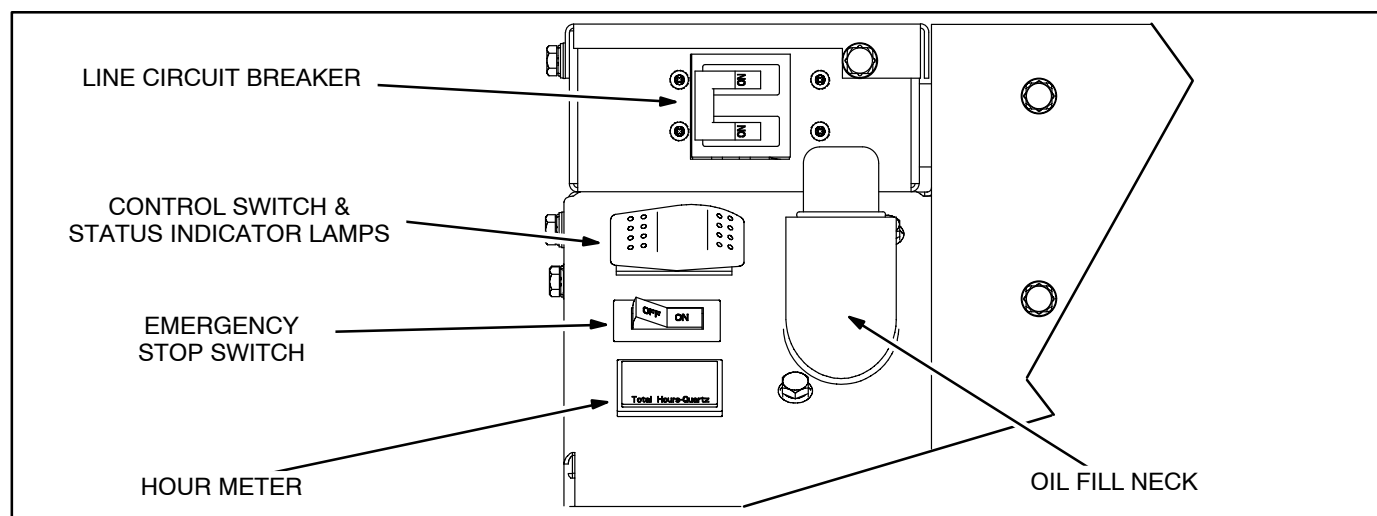


FIGURE 2-1. LOCAL CONTROL PANEL

DIGITAL DISPLAY

The e-Series Digital Display has an LCD screen with 4 navigation buttons, 3 status lamps, a START button and a STOP button (Figure 2-2).

Turning On the Display

Touch any button to turn on the Display, which will initialize and attempt to establish communications with the genset controller. All connected Displays will turn on automatically when the genset is started at any station. They will all turn off 5 minutes after the genset has received a normal command to stop. They will stay on indefinitely until a fault shutdown is cleared by touching any button on any Display.

Start Button

Starting the Genset: *Push and Hold START* until the genset starts. The GENSET status lamp blinks while the engine is cranking. It comes on when the genset starts and stays on while it runs. The status displayed on the LCD changes from *Starting* to *Running* (Figure 2-3). See STARTING THE GENSET (p. 3-3).

Stop Button

Stopping the Genset: *Push and Release STOP*. The GENSET status lamp will go out. The status displayed on the LCD will change from *Running* to *Stopped* (Figure 2-3). See STOPPING THE GENSET (p. 3-3).

Priming the Fuel System: *Push and Hold STOP*. The GENSET status lamp will blink. The status displayed on the LCD will change to *Priming* in 2 seconds (Figure 2-3). See PRIMING THE FUEL SYSTEM (p. 3-3).

Genset Status Lamps

GENSET – This status lamp (green) blinks while the engine is cranking or the fuel system is being primed. It stays on while the genset is running.

PRE-ALARM – This status lamp (amber) comes on when an engine Pre-Alarm condition exists (p. 2-5). It blinks rapidly while the genset is running in voltage adjust mode (p. 10-1).

ALARM – This status lamp (red) blinks during fault shutdown (p. 2-4).

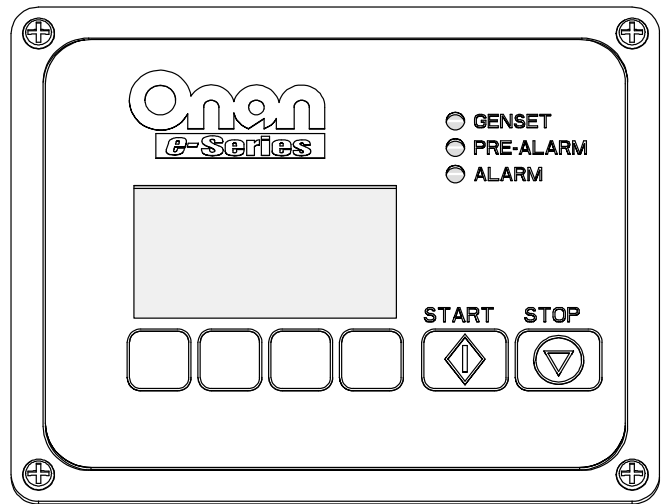


FIGURE 2-2. DIGITAL DISPLAY

Genset Status Screens

Genset status is displayed on 3 screen pages (Figure 2-3). GEN STATUS PG1 appears when the Display is turned on. Press the double arrows [↵] to toggle between the 3 screen pages.

The *Status* line on PG1 will display the word *Priming*, *Starting*, *Running*, *Stopped* or *Volt Adj*. The rest of the lines on the 3 status screen pages display AC output voltage, AC frequency, engine coolant temperature, engine oil pressure, starting battery voltage and total genset running time.

Note: The total time on the control panel hour meter (Page 2-1) prevails if the total time on the e-Series Digital Display is different. See *Configuring Replacement Genset Controller* (p. 2-7) to reset the Digital Display to match the control panel hour meter.

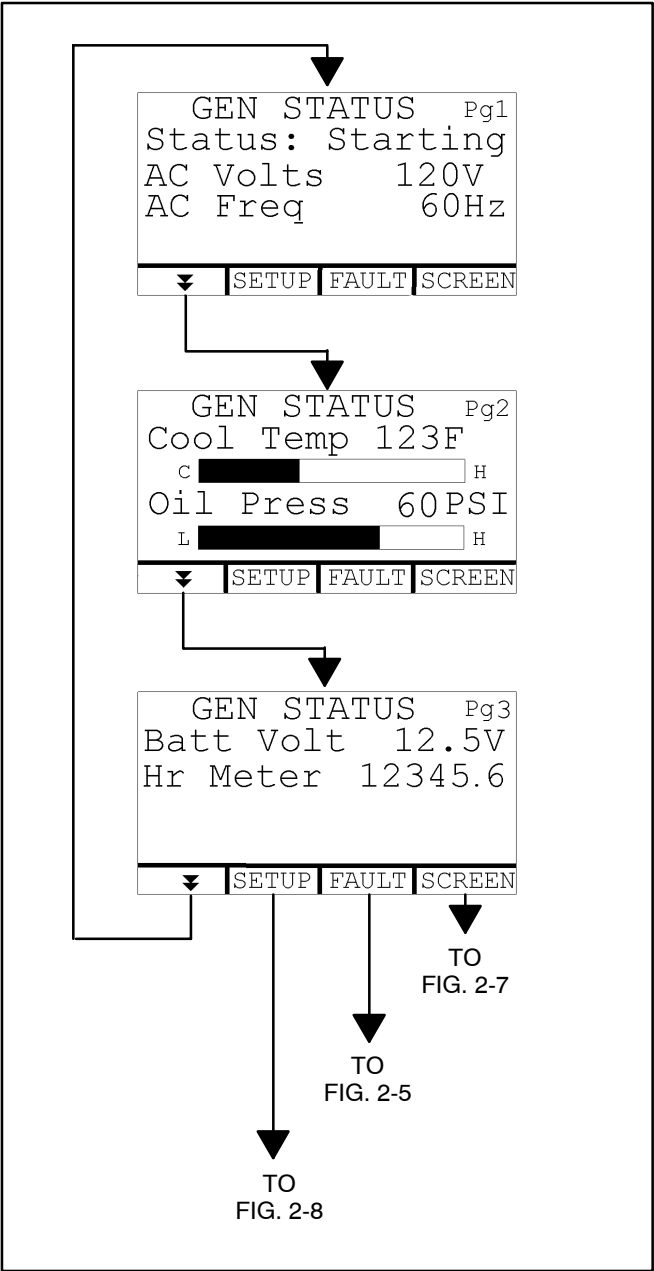


FIGURE 2-3. TYPICAL GENSET STATUS SCREENS

Fault Screens

If a fault shutdown occurs the ALARM status lamp will blink and the LCD screen will display the Fault Number, a description of the Fault and the hour in total genset running time when the Fault occurred (Figure 2-4). Refer to TABLE 11-1. TROUBLE-SHOOTING GENSET FAULTS to diagnose and correct the problem.

The e-Series Digital Display will display the fault indefinitely. Touch any button to clear the fault. The display will turn off in 5 minutes after the fault has been cleared.

Press [◀BACK] to go back to the GEN STATUS screen.

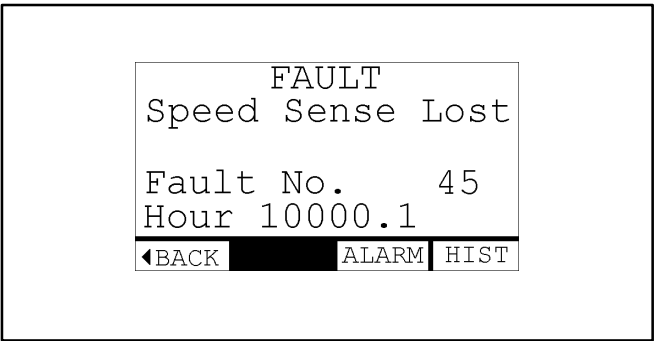


FIGURE 2-4. TYPICAL FAULT SCREEN

Displaying Last 5 Faults

To display any of the last five faults, press the FAULT button on any GEN STATUS screen. Then press the HIST button on the FAULT screen (Figure 2-5).

The FAULT HISTORY screen will display the last Fault Number, a description of the Fault and the hour in total genset running time when the fault occurred. Press the double arrows [↕] to toggle between the last 5 faults. If there are no faults, the FAULT HISTORY screen will display *No Stored Faults*.

Press [↩BACK] to go back to GEN STATUS.

Engine Pre-Alarm Screens

The PRE-ALARM status lamp will start to blink when engine oil pressure or temperature approaches its limit for engine shutdown. The Display will display *Low Oil Pressure* or *High Engine Temperature* on the PRE-ALARM screen (Figure 2-6).

Press [↩BACK] to go back to GEN STATUS to monitor the engine temperature or oil pressure.

Service the genset as required.

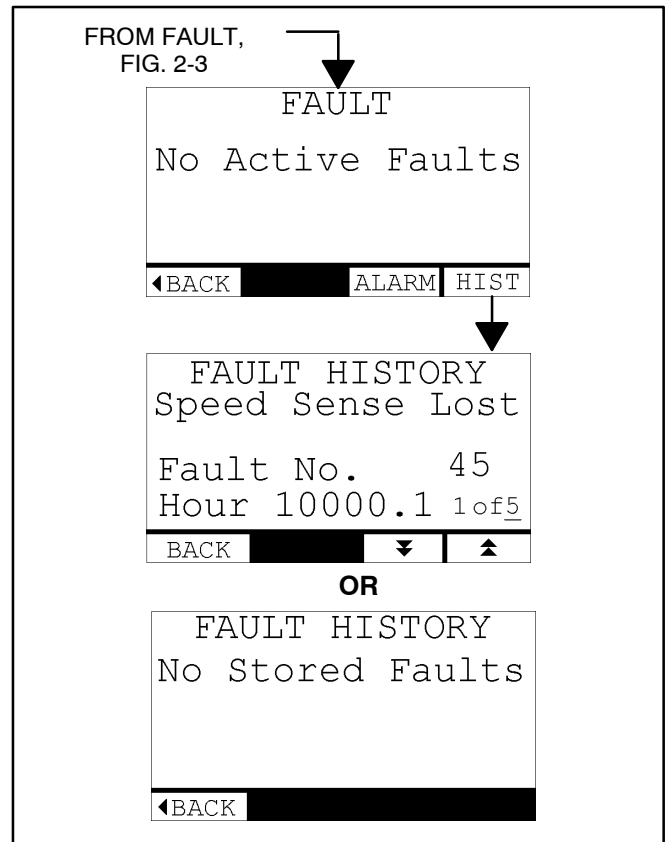


FIGURE 2-5. FAULT HISTORY

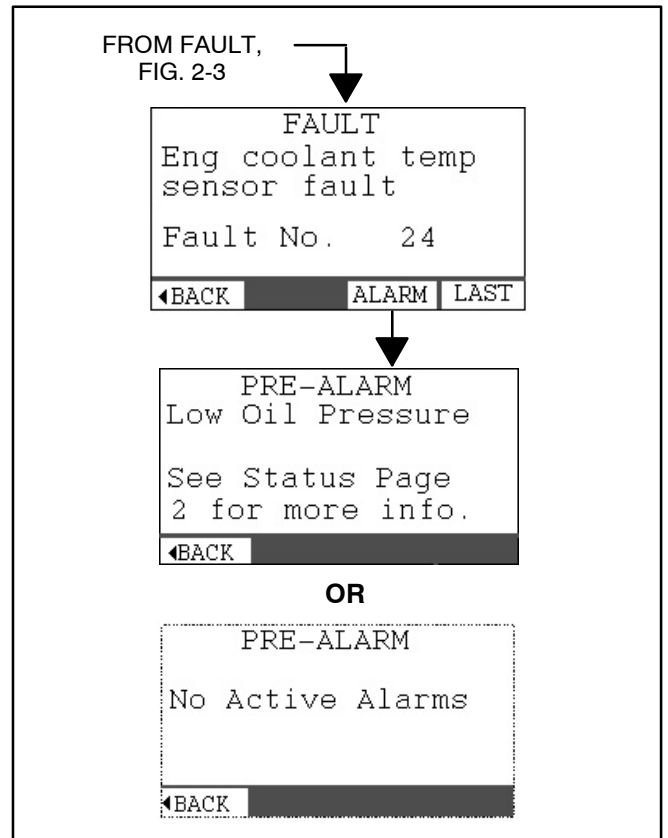


FIGURE 2-6. ENGINE PRE-ALARMS

Screen Brightness and Contrast

To adjust the brightness and contrast of the LCD screen and status lamps, go to the SCREEN ADJUST screen by pressing SCREEN on any GEN STATUS screen. Press NEXT to select *Brightness* or *Contrast*. Increase or decrease the selected item by pressing the increase-decrease buttons [◀ ▶]. See Figure 2-7. (“Contrast” applies only to the LCD screen.)

Press [◀BACK] to save the settings and go back to GEN STATUS.

Display Setup

Go to the SETUP screen by pressing SETUP on any GEN STATUS screen. Press the up-down arrows [▼ ▲] to select *Display Setup* and press ENTER. See Figure 2-8.

Units: To change the units of measure on the GEN STATUS screens, press NEXT to select Units. Then press the up-down arrows [▼ ▲] to toggle between Metric and SAE units.

Press [◀BACK] to save the selection and go back to GEN STATUS.

AC Voltmeter Calibration: To calibrate the Display Voltmeter, press NEXT to select AC Voltmeter Calibration. Then press the up-down arrows [▼ ▲] to increase or decrease the voltage displayed to correspond to an accurate AC output voltmeter (line-to-line or line-to-neutral, as desired).

Press [◀BACK] to save the selection and go back to GEN STATUS.

Note: This procedure does not change AC output voltage. See *Adjusting AC Output Voltage* (Section 10).

Genset and Display Information

Go to the SETUP screen by pressing SETUP on any GEN STATUS screen. Press the up-down arrows [▼ ▲] to select *Genset Info* or *Display Info* and press ENTER. See Figure 2-8. This information may be requested by the service technician.

Keep pressing [◀BACK] to get back to GEN STATUS.

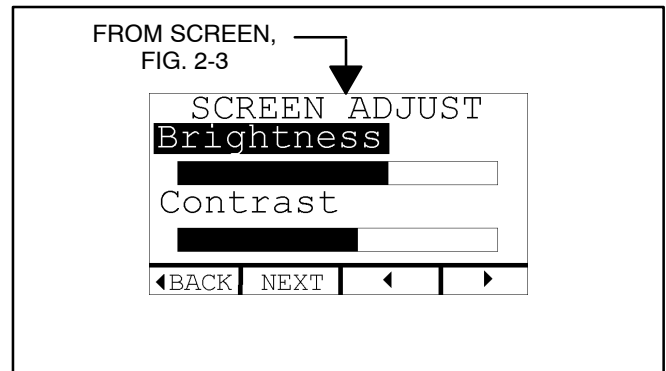


FIGURE 2-7. SCREEN BRIGHTNESS & CONTRAST

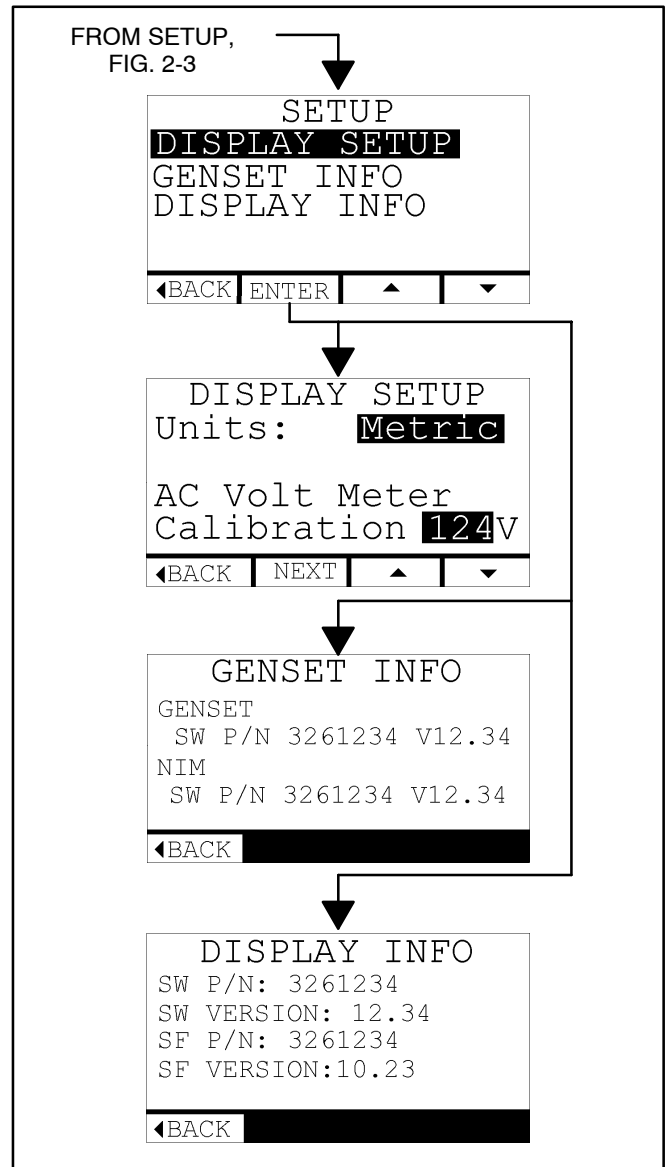


FIGURE 2-8. SETUP, GENSET & DISPLAY INFO

Configuring Genset Controller Using Digital Display

A replacement controller must be configured to match the genset. See shutdown due to INVALID GENSET CONFIGURATION—CODE NO. 37 (p. 11-12). Also, the Digital Display hour meter should be reset to match the control panel hour meter (p. 2-1).

Setting Configuration: Stop the genset and then press STOP 6 times to display the configuration screen (Figure 2-9). Press NEXT to select *Genset Config*. Press the up-down arrows [▼ ▲], as necessary, to increase or decrease the code number. The configuration code number for this genset is “19.”

Press [⏮BACK] to save the selection and get back to GEN STATUS.

Resetting Digital Display Hour Meter: Press NEXT to select *Set Hour Meter*. Then press the up-down arrows [▼ ▲] to match the number of hours on the control panel hour meter (p. 2-1).

Press [⏮BACK] to save the selection and get back to GEN STATUS.

Configuring Genset Controller Using Control Switch

Remove the insulating connectors from wiring harness connectors CONFIG 1 and CONFIG 2 in the control box and connect them together. This places the control in configuration mode. (In configuration mode the control will not start, prime or display faults.)

In configuration mode the status lamp on the control switch will blink the numeric configuration code, a two-digit number. Each time START is pressed the number will increase one unit. Each time STOP is pressed the number will decrease one unit. Press START or STOP, as necessary, to increase or decrease the code number. The configuration code number for this genset is “19.” The lamp should blink as follows when configured correctly:

blink — pause — blink-blink-blink-blink-blink-blink-blink-blink-blink — long pause — repeat

When configured properly, disconnect CONFIG 1 from CONFIG 2 and re-install the insulating connectors that were removed from each connector.

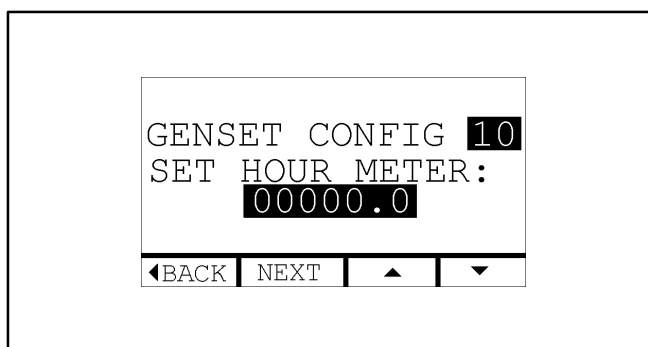


FIGURE 2-9. CONFIGURING CONTROLLER AND SETTING HOUR METER

3. Operation

FUEL

⚠️WARNING Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.

High quality Grade 2-D diesel fuel is necessary for good performance and long engine life. Diesel fuels specified by EN 590 or ASTM D975 are recommended. Use Grade 1-D diesel fuel if the fuel tank is exposed to temperatures below 40° F (5° C).

The Cetane number should not be less than 45 and sulfur content not more than 0.5 percent (by weight). Where fuel is exposed to cold ambient temperatures, use fuel that has a cloud point (temperature at which wax crystals begin to form) at least 10° F (6° C) degrees below the lowest expected fuel temperature.

Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078 or maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

ENGINE OIL

Use API (American Petroleum Institute) Service Category **CI-4** engine oil or better. Also look for the SAE (Society of Automotive Engineers) viscosity grade. Referring to Figure 3-1, choose the viscosity grade appropriate for the ambient temperatures expected until the next scheduled oil change. Multi-grade oils such as SAE 15W-40 are recommended for year-round use.

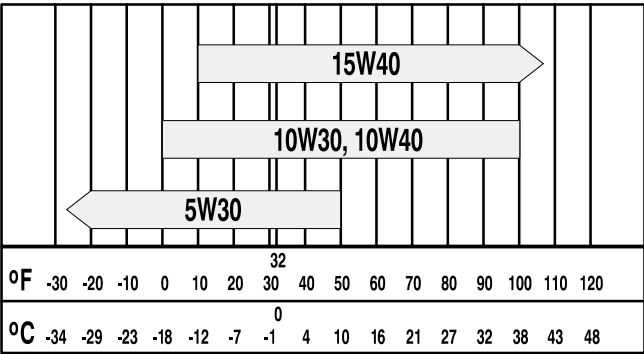


FIGURE 3-1. OIL VISCOSITY GRADE VS. AMBIENT TEMPERATURE

ENGINE COOLANT

⚠ WARNING *Ethylene Glycol antifreeze is considered toxic. Dispose of it according to local regulations for hazardous substances.*

Use the best quality ethylene glycol antifreeze solution available. It should be fully formulated with rust inhibitors and coolant stabilizers. A 50/50 mixture of water and ethylene glycol is recommended to provide protection from freezing down to -34°F (-37°C).

Use fresh water that is low in minerals and corrosive chemicals for the coolant mixture. Distilled water is best.

See *Specifications* (Section 12) regarding coolant capacity.

BATTERIES

Reliable genset starting and starter service life depend upon adequate battery system capacity and maintenance. See MAINTAINING THE BATTERY AND BATTERY CONNECTIONS (p. 4-2) and *Specifications* (Section 12).

FIRE EXTINGUISHER PORT

A genset with an enclosure has a fire extinguisher port accessible by breaking through the circle on the warning label located as shown in Figure 3-2. ***Make sure that the nozzle of the fire extinguisher that will be used in the event of fire is smaller than the circle so that it will fit through the port.*** The fire extinguisher must be of the gaseous type.

In the event of fire:

1. DO NOT open the genset enclosure.
2. Shut down engines, generators and blowers.
3. Break through the circle on the label with the nozzle and discharge the full contents of the fire extinguisher.

