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Service Manual

MDK BK

MDK BL MDK BM MDK BN

MDK BP MDK BR MDK BS

981-0543B

11-05

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.

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.

⚠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.*

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.

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

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. Every character in these numbers is significant. (The last character of the model number is the specification letter, which is important for obtaining the right parts.)

⚠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.*

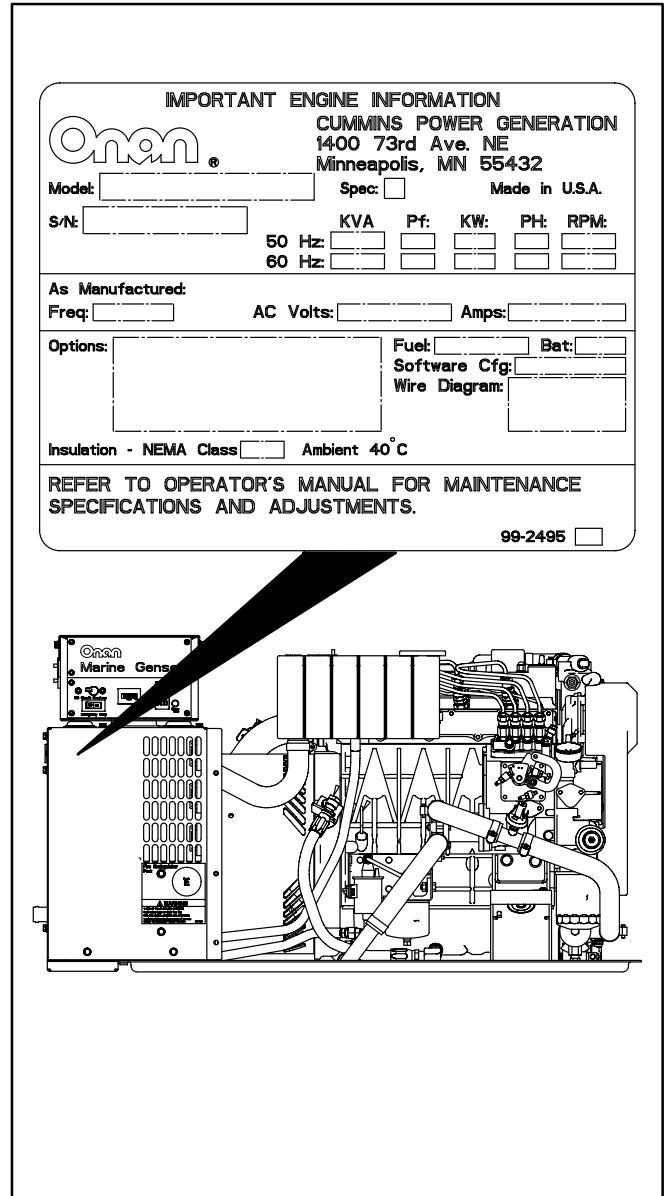


FIGURE 1-1. TYPICAL NAMEPLATE

2. Control Panel

REMOTE CONTROL AND MONITORING

Remote e-Series Digital Displays and Control Switches

The boat may be equipped with several remote genset control stations having either an e-Series Digital Display or control switch.

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.

See NETWORK INTERFACE MODULE (NIM) on Page 5-9.

LOCAL CONTROL PANEL

Refer to Figure 2-1.

Control Switch Panel (Standard)

Control Switch: This switch is used to start and stop the genset and prime fuel.

- *Push and Hold* **START** to preheat, crank and start the genset. The green 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.)

- *Push and Release* **STOP (Prime)** to stop the genset.
- *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 9). 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.

DC Circuit Breaker: This circuit breaker protects the DC control circuits of the genset from short circuits. Reset after all necessary repairs have been made to the genset.

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

e-Series Digital Display Panel (Optional)

The control panel may have an e-Series Digital Display instead of a control switch. See Page 2-3 for details.

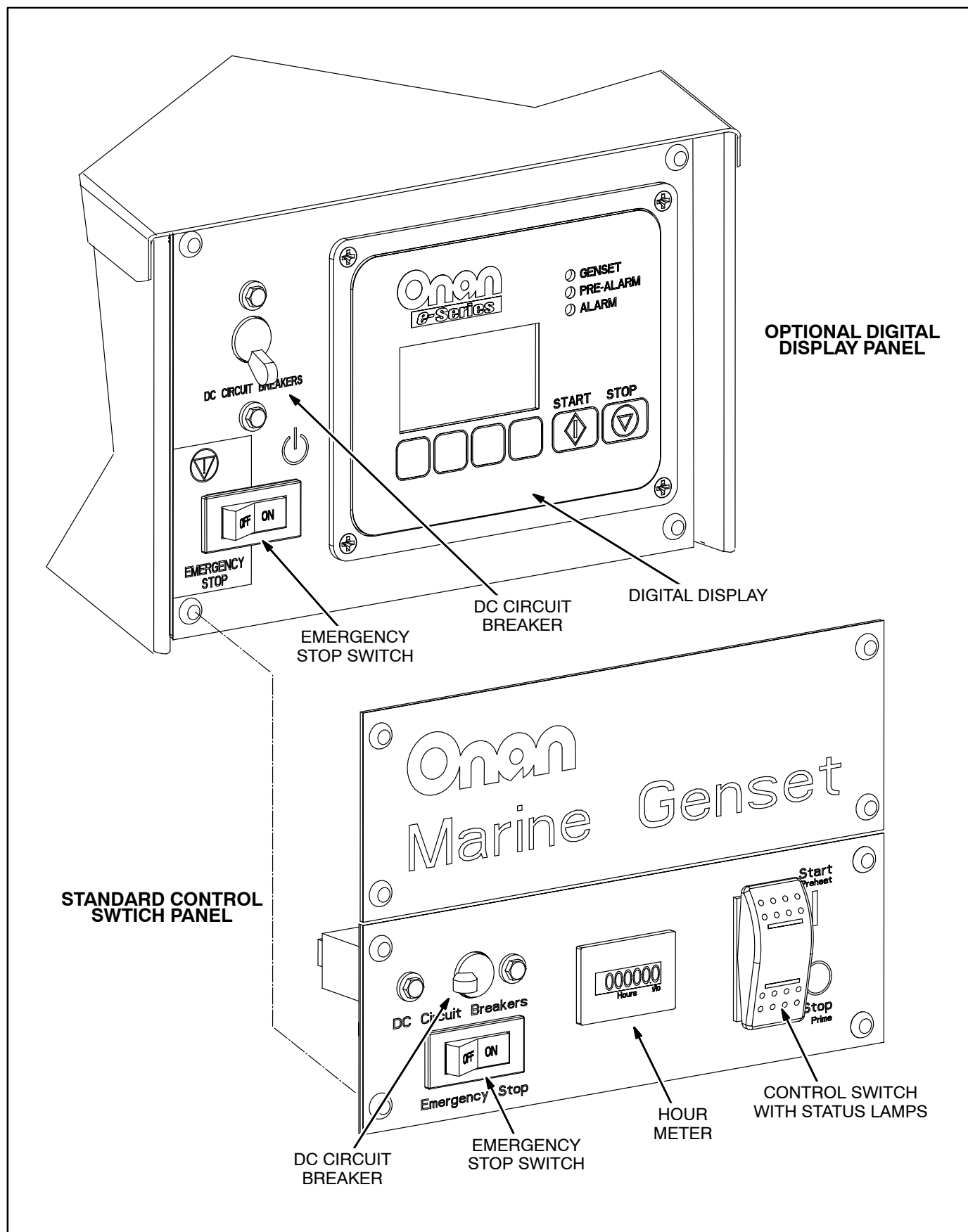


FIGURE 2-1. GENSET CONTROL PANEL

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 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 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. 3-4).

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. 2-6). It blinks rapidly while the genset is running in voltage adjust mode (p. 8-1).

ALARM – This status lamp (red) blinks during fault shutdown (p. 2-5).

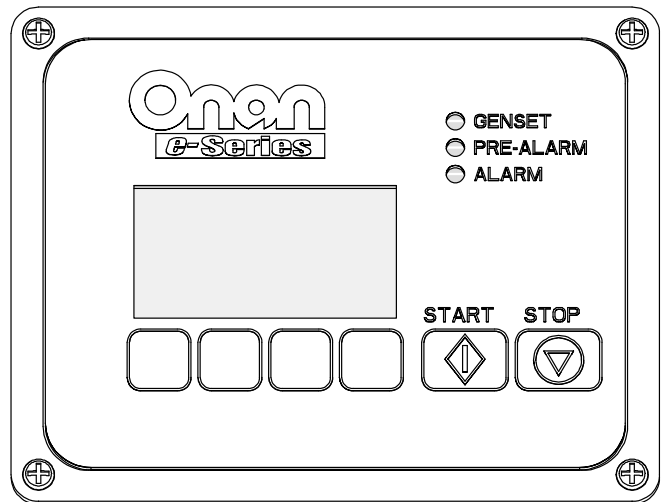


FIGURE 2-2. DIGITAL DISPLAY

Genset Status

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 master hour meter (p. 5-5) prevails if the total time on the e-Series Digital Display is different. See **Configuring Replacement Genset Controller** (p. 2-8) to reset the Digital Display to match the master hour meter.