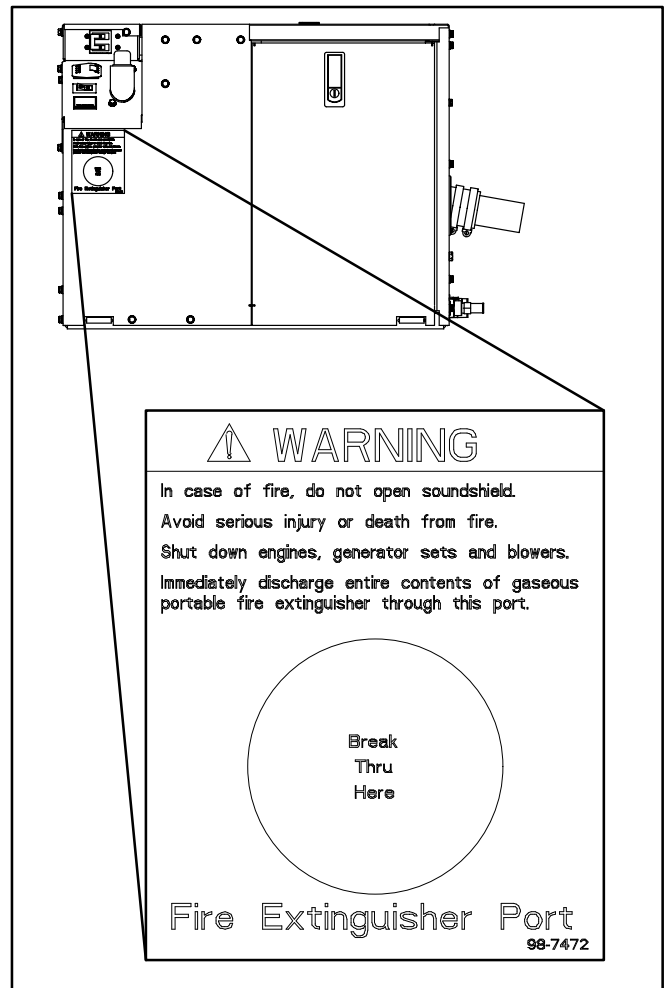


FIGURE 3-2. FIRE EXTINGUISHER PORT

⚠️WARNING **EXHAUST GAS IS DEADLY.** All engine exhaust contains carbon monoxide; an odorless, colorless, poisonous gas that can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

- **Dizziness**
- **Headache**
- **Nausea**
- **Vomiting**
- **Weakness**
- **Sleepiness**
- **Inability to Think Clearly**

GET EVERYONE OUT INTO FRESH AIR IMMEDIATELY IF ANYONE EXPERIENCES ANY OF THESE SYMPTOMS. Seek medical attention if symptoms persist. Never sleep in the boat when the genset is running, unless the cabin has a working carbon monoxide detector.

Look over the entire exhaust system and listen for leaks every time you start up the genset and after every eight hours of operation. Shut down the genset immediately if there is a leak. Do not run the genset until the leak has been repaired. The exhaust system must be installed in accordance with the genset Installation Manual.

PRE-START CHECKS

Before the first start of the day and after every eight hours of operation, inspect the genset as instructed under GENERAL INSPECTION (p. 4-2). Keep a log of maintenance and the hours run and perform any maintenance that may be due. See Returning the Genset to Service (p. 3-5) if the boat has been in storage. Before each start:

1. Make sure all CO detectors on board are working properly.
2. Check for swimmers that might be exposed to the engine exhaust.
3. Disconnect all electrical loads.

PRIMING THE FUEL SYSTEM

The fuel system should be primed after replacing the fuel filter or running the genset out of fuel. To prime the fuel system, **Push and Hold STOP** on the e-Series Digital Display or **STOP (Prime)** on the control switch for at least 30 seconds.

STARTING THE GENSET

The genset can be started and stopped from the genset control panel or remote control panel.

1. **Push and Hold START** on the e-Series Digital Display or control switch until the genset starts. The genset status lamp blinks when the engine is cranking and comes on and stays on when the genset starts and runs. The status displayed on the e-Series Digital Display changes from *Starting* to *Running* (Figure 2-3).
2. For longer engine life, let the engine warm up for two minutes before connecting air conditioners and other large electrical loads.
3. Check for water, coolant, fuel and exhaust leaks. Stop the genset immediately if there is a leak. Repair fuel leaks immediately.
4. Monitor generator set status using the e-Series Digital Display (p. 2-3), if so equipped. Perform maintenance or service as necessary if the Display indicates a **Pre-Alarm** condition (p. 2-2).
5. **If the genset fails to start**, cranking will discontinue in 20 to 60 seconds, depending on engine temperature. The e-Series Digital Display and/or control switch status lamp will indicate Fault Code No. 4. See *Troubleshooting* (Section 11) if the genset does not start after several tries.

⚠️CAUTION **Do not continue cranking and risk burning out the starter or flooding the engine (exhaust flow during cranking is too low to expel water from a wet exhaust system). Find out why the genset does not start and make necessary repairs.**

6. **If the genset shuts down**, the e-Series Digital Display and/or control switch status lamp will indicate the numeric fault code. See *Troubleshooting* (Section 11).

STOPPING THE GENSET

Disconnect all electrical loads to let the genset run without load and cool down. After 2 minutes **Push and Release STOP** on the e-Series Digital Display or control switch. The genset status lamps will go out.

EMERGENCY STOP

Push the **EMERGENCY STOP SWITCH** to **OFF** (p. 2-1). After all necessary repairs have been made, push the switch to **ON** so that the genset can be operated.

LOADING THE GENSET

How much equipment load can be powered depends upon the genset power rating. The genset will shut down or its AC output circuit breakers will trip if the sum of the loads exceeds genset power or circuit breaker rating.

The genset may shut down due to overload when a large motor or air conditioner is started or cycles off and then on again, even though the sum of the loads is less than genset rating. The reason for this is that a motor's startup load is much larger than its running load. ***It may be necessary to run fewer loads when large motors and air conditioners are cycling on and off.***

The genset is rated at standard barometric pressure, humidity and temperature (ref. ISO 3046). Either low barometric pressure (high altitude) or high ambient temperature will decrease engine power. ***It***

may be necessary to run fewer loads under such conditions.

NO-LOAD OPERATION

Keep no-load operation to a minimum. During no-load operation cylinder temperatures drop to the point where fuel does not burn completely, causing fuel wetting and white smoke. It is best to run the genset at 1/4 to 3/4 load.

CONNECTING TO SHORE POWER

When provisions have been made for connecting shore power, the boat must have an approved device to keep the genset and shore power from being interconnected.

⚠️WARNING *Interconnecting the genset and shore power can lead to electrocution of utility line workers, equipment damage and fire. Use an approved switching device to prevent interconnections.*

RESETTING LINE CIRCUIT BREAKERS

If the genset line circuit breaker trips (p. 2-1), or a circuit breaker in the power distribution panel of the boat, either a circuit shorted or too many loads were connected. Note that the genset will continue to run after a line circuit breaker trips.

If a circuit breaker trips, disconnect or turn off as many loads as possible and reset the circuit breaker. If the circuit breaker trips right away, either the electrical distribution system has a short or the circuit breaker is faulty. Call a qualified electrician.

If the circuit breaker does not trip, reconnect loads one-by-one up to a total load that does not overload the genset or cause the circuit breaker to trip. The circuit probably has a short if the circuit breaker trips right away when it is connected.

Electrical equipment must be used and maintained properly and be properly grounded to cause the line circuit breakers to trip when short circuits occur.

⚠WARNING *Short circuits in electrical equipment can cause fire and electrical shock leading to severe personal injury or death. Electrical equipment and its grounding must be maintained properly to protect against short circuits.*

COLD TEMPERATURE OPERATION

Drain the heat exchanger (p. 4-12) and muffler before cold weather sets in if the genset is not being used. Freezing water can damage the muffler and the raw water tubes in the heat exchanger.

CARE OF NEW OR RE-BUILT ENGINE

Avoid no-load operation as much as possible during break-in. Change the oil and oil filter after the first 50 hours of operation (p. 4-4).

EXERCISING THE GENSET

Exercise the genset at least 1 hour every month if use is infrequent. Run the genset at 1/4 to 3/4 load. A single exercise period is better than several shorter periods. Exercising a genset drives off moisture, re-lubricates the engine, uses up fuel before it becomes stale and removes oxides from electrical contacts. The result is better starting, more reliable operation and longer engine life.

STORING THE GENSET

Proper storage is essential for preserving top genset performance and reliability when the genset cannot be exercised regularly and will be idle for more than 120 days.

Storing the Genset

1. Turn off the genset line circuit breaker (p. 2-1).
 2. Change the engine oil and filter and attach a tag indicating oil viscosity. See ENGINE OIL RECOMMENDATIONS (p. 3-1).
 3. Crank the engine several revolutions but do not let it start. This will fill the oil passages with the new oil.
 4. Disconnect the battery cables (negative [-] cable first) from the starting battery and store the battery according to the battery manufacturer's recommendations. See MAINTAINING THE BATTERY AND BATTERY CONNECTIONS (p. 4-2).
 5. Check coolant level and add as necessary (p. 4-6). Test the coolant mixture if freezing temperatures are possible and change if necessary.
- ⚠WARNING** *Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.*
6. Drain the heat exchanger and muffler if freezing temperatures are expected.
 7. Clean and lightly oil parts that can rust.

Returning the Genset to Service

1. Check the oil tag on the genset and change the oil if the viscosity indicated is not appropriate for the temperatures expected. See ENGINE OIL RECOMMENDATIONS (p. 3-1).
2. Reconnect the starting battery (negative [-] cable last). See MAINTAINING THE BATTERY AND BATTERY CONNECTIONS (p. 4-2).
3. Replace the raw water pump impeller if it was installed more than a year ago (p. 4-10).
4. Perform the maintenance required (p. 4-1), conduct the pre-start checks and prime the fuel system.
5. Start and run the genset.
6. Turn on the genset line circuit breaker (p. 2-1) when ready to power loads.

4. Periodic Maintenance

PERIODIC MAINTENANCE SCHEDULE

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable at the battery to prevent starting while working on the genset.*

Periodic maintenance is essential for top perfor-

mance and long genset life. Use Table 4-1 as a guide for normal periodic maintenance.

Maintenance, replacement or repair of emission control devices and systems may be performed by any engine repair establishment or individual. However, warranty work must be completed by an authorized Onan service representative.

TABLE 4-1. PERIODIC MAINTENANCE SCHEDULE

	After First 50 Hrs	Every Day / 8 Hrs	Every Month/ 100 Hrs	Every Year/ 200 Hrs	Every Year/ 500 Hrs	Every 800 Hrs	Every 2 Years	Every 5 Years/ 2000 Hrs	Page
General Inspection		x ¹							4-2
Check Engine Oil Level		x							4-3
Check Battery			x ²						4-2
Check V-Belt Tension			x ³						4-9
Drain Fuel Filters			x						4-5
Check Siphon Break			x						4-8
Change Oil/Oil Filter	x			x					4-4
Check Brushes/Slip Rings				x ⁵					4-4
Replace Fuel Filters					x				4-5
Replace Pump Impeller					x				4-10
Adjust Engine Valve Lash						x			–
Replace Coolant, Pressure Cap & Thermostat							x ⁴		4-6
Check Generator Bearings, Drive Belt, Belt Tensioner & Drive Coupling								x ⁵	–
1. Includes inspection of Oil Level, Coolant Level, Fuel System, Exhaust System, Batteries and Sea Water Strainer. 2. See battery manufacturer's recommendations. 3. Check for slippage, cracking and wear (pump drive belt only). 4. There is no zinc anode to replace. 5. Must be performed by a trained and experienced mechanic (Onan Distributor/Dealer) in accordance with the engine and genset Service Manuals.									

GENERAL INSPECTION

Inspect the genset before the first start of the day and after every eight hours of operation.

Oil Level

Check engine oil level (p. 4-3).

Exhaust System

⚠️WARNING ***EXHAUST GAS IS DEADLY! Do not operate the genset until all exhaust leaks have been repaired.***

Inspect the exhaust system for leaks and loose hose clamps at the exhaust manifold, exhaust elbow, muffler, water separator and hull fittings. Replace damaged sections of exhaust hose.

Check that all CO monitors are working properly.

Fuel System

⚠️WARNING ***Fuel leaks can lead to fire. Repair leaks immediately. Do not run the genset if it causes fuel to leak.***

Check for leaks at hose, tube and pipe fittings in the fuel supply and return systems while the genset is running and while it is stopped. Check flexible fuel hose for cuts, cracks, abrasions and loose hose clamps. Make sure fuel lines do not rub against other parts. Replace worn or damaged fuel line parts before leaks occur. Replace hose with with USCG TYPE A1 or ISO 7840-A1 fuel hose.

Prime the fuel system if the genset ran out of fuel.

Coolant Level

Check coolant level in the recovery tank and, if necessary, refill to COLD when the engine is cold or to HOT when it is at normal running temperature. The recovery tank is designed to maintain coolant level, not to fill the system. If the tank is empty, check for and repair any coolant leaks and refill the system through the fill neck on the engine. See Refilling the Cooling System (p. 4-6). Use the recommended antifreeze mixture (p. 3-2).

Raw Water System

Clean out the sea water strainer if necessary and make sure the sea cock is open for genset operation. Also, when a water/exhaust separator is pro-

vided (see Installation Manual), open the sea cock for the water drain hose.

Check for and replace hoses that leak or are damaged.

Battery Connections

See MAINTAINING THE BATTERY AND BATTERY CONNECTIONS.

Mechanical

Monitor generator set status using the e-Series Digital Display (p. 2-3).

Look for mechanical damage and listen for unusual noises when the genset is running. Check the genset mounting bolts. Check to see that the genset air inlet and outlet openings are not clogged with debris or blocked. Keep the genset compartment clean.

MAINTAINING THE BATTERY AND BATTERY CONNECTIONS

⚠️WARNING ***Arcing at battery terminals or in light switches or other equipment, and flames or sparks, can ignite battery gas causing severe personal injury—Ventilate battery area before working on or near battery—Wear safety glasses—Do not smoke—Switch work light ON or OFF away from battery—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.***

Refer to Table 4-1 for scheduled battery maintenance, and follow the battery manufacturer's instructions. Have the battery charging system serviced if DC system voltage is consistently low or high.

Check the battery terminals for clean, tight connections. Loose or corroded connections have high electrical resistance which makes starting harder. Always:

1. Keep the battery case and terminals clean and dry and the terminals tight.
2. Use a battery terminal puller if the battery has terminal posts.
3. Make sure which terminal is positive (+) and which is negative (–) before making battery connections, always removing the negative (–) cable first and reconnecting it last to reduce arcing.

CHECKING ENGINE OIL LEVEL

⚠️WARNING *State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Avoid skin contact and breathing of vapors. Use rubber gloves and wash exposed skin.*

⚠️WARNING *Crankcase pressure can blow hot engine oil out the fill opening causing severe burns. Always stop the genset before removing the oil fill plug.*

1. Pull the plug and dipstick out of the oil fill neck (Figure 4-1). The plug may be difficult to pull straight out. It is easier if you tilt the plug in its socket while pulling out. Wipe off the dipstick and thread it back into the fill neck and seat the plug, which snaps into its socket. Remove the plug and dipstick again and check the oil level on the dip stick.
2. Add or drain oil as necessary. See ENGINE OIL RECOMMENDATIONS (Page 3-1). Keep the oil level between the high and low beads on the end of the dipstick, as shown. It is not necessary to add oil between oil changes if the oil has not dropped more than 1/3 of the way between the high and low beads.

⚠️CAUTION *Too little oil can cause severe engine damage. Too much oil can cause high oil consumption.*

3. Secure the oil fill plug, which snaps into its socket.

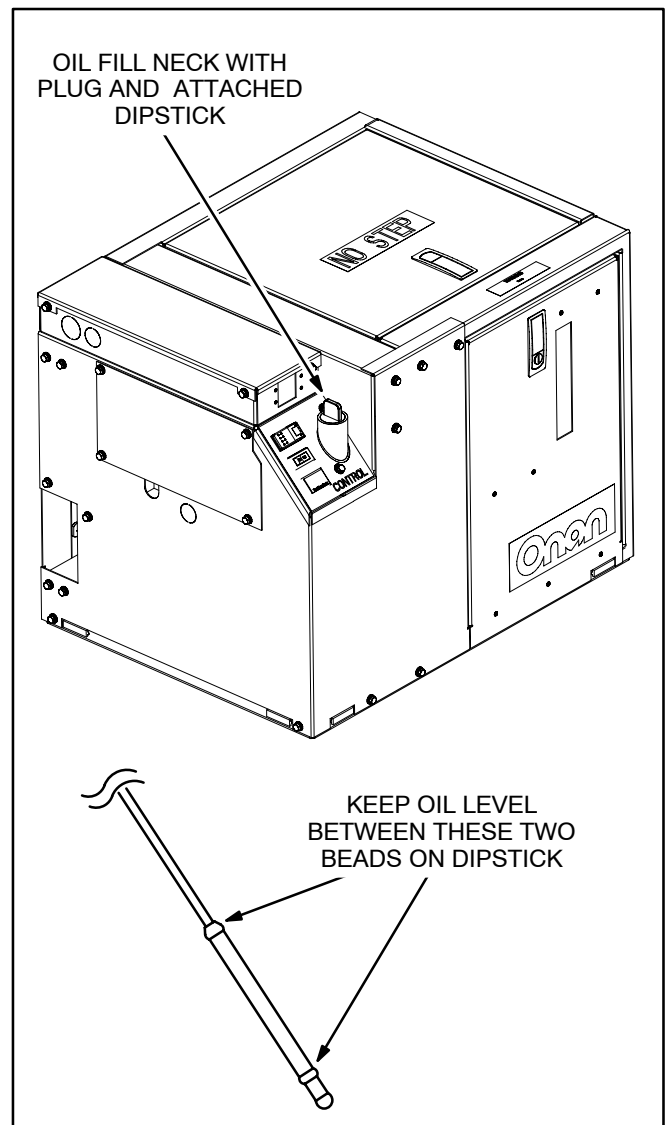


FIGURE 4-1. OIL FILL NECK AND DIPSTICK

CHANGING ENGINE OIL AND FILTER

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable at the battery to prevent the engine from starting.*

⚠WARNING *State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Avoid skin contact and breathing of vapors. Use rubber gloves and wash exposed skin.*

⚠WARNING *Crankcase pressure can blow hot engine oil out the fill opening causing severe burns. Always stop the genset before removing the oil fill plug.*

Refer to Table 4-1 for scheduled engine oil change.

1. Run the genset under load until it is up to operating temperature, stop it and disconnect the negative (–) battery cable at the battery.
2. Remove the oil fill plug (Figure 4-1), open the front access door and drain the engine oil into a container by opening the drain valve (Figure 4-2). (The drain valve has a 3/8 NPT outlet for connecting a hose fitting to facilitate oil draining.) If an oil pump-out system is installed, follow the instructions provided.
3. *Close the oil drain valve.*
4. Spin off the old oil filter with a filter wrench and wipe off the filter mounting surface. (A filter wrench is available from Onan.) Remove the old gasket if it does not come off with the filter.
5. Apply a film of oil to the filter gasket and partly fill the filter with oil so that it reaches engine parts sooner at startup. Spin the new filter on by hand until the gasket just touches the mounting pad and tighten 3/4 turn.
6. Refill the engine with the proper type and amount of engine oil. See ENGINE OIL RECOMMENDATIONS (p. 3-1) and *Specifications* (Section 12). Check the oil level and add or drain oil as necessary.

⚠CAUTION *Too little oil can cause severe engine damage. Too much oil can cause high oil consumption.*

7. Close the access door and dispose of the used oil and oil filter according to local environmental regulations.

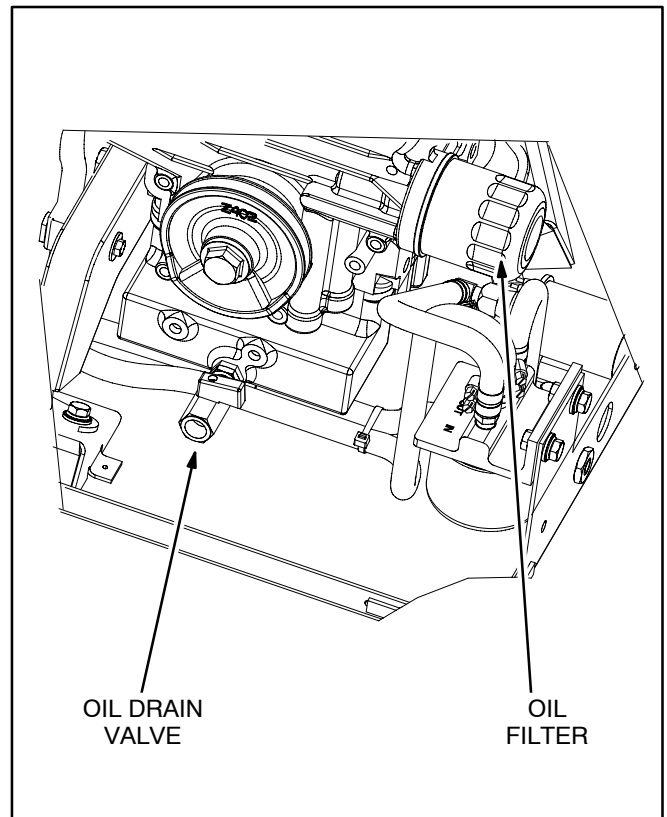


FIGURE 4-2. OIL FILTER AND DRAIN VALVE

DRAINING/REPLACING THE FUEL FILTER

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable at the battery to prevent the engine from starting.*

⚠WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.*

Keep dirt, water and other contaminants from entering the fuel system and corroding or clogging fuel injection components.

The genset has a water-separator fuel filter (Figure 4-3). Check for other up-stream filters which may also need to be drained or replaced.

Draining Water and Sediment

Drain water and sediment more often than scheduled (Table 4-1) if fuel quality is poor or condensation cannot be avoided.

1. Disconnect the negative (–) cable at the battery to prevent the engine from starting and close any fuel supply and return valves.
2. Open the front access door and drain the filter (about 1/2 cup [120 ml]) into a suitable container by removing the drain plug (bottom of filter).
3. Re-install the drain plug and dispose of the drain-off in accordance with local environmental regulations.

Replacing Fuel Filter

See Table 4-1 for scheduled filter change. Change the filter if the engine lacks power.

1. Disconnect the negative (–) cable at the battery to prevent the engine from starting and close any fuel supply and return valves.
2. Open the front access door and spin off the old filter with a filter wrench and dispose of it in accordance with local environmental regulations.
3. Clean the contact surface on the filter base, lubricate the new filter gasket and spin the new filter on hand tight.
4. Prime the engine for at least 30 seconds (Page 3-3) to fill the new filter. Run the genset and check for leaks. Tighten the filter by hand, if necessary.

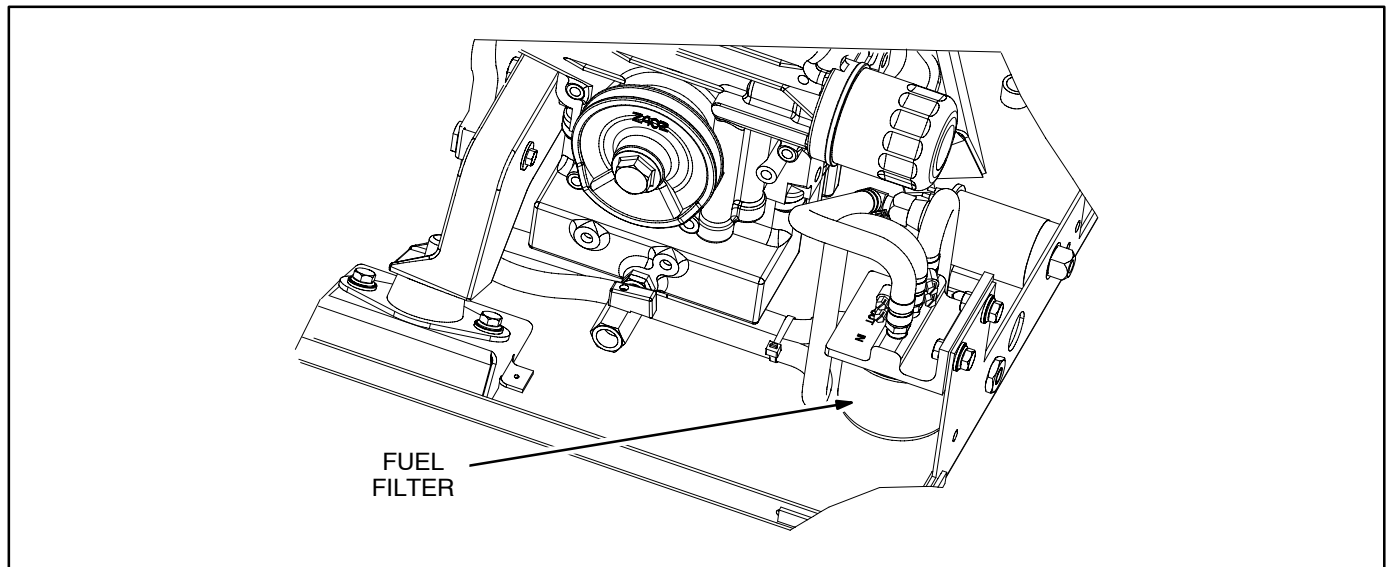


FIGURE 4-3. FUEL FILTER

MAINTAINING THE ENGINE COOLING SYSTEM

Refer to Table 4-1 for scheduled maintenance.

Cooling System Overview

The engine is cooled by a pressurized, closed-loop liquid cooling system in which coolant is pumped through passages in the engine block, head and exhaust manifold (Figure 4-4). The exhaust manifold also serves as the engine coolant reservoir.

The heat exchanger is mounted inside the exhaust manifold. Raw water (the flotation water) is pumped through tubes in the heat exchanger to cool the engine coolant. The raw water then passes through a hose into the exhaust-water mixer where it cools the exhaust gases and is expelled. The V-belt drives the coolant and the raw water pumps.

Recommended Coolant Mixture

See ENGINE COOLANT (p. 3-2) for recommendations.

Replenishing Normal Coolant Loss

Check coolant level in the recovery tank before the first startup of each day and, if necessary, refill to COLD when the engine is cold or to HOT when it is running. The recovery tank is designed to maintain coolant level, not to fill the system. If the tank is empty, check for and repair any coolant leaks and refill the system through the fill neck on the engine.