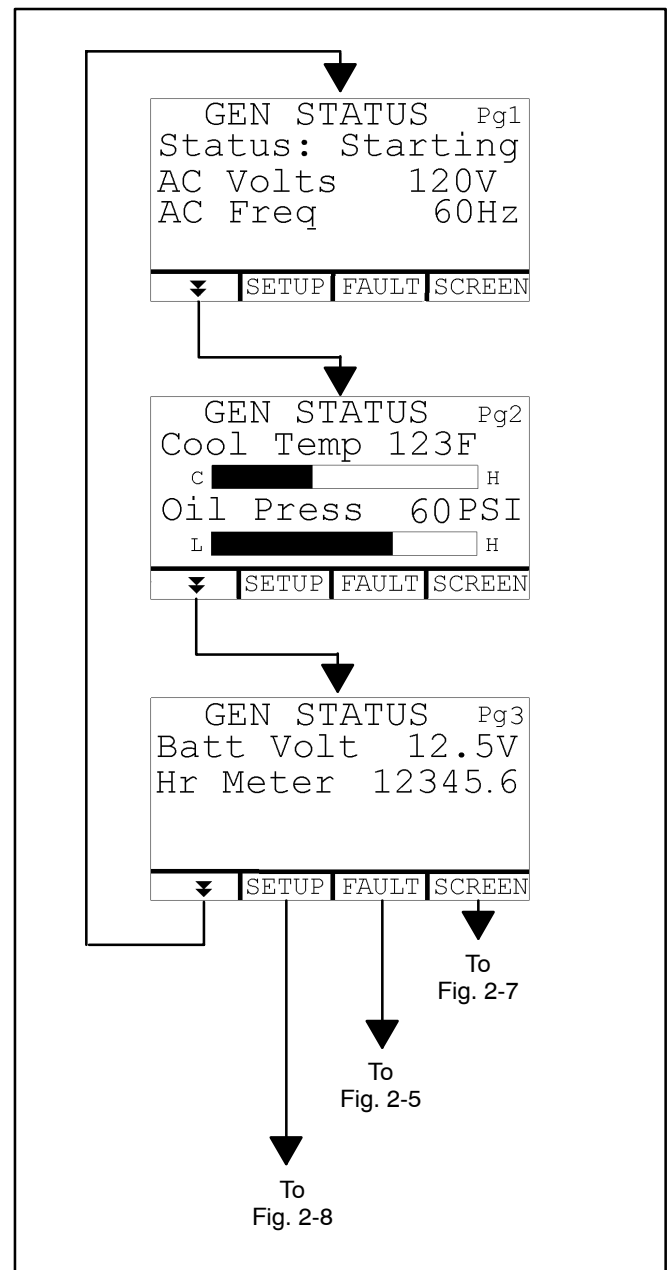


FIGURE 2-3. TYPICAL GENSET STATUS SCREENS

Fault Screen

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 9-1. 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.

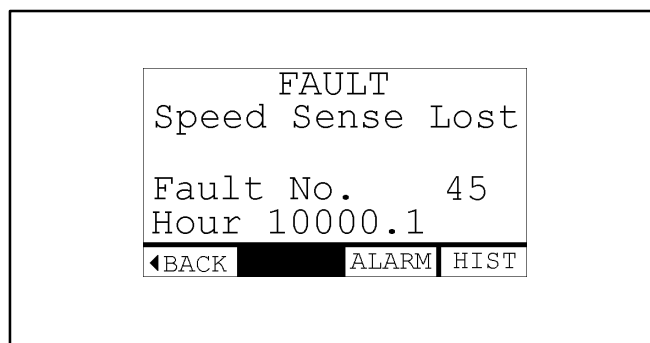


FIGURE 2-4. TYPICAL FAULT SCREEN

Fault History

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-Alarms

The PRE-ALARM status lamp will come on 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.

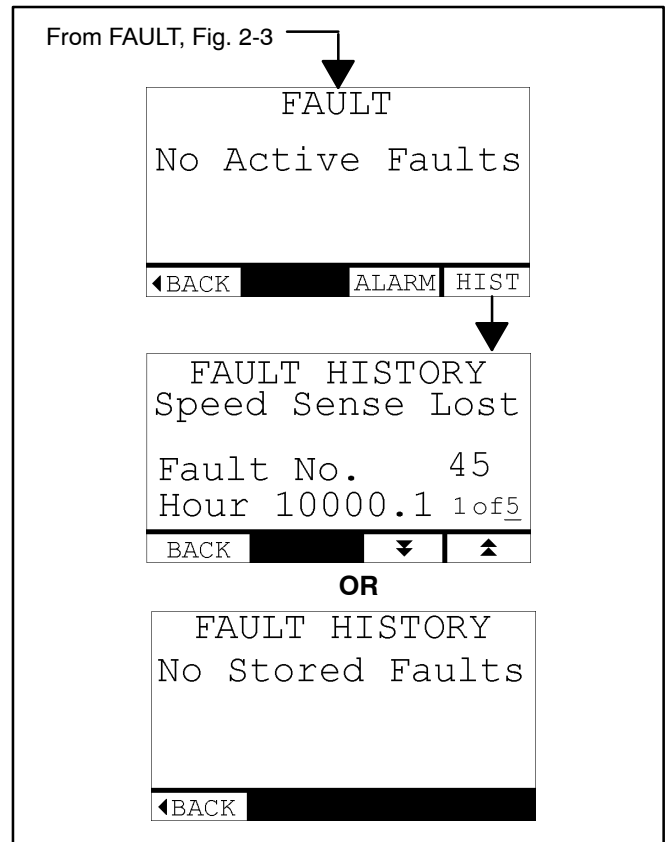


FIGURE 2-5. FAULT HISTORY

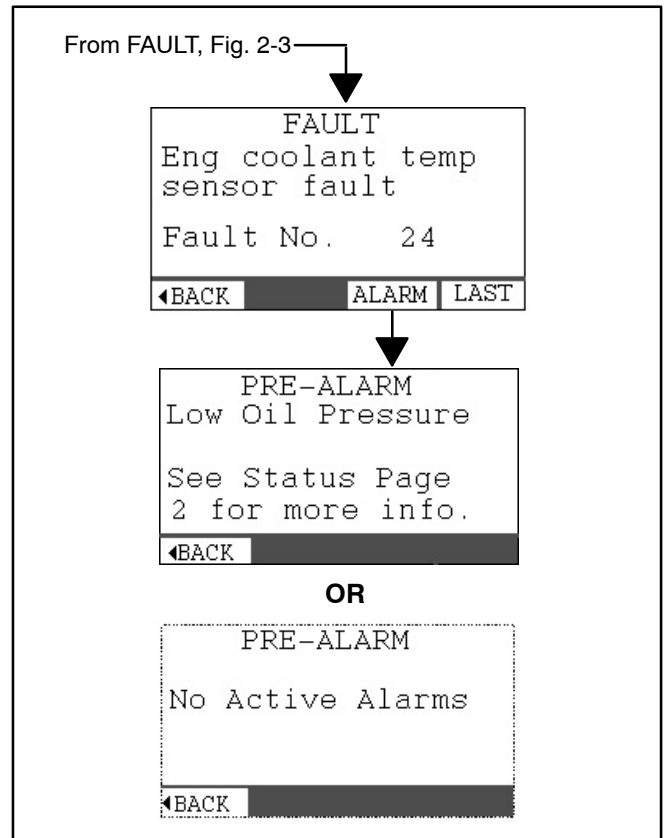


FIGURE 2-6. ENGINE PRE-ALARMS

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 8).

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.

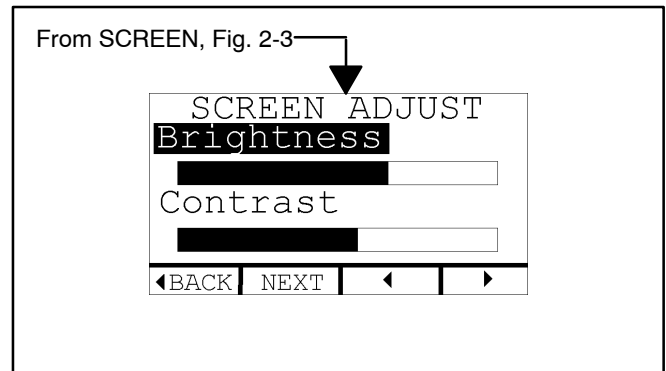


FIGURE 2-7. SCREEN BRIGHTNESS & CONTRAST

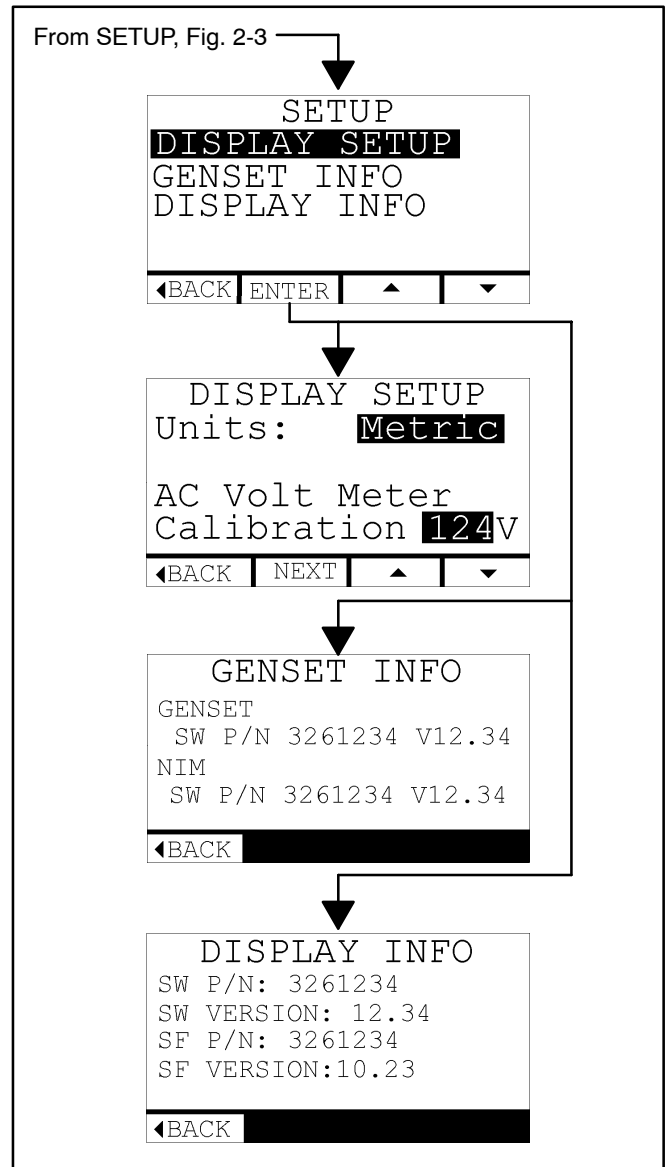


FIGURE 2-8. SETUP, GENSET & DISPLAY INFO

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. 9-9). Also, the Digital Display hour meter should be reset to match the master hour meter (p. 5-5).

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 is marked on the genset nameplate. Also see Table 2-1.

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 master hour meter (p. 5-5).

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. For example, the lamp should blink as follows when configured for a 1-Phase, Model MDKBR genset (15):

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

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

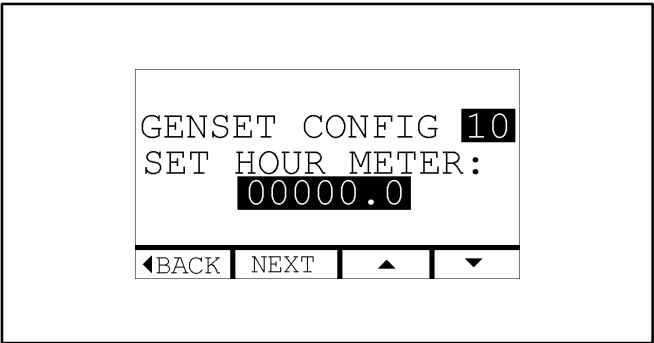


FIGURE 2-9. CONFIGURING CONTROLLER AND SETTING HOUR METER

TABLE 2-1. GENSET CONFIGURATION CODES

GENSET MODEL	CODE NUMBER
MDKBK—1-Phase	18
MDKBL—1-Phase	18
MDKBM—1-Phase	12
MDKBN—1-Phase	13
MDKBP—1-Phase	14
MDKBP—3-Phase	24
MDKBR—1-Phase	15
MDKBR—3-Phase	16
MDKBS—1-Phase	17
MDKBS—3-Phase	25

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.

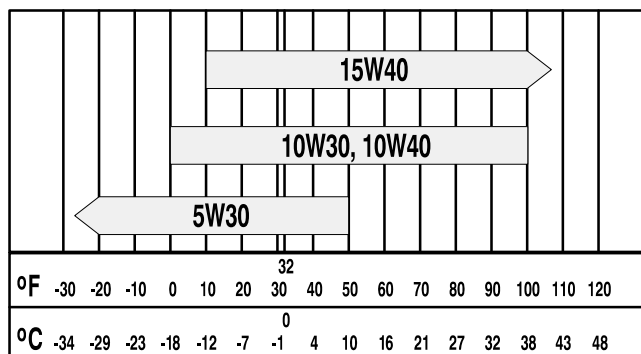


FIGURE 3-1. OIL VISCOSITY GRADE VS. AMBIENT TEMPERATURE

ENGINE COOLANT

Use the best quality ethylene glycol antifreeze solution available. It should be a 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 10) regarding coolant capacity.

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

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 10).

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.

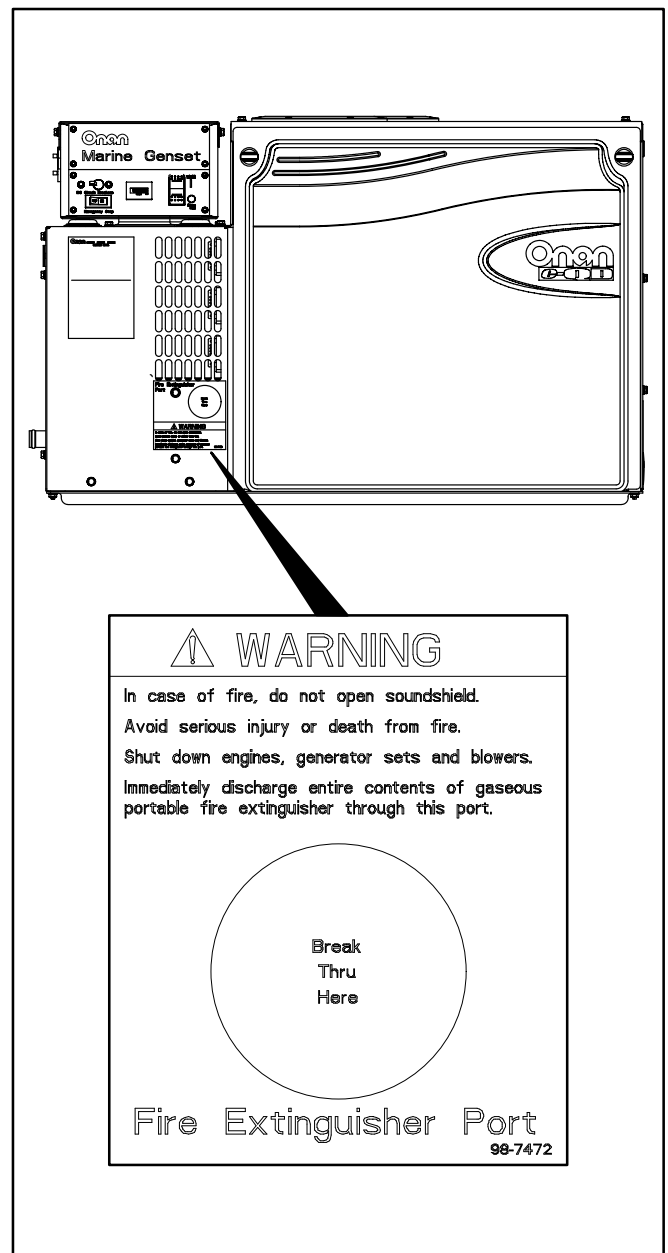


FIGURE 3-2. FIRE EXTINGUISHER PORT

⚠ 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***
- ***Weakness and Sleepiness***
- ***Vomiting***
- ***Inability to Think Coherently***

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. 3-6) 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 and disengage the PTO (if so equipped).

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 or engaging the PTO (if so equipped).
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. 2-4), if so equipped. Perform maintenance or service as necessary if the Display indicates a **Pre-Alarm** condition (p. 2-3).
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 9) 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 9).

STOPPING THE GENSET

Disconnect all electrical loads and disengage the PTO (if so equipped) 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.***

On gensets so equipped, the PTO can take most, if not all, of the power available from the engine. The boat builder may have made provisions to automatically disconnect all or most electrical loads when the PTO is engaged. ***It may be necessary to run fewer electrical loads—or none at all—when the PTO is engaged.***

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.