Make sure the two hoses from the recovery tank are routed through the two holes in the right end of the genset enclosure, that the coolant recovery hose is connected to the fill neck on the engine and that the overflow hose terminates in the drip pan where it will not splash coolant on electrical components.

Pressure Cap

Replace the pressure cap every two years (seals deteriorate and leak). Proper cooling system pressure (10 psi) is essential for optimal engine cooling and minimal coolant loss.

Coolant Hoses

Check for and replace hoses that leak or are damaged.

Draining and Cleaning Cooling System

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable from the battery to prevent the engine from starting.*

⚠ WARNING *Hot coolant spray can cause severe burns. Let the engine cool before releasing the pressure cap or removing the drain cap.*

1. Have towels and containers ready to wipe up, collect and properly dispose of the coolant.
2. Disconnect the negative (–) cable at the battery to prevent the engine from starting, let the engine cool and remove the front and top access doors and the coolant pressure cap.
3. Drain the exhaust manifold/coolant reservoir by disconnecting the hose at the coolant pump inlet (Figure 4-4) and twisting it down into a container.
4. Drain the block by removing the cap on the drain fitting on the left side of the block (Figure 4-4). Use an 11/16 inch socket on a swivel and 12 to 18 inch extension. To catch the coolant and direct it into a container, insert the socket and extension through a piece of hose large enough to fit over the socket but shorter than the extension. The hose will catch the coolant as the cap is being unscrewed.
5. Use radiator cleaning chemicals to clean and flush the cooling system before refilling with fresh coolant. Follow the cleaner manufacturer's instructions.

Refilling Cooling System

⚠ CAUTION *Low coolant level can cause severe engine damage. Make sure the system is full.*

⚠ CAUTION *Filling a hot engine with cold water can cause cracks in the manifold, head and block.*

Close the block drain cap and reconnect the pump inlet hose and fill the system through the engine fill neck. The system will fill only as fast as the air can escape. Fill to the bottom of the fill neck. Start and run the engine for a couple of minutes to dislodge air pockets and shut it down. Add as much coolant as necessary and secure the pressure cap. Then refill the recovery tank up to the COLD mark.

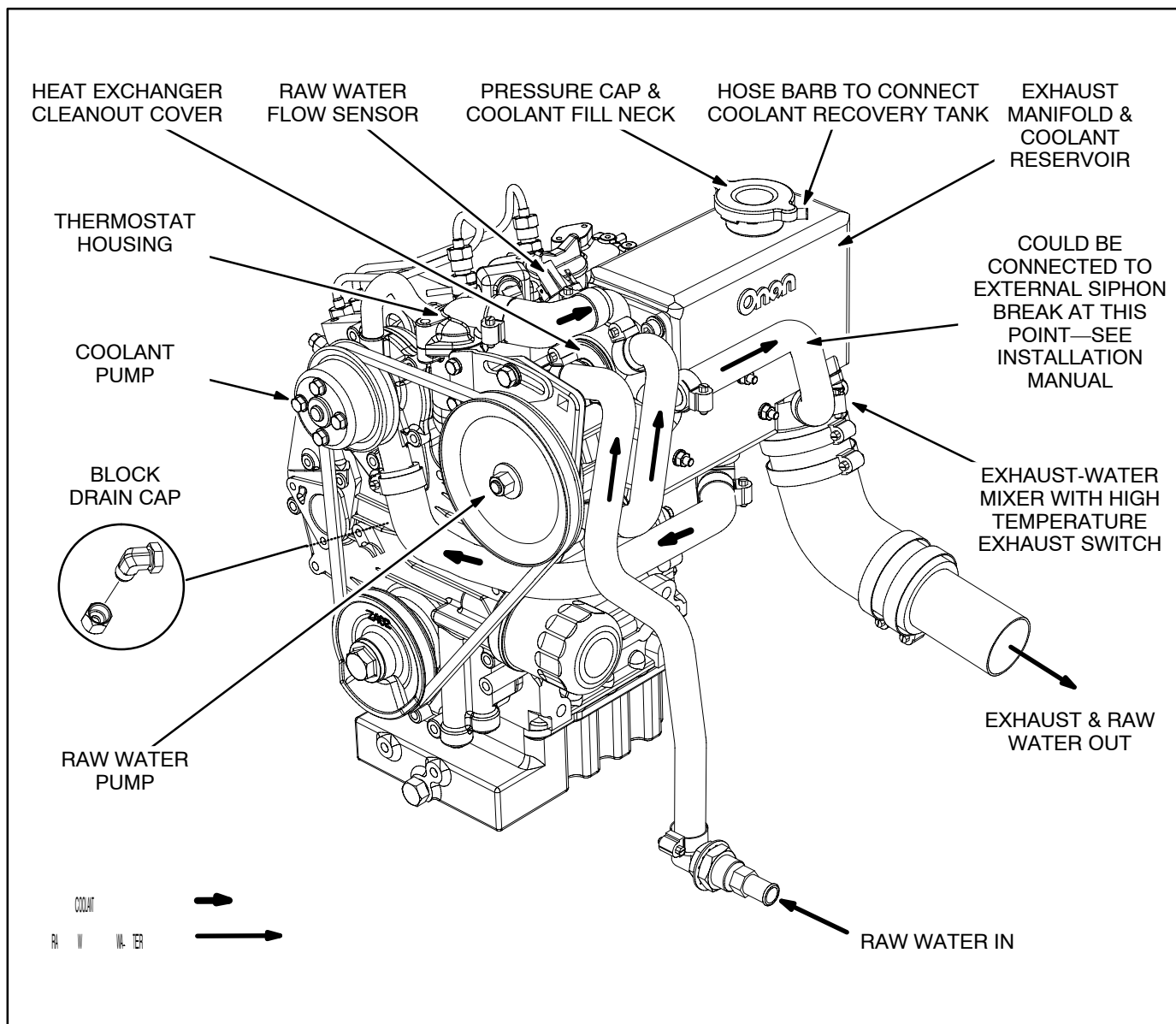


FIGURE 4-4. ENGINE COOLING SYSTEM

Replacing the Thermostat

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable from the battery to prevent the engine from starting.*

⚠WARNING *Hot coolant spray can cause severe burns. Let the engine cool before releasing the pressure cap or removing the drain cap.*

See Table 4-1 for scheduled replacement. Referring to Figure 4-5, replace the thermostat as follows:

1. Disconnect the negative (–) cable at the battery to prevent the engine from starting, let the engine cool and remove the top access door and pressure cap.
2. Remove the two thermostat housing bolts and pull off the housing, thermostat and gasket. The hose does not need to come off.
3. Clean off the gasket area and install the new thermostat and gasket. Apply Three Bond 1215 liquid sealant or equivalent to the top side of the gasket.
4. Replenish any lost coolant, secure the pressure cap, secure the access door and reconnect the battery cables (negative [–] last).

Siphon Break

⚠WARNING *Bypassing a siphon break or failing to maintain it can lead to engine flooding and damage to the engine not covered under Warranty.*

See Table 4-1 for scheduled maintenance. A siphon break is installed when the exhaust-water mixer is below the water line. If of a spring-loaded valve design, check for free movement of the plunger. Replace the device if the plunger does not move freely or the body is encrusted with deposits from leakage past the valve seat. If of the bleed-vent type, check that the vent hose is properly connected on both ends. If the vent is connected to a through-hull fitting, check for normal water flow whenever the engine is running. See the Installation Manual for more information regarding siphon break installation.

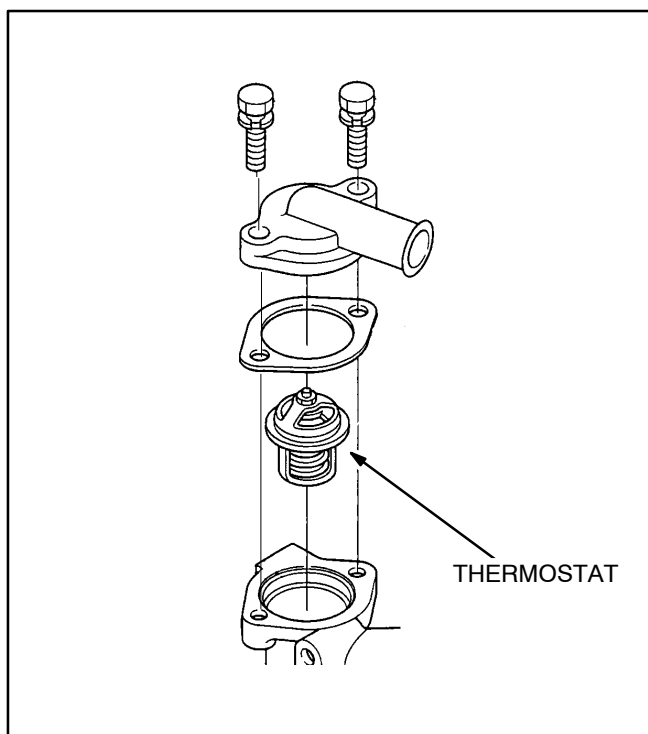


FIGURE 4-5. TYPICAL THERMOSTAT

Adjusting V-Belt Tension

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable at the battery to prevent the engine from starting.*

See Table 4-1 for scheduled inspection or replacement. Adjust belt tension as follows:

1. Disconnect the negative (–) cable at the battery to prevent the engine from starting.
2. Remove the front and top access doors. If work space is limited, remove the end panel (Figure 4-6) to be able to hold the nut on the pump pivot bolt (Figure 4-7) with an open-end wrench while loosening the bolt.
3. Loosen both bolts so that the pump can pivot.
4. Pivot the pump out to tighten belt tension. Hold tension by tightening the tension adjusting bolt and check it by applying 20 pounds (10 kg) to the middle of the pulley span. Belt tension is correct when deflection is 0.4 inch (10 mm).
5. Tighten the bolts, reassemble the panels and doors and reconnect the battery cables (negative [–] last).

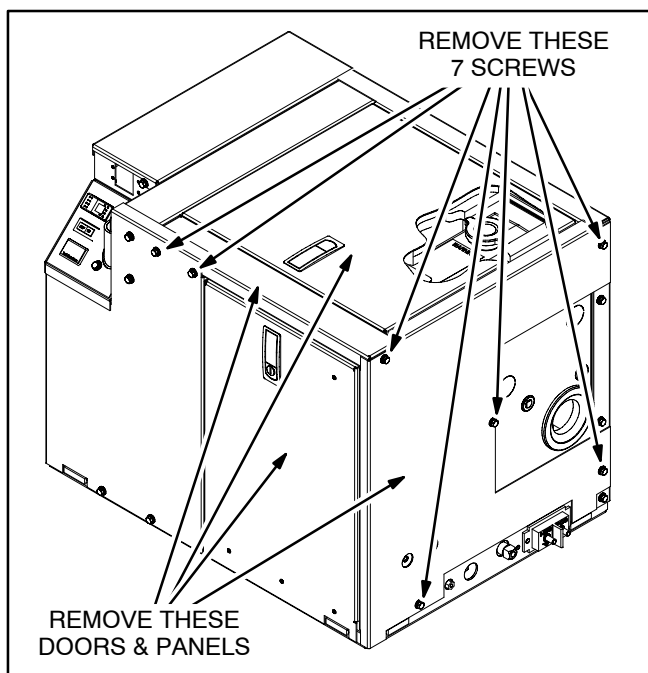


FIGURE 4-6. REMOVING ACCESS PANELS

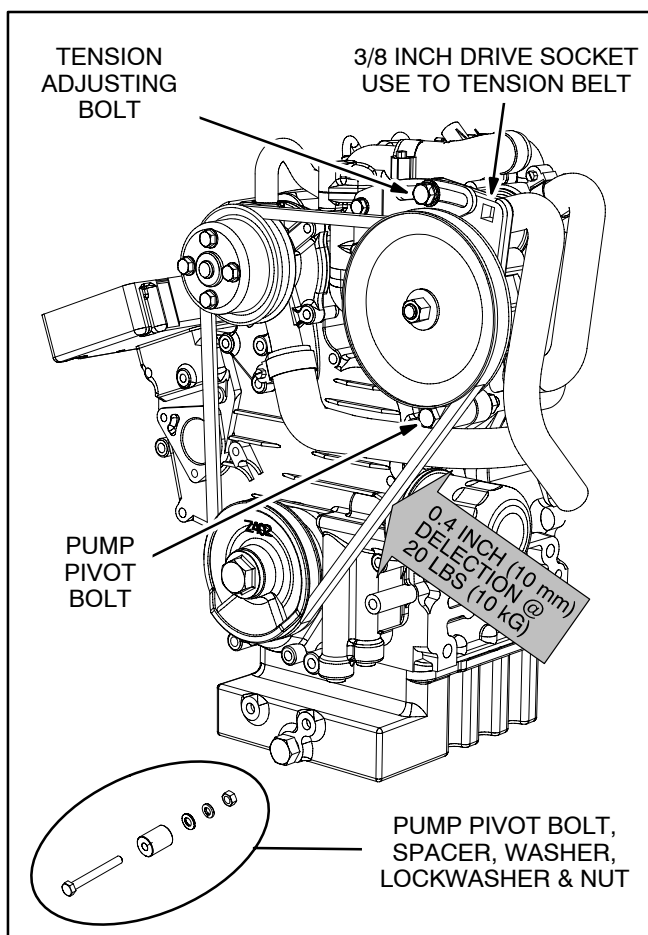


FIGURE 4-7. ADJUSTING V-BELT TENSION

Replacing the Raw Water Pump Impeller

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable at the battery to prevent the engine from starting.*

See Table 4-1 for scheduled replacement. Have towels and containers ready and avoid spilling raw water on the electrical components below the pump. Referring to Figures 4-8 and 4-9, replace the impeller as follows:

1. Close the sea cock.
2. Disconnect the negative (–) cable at the battery to prevent the engine from starting.
3. Remove the front and top access doors. If work space is limited, remove the end panel (Figure 4-6) to be able to hold the nut on the pump pivot bolt (Figure 4-8) with an open-end wrench while loosening the bolt.
4. Loosen the hose clamps shown in Figure 4-8 and disconnect the hoses.
5. Loosen the two pump mounting bolts and remove the belt. Remove the tension adjusting bolt first and swing the pump out for access to the pivot bolt nut, lock washer and flat washer. Remove the pivot bolt and pull the pump out.

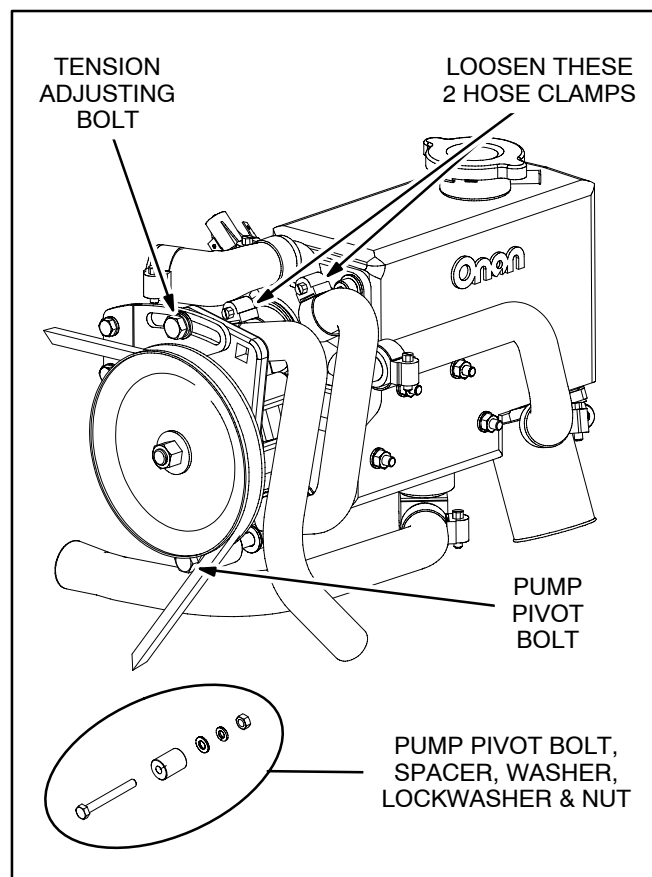


FIGURE 4-8. REMOVING RAW WATER PUMP

6. Remove the 4 pump cover screws (Figure 4-9) and remove the impeller and O-ring. Use two pliers to grip vanes on opposite sides if the impeller is difficult to remove. *It will be necessary to check for and cleanout pieces of the impeller from the heat exchanger and exhaust elbow if vanes have broken off.*

7. Install the new impeller. It helps to twist the impeller clockwise (the way it turns) while squeezing it into the housing.

8. To provide initial lubrication and better pump suction before water reaches the pump, wet the inside of the pump and impeller with water, soap solution or a silicone lubricant.

⚠ CAUTION *Do not lubricate the impeller with grease or oil or other petroleum products because they are known to chemically attack impeller materials.*

9. Secure the cover and O-ring.

10. Remount the pump, reconnect the hoses, adjust V-belt tension (Page 4-9) and reassemble the enclosure panels and doors.

11. *Fill the sea water strainer for faster priming at startup if it is above the water line.*

12. Open the sea cock, reconnect the battery cables (negative [–] last) and start the genset. The genset will shut down within 8 seconds if there is no raw water flow and Fault Code No. 7 (p. 11-6) will be declared. If it shuts down, find out why, remove any blockage and restart the genset.

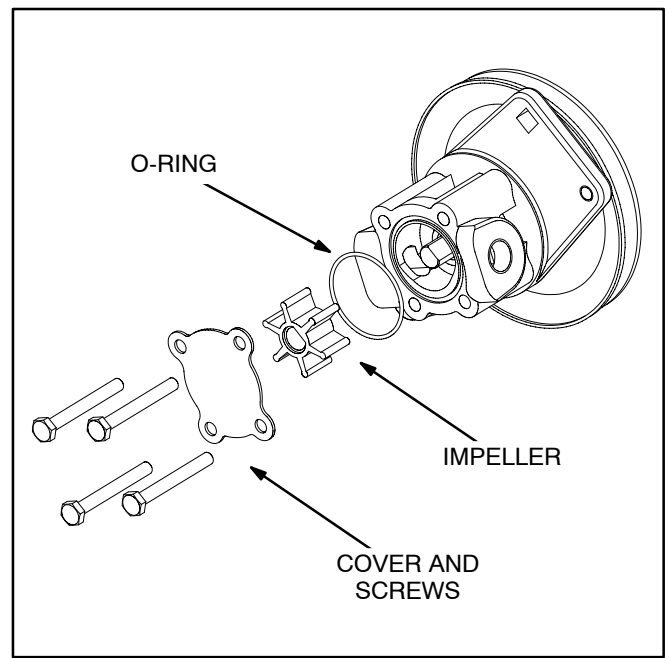


FIGURE 4-9. REPLACING THE IMPELLER

Heat Exchanger

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (–) cable from the battery to prevent the engine from starting.*

The heat exchanger has a cleanout cover and drain plug (Figure 4-10). Clean the raw water tubes if the engine keeps shutting down (Code No. 1) or the engine gauge indicates abnormally high engine temperatures. Drain the heat exchanger if there is a danger of freezing when the genset is not running or is in storage. (Freezing water can damage the raw water tubes in the heat exchanger. Engine coolant, but not raw water, is protected from freezing.)

Cleaning and Draining the Heat Exchanger: To clean the tubes or to drain raw water, first remove the end enclosure panel or the raw water pump (p. 4-10). Have towels and containers ready to prevent spilling raw water on the electrical components below the heat exchanger.

Remove the drain plug or cleanout cover. Clean and flush the tubes. The drain plug must be removed to get all the water out of the tubes. Do not use metal rods to clean the tubes. The tubes are made of relatively soft copper alloy and can be damaged.

Use thread sealant on the drain plug and a new clean out cover gasket if the old one is torn or otherwise damaged. Reassemble all the parts that were disassembled for access.

Removing/Installing the Heat Exchanger: Remove the heat exchanger and have it cleaned at a radiator shop if there is hard scale in the tubes.

To remove the heat exchanger, first disconnect the two leads at the flow sensor, remove the sensor and disconnect the three hoses. (To work the coolant hose elbow off the fitting on the heat exchanger, it will be necessary to loosen the hose clamps on both ends.) Then remove the four mounting bolts and withdraw the heat exchanger.

To install the heat exchanger, first clean the mating gasket faces, taking special care not to scratch the face on the aluminum manifold. Use a new gasket and torque the mounting bolts to 19 lb-ft (26 N-m). Then install the flow sensor using pipe thread sealant and reconnect the two leads in the harness. Reconnect the hoses and reassemble all the parts that were disassembled for access.

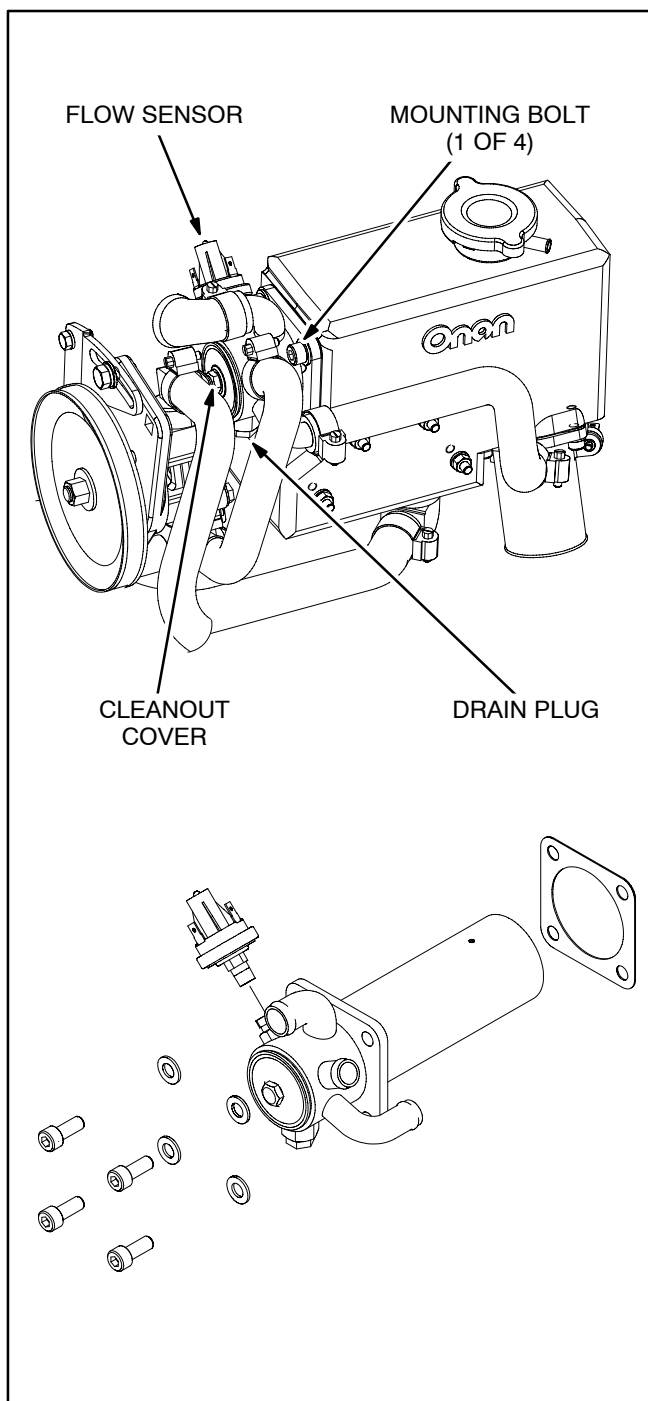


FIGURE 4-10. HEAT EXCHANGER

5. Enclosure, Drip Pan and Mounting System

ENCLOSURE PANELS

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

The genset enclosure panels and access doors are assembled as shown (Figure 5-1).

Back Panel

This panel is secured by 5 screws along its left edge (looking from the back), 3 along its right edge and 7 on its back. Remove this panel for access to the generator drive (Page 7-1).

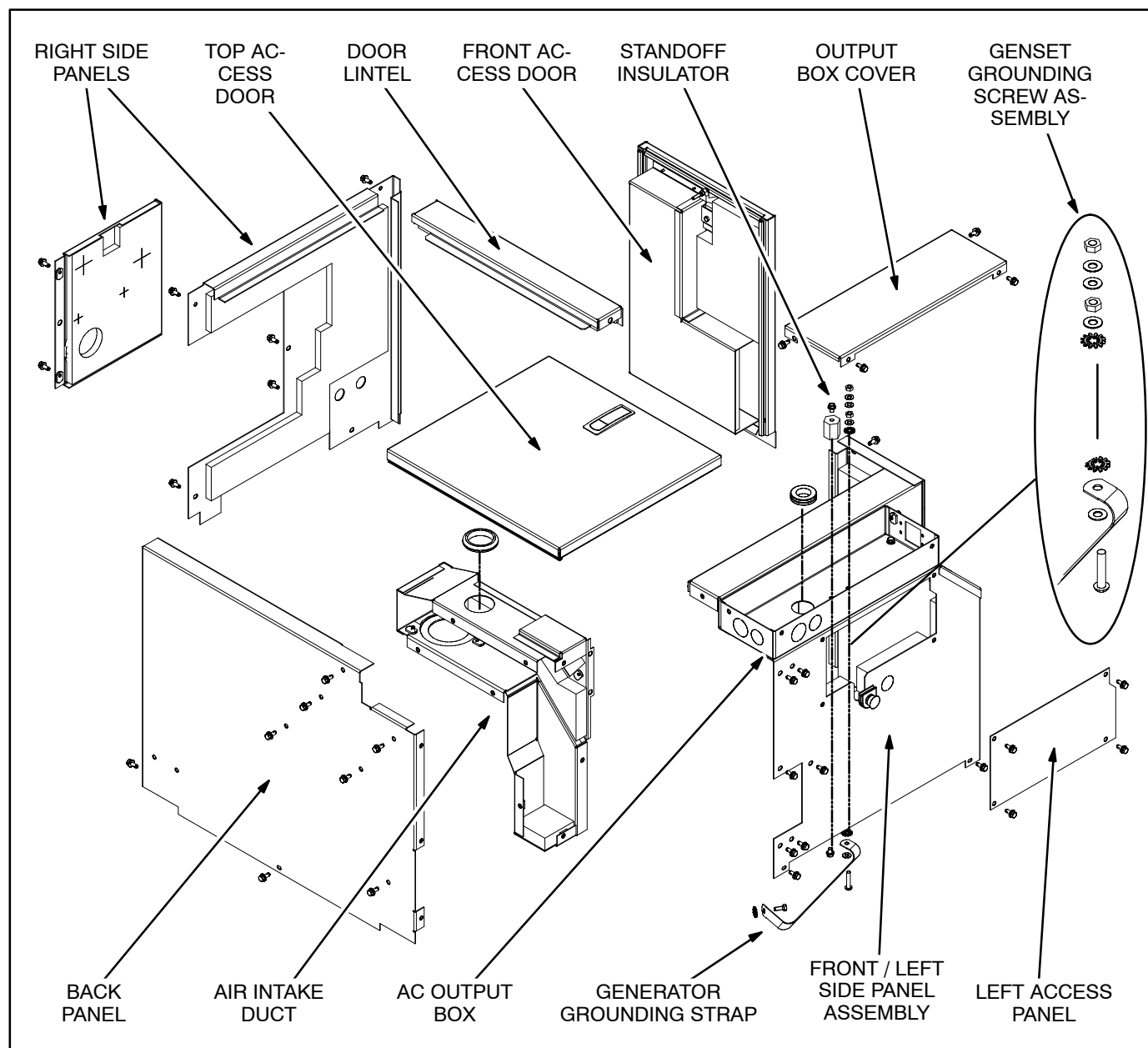


FIGURE 5-1. GENSET ENCLOSURE

Right Side Panel

The main panel is secured by 5 screws, 1 near each corner and 1 near the center. The smaller panel is secured by 3 screws. *Removing these panels provides access to the engine components on the right side.*

Access Doors

The access doors are latched and the front is lockable with a key. The door lintel between them is a channel secured by 1 screw on the right side and 2 screws on the left.

Front / Left Side Panel Assembly

This panel assembly is secured by 2 screws to the access door lintel, 4 to the drip pan, 6 on the side and 1 in back along the top edge, right of the AC outlet box. *Remove this assembly and the access doors for full access from the top, front and left side.* To remove it, remove the 4 screws that secure the AC output box, disconnect all wiring at the control panel and remove the two screws that secure the oil fill neck to the control panel. *This panel assembly can be pulled forward and removed without having to disturb connections in the AC output box.*

AC Output Box

The AC output box is secured by 4 screws in the bottom of the box. The genset grounding screw and standoff insulator are for generator, load and grounding connections.

Air Intake Duct

The duct is secured to the back by 5 screws and to the side by 3 screws.

DRIP PAN AND MOUNTING SYSTEM

Front Engine Support Bracket

Torque the 3 bolts that secure the bracket to the engine to 41 lb-ft (55 N-m).

Vibration Isolation Mounts

Two of the three mounts are bolted to the engine-generator adapter (Figure 5-2) and one to the front mount. Torque the through bolts and the two mounting bolts to the drip pan to 20 lb-ft (27 N-m).

Generator End Bell Support Bracket

See Figure 5-2. Torque all the bolts to 8 lb-ft (11 N-m).

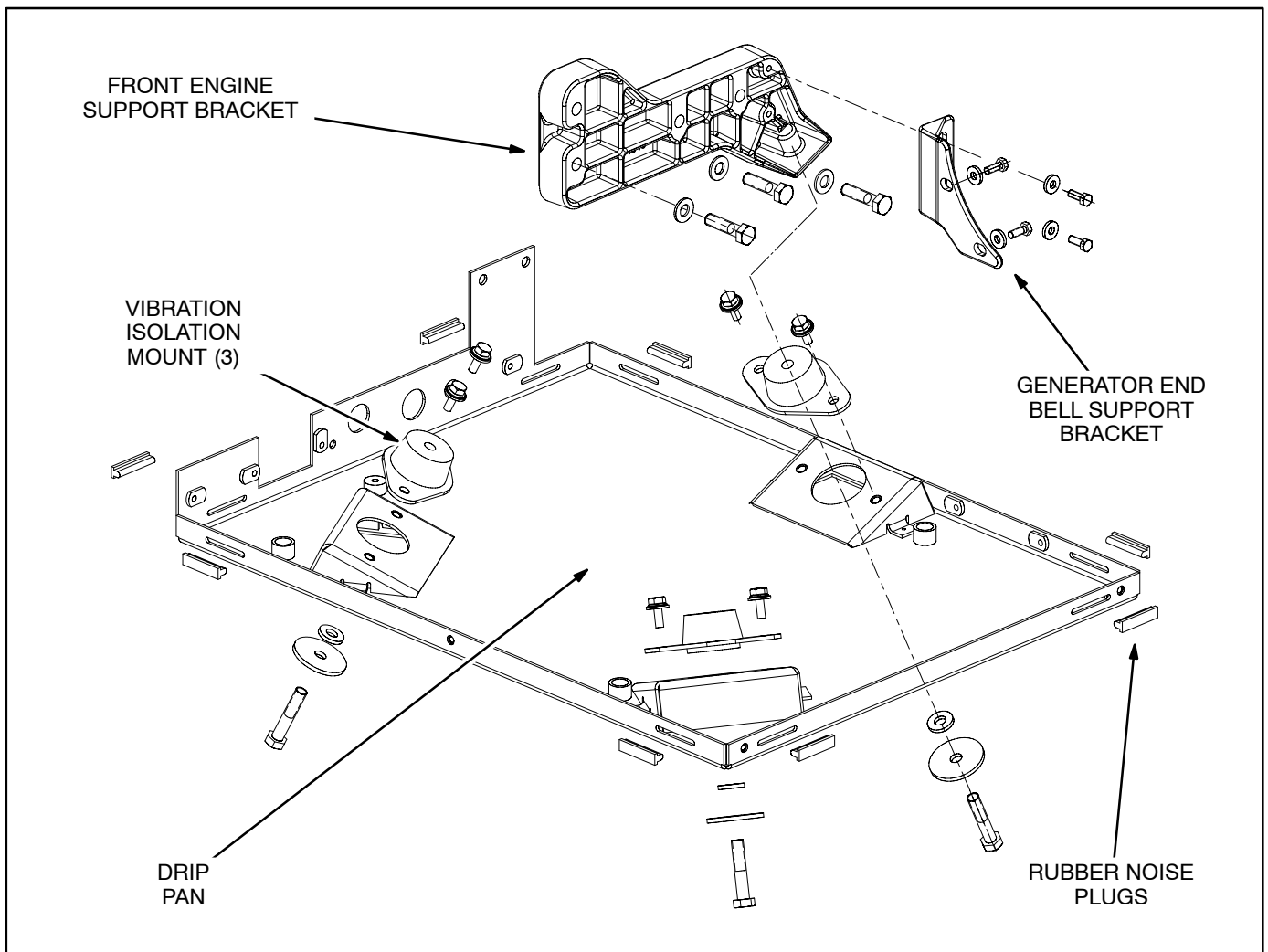


FIGURE 5-2. DRIP PAN AND MOUNTING SYSTEM

6. Engine and Accessories

MAJOR ENGINE SERVICE

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Refer to engine Workshop Manual 981-0533 for major engine service and for servicing fuel injectors, setting fuel injection timing, replacing glow plugs, cleaning the crankcase breather assembly and replacing the coolant pump.

Note: To preserve the existing high-idle speed adjustment, do not disturb the lock wires on the adjusting screws on the governor actuator base (Page 6-7) when removing it from the engine for engine service.

Cooling System: Refer to ENGINE COOLING SYSTEM (Page 4-6) for replacing thermostat, raw water impeller, heat exchanger and V-belt.

Fuel Injection Timing Marks: Note the fuel injection timing marks (Figure 6-1), which line up at 19° BTDC. They are visible when the back or side panel is removed (Page 5-1).

Adjusting Valve Lash: Do not use the fuel injection timing marks (Figure 6-1) when adjusting valve lash. Using them could lead to misadjustments.

Valve lash should be adjusted when both valves are closed at TDC for the cylinder power stroke (every other revolution). To locate this position for either cylinder, rotate the engine clockwise (looking from the front) until the intake valve push rod (Figure 6-2) just stops moving down (valve closed). Then turn the engine one half turn more and adjust lash for both valves (intake and exhaust). Repeat this procedure for the other cylinder. Adjust valve lash to 0.0059–0.0073 inch (0.145–0.185 mm).

The rocker arm cover is accessible through the top access opening (Page 5-1). To get the rocker arm cover off, remove the screw that secures the intake resonator (Figure 6-3) to the cover and tilt the resonator out of the way. Also remove the glow plugs.

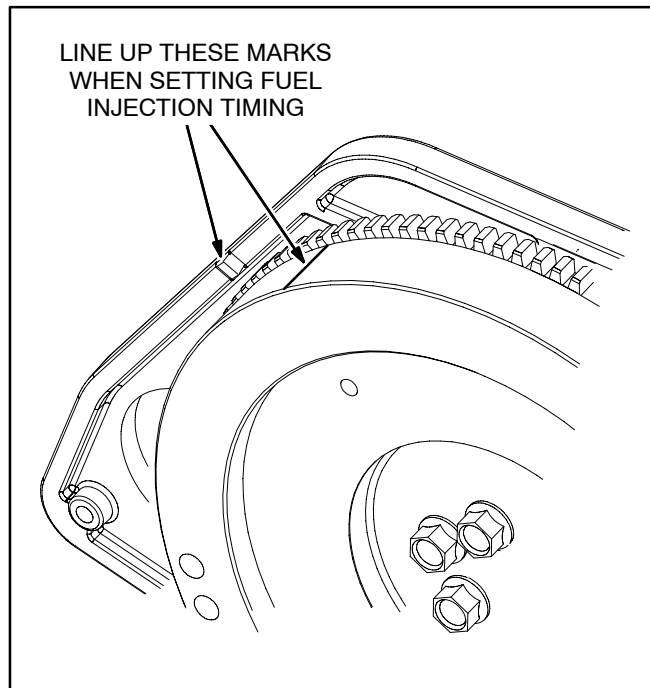


FIGURE 6-1. FUEL INJECTION TIMING MARKS

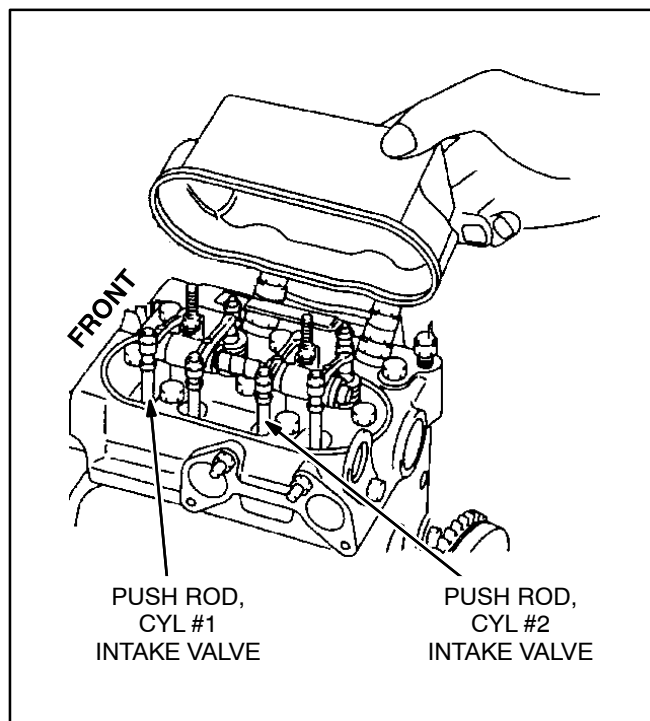


FIGURE 6-2. ROCKER ARMS AND PUSH RODS

INTAKE RESONATOR ASSEMBLY

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Figure 6-3 illustrates how the intake resonator system is assembled. The arrows indicate the air flow. Remove the top access door and the control access panel on the left side for access (Page 5-1). When reassembling, make sure the tails on the hose

clamps will not touch the insulation on the access door.

Before installing the second resonator chamber, make sure that:

- The brush block leads are connected (Page 8-4).
- The fuel lines are connected at the fuel injector (Figure 6-5).
- The oil fill hose is connected at the engine fill tube (Page 6-5).
- All adjustments to the governor actuator have been completed (Page 6-7).

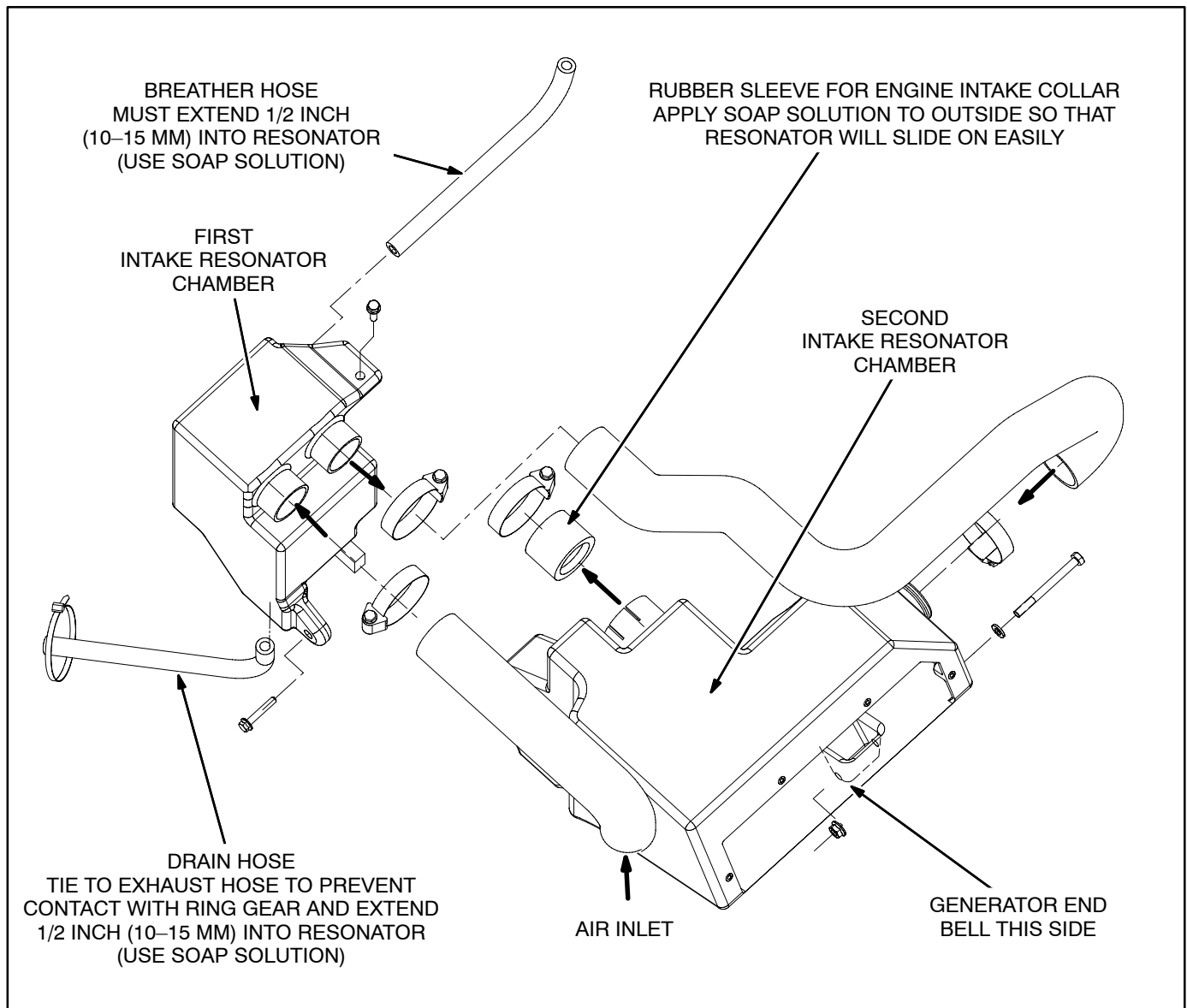


FIGURE 6-3. INTAKE RESONATOR ASSEMBLY

EXHAUST MANIFOLD

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

Figure 6-4 illustrates how the exhaust system is assembled. Remove the front and top access doors and the right side panel for access (Page 5-1).

Use new manifold and mixer gaskets when re-assembling. Torque the 4 manifold nuts and the 3 mixer bolts to 8 lb-ft (11 N-m).

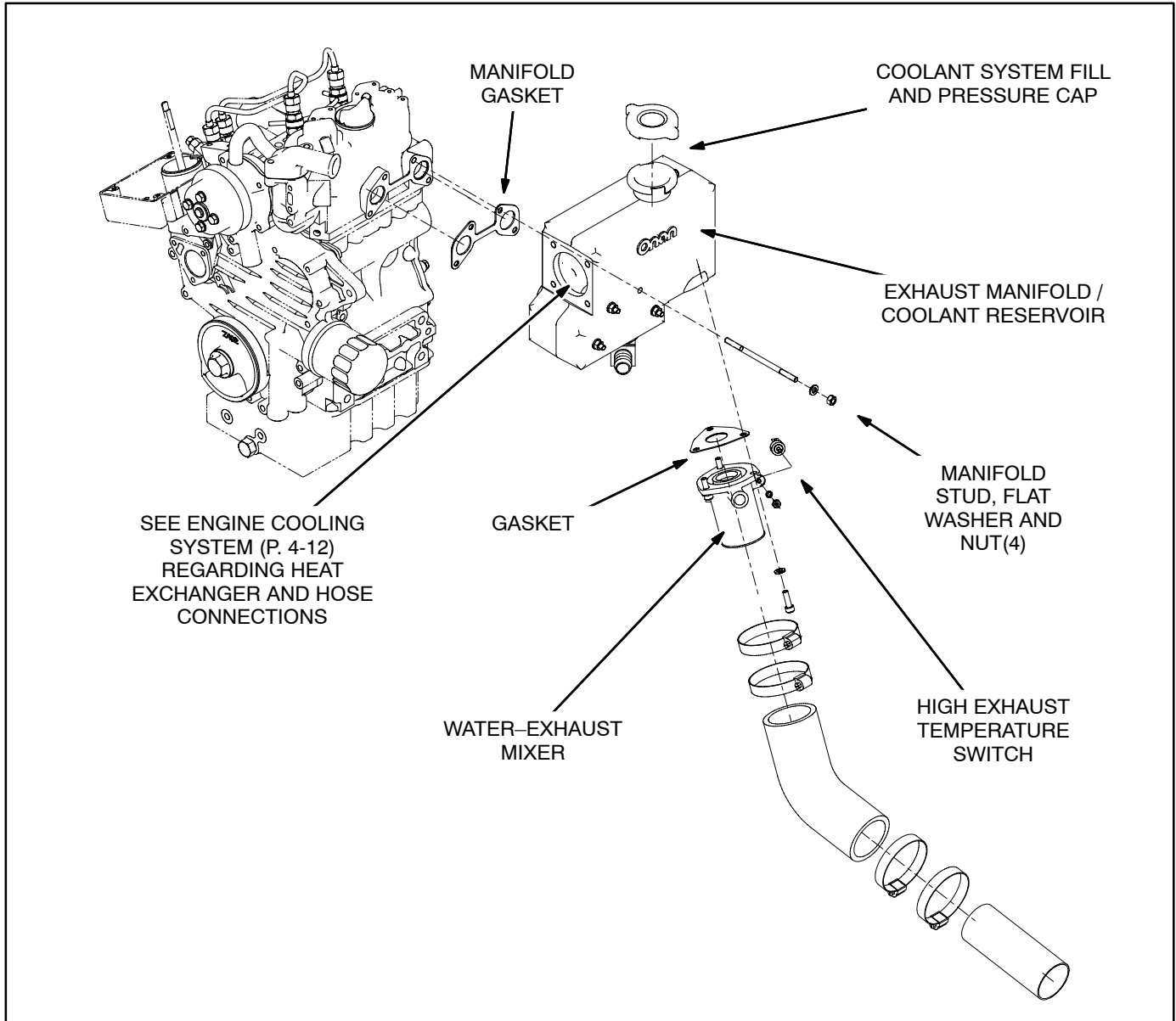


FIGURE 6-4. EXHAUST MANIFOLD

FUEL SYSTEM

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

⚠WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.*

Figure 6-5 illustrates how the fuel system is assembled for delivering fuel to and from the fuel injection system.

Fuel Filter

See the engine Workshop Manual (981-0533) for fuel injection system service. See DRAINING / CHANGING FUEL FILTER (Page 4-5) regarding fuel filter maintenance.

Fuel Pump Tests

A quick test to determine if the fuel pump is weak is to pinch the fuel bypass hose (Figure 6-5) with rubber tipped visegrips. If an engine that fails to start starts and runs with bypass flow cut off, fuel delivery to the engine is weak. Service all of the fuel filters in the system and repair any restrictions to fuel flow. If fuel delivery is still weak, replace the fuel lift pump.

To test fuel lift pump delivery:

1. Disconnect the fuel return hose from the line to the supply tank and point the end into a container of known volume, such as a 1 or 2 liter (quart) bottle.

2. Prime the genset by pushing the Start/Stop switch to **STOP(Prime)** and holding it there for the duration of the test. It should not take longer than 1-1/2 minutes to fill a 1 liter container (2/3 liter per minute).
3. If flow is less than specified, service all of the fuel filters in the system and repair any restrictions to fuel flow. If fuel delivery is still weak, replace the fuel lift pump.

Fuel Pump Removal and Installation

Remove the right side panel for access (Page 5-1). Alternatively, if the starter has been removed from the front, the fuel pump can also be removed from the front.

Fuel Fittings

The connections for fuel supply and return that extend through the side of the drip pan are pipe thread fittings. For these fittings use *liquid-type* pipe thread sealant Listed as suitable for diesel fuel. Apply the sealant sparingly to the male threads only.

⚠CAUTION *Excess liquid-type pipe thread sealant or pieces of Teflon-type pipe thread sealant can plug the engine fuel system. Apply liquid-type pipe thread sealant sparingly to the male threads only. Do not use Teflon tape.*

Fuel Hose

Replace worn or damaged fuel hose with with USCG TYPE A1 or ISO 7840-A1 fuel hose. The hoses must be long enough to be clamped and to be routed underneath the engine oil pan without rubbing on the oil pan.

Note: The second intake resonator chamber (Figure 6-4) must be removed to connect and disconnect the supply hose at the fuel injector.

GLOW PLUGS

Refer to engine Workshop Manual 981-0533 when replacing the glow plugs (Figure 6-5).

Note: If a glow plug does not come out after unscrewing it, or the end has broken off, it will be necessary to remove the engine head. Glow plugs can swell if pre-heat voltage is greater than 14 volts, such as when a battery booster is used for starting.

Inspect the glow plugs as follows:

1. Check for **B+** at the glow plug terminals during cranking. If there is no **B+**, remove glow plug relay K3 from its socket, test for proper operation (p. 9-7) and replace if necessary. Also

check for **B+** at relay socket terminal 30, for continuity between terminal 87 and the glow plugs and for continuity between terminal 86 and **B-** (ground). Clean and tighten connections and replace wiring as necessary.

2. Check for **B+** at relay socket terminal 85 while cranking. If there is no **B+**, disconnect connector **P1** (black) from the genset controller (p. 9-1) and check for a missing, bent or corroded Pin 1 and for faulty wire and repair as necessary.
3. Remove the glow plug bus bar and check for electrical continuity between each glow plug terminal and **B-** (ground). Replace any open glow plug.