RESETTING LINE CIRCUIT BREAKERS

If the genset line circuit breaker trips, or 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.*

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.*

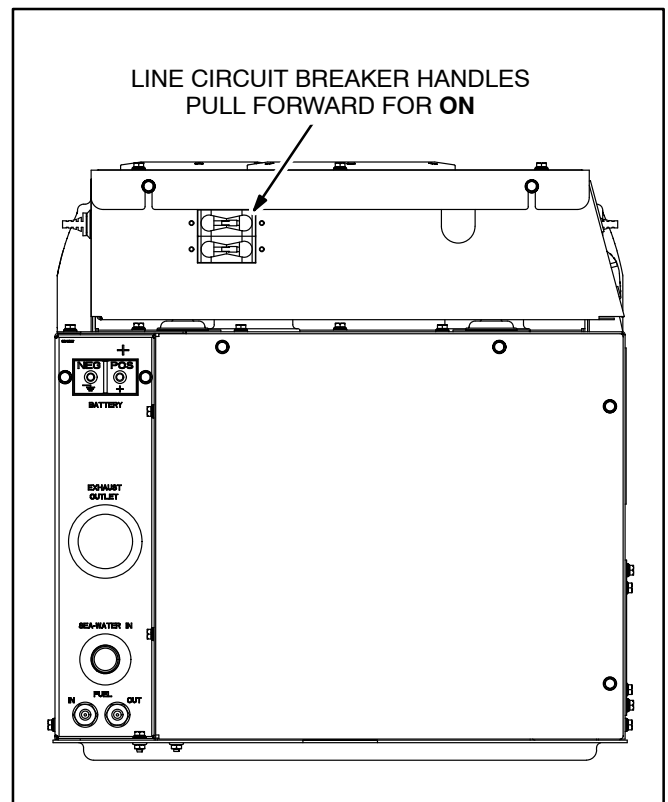


FIGURE 3-3. LINE CIRCUIT BREAKER

COLD TEMPERATURE OPERATION

Drain the heat exchanger (p. 4-7) 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. 4-3).

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.
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. Disengage a PTO clutch if so equipped.
8. 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 when ready to power loads.

4. Periodic Maintenance

Periodic maintenance is essential for top performance 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. How-

ever, warranty work must be completed by an authorized Onan service representative.

⚠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.*

TABLE 4-1. PERIODIC MAINTENANCE SCHEDULE

MAINTENANCE OPERATION	MAINTENANCE FREQUENCY								Page
	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	
General Inspection ¹		•							4-2
Check Engine Oil Level		•							4-3
Drain Water from Fuel Filter			•						4-5
Inspect Battery and Battery Connections ²			•						4-2
Check V-Belt Tension ³			•						4-11
Inspect Siphon Break			•						4-7
Change Engine Oil and Oil Filter	•			•					4-3
Replace Fuel Filters					•				4-5
Inspect Zinc Anode					•				4-7
Replace Raw Water Impeller					•				4-10
Adjust Engine Valve Lash ⁴						•			–
Replace Coolant, Pressure Cap & Thermostat							•		4-6
Inspect Generator Bearing ⁴								•	–
1 – Includes inspection of Oil Level, Coolant Level, Fuel System, Exhaust System, Batteries and Battery Connections. 2 – See battery manufacturer's recommendations. 3 – Check for slippage, cracking and wear. 4 – Must be performed by a qualified mechanic (authorized Onan dealer).									

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

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.

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

Fuel System

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.

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

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. 4-7). Use the recommended antifreeze mixture (p. 3-1).

Raw Water System

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

vided (see Installation Manual), open the sea valve 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. 2-4).

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. Remove battery cables with a battery terminal puller.
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.*

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

Shut off the genset and check the oil level with the dip stick (Figure 4-1 or 4-2). Add or drain oil as necessary. Add 1 quart (0.9 liters) when the level falls to the ADD mark. Drain oil if the level is above the full mark.

See ENGINE OIL RECOMMENDATIONS (p. 3-1).

CHANGING ENGINE OIL AND FILTER

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.

⚠️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.*

2. Be ready to drain the oil into a suitable container and then open the drain valve or unscrew the plug on the end of the drain hose (Figure 4-1 or 4-2) and drain the oil into a suitable container. (Two wrenches are necessary to keep from twisting the hose when loosening and tightening the plug.) If an oil pump-out system is installed, follow the instructions provided.
3. Secure the drain plug or 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 10). Check the oil level and add or drain oil as necessary.
7. Dispose of the used oil and oil filter according to local environmental regulations.