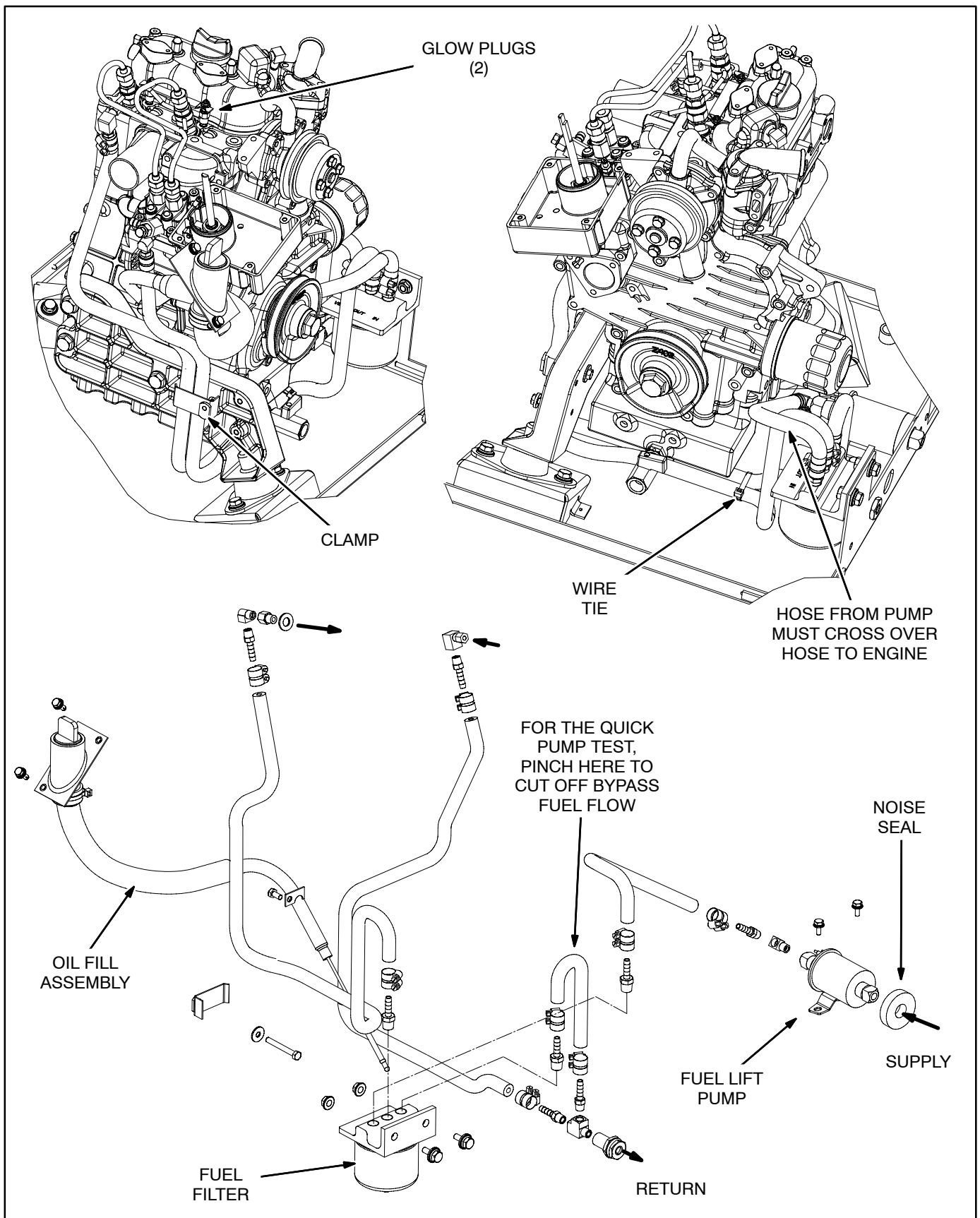


FIGURE 6-5. FUEL SYSTEM AND GLOW PLUGS

GOVERNOR ACTUATOR

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

The position of the rotor in governor actuator A12 (Figure 6-6) is determined by the modulated pulse width of the current supplied by the genset controller.

Checks and Tests

When the governor appears to be malfunctioning—see *Troubleshooting* (Section 11)—remove the front and top access doors and lintel (p. 5-1) and the governor actuator cover (p. 6-7). Observe the actuator rotor while cranking. (Remember to re-attach the leads after removing the cover.) The governor probably is not the problem if the rotor rotates smoothly through about 1/2 inch (12 mm). If it does not:

1. Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand

(against the fuel rack return spring). It should rotate smoothly about 1/2 inch (12 mm) and return smoothly.

- A. **If the governor binds or catches**, remove the bearing carrier and stator and look for signs of physical contact between rotor and stator and service as necessary. If there are no signs of contact, remove the governor base. Replace the base or service the internal engine governor mechanism, as necessary, in accordance with the engine Workshop Manual (p. 6-1).
- B. **If the governor rotates smoothly by hand**, check resistance across the actuator terminals with an accurate digital ohmmeter. If resistance is not between 1.7 and 2.8 ohms, replace the actuator stator.
- C. **If the governor still does not function**, disconnect connector **P1** (black) from the genset controller (p. 9-1) and measure resistance between Pin 5 and A12+ and between Pin 4 and A12–. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.

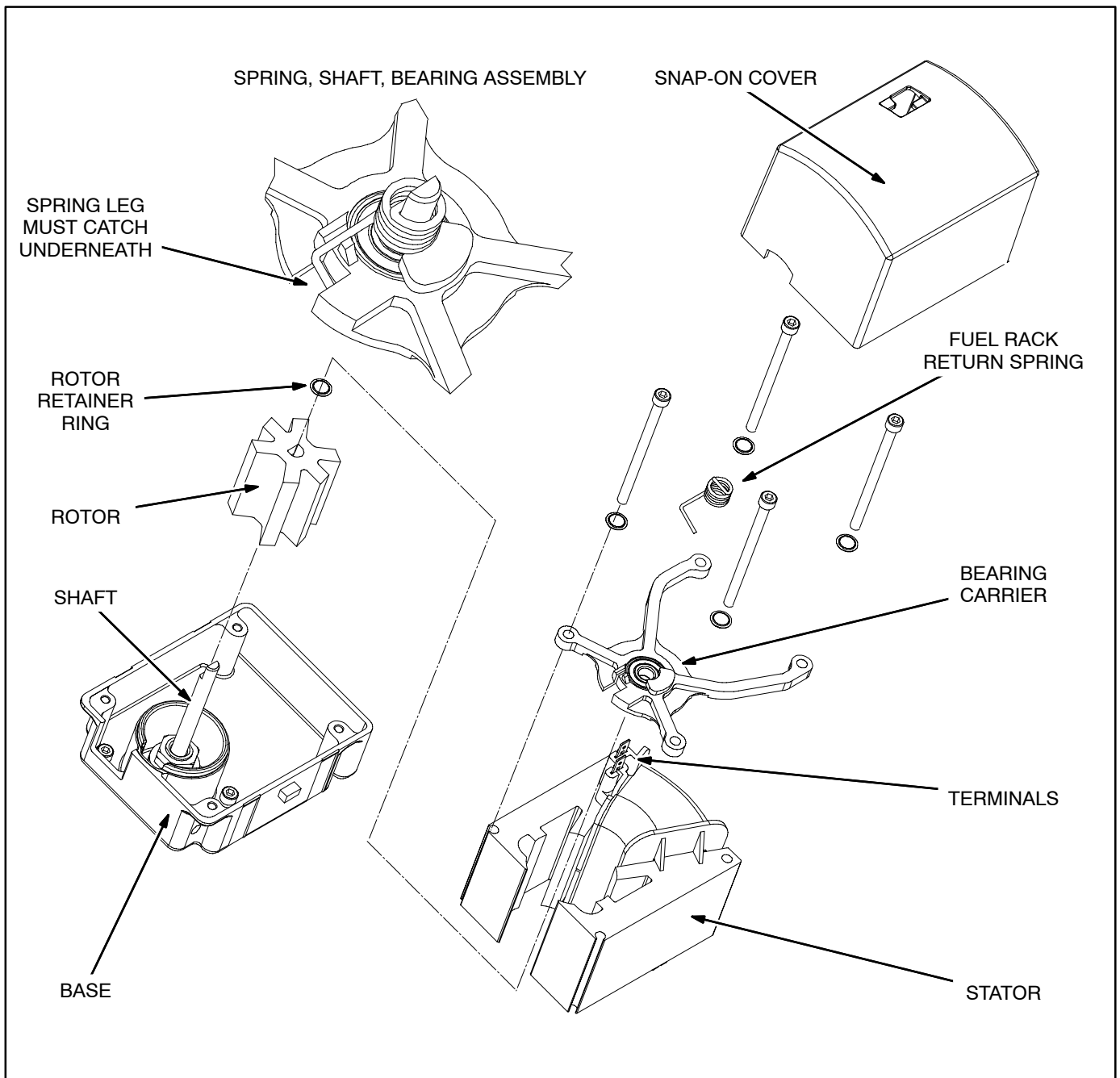


FIGURE 6-6. GOVERNOR ACTUATOR

Assembly / Disassembly

Stator: Remove the front and top access doors for access (Page 5-1). To remove the stator, disconnect the 2 actuator leads and remove the cover and 4 stator screws. Pry out the leg of the return spring with a screwdriver. (Be prepared to catch the spring if it flies off.) Lift off the bearing carrier and stator.

⚠WARNING *The spring can fly off and cause severe eye injury. Wear safety glasses.*

Stator reassembly is the reverse of disassembly. The bearing carrier must seat squarely in the stator. Torque the stator screws to 24 lb-in (2.7 N-m).

Replace the return spring if it is worn. This spring returns the fuel rack to the no-fuel position. Push the spring on over the flat on the shaft and pry the leg into its slot. The leg below the knee must catch underneath and the spring must be pushed down as far as it will go.

⚠CAUTION *The genset may not stop reliably if the fuel rack return spring is not assembled properly.*

Use wire ties to secure the cover.

Rotor: The rotor can be pried off the shaft after the bearing carrier has been removed.

Use a new retainer ring when reassembling. Note that the ring is concave (dished). Push the dished side up against the rotor to keep it in place on the shaft.

Base: See engine Workshop Manual 981-0533 if it is necessary to remove the actuator base or replace internal engine governor parts. The stator must be removed for access to the screws that secure the base to the engine.

Note: To preserve the existing high-idle speed adjustment (Page 6-10), do not disturb the lock wires on the adjusting screws on the governor actuator

base when removing it from the engine for engine service.

Adjusting Speed Control Lever Stop

The actuator speed control lever stop (Figure 6-7) must be adjusted whenever a different actuator base assembly is installed. The stop screw, rather than the fuel rack control lever, must stop the speed control linkage when the fuel rack is driven to the no-fuel position.

Note: To adjust the stop, the rotor need not be on the shaft, but the end of the shaft must be supported by the bearing carrier.

1. Remove the front and top access doors (Page 5-1) and loosen the front / left side panel assembly so that it can be swung to the left for access to the adjusting screw.
2. Loosen the stop screw locknut and back the screw out a few turns. (Top one in the group of three.)
3. Turn the stop screw in until it just makes contact and set the locknut.

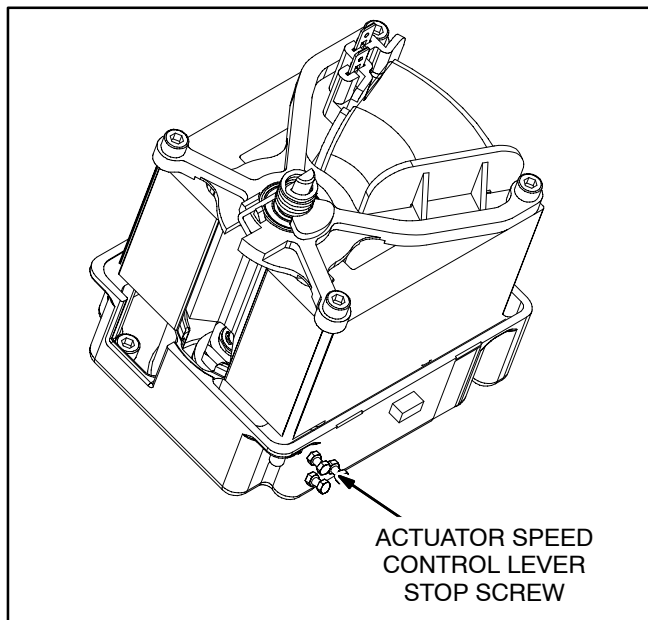


FIGURE 6-7. SPEED CONTROL LEVER STOP

Adjusting High-Idle Speed

⚠WARNING *This adjustment involves operating the genset with enclosure panels removed that guard against moving parts that can cause severe personal injury or death. Keep your hands away from the engine belt and pulleys.*

High-idle speed must be checked each time an actuator base is reinstalled or replaced. For an initial adjustment when installing a new base, (to make sure the engine stops when the actuator is deenergized), turn the high-idle speed adjusting screw in until the head of the screw is 3/4 inch (19 mm) from the base (Figure 6-8).

Note: Be prepared, if necessary, to clamp off the supply and return fuel lines to stop the engine.

1. Adjust the speed control lever stop (Page 6-9).
2. For this test, measure engine speed with a strobe or injector clamp-on type tachometer.
3. Remove the front and top access doors (Page 5-1) and loosen the front / left side panel assembly so that it can be swung to the left for access to the speed adjusting screw.
4. Disconnect the actuator leads and connect a 12 volt battery to the actuator terminals *using a battery switch*. (The battery will hold the governor mechanism against the high speed stop and allow the engine to run after shutdown—probably Code No. 15.)

⚠CAUTION *The actuator could overheat if the battery is left on more than 10 minutes.*

5. When ready, switch the battery on, start the genset, measure engine speed (rpm) and stop the engine by switching off the battery.
6. Readjust high-idle speed, as follows, if not between 3300 and 3400 rpm:
 - A. Loosen the lock nuts on the two bottom screws and back out the clamping screw.
 - B. To increase speed, turn the speed adjusting screw in 1 turn (clockwise). To decrease speed, turn it out 1 turn (counter-clockwise).
7. Repeat Steps 5 and 6 until high-idle speed is between 3300 and 3400 rpm. Set the lock nut.
8. Run the clamping screw in by hand until snug, back it out 1-1/2 turns and set the lock nut.

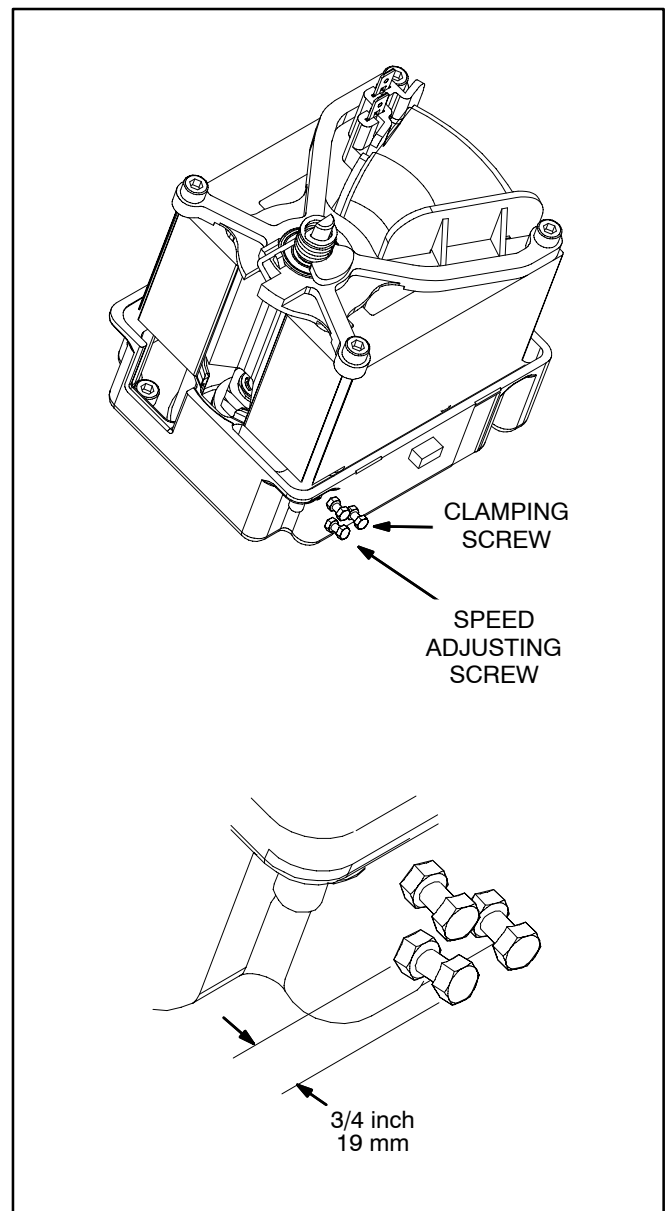


FIGURE 6-8. HIGH-IDLE SPEED SCREW

STARTER

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Starter Removal and Replacement

The starter motor (Figure 6-9) is accessible for removal and installation by removing the right side enclosure panel (Page 5-1). Alternatively, it can be removed and installed through the front access opening if the raw water pump is removed (Page 4-10) and the fuel filter bracket is unbolted from the drip pan and moved out of the way (Figure 6-5). Parts

are available for rebuilding the starter. Torque the mounting bolts to 29 lb-ft (39 N-m). Make sure starter B+ is connected to genset B+.

Negative (Ground) Connection

Before installing the starter motor, make sure that the engine block is grounded properly, depending on whether standard or isolated ground connections are required (Figure 6-9). The star washer must be installed between the engine block and cables. Torque the bolt to 41 lb-ft (55 N-m).

Ground Isolation Relay K9

The relay is accessible after the starter or side panel has been removed. Replace the relay if its contacts do not close when 12 VDC is applied to the coil.

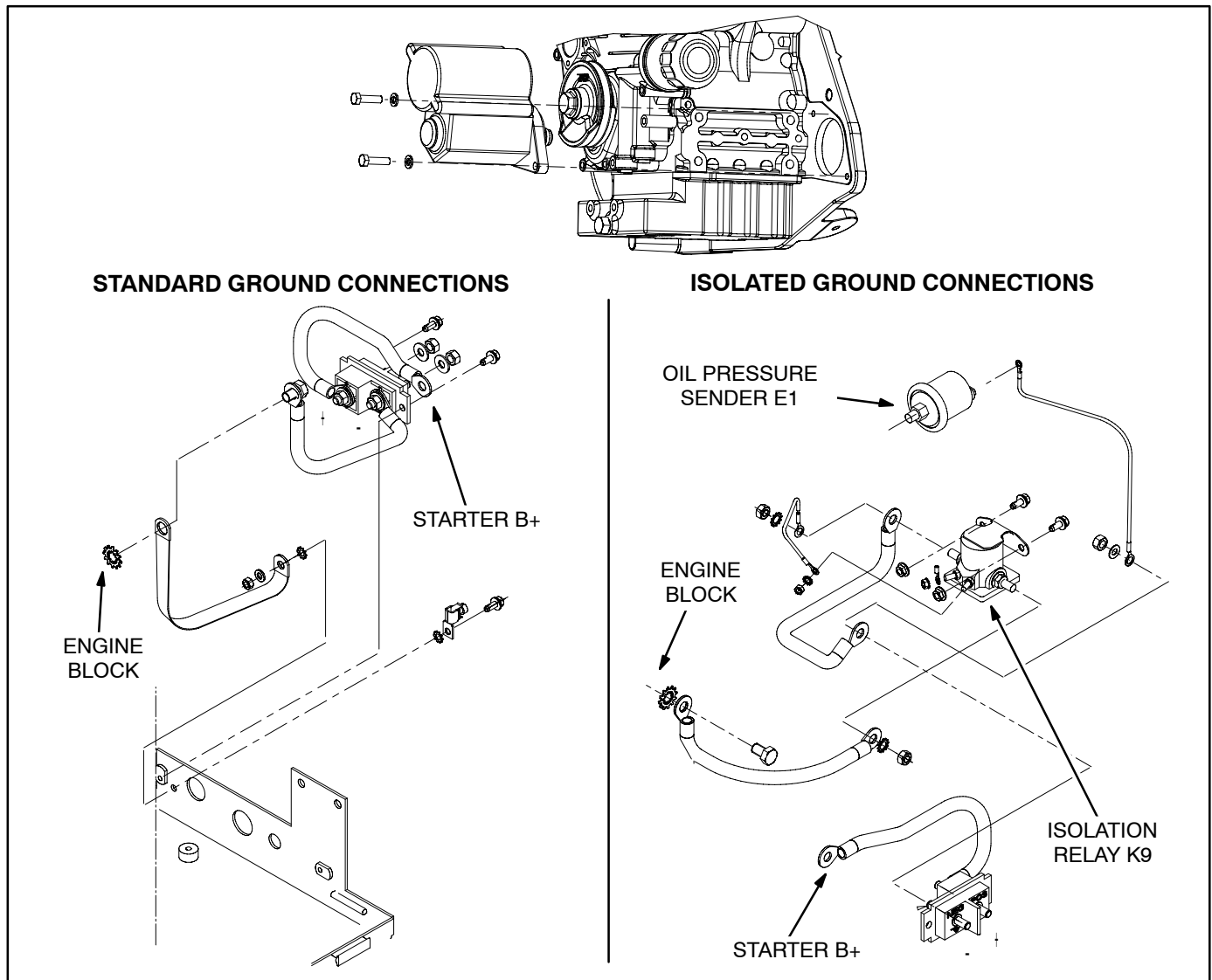


FIGURE 6-9. STARTER MOTOR MOUNTING AND CONNECTIONS

7. Generator Drive

OVERVIEW

The engine drives the generator by means of a 6-rib "Poly-Vee" belt (Figure 7-1). The drive pulley is mounted on the engine flywheel by means of a flex-

ible coupling. The generator pulley is center-bolted to the tapered end of the rotor shaft. The pulley must be removed to remove the generator rotor from the engine-generator adapter.

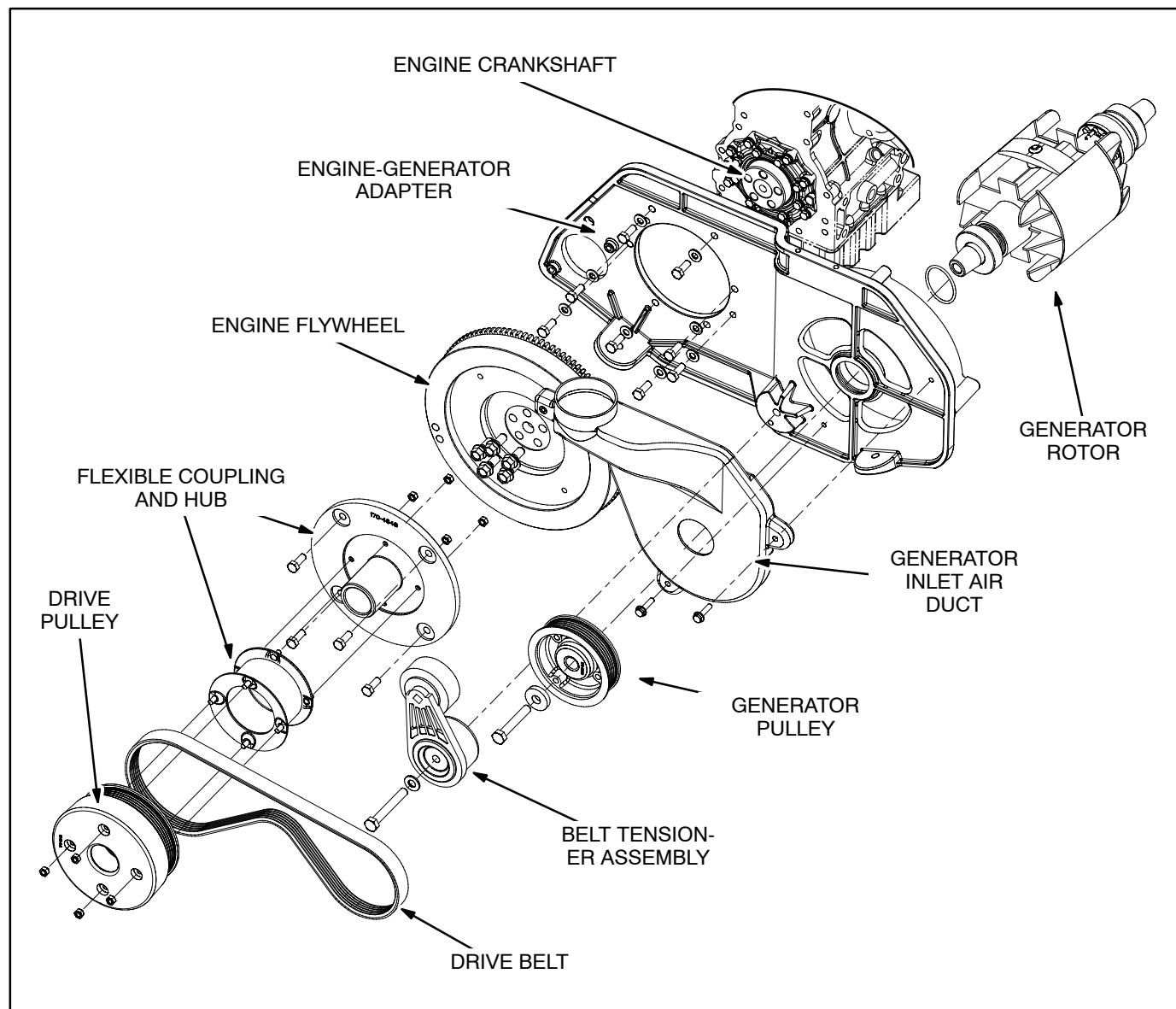


FIGURE 7-1. GENERATOR DRIVE

INSPECTING DRIVE AND BEARINGS

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

Remove the back panel (Page 5-1) to inspect the drive and bearings:

1. Pivot the belt tensioner away from the belt with a 3/8 inch drive and remove the belt. Examine the belt for cracks, worn spots and other signs of deterioration. Replace the belt if necessary or if it has been in service 5 years or 2000 hours.
2. Remove the drive pulley and coupling as an assembly from the flywheel and then the pulley from the coupling. Examine the coupling for wear and deterioration and replace it if necessary. Examine the two split-sleeve bearings in the pulley hub for wear and scoring and replace them if necessary.
3. When reassembling, torque the coupling nuts to 8 lb-ft (12 N-m) and the 4 hub-to-flywheel bolts to 21 lb-ft (29 N-m).
4. Spin the idler pulley. Replace the bearing if it does not spin smoothly or is noisy. Replace the idler assembly if it does not pivot smoothly from one end of its travel to the other.
5. Spin the generator pulley by hand to determine if there is any noise, looseness or grinding. Check for side-to-side and up-and-down looseness of the bearing. If necessary, disassemble the generator (p. 8-3) to determine the cause of the looseness or noise. Replace the rotor assembly if it is evident that either bearing has spun on the shaft. Replace the end bell or adapter if it is evident that the bearing has spun in the bore. Replace the bearings if they have been in service 5 years or 2000 hours.

SERVICE

Generator Pulley

Remove the belt and pulley center bolt and use a claw-type wheel puller to break the pulley free of the generator shaft taper. (To keep the rotor from turning while loosening the pulley bolt, hold the fan bolt

with a wrench.) Torque the center bolt to 45 lb-ft (60 N-m) when reassembling. Make sure to install the generator inlet air duct before installing the pulley.

Generator Inlet Air Duct

Torque the three mounting bolts to 8 lb-ft (12 N-m). Make sure to install it before installing the pulley.

Tensioner Pulley Assembly

Spin the idler pulley. Replace the bearing if it does not spin smoothly or is noisy. Replace the idler assembly if it does not pivot smoothly from one end of its travel to the other. Torque the center pivot bolt 45 lb-ft (60 N-m).

Drive Pulley and Coupling

Remove the drive pulley and coupling as an assembly from the flywheel. Then, if necessary, remove the 4 coupling nuts on each end to disassemble the coupling from the hub and the pulley. Examine the coupling for wear and deterioration and replace it if necessary. Examine the two split-sleeve bearings in the pulley hub for wear and scoring and replace them if necessary.

Torque the coupling nuts to 8 lb-ft (12 N-m) and the 4 hub-to-flywheel bolts to 21 lb-ft (29 N-m).

Flywheel

Remove the drive pulley and coupling as an assembly for access to the flywheel mounting bolts. Scribe a line across crankshaft and flywheel to make re-alignment easier when reassembling. ***The flywheel will only go on one way because the bolts are not quite evenly spaced. Proper alignment is necessary to preserve engine balance and timing mark.***

Torque the 5 mounting bolts to 42 lb-ft (56 N-m) when remounting the flywheel.

Engine-Generator Adapter

To remove the adapter, first remove the engine-generator assembly from its mounting (p. 5-2), the generator (Section 8) from the adapter and the flywheel from the engine (Section 6). Torque the 6 mounting bolts to 21 lb-ft (29 N-m) when reassembling.

8. Generator

OVERVIEW

These are 2-bearing, belt-driven, 2-pole revolving-field generators with brushes and slip rings (Figure 8-1). Output voltage is regulated by microcontroller-based genset controller (Page 9-1).

Stator

The stator consists of steel laminations with three sets of windings in the lamination slots. The main windings (T1–T2, T3–T4) are for powering the connected loads, the quadrature winding (Q1–Q2) is for field excitation and the (B1–B2) winding for battery charging.

Rotor

The rotor consists of a shaft with steel laminations wrapped with field windings. A molded slip ring assembly is pressed on to supply field current to the

rotor windings through the brush block assembly. The rotor shaft is supported on both ends by sealed ball bearings. The drive belt pulley and fan are center-bolted to the tapered rotor ends.

Brush Block

Field current passes through the brush block which has two spring-loaded carbon brushes that make contact with the rotor slip rings.

Principle of Operation

During startup genset controller A1 flashes the field with battery current for fast buildup of generator voltage as the engine accelerates to operating speed. During operation, the controller maintains nominal AC output voltage by varying field current in response to load. In response to transient loads, the controller lowers the voltage setpoint to allow for engine recovery.

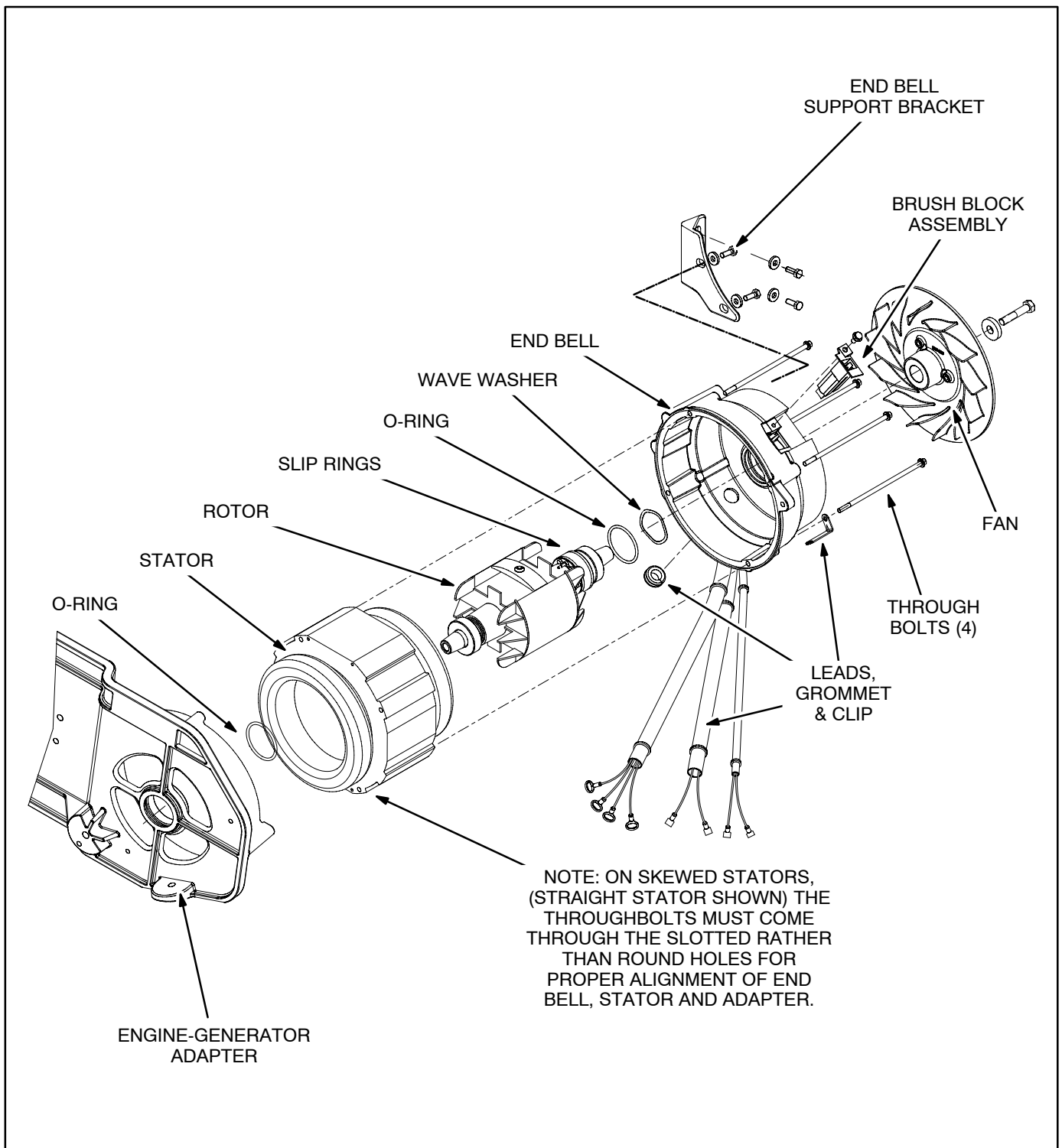


FIGURE 8-1. GENERATOR

SERVICING THE GENERATOR

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Stator Removal

1. Disconnect the generator leads inside the AC outlet box and remove the top, front and left side access doors and panels (Page 5-1).
2. Remove the second intake resonator chamber (Page 8-4).
3. Remove the brush block (Figure 8-2).

⚠ CAUTION *The brushes can be damaged if the brush block is not removed before removing the end bell.*

4. Remove the fan hub bolt and fan. (To keep the rotor from turning while loosening the fan bolt, hold the pulley bolt with a wrench.) To pull the fan off the shaft taper, secure a three-point wheel puller to the three holes in the fan hub with M6 or 1/4 inch self-tapping screws.
5. Remove the end bell support bracket from the engine bracket and the end bell (4 bolts).
6. Free the 8 generator leads from their connections and the clip on the side of the generator.
7. Scribe a line across the adapter, stator laminations and end bell to make realignment easier during reassembly.
8. Block the stator so that it does not fall against the rotor, and then remove the four generator through bolts.
9. Pull the generator end bell straight out. Examine the bearing bore and replace the end bell if it is scored or otherwise damaged by the bearing.
10. Pull the stator assembly straight out, taking care not to damage rotor or stator windings.
11. Block the rotor to support its hanging weight to prevent damage to the adapter and bearing.

Stator Reassembly

Reassembly is the reverse of removal. Note the following:

1. Loosen the end bell support bracket bolts, if not already removed, so that the bracket does not interfere with proper stator and end bell alignment.
2. Align the stator and end bell with the line scribed on them during disassembly. **Note:** **Figure 8-1 shows a straight stator and the through bolts lined up to pass through round holes in the stator laminations. On models with skewed stators the through bolts must pass through slotted holes for the end bell, stator and adapter to line up properly.**
3. Relubricate the bearing bore in the end bell with molybdenum disulfide paste (Onan PN 524-0118 or equivalent).
4. Make sure the wave washer and O-ring are in place in the bearing bore.
5. Torque the stator through bolts and end bell bracket bolts to 8 lb-ft (11 N-m) and the fan hub bolt to 45 lb-ft (61 N-m). (To keep the rotor from turning while tightening the fan bolt, hold the pulley bolt with a wrench.)
6. Make sure to tie the generator leads to the clip on the side of the generator.

Rotor

To remove the rotor, remove the stator and then the drive pulley (Page 7-2) and pull the rotor straight out to the front. When reassembling, lubricate the bearing bores in the end bell and adapter with molybdenum disulfide paste (Onan PN 524-0118 or equivalent). Make sure the wave washer is in place in the end bell and that the O-rings are in place in the bearing bore grooves in both ends.

Press each bearing on up to its shaft shoulder using a bench press.

⚠ CAUTION *Apply force only to the bearing inner race to avoid damage to the bearing.*

SERVICING BRUSHES AND SLIP RINGS

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Brush Block

Access: For access to the brush block, remove the enclosure front / left side assembly (Page 5-1) or swing it out to the left. Move the second resonator chamber (Page 8-4) out of the way by removing the bolt that secures it to the generator and by loosening the clamp at the intake manifold.

Service: Disconnect the field leads from the brush block (Figure 8-2), remove the mounting screw and withdraw the brush block from the generator end bell. Replace the brush block assembly if either brush is shorter than 7/16 inch (11 mm), binds in the brush block or is damaged in any way.

Reconnect the field leads, **F–** (black) to the outside terminal, and **F+** (red) to the inside terminal.

Slip Rings

Remove the brush block and inspect the slip rings for grooves, pits, or other damage. Use a Scotch Brite pad or commutator stone to remove light wear or corrosion.

TESTING FIELD FLASH

Field flash can be tested by measuring output voltage while cranking with the governor actuator leads (Page 6-7) disconnected to keep the engine from starting. If output voltage increases at least 1 volt while cranking, the whole field excitation system—controller, brushes, slip rings and rotor—are probably in working order and the problem lies elsewhere. See *Troubleshooting* (Section 11).

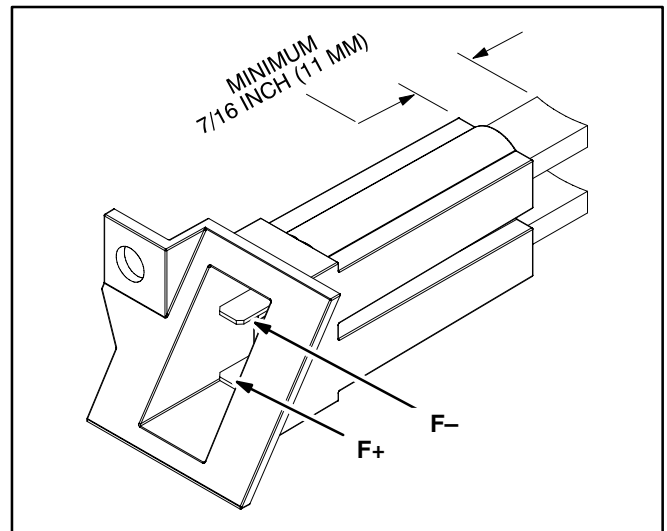


FIGURE 8-2. BRUSH BLOCK

TESTING GENERATOR WINDINGS

Testing the Rotor

Field Resistance Test: Disconnect field leads F1 and F2 from controller A1 by pulling green connector P3 and measure resistance across pins 7 and 8. If resistance is not as specified in Table 8-1:

1. Check for and repair faulty field leads.
2. Service brush block and slip rings (Page 8-4).
3. Check rotor resistance across the slip rings (Figure 8-3). Replace the rotor if resistance is not as specified.

Ground Test: Using a megger or the highest scale on a digital ohmmeter, measure resistance between the rotor and either slip ring (Figure 8-4). Replace the rotor if its winding has less than one megohm resistance to ground.

Testing the Stator

Disconnect T1, T2, T3 and T4 from the terminals in the output box. Disconnect B1 and B2 from charging regulator AVR1 (Figure 9-1). Disconnect Q1 and Q2 from controller A1 by pulling green connector P3 (Pins 4 and 5).

Open Winding Test: Measure resistance across each winding lead pair (Table 8-1). Replace the stator if any winding is open (zero ohms).

Winding Resistance Test: Use a meter (Wheatstone Bridge) having 0.001 ohm precision to measure resistance across each winding lead pair (Table 8-1). Replace the stator if resistance in any winding is not as specified.

Ground Test: Using a megger or the highest scale on a digital ohmmeter, measure resistance between the stack and each stator lead. Replace the stator if any winding has less than one megohm resistance to ground.

TABLE 8-1. GENERATOR WINDING RESISTANCES

Winding	Resistance (Ohms) @ 77° F (25° C) ± 10%
T1–T2, T3–4	0.353
Q1–Q2	2.93
B1–B2	0.114
F1–F2	32

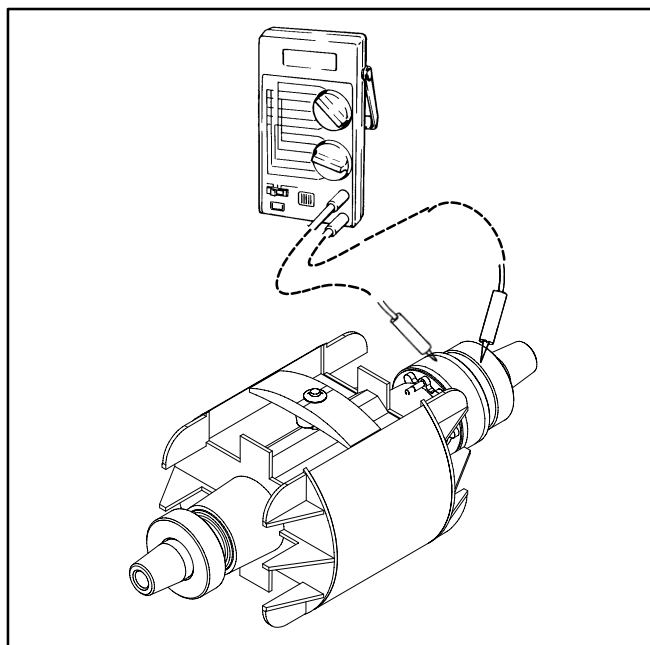


FIGURE 8-3. OPEN OR SHORTED ROTOR TEST

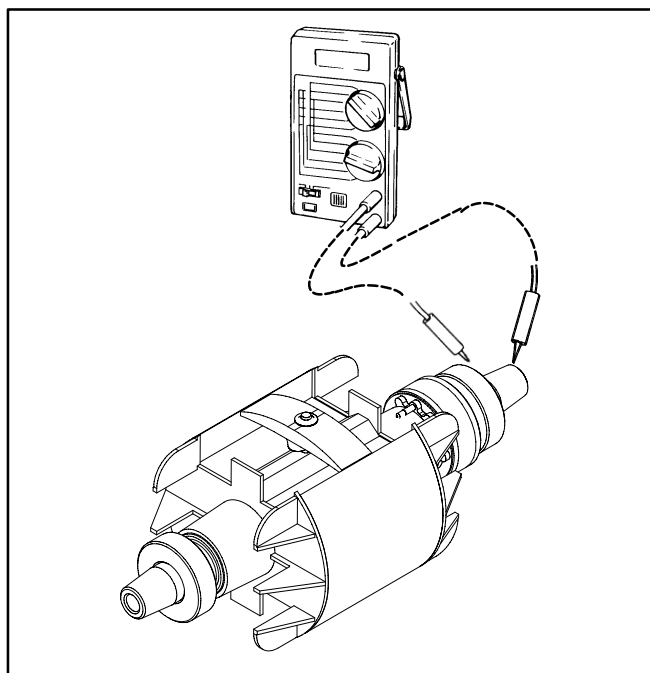


FIGURE 8-4. GROUNDED ROTOR TEST

9. Genset Control

OVERVIEW

Figure 9-1 illustrates the location and mounting of the genset controller behind the air inlet screen on the front of the genset. The control board has a microprocessor controller that provides all the control, monitoring and diagnostic functions required to operate the genset.

Up to three Onan e-Series Digital Displays (Figure 2-1) may be connected to the genset for operator control and monitoring.

An optional Network Interface Module (NIM) is available for mounting in the control box for connections to an integrated boat monitoring system (p. 9-8).

Figure 9-2 is a control block diagram. Pages A-1 through A-3 are the control schematic and connection drawings.

GENSET CONTROLLER

Configuring a Replacement Controller

A replacement controller must be configured to the genset model and generator. See Page 2-7.

Connectors

⚠ WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a housing panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

⚠ CAUTION *Makeshift meter test probes used for testing Control Board connections during troubleshooting can damage pin sockets by spreading or dislodging the contact wiper arms, resulting in an open or intermittent electrical connection. Use a mating pin (PN 323–1491) or a test probe that is 0.045 inches in diameter. Replace damaged pin sockets (PN 323–1492). Make sure the pin sockets are fully seated and cannot be pulled out.*

All connections to the controller are through connectors **P1** (black), **P2** (grey) and **P3** (green). When removing a connector from the controller, squeeze the locking tabs on the sides while pulling it out. When reinstalling a plug, make sure the seal is in place and that the locking tabs snap into position.

Removing / Replacing the Controller

The controller is mounted in the second intake resonator chamber where it is cooled by the intake air and is accessible through the left access panel (Figure 9-1). It is easier to remove if all the screws securing the front / left side panel are loosened from the drip pan and other panels so that the panel can be shifted. Alternatively, remove the AC output box.

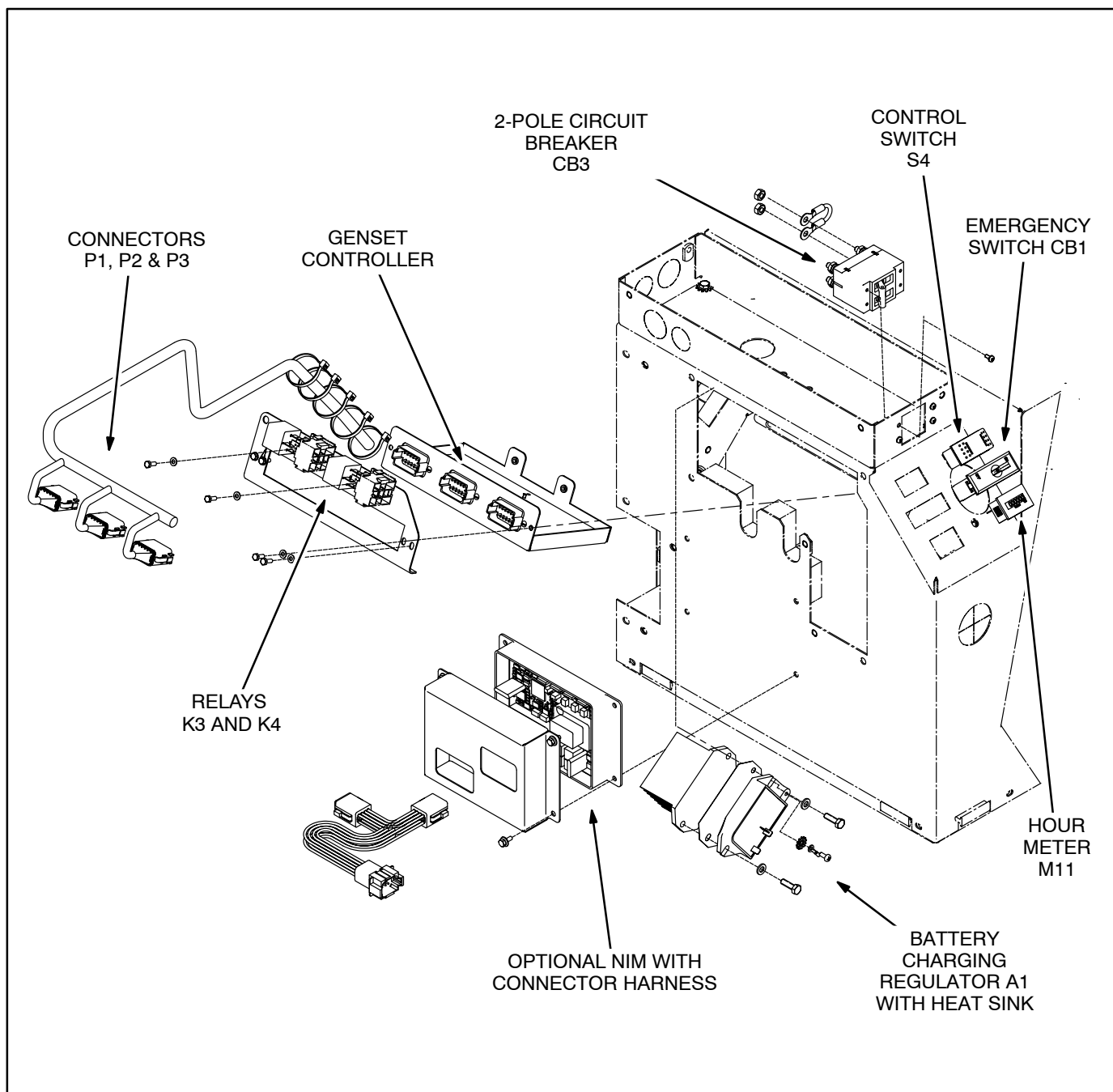


FIGURE 9-1. GENSET CONTROLLER AND ITS MOUNTING

Major Functions of Genset Controller

Initialization: Control initialization consists of checking memory (RAM, ROM, EEPROM) and genset configuration.

Fuel Prime: Press and hold the control switch at **STOP (Prime)** for more than 2 seconds to cause fuel pump E5 to prime the fuel system.

Startup: Press and hold the control switch at **START (Preheat)** until the genset starts. The controller:

1. Enables the *amber* status lamp to blink rapidly.
2. Enables some fault detection.
3. Energizes fuel lift pump E5.
4. Energizes the glow plugs during pre-heat and cranking. The duration of pre-heat prior to cranking is engine temperature dependent, but does not exceed 15 seconds.
5. Enables cranking. The maximum allowed duration of cranking is engine temperature dependent and varies between 20 and 60 seconds.
6. Enables field flash if no frequency pulses are present (F1-F2).
7. Energizes governor actuator A12 (full rack).
8. Disconnects the starter (B1) at 800 rpm.
9. When operating speed is reached:
 - A. Enables output voltage.
 - B. Turns off field flash.
 - C. Turns off *amber* status lamp.
 - D. Turns on *green* run lamp.
 - E. Enables Switched B+ (J7).
 - F. Enables complete fault detection.

Stop: Touch the control switch to **STOP (Prime)**. The controller:

1. Disables output voltage.
2. Deenergizes the fuel lift pump and governor actuator.
3. Turns off the *green* run lamp.
4. Writes session data (number of cranks, minutes of operation, last fault, etc.) to non-volatile memory (NVM).
5. Removes processor power when idle 5 minutes.

Note: Stop takes precedence over Start if both present due to a faulty switch or other cause.

Voltage Control: The controller maintains nominal AC output voltage by varying field current as load varies. In response to transient loads it lowers the voltage setpoint to allow engine recovery. Field power is supplied by the quadrature windings (Q1-Q2).

To Adjust Voltage: See Page 10-2.

Fuel Control: The controller positions the fuel rack to maintain nominal frequency as load varies by sending a pulse-width-modulated square-wave signal (PWM) to governor actuator A12 (p. 9-7). It determines frequency by sensing the frequency of the quadrature winding output. When the actuator is not energized, its spring-loaded plunger holds the fuel rack in the no-fuel position.

To Change Frequency: See Page 10-1.

Fault Monitoring, Shutdown and Diagnostics: See *Troubleshooting* (Page 11-1).