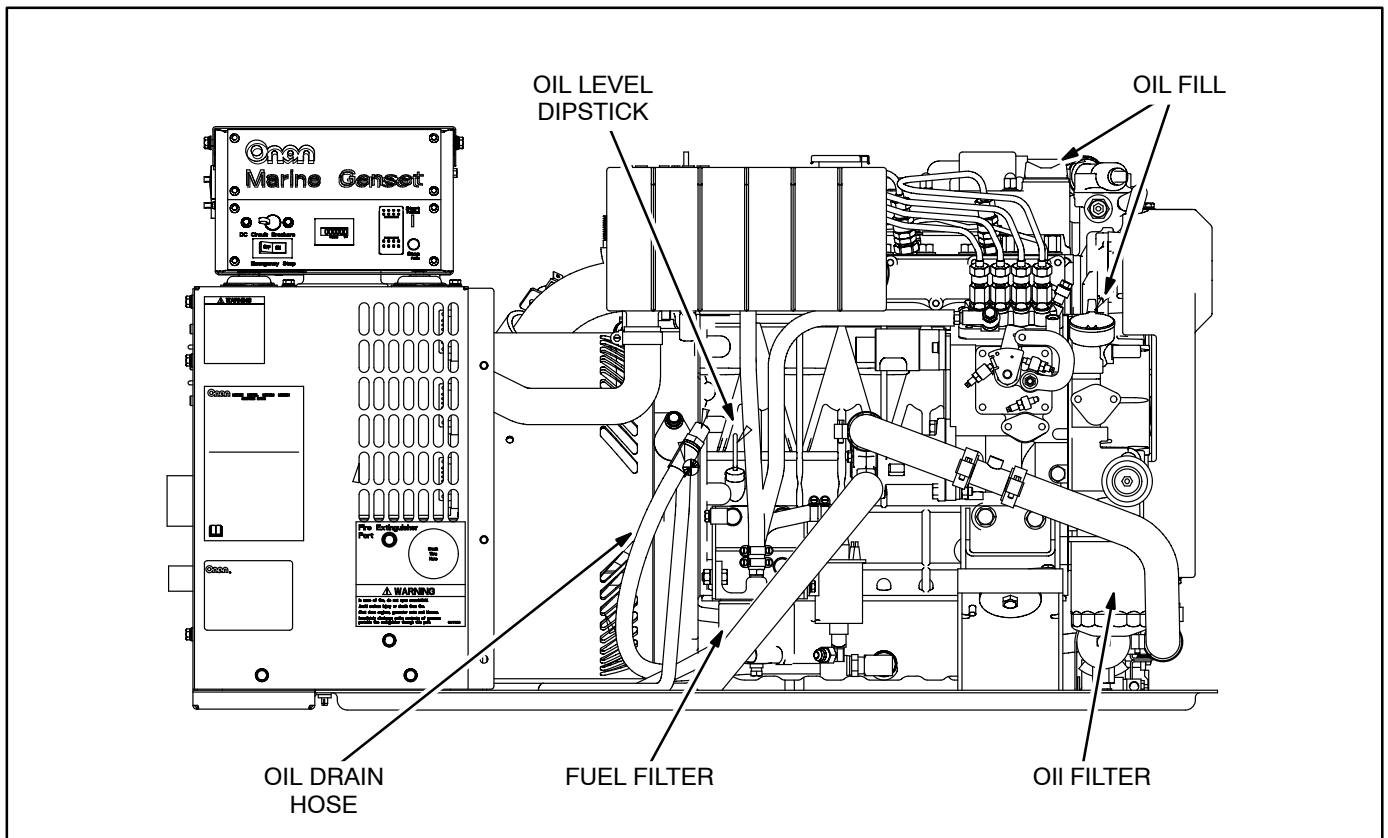


FIGURE 4-1. OIL AND FUEL SERVICE POINTS—MDKKBK, MDKBL, MDKBM, MDKBN

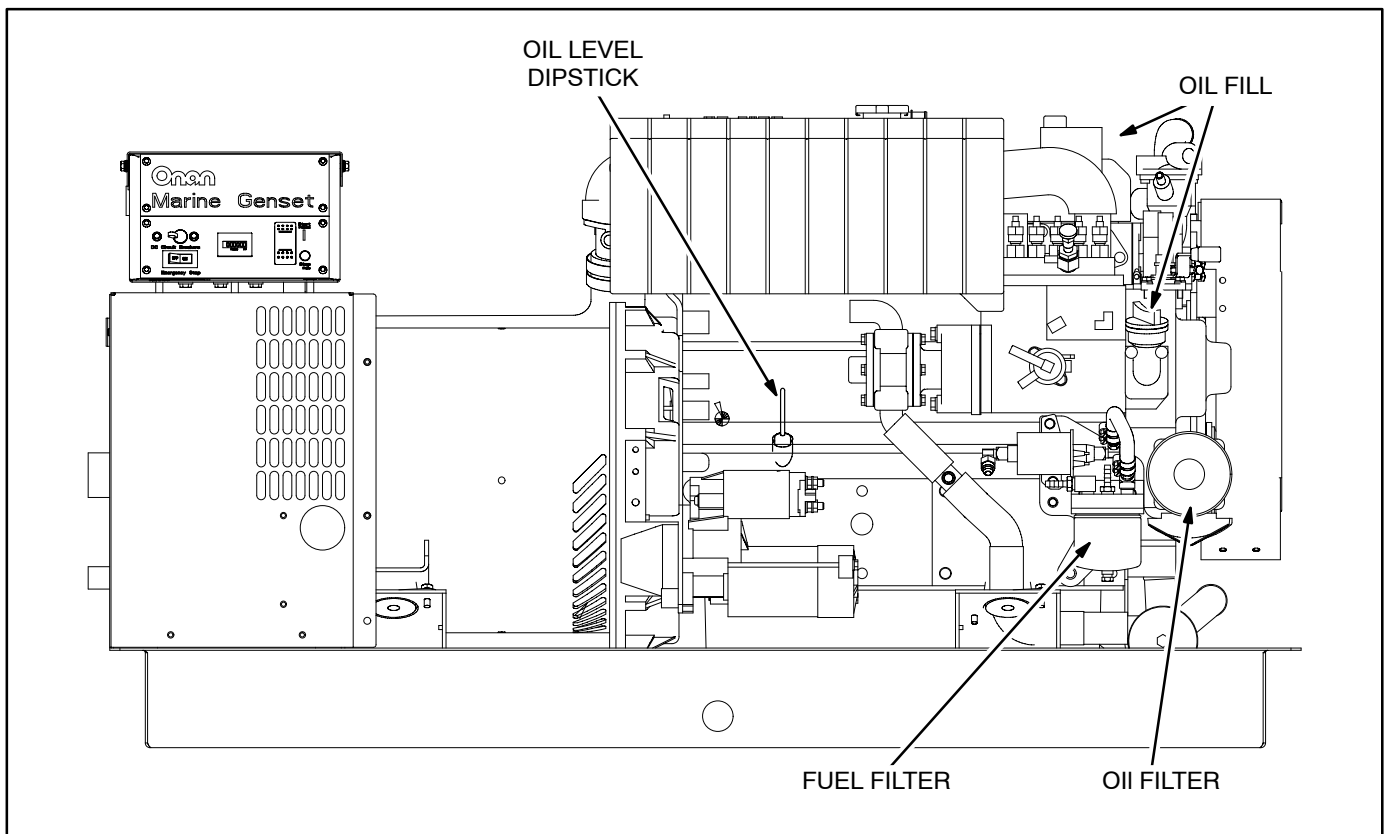


FIGURE 4-2. OIL AND FUEL SERVICE POINTS—MDKBP, MDKBR, MDKBS

DRAINING/REPLACING THE FUEL FILTER

⚠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 4-1 or 4-2). 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. Drain the filter (about 1/2 cup [120 ml]) into a suitable container by removing the drain plug (bottom of filter).

2. Re-install the drain plug and dispose of the drain-off in accordance with local environmental regulations.

Changing 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.

⚠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.*

2. 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 (p. 3-3) to fill the new filter. Run the genset and check for leaks. Tighten the filter by hand, if necessary.

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 4-3 or 4-4). Heat is carried away from the coolant by a keel cooler or raw water (sea water) heat exchanger. A gear-driven raw water pump is provided if the genset has a heat exchanger or wet exhaust.

Keel Cooler: A keel cooler, when provided, is part of the pressurized, closed-loop liquid cooling system through which the coolant flows.

Heat Exchanger: When a heat exchanger is provided, raw water (the floatation water) is pumped through tubes in the heat exchanger to cool the engine coolant. The water is then passed through a hose into the exhaust-water mixer to cool the exhaust gases. The raw water is expelled from the boat along with the exhaust gases.

Recommended Coolant Mixture

See ENGINE COOLANT (p. 3-1) 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.

Pressure Cap

Replace the pressure cap every two years (seals deteriorate and leak). Proper cooling system pres-

sure (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

Have towels and containers ready to wipe up, collect and properly dispose of the coolant. Disconnect the negative (–) cable at the battery to prevent the engine from starting and let the engine cool before removing the pressure cap.

⚠ 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.*

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

Remove the pressure cap and open the block and heat exchanger drain valves (Figure 4-3 or 4-4) and drain the coolant into suitable containers for disposal in accordance with the local regulations for hazardous substances.

Drain or flush a keel cooler in accordance with the manufacturer's instructions.

Use radiator cleaning chemicals to clean and flush the cooling system before refilling with fresh coolant. Follow the cleaner manufacturer's instructions.

⚠ CAUTION *Filling a hot engine with cold water can cause cracks in the manifold, head and block. Follow the manufacturer's instructions for cleaning and flushing.*

Refilling Cooling System

Close the block and heat exchanger drain valves 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.

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

Heat Exchanger

Both ends of the heat exchanger (Figure 4-3 or 4-4) have raw water drain plugs and cleanout covers. Clean the raw water tubes if the engine keeps shutting down (Code No.1). 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.)

Zinc Anode

Replace the zinc anode as recommended (Table 4-1). Use thread sealant on the zinc plug and drain plugs and replace the clean out cover gaskets if the old ones are torn or otherwise damaged.

Siphon Break

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.