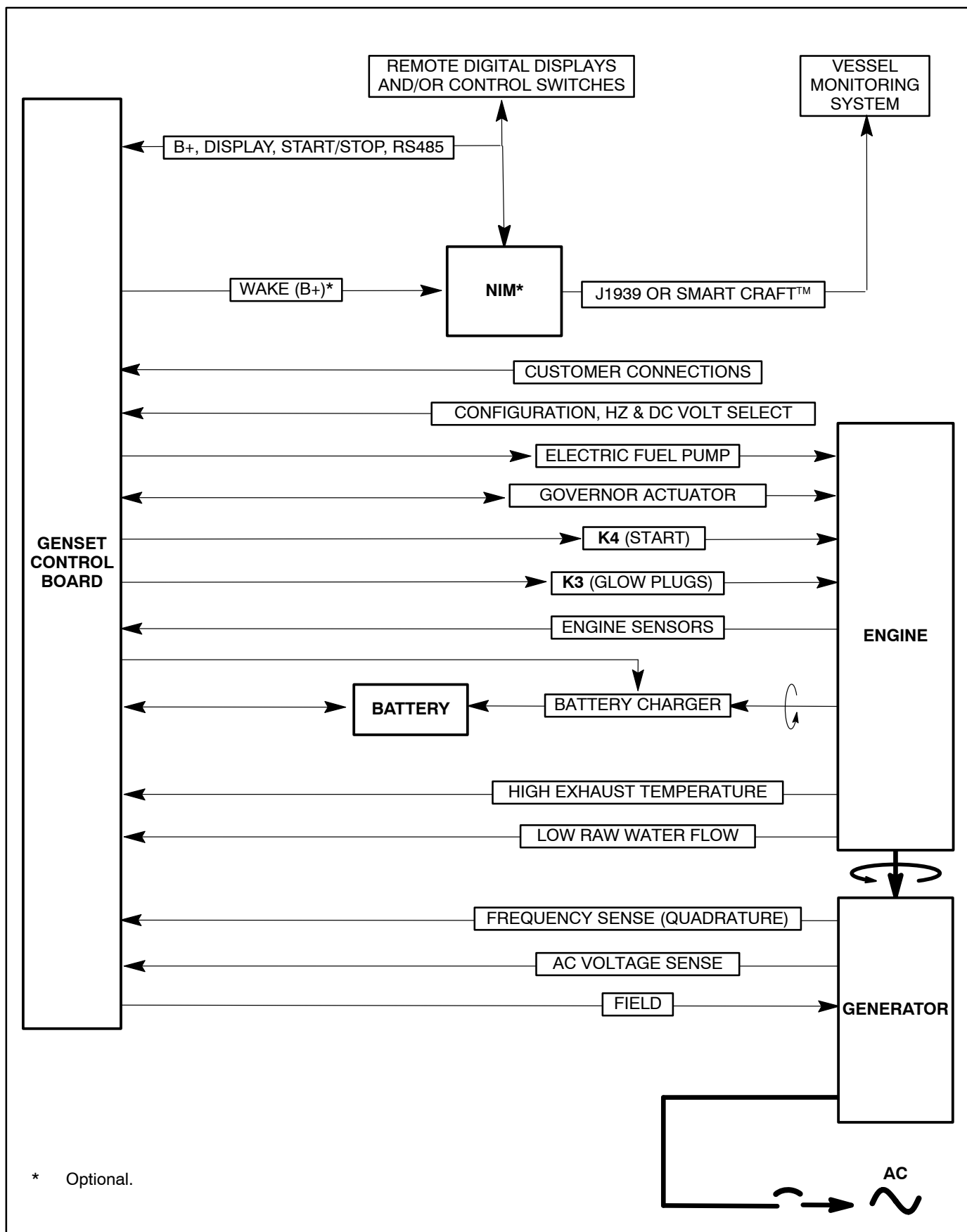


FIGURE 9-2. CONTROL BLOCK DIAGRAM

OPTIONAL REMOTE DIGITAL DISPLAY

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

See DIGITAL DISPLAY (p. 2-2) regarding function.
See Page A-1 for connections.

LOCAL/REMOTE CONTROL SWITCH (S4)

The control switch, when located on the genset, is mounted on the control panel (Figure 9-1). Unsnap the connector for access to its terminals (Figure 9-3). Replace the switch if **Start** does not close terminals 2 and 3, **Stop** does not close terminals 1 and 2, *Green* does not light when battery voltage is applied across terminals 7 (–) and 8 (+), or *Amber* when battery voltage is applied to terminals 7 (–) and 6 (+).

EMERGENCY STOP SWITCH (CB1)

The switch/circuit breaker is mounted on the control panel (Figure 9-1). Disconnect the leads and check electrical continuity across the two terminals. Replace the circuit breaker if it does not reset or turn ON and OFF. For easier access to the switch terminals, push out the four plastic buttons that secure the panel and pull the panel and switch forward.

HOURLY METER (M11)

The hour meter is mounted on the control panel (Figure 9-1). See Page 2-7 for instructions on how to reset the hour meter on the optional Digital Display to match the master hour meter when replacing the genset controller.

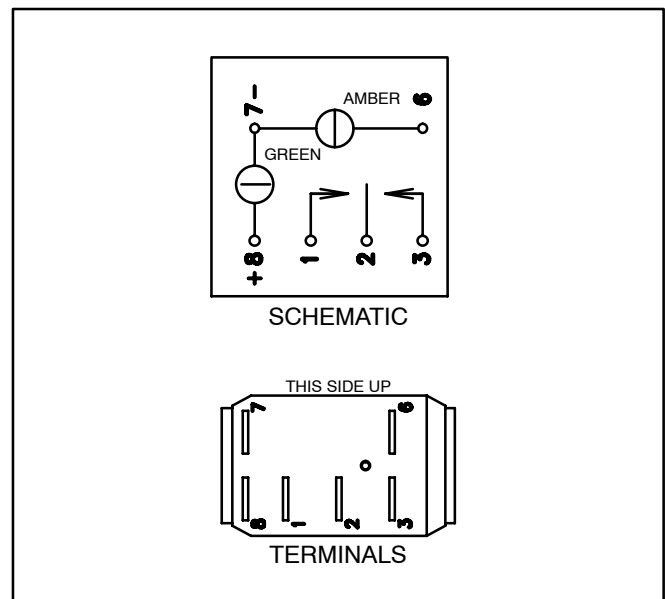


FIGURE 9-3. CONTROL SWITCH S4

ENGINE OIL PRESSURE SENDER (E1)

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

The oil pressure sender is threaded into the side of the block (Figure 9-4). Use thread sealant and engage at least two full threads when installing. In isolated-ground applications the sender has two terminals.

Check electrical resistance through the sender. Replace the sender if resistance is not between 227 and 257 ohms (0 psi) when the engine is stopped.

ENGINE COOLANT TEMPERATURE SENDER (E2)

The engine coolant temperature sender is threaded into the thermostat housing (Figure 9-4). Use thread sealant and engage at least two full threads when installing. In isolated-ground applications the sender has two terminals.

Replace the sender if resistance is not approximately 800 ohms at room temperature or does not decrease rapidly when immersed in boiling water.

BATTERY CHARGING REGULATOR (A1)

Mounting: The regulator and heat sink are mounted on the air intake duct (Figure 9-1). The regulator is easier to remove if the AC outlet box is tilted out (secured by 4 screws inside the box).

Testing: See Page 8-5 to test battery charge winding B1–B2. To test the regulator, remove the lead from terminal B+. If B1–B2 output is 15 to 20 VAC, but regulator output is less than 12.8 VDC, replace regulator AVR1.

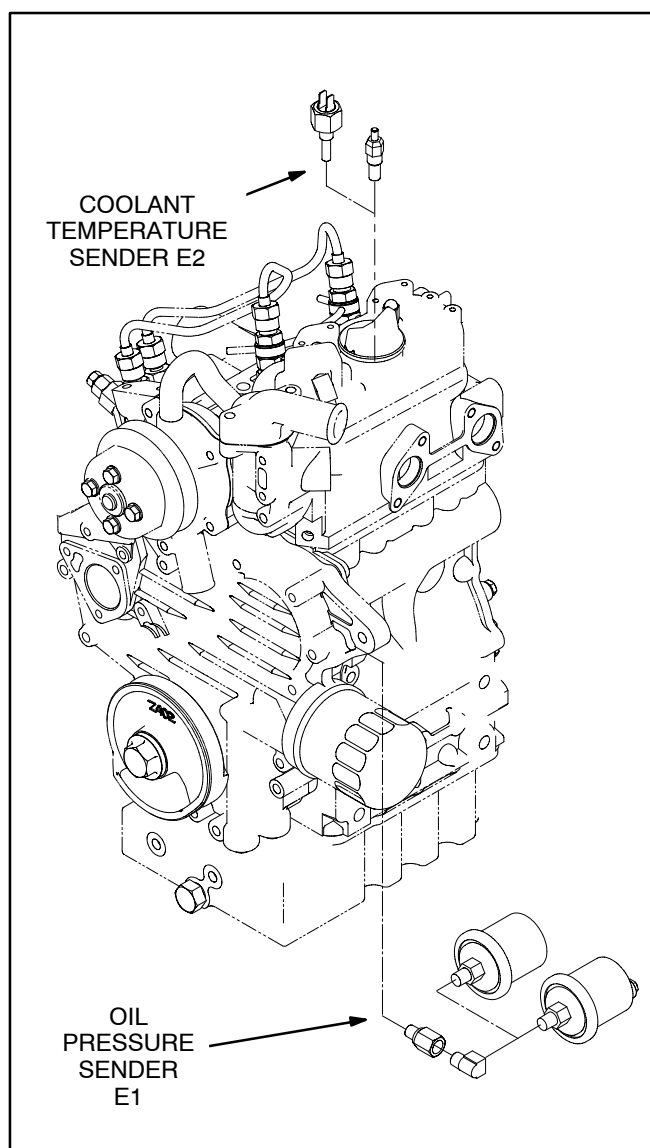


FIGURE 9-4. ENGINE SENDERS

HIGH EXHAUST TEMPERATURE SWITCH (S5)

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

The high exhaust temperature switch is bolted to the ear on the side of the water/exhaust mixer (Figure 9-5). The switch is accessible by removing the enclosure back panel.

RAW WATER FLOW SWITCH (S6)

The raw water flow switch is threaded into the heat exchanger (Figure 9-5) and is accessible through the top access opening. Use thread sealant and engage at least two full threads when installing.

Check continuity across the switch terminals while blowing into it (1 psi). Replace the switch if it does not open and close.

GLOW PLUG RELAY (K3)

The glow plug relay is mounted on its wiring socket on the controller mounting bracket (Figure 9-1). Pull the relay out to test it. Apply 12 VDC across terminals 85–86. Replace the relay if the contacts across terminals 30–87 (NO) do not open and close.

STARTER RELAY (K4)

The starter relay is mounted on its wiring socket on the controller mounting bracket (Figure 9-1). Pull the relay out to test it. Apply battery voltage across terminals 85–86. Replace the relay if the contacts across terminals 30–87 (NO) do not open and close.

GOVERNOR ACTUATOR (A12)

See Page 6-7.

GROUND ISOLATION RELAY (K9)

See Page 6-11.

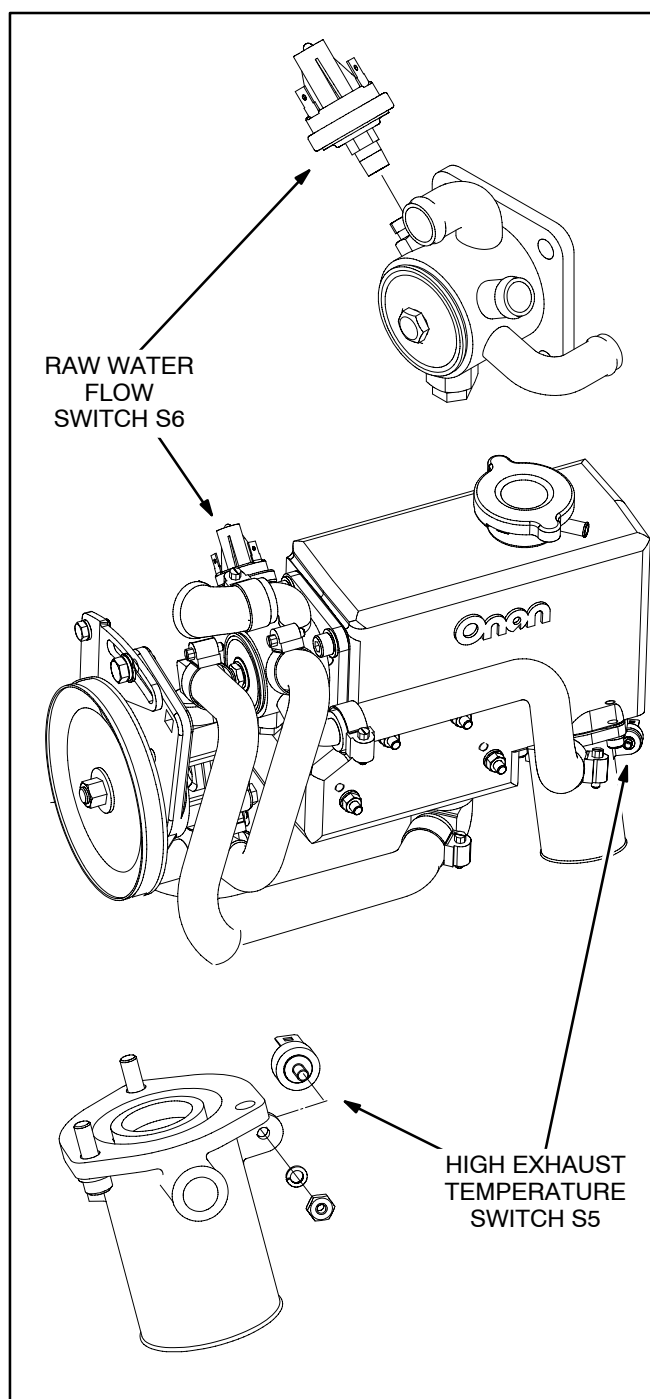


FIGURE 9-5. HIGH EXHAUST TEMPERATURE AND RAW WATER FLOW SWITCHES

NETWORK INTERFACE MODULE (NIM)

The optional NIM board is mounted on the side of the genset (Figure 9-1) and is connected as shown on Page A-1. It has five jumpers to configure the board for the specific application (Figure 9-6). Make sure a replacement board is configured the same as the old one.

Note: For *SAE J1939* applications, see Onan Publication D-3315, *Supported Messages on SAE J1939*. This is the basis for the software interface between the genset controller and the remote boat monitor.

Note: For *SmartCraft™* applications, see your Cummins MerCruiser Distributor for more information.

1. Jumper **W1** has no function at this time.
2. Jumper **W2** will be cut when the genset is in an *SAE J1939* network application. The jumper must remain uncut when the genset is in a *SmartCraft™* network application.
3. Jumpers **W3** and **W4** are used to assign the J1939 network address of the genset in a multiple-genset installation. To assign an address, cut the jumpers as scheduled in Table 9-1.

In *SmartCraft™* applications, see your Cummins MerCruiser Distributor.

TABLE 9-1. J1939 ADDRESSES

Jumper W3	Jumper W4	Address
Not Cut	Not Cut	234
Not Cut	Cut	158
Cut	Not Cut	179
Cut	cut	203

4. Cut Jumper **W5** if the bus termination resistor on this NIM board is not required to terminate the network bus. (The jumper is cut on a *SmartCraft™* board.)

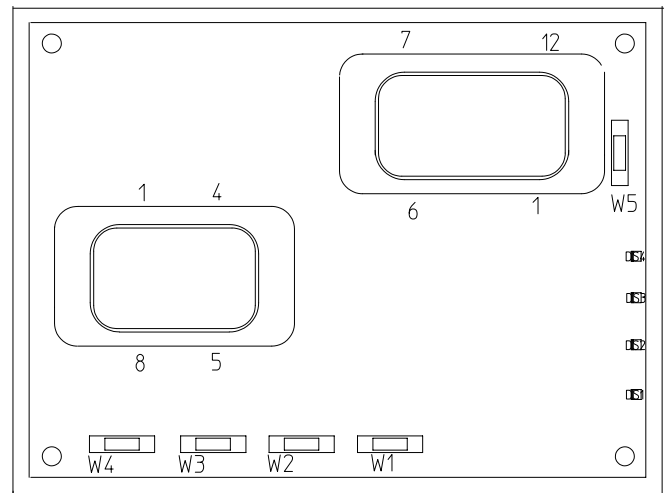


FIGURE 9-6. NIM CONFIGURATION JUMPERS

10. Reconfiguring Voltage and Frequency

“AS MANUFACTURED” BLOCK ON NAMEPLATE

The genset was set up and adjusted at the factory for the frequency and voltage stated in the “As Manufactured” block on the nameplate (Figure 10-1). If it is necessary to reconfigure voltage and/or frequency for the application, follow the instructions in this section.

RECONNECTION LABEL

The bag in which this manual was shipped has a sheet with peel-off reconnection labels (Figure 10-2) to apply over the “As Manufactured” block on the genset nameplate (Figure 10-1) when reconfiguring the genset for the application. Apply the appropriate label if different from the “As Manufactured” data block.

CHANGING FREQUENCY

The genset control box has three frequency selection jumper leads terminated in connectors **J5**, **P6** and **P7** (p. A-1). If application frequency is different from “As Manufactured” frequency:

- Connect **J5** to **P6** for 60 HZ.
- Disconnect **J5** from **P7** for 50 HZ.
- Apply the appropriate reconfiguration label.


RECONNECTING GENERATOR

⚠WARNING *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable at the battery to prevent the engine from starting.*

Reconnect the generator for the application voltage, if necessary, in accordance with the appropriate generator connection schematic on Page A-2. Apply the appropriate reconfiguration label and adjust voltage, if necessary. See ADJUSTING VOLTAGE (p. 10-2).

Note: It may be necessary to change circuit breakers to provide required protection or full genset power when reconnecting the generator.

IMPORTANT ENGINE INFORMATION



CUMMINS POWER GENERATION
1400 73rd Ave. NE
Minneapolis, MN 55432

Model: Spec: ☐ Made in U.S.A.

S/N:

50 Hz:

60 Hz:

KVA:

Pf:

KW:

PH:

RPM:

As Manufactured:

Freq: AC Volts: Amps:

Options:

Fuel: Bat:

Software Cfg:

Wire Diagram:

Insulation - NEMA Class Ambient 40°C

REFER TO OPERATOR'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.

99-2495 ☐

FIGURE 10-1. “AS MANUFACTURED” BLOCK ON NAMEPLATE

ALTERNATOR RECONNECTION LABEL

THESE LABELS ARE TO BE USED WHEN GENSET IS REWIRED.
*TEAR-OFF LABEL SHOULD BE APPLIED OVER GENSET NAMEPLATE VOLTAGE.
REFER TO INSTALLATION MANUAL FOR DIRECTIONS.

CAUTION: CIRCUIT BREAKER MAY NEED TO BE CHANGED.

FOR GENERATOR SET MODEL: **4/5 MDKBH**

THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 115/230V	Amps: 34.8/17.4
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 60HZ	AC Volts: 120V	Amps: 41.7
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 60HZ	AC Volts: 120/240V	Amps: 41.7/20.8
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 120/240V	Amps: 33.3/16.7

FIGURE 10-2. RECONNECTION LABELS

ADJUSTING VOLTAGE USING CONTROL SWITCH

1. Start the genset and let voltage and frequency stabilize for 5 to 10 seconds. Make sure all loads have been disconnected.
 2. Rapidly press **START** 6 times *during the first minute after startup* to put the genset controller into *voltage adjust mode*. The amber status lamp will begin blinking about once every second to indicate the change to voltage adjust mode. The green status lamp will remain on.
 3. **To adjust voltage up**, press and quickly release **START**. Voltage will increase approximately 0.6 volts each press and release.
 4. **To adjust voltage down**, press and hold **START** for about 2 second. Voltage will decrease approximately 0.6 volts each press and release.
 5. When satisfied with the adjustment, wait about 20 seconds for the amber lamp to stop blinking and then press **STOP** to stop the genset and save the adjustment.
 6. Restart the genset and check voltage.
2. Rapidly press **START** 6 times *during the first minute after startup* to put the genset controller into *voltage adjust mode*. The green status lamp will blink rapidly and the Display will indicate a Status change from *Running* to *Volt Adj* (Figure 10-3).
 3. **To adjust voltage up**, press and quickly release **START**. Voltage will increase approximately 0.6 volts each press and release.
 4. **To adjust voltage down**, press and hold **START** for about 1 second. Voltage will decrease approximately 0.6 volts each press and release.
 5. When satisfied with the adjustment, wait about 20 seconds for the Display to indicate a Status change from *Volt Adj* to *Running* and then press **STOP** to stop the genset and save the adjustment.
 6. Restart the genset and check voltage.
 7. Recalibrate AC Voltage on the Digital Display as instructed on Page 2-6.

ADJUSTING VOLTAGE USING OPTIONAL DIGITAL DISPLAY

Note: The GEN STATUS screen will not display AC Voltage while the genset is in voltage adjust mode. The line for displaying the voltage is filled in as shown in Figure 10-3. A separate voltmeter is required for voltage adjustment.

1. Start the genset and let voltage and frequency stabilize for 5 to 10 seconds. Make sure all loads have been disconnected.

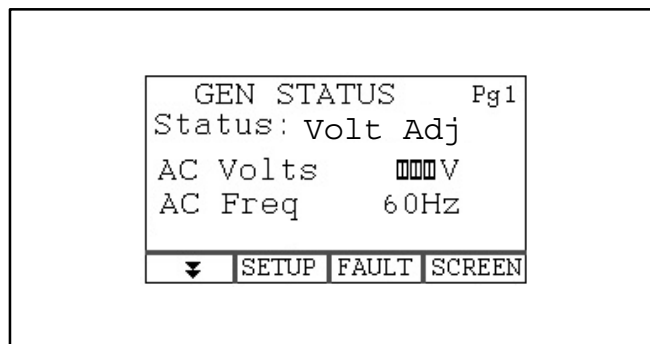


FIGURE 10-3. VOLTAGE ADJUSTMENT SCREEN

11. Troubleshooting

To troubleshoot the genset use TABLE 11-1. TROUBLESHOOTING GENSET FAULTS in conjunction with the e-Series Digital Display or blinking of the control switch status lamp. Perform the step-by-step corrective actions suggested.

Note: Many genset shutdowns can be avoided by performing periodic maintenance on schedule (TABLE 4-1. PERIODIC MAINTENANCE SCHEDULE) and by *not* running the genset out of fuel. Note that when gensets and propulsion engines draw from the same fuel tanks, the fuel dip tubes are usually arranged so that the gensets run out of fuel first. By marking the genset empty points on the fuel gauges, it will be easier to tell when to stop the gensets before running them out of fuel.

TROUBLESHOOTING WITH DIGITAL DISPLAY

If a fault shutdown occurs the ALARM status lamp on the e-Series Digital Display will blink and the LCD screen will display the Fault Number, a description of the Fault and the hour in total genset running time when the Fault occurred (Figure 2-4).

The fault will be displayed indefinitely. Touch any button to clear the fault. The display will turn off in 5 minutes after the fault has been cleared.

See Page 2-5 to display any of the **last five faults** in fault history.

TROUBLESHOOTING WITH STATUS LAMP

If a fault shutdown occurs, the amber status lamp on the control switch will repeatedly blink sets of **3, 4, 5** or **7** blinks.

- **One blink** indicates shutdown due to high engine temperature.
- **Two blinks** indicate shutdown due to low oil pressure.
- **Three blinks** indicate a service fault. Press **Stop** once to cause the two-digit shutdown code to blink. (Pressing **Stop** again will stop the blinking.) The two-digit code consists of 1 to 7 blinks, a brief pause, and then 1 to 9 blinks. The first set of blinks represents the tens digit and the second set of blinks the units digit of the shutdown code number. For example, **Shutdown Code No. 36** appears as:

blink – blink – blink — pause — blink – blink – blink – blink – blink — long pause — repeat.

- **Four blinks** indicate shutdown due to a failure to start within the time allowed for cranking.
- **Five blinks** indicate shutdown due to high levels of Carbon Monoxide (CO) in the vessel.
- **Seven blinks** indicate shutdown due to a loss of raw water flow for engine and exhaust cooling.

The fault code stops blinking after five minutes. Press **Stop** three times within three seconds to restore fault code blinking.

Note: The last fault logged will blink even though the condition that caused the shutdown may have been corrected.

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

NO RESPONSE AT DIGITAL DISPLAY OR CONTROL SWITCH

Possible Cause: Faulty switch, poor or missing connections, dead battery

Corrective Action: Refer to Pages A-1 through A-3 as appropriate.

1. Push the Emergency Stop Breaker **ON** if tripped.
2. Try the Digital Display or control switch on the genset (local) if there is no response at a remote Display or control switch, and vice versa. If at least one control switch or Display works, but not the others, go to Step 7.
3. If none of the Displays or control switches works, service as necessary by cleaning and tightening battery connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
4. If there still is no response, disconnect the mate to connector J4 (P1 or P33) in the control box. Check for battery voltage across pins J4-4 and J4-1 (B+, Display, Start/Stop and ground). If there is voltage, go to Step 7. If there is no voltage, go to Step 5.
5. Disconnect connector P2 (grey) from the genset controller (p. 9-1) and check for battery voltage across pin sockets P2-1 and P2-6. If there is voltage, replace the controller. If there is no voltage, go to Step 6.
6. Test the Emergency Stop Breaker (CB1) and replace if necessary (p. 9-5). If there still is no voltage, check for and repair faulty wiring and connectors between: P2-1 and CB1-1; CB1-2 and B1-BAT; and P2-6 and GND-ENG.
7. Test for and replace a faulty Display or control switch (p. 9-5) and repair faulty wiring and connectors. See Page A-1.

THE STARTER ENGAGES AND DISENGAGES

Possible Cause: Low cranking voltage

Corrective Action:

1. Push the genset line circuit breaker OFF.
2. Service the battery as necessary by cleaning and tightening connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
3. Service the starter (p. 6-11).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

THE STARTING BATTERIES DO NOT MAINTAIN A CHARGE

Possible Cause: Marginal battery, battery connections or charging system

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Service the battery as necessary by cleaning and tightening connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
2. Check for and disconnect parasitic battery loads.
3. Test the battery charging regulator and replace it if necessary (p. 9-6).

NO AC POWER WHEN GENSET IS RUNNING

Possible Cause: A Circuit Breaker is OFF, tripped or malfunctioning or the generator is not connected properly

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Reset or turn ON the genset circuit breaker if OFF or tripped.
2. Reset or turn ON any other circuit breaker in the AC power supply system if OFF or tripped.
3. Reconnect the generator properly for the application. See Page A-2.

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

HIGH ENGINE TEMPERATURE—CODE NO. 1

Control Logic: Engine coolant temperature exceed design limit

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Open the sea valve.
2. Check for and clean a blocked sea water strainer. If above the water line, fill the strainer with water to assist priming.
3. Check engine coolant level, add coolant as necessary and check for and repair leaks (p. 4-6).
4. Check for and reconnect or replace any disconnected, kinked or leaking raw water hoses.
5. Check for and readjust a loose pump belt (p. 4-9).
6. Check for a worn raw water impeller and replace as necessary (p. 4-10).
7. Clean the heat exchanger (p. 4-12).
8. Check the bottom of the hull for any blockage at the through-hull fitting.
9. Drain and clean the cooling system to remove fouling (p. 4-6).
10. Replace the coolant thermostat, which might not be opening fully (p. 4-8).
11. If loose, tighten the ring terminal on coolant sender **E2** (p. 9-6).
12. Test coolant sender **E2** and replace if necessary (p. 9-6).
13. Disconnect connector **P1** (black) from the genset controller (p. 9-1) and check for electrical continuity between **Pin 9** and the ring terminal on sender **E2**. If it is an isolated-ground sender, also check for electrical continuity between **E2-2** and **B–** (ground). Repair wiring and connectors as necessary.