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

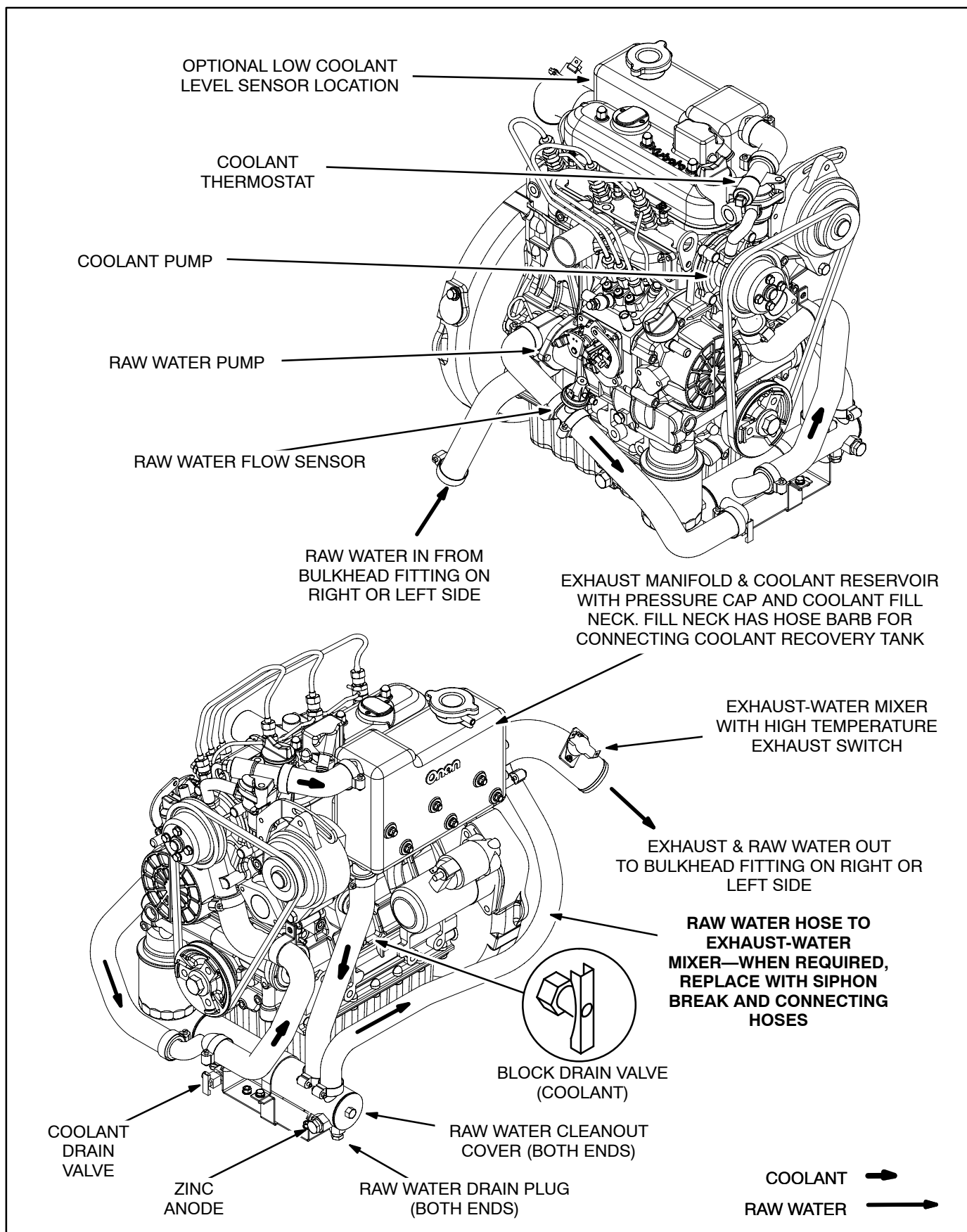


FIGURE 4-3. ENGINE COOLING SYSTEM—MDKBL, MDKBL, MDKBM, MDKBN

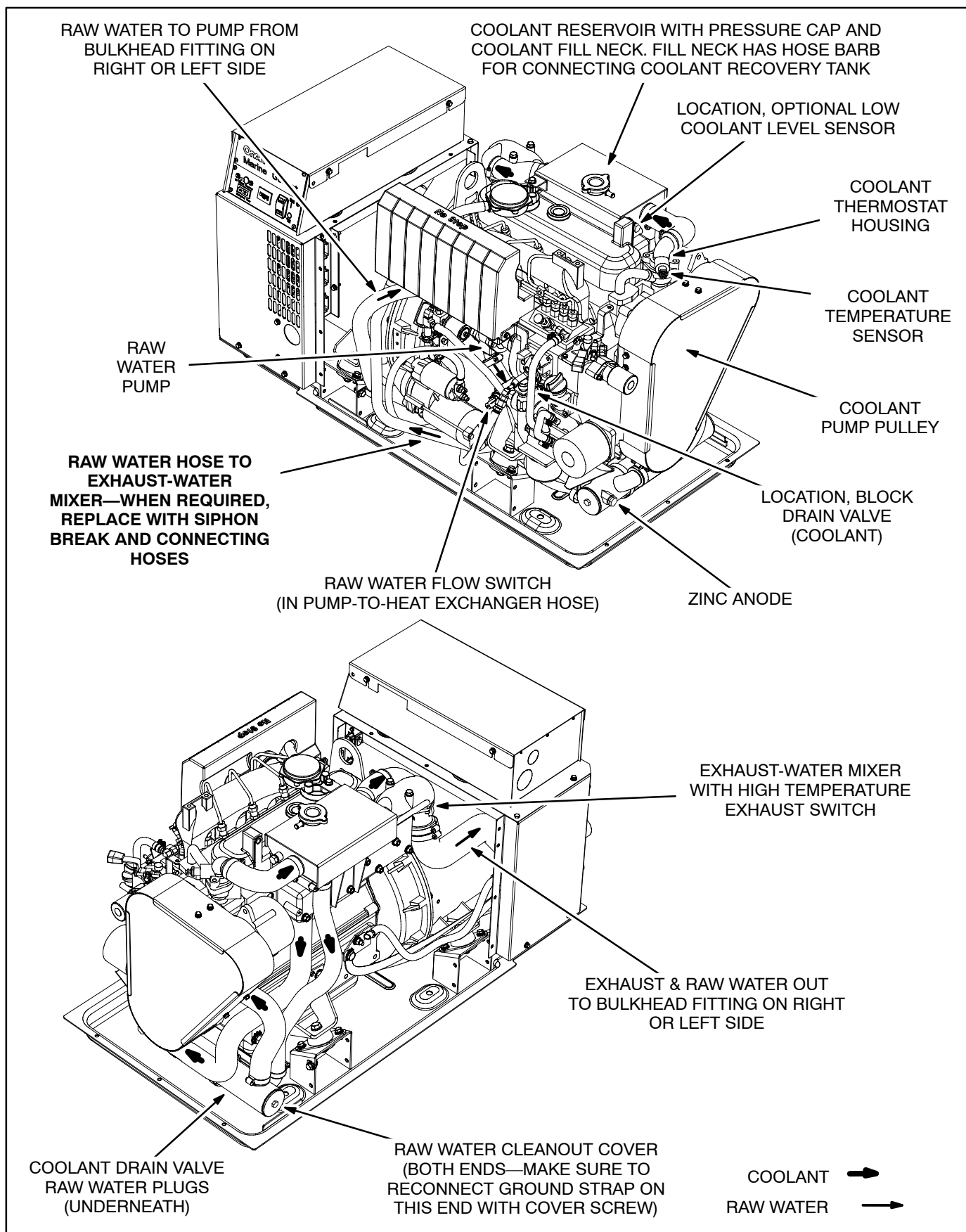


FIGURE 4-4. ENGINE COOLING SYSTEM—MDKBP, MDKBR, MDKBS

Replacing the Raw Water Pump Impeller

See Table 4-1 for scheduled replacement. Replace the impeller as follows:

1. Close the sea valve.
2. Disconnect the negative (–) cable at the battery to prevent the engine from starting.

⚠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.*

3. Loosen the three screws on the end of the pump body to remove the pump body or impeller cover, depending on construction (Figure 4-5).
4. Remove the impeller. An impeller removal tool may be necessary to pull the impeller off the shaft.
5. Install the new impeller. It helps to twist the impeller while squeezing it into the housing. *Note: It will be necessary to check for and cleanout pieces of the impeller from the heat exchanger if vanes have broken off.*
6. 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.*

7. Secure the cover or pump body and O-ring.
8. *Fill the sea water strainer for faster priming at startup if it is above the water line.*
9. Open the sea valve, reconnect the battery cables (negative [–] last) and start the genset. The genset will shut down within a few seconds if there is no raw water flow and Fault Code No. 7 (p. 9-5) will be declared. If it shuts down, find out why, remove any blockage and restart the genset.

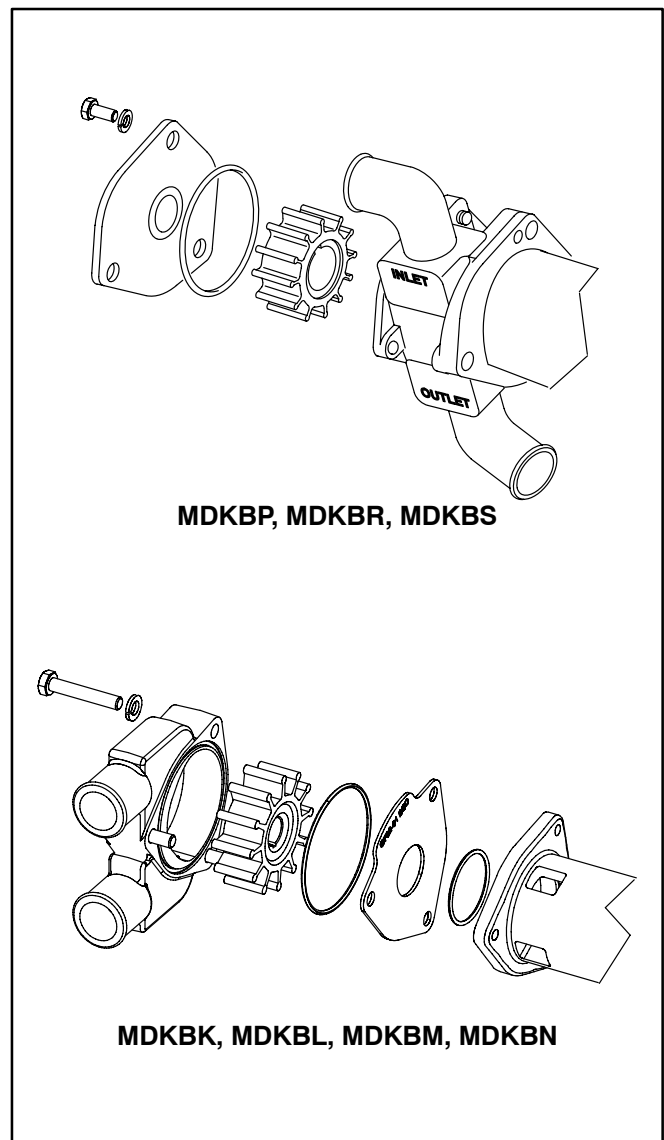


FIGURE 4-5. TYPICAL RAW WATER PUMPS

Adjusting V-Belt Tension

The V-belt drives the battery charging alternator and coolant pump (Figure 4-6). 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.

⚠ 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.*

2. Remove the belt guard or enclosure top panel and access doors.
3. Loosen the alternator pivot bolt first and then the adjusting bracket bolt on top.
4. Pivot the alternator out to tighten belt tension. Hold tension by tightening the tension adjusting bolt and then check tension 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). Tighten the alternator bolts when tension is correct.
5. Tighten the bolts, secure the belt guard or enclosure and reconnect the battery cables (negative [–] last).

Replacing V-Belt When PTO Equipped

A special belt replacement kit must be used when the genset is equipped with a PTO. The kit includes a tool to keep the flexible coupling from twisting during assembly/disassembly. The coupling has to be disassembled so that the belt can be looped around the crank pulley. Follow the instructions in the kit.

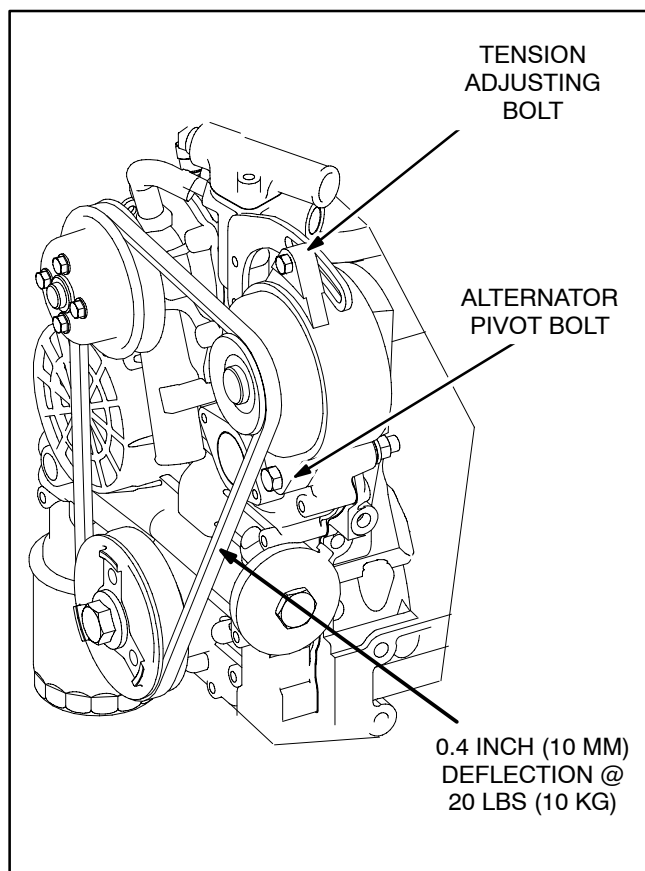


FIGURE 4-6. ADJUSTING V-BELT TENSION

Replacing the Thermostat

See Table 4-1 for scheduled replacement. Referring to Figure 4-7, 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 front and back access doors if the genset has an enclosure.

⚠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.

HOT COOLANT is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.

2. Remove the coolant pressure cap.
3. Remove the two thermostat housing bolts and pull off the housing, thermostat and gasket. The hose does not need to come off.
4. 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.
5. Replenish any lost coolant, secure the pressure cap and any doors and panels removed and reconnect the battery cables (negative [–] last).

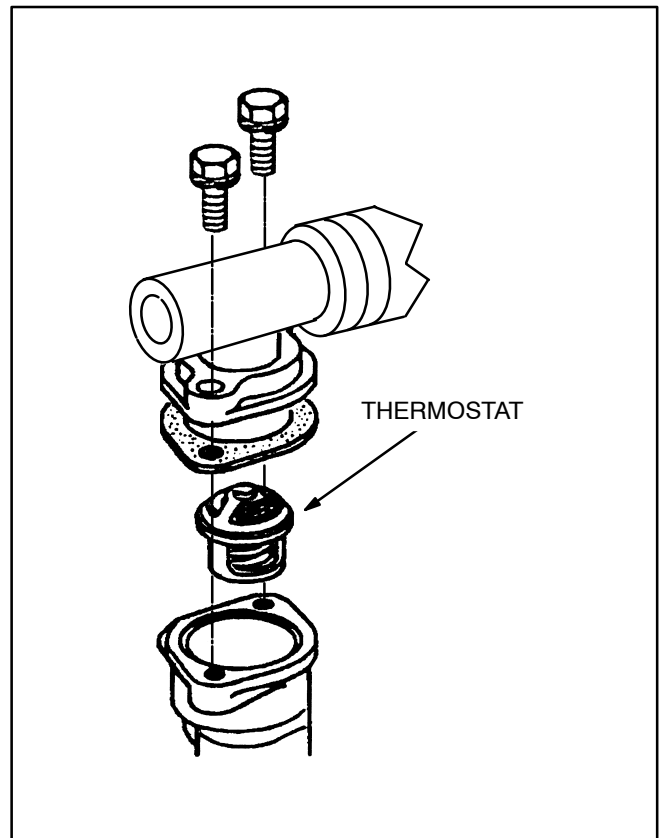


FIGURE 4-7. TYPICAL THERMOSTAT

5. Genset Control

⚠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.*

OVERVIEW

Figure 5-1 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. 5-9).

Figure 5-2 is a control block diagram. Pages A-1 through A-5 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 (1-Phase or 3-Phase). See Page 2-8.

Connectors

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.

⚠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.*

Removing / Replacing the Controller

All Models Except MDKKBK: Disassemble the controller as follows:

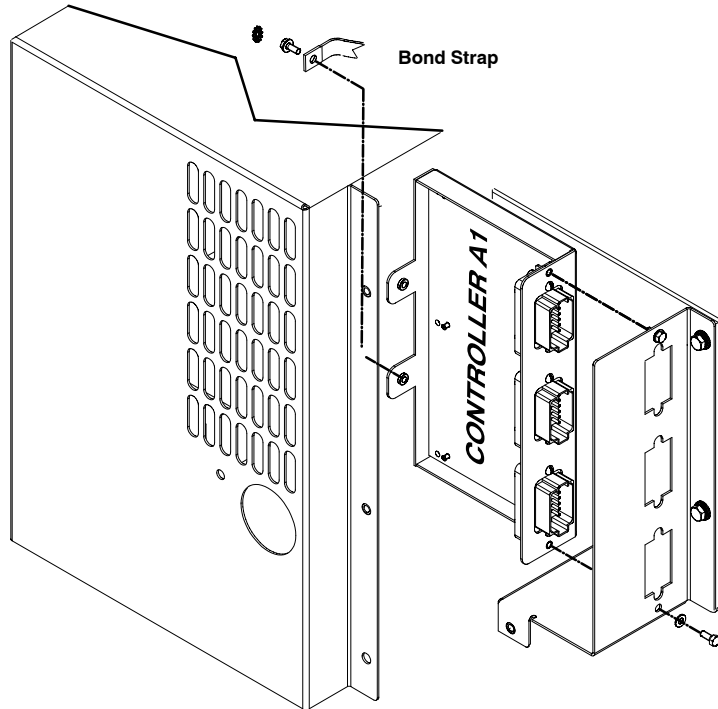
1. If the genset has an enclosure, remove the front access door and panel to the left.
2. Remove the panel on the left end of the genset.
3. Remove the screw securing the bond strap to the left side of the controller.
4. Remove the three connectors and two mounting screws on the right side of the controller and withdraw the controller out to the left.

When reassembling the controller, make sure to reconnect the electrostatic discharge bond strap.

Model MDKKBK: Remove the four (4) screws that secure the controller enclosure to the side of the genset and pull the enclosure and controller away as an assembly. If it is necessary to remove the controller, remove the four (4) screws that secure the controller to the enclosure and disconnect the three connectors, which come out the bottom.

When reassembling the controller, make sure to reconnect the electrostatic discharge bond strap.

ALL MODELS EXCEPT MDK BK



MODEL MDK BK

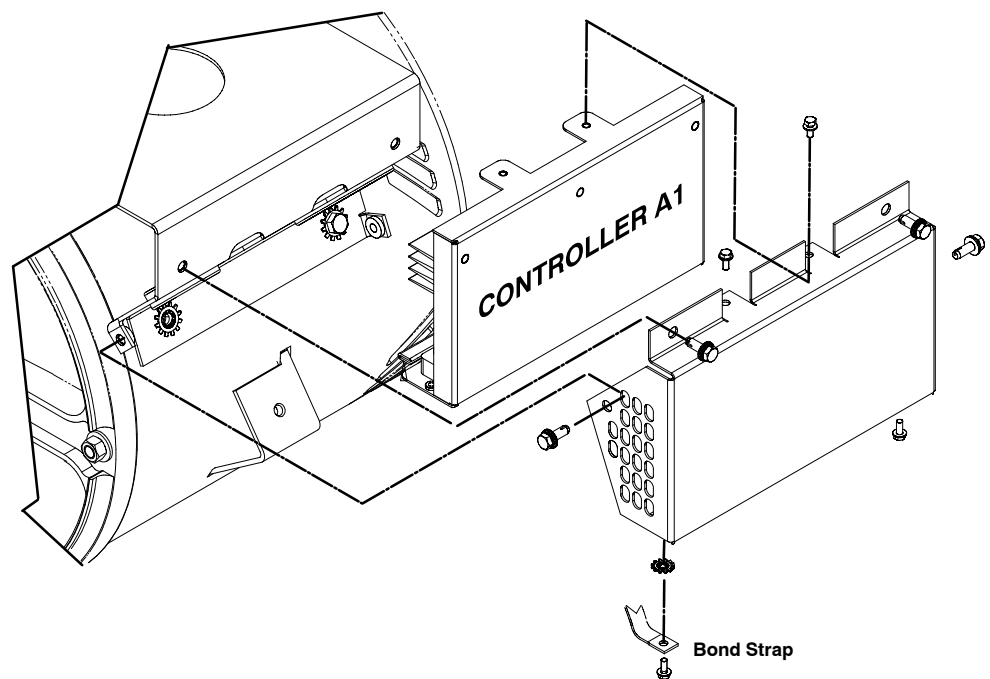


FIGURE 5-1. GENSET CONTROLLER AND ITS MOUNTING

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 ADJUSTING VOLTAGE (p. 8-2).