LOW OIL PRESSURE—CODE NO. 2

Control Logic: Low oil pressure

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Check the engine oil level and add or drain oil as necessary (p. 4-3). Repair any oil leaks.
2. If loose, tighten the ring terminal on oil pressure sender **E1** (p. 9-6).
3. Check electrical resistance through sender **E1** (p. 9-6) and replace if necessary.
4. Disconnect connector **P1** (black) from the genset controller (p. 9-1) and check for electrical continuity between **Pin 10** and the ring terminal on sender **E1**. If it is an isolated-ground sender, also check for electrical continuity between **E1-2** and **B–** (ground). Repair wiring and connectors as necessary.
5. Replace the sender with a gauge, ground the sender wire (to keep the engine running) and start the engine. *Shut down the engine immediately if there is no oil pressure.* Service the engine lubrication system in accordance with the engine Workshop Manual (p. 6-1) if oil pressure is less than 14 psi (98 kPa).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

SERVICE CHECK—CODE NO. 3

Control Logic: A fault with a 2-Digit Fault Code Number occurred

Corrective Action: Check the 2-Digit fault code by *Pushing* and *Releasing Stop*. The 2-Digit fault will be one of the following in this table. (Does not apply to e-Series Digital Display.)

OVERCRANK—CODE NO. 4

Control Logic: Cranking time exceeded 20 to 60 seconds, depending on ambient temperature

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Push the genset line circuit breaker OFF.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove combustion air or exhaust system blockages.
4. Open any closed fuel supply and return valves.
5. Prime the engine fuel system for at least 30 seconds (p. 3-3).
6. Service the battery as necessary by cleaning and tightening connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
7. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime.
8. Replace the fuel filters and reprime (p. 4-5).
9. Change the engine oil to oil of the proper viscosity for the ambient temperature. High oil viscosity can slow down cranking speed.
10. Conduct a fuel pump test and replace if necessary (p. 6-4).
11. If loose, tighten the glow plug terminals (p. 6-5).
12. Inspect and service the glow plugs as necessary (p. 6-5).
13. Service the fuel injectors in accordance with the engine Workshop Manual (p. 6-1).
14. Service a worn engine in accordance with the engine Workshop Manual (p. 6-1).

WARNING—SHUTDOWN DUE TO VESSEL CO—CODE NO. 5

Control Logic: Dangerous levels of Carbon Monoxide in Vessel

Corrective Action: Get everyone out into fresh air immediately and seek medical attention.

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

LOSS OF RAW WATER FLOW—CODE NO. 7

Control Logic: Insufficient raw water flow through the heat exchanger to cool the engine

Corrective Action:

1. Open the sea valve.
2. Check for and clean a blocked sea water strainer. If above the water line, fill the strainer with water to assist priming.
3. Check for and reconnect or replace any disconnected, kinked or leaking raw water hoses.
4. Check for and readjust a loose pump belt (p. 4-9).
5. Check for a worn raw water impeller and replace as necessary (p. 4-10).
6. Check the bottom of the hull for any blockage at the through-hull fitting.
7. Disconnect connector **P1** (black) from the genset controller (p. 9-1) and check continuity between Pin **8** and **B–** (ground). If open, check for a missing, bent or corroded pin, faulty wiring or open raw water flow switch **S6** (p. 9-7). Repair as necessary.

HIGH AC VOLTAGE—CODE NO. 12

Control Logic: After voltage regulation was enabled Output Voltage jumped to more than 125percent of rated for 75 milliseconds or to more than 115percent of rated for 3 seconds

Corrective Action:

1. Push the genset line circuit breaker **OFF**, start the genset. If output voltage is normal, the problem is in the circuits external to the genset.
2. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime. (Air bubbles can disrupt frequency.)
3. Check the brushes and slip rings (p. 8-4) and rotor and stator windings (p. 8-5) and service as necessary.
4. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

LOW AC VOLTAGE—CODE NO. 13

Control Logic: After voltage regulation was enabled Output Voltage fell to less than 90percent of rated for 5 seconds

Corrective Action:

1. Push the genset line circuit breaker **OFF**. If the genset now runs and voltage and frequency are normal, reduce the number of electrical loads.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove combustion air or exhaust system blockages.
4. Prime the engine fuel system for at least 30 seconds (p. 3-3).
5. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime. (Air bubbles can disrupt frequency.)
6. Replace the fuel filters and reprime (p. 4-5).
7. Check the brushes and slip rings (p. 8-4) and rotor and stator windings (p. 8-5) and service as necessary.
8. Conduct a fuel pump test and replace if necessary (p. 6-4).
9. Check for proper operation of the governor actuator and service as necessary (p. 6-7).
10. Readjust high idle speed (p. 6-10).
11. Service the fuel injectors in accordance with the engine Workshop Manual (p. 6-1).
12. Check fuel injection timing in accordance with the engine Workshop Manual (p. 6-1).
13. Check for proper operation of the internal governor mechanism in accordance with the engine Workshop Manual (p. 6-1).
14. Service a worn engine in accordance with the engine Workshop Manual (p. 6-1).
15. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

HIGH AC FREQUENCY—CODE NO. 14

Control Logic: After the starter was engaged Frequency jumped to more than 70 Hz for 40 milliseconds or to more than 2percent over nominal for 6 seconds

Corrective Action:

1. Check for a tripped genset circuit breaker, reset it if necessary, and run with fewer connected loads. (A breaker tripping under load can cause genset frequency to overshoot.)
2. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime. (Air bubbles can disrupt frequency.)
3. Check for proper operation of the governor actuator and service as necessary (p. 6-7).
4. Check for proper operation of the internal governor mechanism in accordance with the engine Workshop Manual (p. 6-1).
5. Replace the genset genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

LOW AC FREQUENCY—CODE NO. 15

Control Logic: During normal operation Frequency fell to less than 90percent of nominal for more than 8 seconds

Corrective Action:

1. Push the genset line circuit breaker OFF. If the genset now runs, reduce the number of loads, especially those with high motor starting loads such as air conditioners.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove combustion air or exhaust system blockages.
4. Prime the engine fuel system for at least 30 seconds (p. 3-3).
5. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime. (Air bubbles can disrupt frequency.)
6. Replace the fuel filters and reprime (p. 4-5).
7. Conduct a fuel pump test and replace if necessary (p. 6-4).
8. Check for proper operation of the governor actuator and service as necessary (p. 6-7).
9. Readjust high idle speed (p. 6-10).
10. Service the fuel injectors in accordance with the engine Workshop Manual (p. 6-1).
11. Check fuel injection timing in accordance with the engine Workshop Manual (p. 6-1).
12. Check for proper operation of the internal governor mechanism in accordance with the engine Workshop Manual (p. 6-1).
13. Service a worn engine in accordance with the engine Workshop Manual (p. 6-1).
14. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

GOVERNOR OVERLOAD—CODE NO. 22

Control Logic: Maximum allowable time at full-duty cycle was exceeded

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove combustion air or exhaust system blockages.
4. Prime the engine fuel system for at least 30 seconds (p. 3-3).
5. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime.
6. Replace the fuel filters and reprime (p. 4-5).
7. Conduct a fuel pump test and replace if necessary (p. 6-4).
8. Check for proper operation of the governor actuator and service as necessary (p. 6-7).
9. Readjust high idle speed (p. 6-10).
10. Service the fuel injectors in accordance with the engine Workshop Manual (p. 6-1).
11. Check fuel injection timing in accordance with the engine Workshop Manual (p. 6-1).
12. Check for proper operation of the internal governor mechanism in accordance with the engine Workshop Manual (p. 6-1).
13. Service a worn engine in accordance with the engine Workshop Manual (p. 6-1).
14. Replace the genset controller (p. 9-1).

FAULTY OIL PRESSURE SENDER—CODE NO. 23

Control Logic: Controller sensed grounded sender

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. If loose, tighten the ring terminal on sender **E1** (Page 9-6). (This fault will occur if a loose ring terminal touches grounded metal.)
2. Disconnect connector **P1** (black) from genset controller (Page 9-1) and check continuity between **Pin 10** and ring terminal **E1-1**. If it is an isolated-ground sender, also check continuity between **E1-2** and **B–** (ground). Repair wiring and connectors as necessary.
3. Test sender **E1** and replace as necessary (Page 9-6).
4. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

FAULTY TEMPERATURE SENDER—CODE NO. 24

Control Logic: Controller sensed open sender

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. If loose, tighten the ring terminal on sender **E2** (Page 9-6). If it is an isolated-ground sender, also make sure the flag terminal is connected to terminal **2** on the sender.
2. Disconnect connector **P1** (black) from genset controller (Page 9-1) and check continuity between **Pin 9** and ring terminal **E2-1**. If it is an isolated-ground sender, also check continuity between **E2-2** and **B–** (ground). Repair wiring and connectors as necessary.
3. Test sender **E2** and replace as necessary (Page 9-6).
4. Replace the genset controller (p. 9-1).

LOSS OF AC VOLTAGE SENSE—CODE NO. 27

Control Logic: The genset Controller lost VAC sensing during normal voltage regulation when the field was functioning normally and frequency was at least 40 Hz

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Disconnect connector **P3** (green) from the genset controller (p. 9-1) and check continuity between **Pin 11** (S1) and **Pin 12** (S2). If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
2. Service or replace the brush block, slip rings, rotor or stator as necessary (Section 8).
3. Replace the genset controller (p. 9-1).

HIGH BATTERY VOLTAGE—CODE NO. 29

Control Logic: During startup the genset Controller sensed that battery system voltage was greater than 19.2 volts

Corrective Action:

1. Check battery bank connections and reconnect if necessary for 12 volts.
2. Select a lower battery booster charge rate.

CONTROL CARD FAILURE—EE—CODE NO. 35

Control Logic: During startup the genset Controller detected a EE memory error

Corrective Action: Replace the genset controller (p. 9-1)

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

UNKNOWN SHUTDOWN—CODE NO. 36

Control Logic: The genset Controller declared this fault because engine speed fell below 1000 RPM for 0.5 seconds, though not by genset or engine control action

Corrective Action:

1. Check for mechanical damage and service as necessary.
2. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
3. Check fuel level and refill as necessary. (Note: The genset fuel pickups are probably higher than the propulsion engine fuel pickups.)
4. Remove combustion air or exhaust system blockages.
5. Prime the engine fuel system for at least 30 seconds (p. 3-3).
6. Check all fuel filters and fittings for fuel and air leaks, tighten as necessary and reprime.
7. Replace the fuel filters and reprime (p. 4-5).
8. Conduct a fuel pump test and replace if necessary (p. 6-4).
9. Check for proper operation of the governor actuator and service as necessary (p. 6-7).
10. Service the brushes and slip rings as necessary (p. 8-4) and test the rotor and quadrature windings for opens and shorts (p. 8-5). Replace a stator or rotor with faulty windings.
11. Service the fuel injectors in accordance with the engine Workshop Manual (p. 6-1).
12. Check for proper operation of the internal governor mechanism in accordance with the engine Workshop Manual (p. 6-1).
13. Service a worn engine in accordance with the engine Workshop Manual (p. 6-1).
14. Replace the genset controller (p. 9-1).

INVALID GENSET CONFIGURATION—CODE NO. 37

Control Logic: The genset Controller is not configured properly for the genset

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Make sure the ends of the two leads marked CONFIG 1 and CONFIG2 in the wiring harness are not connected and that they are terminated with insulated connectors.
2. Reconfigure the genset controller (p. 2-7).
3. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

FIELD OVERLOAD—CODE NO. 38

Control Logic: High field voltage induced by high rotor temperature or low power factor loads

Corrective Action:

1. Remove blockages to generator air flow at the front inlet grill and right side, if enclosed.
2. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
3. Have air conditioners and other appliances checked for proper operation. (A locked compressor rotor can cause very low power factor.)
4. Check for a loose generator fan (p. 8-3) and repair or replace as necessary.
5. Service the brushes and slip rings as necessary (p. 8-4) and test the generator field, stator and quadrature windings for opens and shorts (p. 8-5). Replace a stator or rotor with faulty windings.

GENERATOR ROTOR FAULT—CODE NO. 41

Control Logic: F+ grounded

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Disconnect connector **P3** (green) from the genset controller and check for continuity between Pin **P3-7** (F+) and **B–** (ground). **Pin P3-7 should not be grounded.** Repair or replace wiring, brushes and slip rings (Page 8-4) or rotor (Page 8-5), as necessary.
2. Replace the genset controller (p. 9-1).

CONTROL CARD FAILURE—RAM—CODE NO. 43

Control Logic: During startup the genset Controller detected a RAM memory error

Corrective Action: Replace the genset controller (p. 9-1)

SPEED SENSE LOST—CODE NO. 45

Control Logic: After start disconnect the genset Controller lost speed sense [quadrature zero crossings] for 0.25 seconds

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Disconnect connector **P3** (green) from the genset controller and check for open or shorted field (**P3-6—P3-7**) or quadrature (**P3-4—P3-5**) windings (p. 8-5). Service or replace brush block, slip rings, rotor or stator as necessary.
2. Replace the genset controller (p. 9-1).

TABLE 11-1. TROUBLESHOOTING GENSET FAULTS (CONT.)

⚠ WARNING *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (–) cable from the battery to prevent the engine from starting.

FIELD SENSE LOST—RAM—CODE NO. 48

Control Logic: Controller unable to sense field voltage

Corrective Action: Replace the genset controller (p. 9-1)

OVERPRIME—CODE NO. 57

Control Logic: A local or remote control switch was held in the Prime position for more than 5 minutes

Corrective Action:

1. Check for and remove any object that may be holding any control switch (local or remote) in the prime position.
2. Replace any control switch (S4) in the control system that does not open across terminals **1** and **2** when **Stop** is released (p. 9-5).

HIGH EXHAUST TEMPERATURE—CODE NO. 58

Control Logic: Exhaust temperature exceeded design limits due to lack of water delivered to the exhaust/water mixer

Corrective Action: *Refer to Pages A-1 through A-3 as appropriate.*

1. Open the sea valve.
2. Check for and clean a blocked sea water strainer. If above the water line, fill the strainer with water to assist priming.
3. Check for and reconnect or replace any disconnected, kinked or leaking raw water hoses.
4. Inspect the siphon break (if provided) for proper operation.
5. Check for and readjust a loose pump belt (p. 4-9).
6. Check for a worn raw water impeller and replace as necessary (p. 4-10).
7. Clean the heat exchanger (p. 4-12).
8. Disconnect connector **P1** (black) from the genset controller (p. 9-1) and check continuity between Pin **P1-11** and **B–** (ground). If open, check for a missing, bent or corroded pin, faulty wiring or open exhaust temperature switch **S5** (p. 9-7). Repair as necessary.

EXTERNAL SHUTDOWN—CODE NO. 61

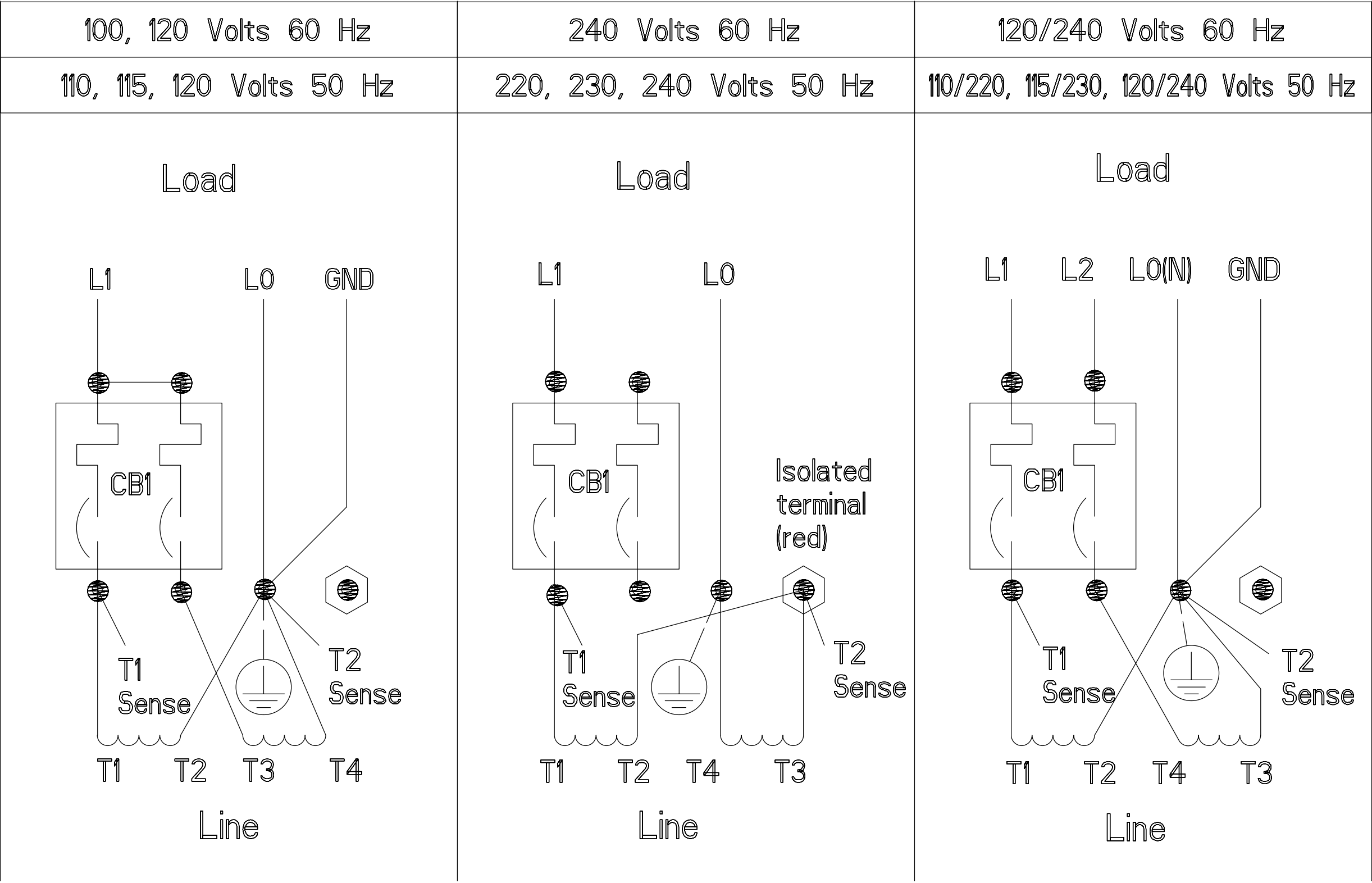
Control Logic: Genset was shut down by a fire suppression system or other external control

Corrective Action: Make all necessary repairs to the genset and connected equipment and reset the external control which shut down the genset.

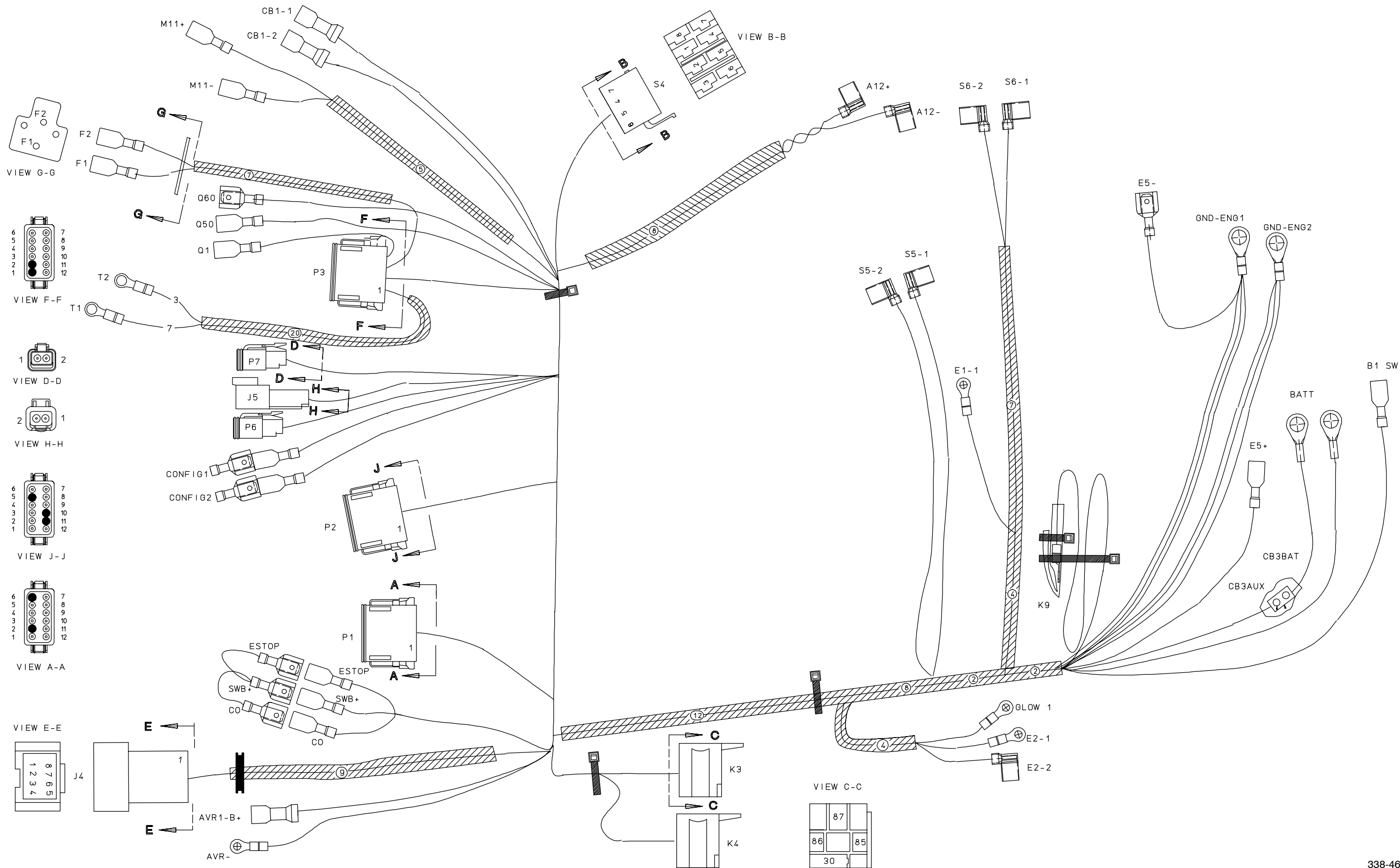
12. Specifications

GENERATOR: 2-Bearing, 2-Pole Rotating Field, Microprocessor Regulated. Rating on Genset Nameplate		
FUEL CONSUMPTION:		
60 Hz:	Full Load	0.60 gph (2.3 liter/hr)
	Half Load	0.35 gph (1.3 liter/hr)
50 Hz:	Full Load	0.50 gph (1.9 liter/hr)
	Half Load	0.29 gph (1.1 liter/hr)
Engine/Generator Speed:	60 Hz	2900/3600 rpm
	50 Hz	2400/3000 rpm
ENGINE: 4-Stroke Cycle, Indirect Injection Diesel, Water Cooled, Microprocessor Governed (Isochronous)		
Number of Cylinders		2
Bore		2.52 inch (64 mm)
Stroke		2.45 inch (62.2 mm)
Displacement		24.41 inch ³ (400 cm ³)
Compression Ratio		23:1
Firing Order (Clockwise Rotation)		1-2
Fuel Injection Timing		18° – 20° BTDC
Fuel Injection Pressure		1991 psi (13.73 MPa)
Valve Lash (cold)		0.0059 – 0.0073 INCH (0.145 – 0.185 MM)
Engine Oil Capacity		2.2 quart (2.1 liter)
Engine Oil Drain Connection		3/8 NPT
Coolant Capacity		2.2 quart (2.1 liter)
Coolant Flow:	60 Hz	3.5 gpm (13 liter/min)
	50 Hz	3.0 gpm (16 liter/min)
Raw Water Flow:	60 Hz	5.0 gpm (19 liter/min)
	50 Hz	4.0 gpm (15 liter/min)
Maximum Raw Water Pump Lift		4 feet (1.2 m) with 5/8 inch ID hose
Raw Water Inlet Connection		5/8 inch (15.9 mm) ID Hose
Maximum Fuel Pump Lift		4 feet (1.2 m) with 3/8 inch ID fuel line
Recommended Fuel Line Size		3/8 inch (9 mm) ID
Fuel Supply Connection		1/8 NPT female
Fuel Return Connection		1/8 NPT female
Maximum Exhaust Back Pressure		3 INCH (76 MM) HG
Wet Exhaust Outlet Connection		2.0 INCH (50.8 MM) ID HOSE
Combustion Air		18 CFM (30 M ³ /HR)
Generator Cooling Air		60-80 CFM (100-135 M ³ /HR)
BATTERIES:		
Nominal Battery Voltage		12 volts
Minimum CCA Rating		360 amps
Battery Charging Output		Trickle (3 amps)
SIZE, WEIGHT, NOISE:		
Size: L x W x H		26 x 20.1 x 20.6 inch (662 x 511 x 524 mm)
Weight (dry)		350 lbs (159 kg)
Noise:	60 Hz	71 dB(A)
	50 Hz	68 dB(A)

WIRING DIAGRAM



GENERATOR CONNECTION DIAGRAM



CONTROL WIRING HARNESS