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 (Page 5-8). 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 CHANGING FREQUENCY (p. 8-1).

Fault Monitoring, Shutdown and Diagnostics: See *Troubleshooting* (Section 9).

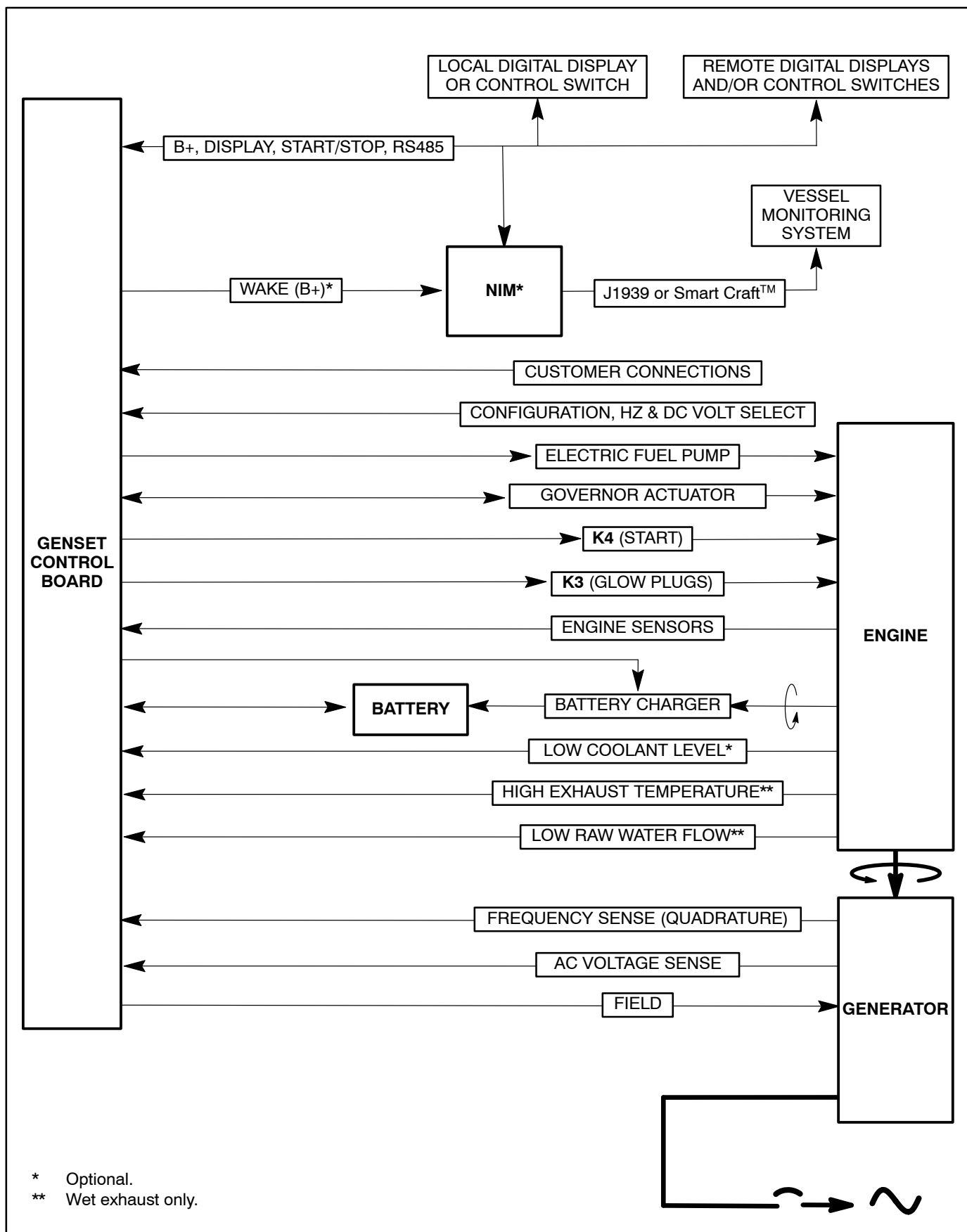


FIGURE 5-2. CONTROL BLOCK DIAGRAM

⚠️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.*

DIGITAL DISPLAY

Either a Digital Display or a control switch is mounted on the control panel (Figure 2-1). See DIGITAL DISPLAY (p. 2-3) regarding function. Up to three Digital Displays may be connected in the control system. See Page A-3 for connections.

CONTROL SWITCH (S4)

The control switch, when located on the genset, is mounted on the control panel (Figure 2-1). Unsnap the connector for access to its terminals (Figure 5-3). 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 2-1). 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.

DC CIRCUIT BREAKER (CB2)

The switch/circuit breaker is mounted on the control panel (Figure 2-1). 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.

MASTER HOUR METER (M11)

The master hour meter is mounted on the control panel (Figure 2-1) or on a bracket on the back of the control panel, inside the control box (Figure 5-4).

See Page 2-8 for instructions on how to reset the hour meter on the Digital Display to match the master hour meter when replacing the genset controller.

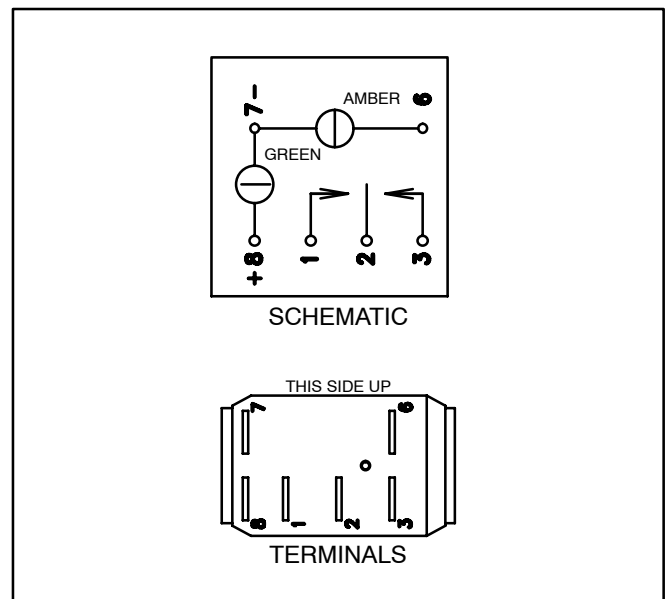


FIGURE 5-3. CONTROL SWITCH S4

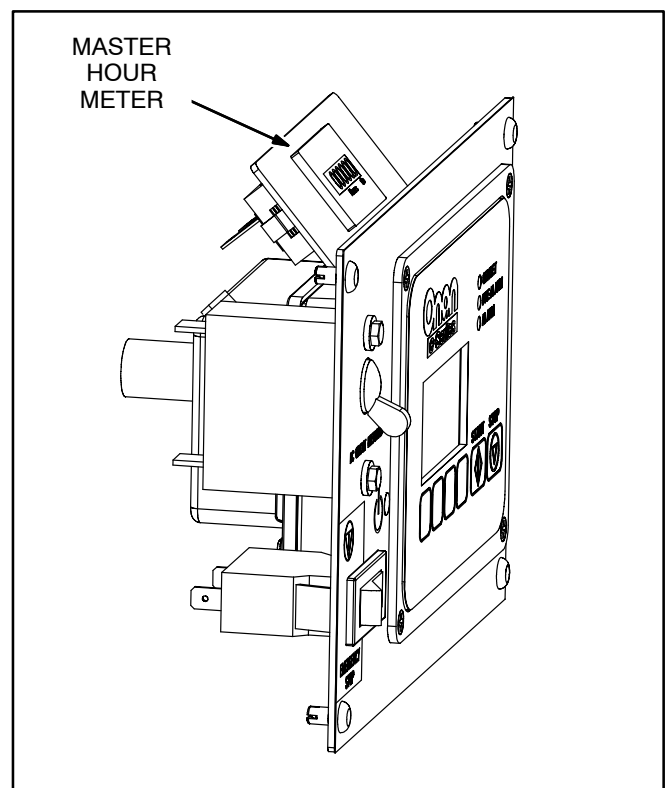


FIGURE 5-4. MASTER HOUR METER

⚠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.*

ENGINE OIL PRESSURE SENDER (E1)

The oil pressure sender is threaded into the side of the block (Figure 5-5 or to a manifold (Figure 5-6). Use thread sealant and engage at least two full threads when installing. In isolated-ground applications the sender has two terminals.

ENGINE COOLANT TEMPERATURE SENDER (E2)

The engine coolant temperature sender is threaded into the thermostat housing (Figure 5-5 or 5-6). 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.

RAW WATER FLOW SWITCH (S6)

The raw water flow switch is threaded into a hose “T” (Figure 5-5 or 5-6). 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.

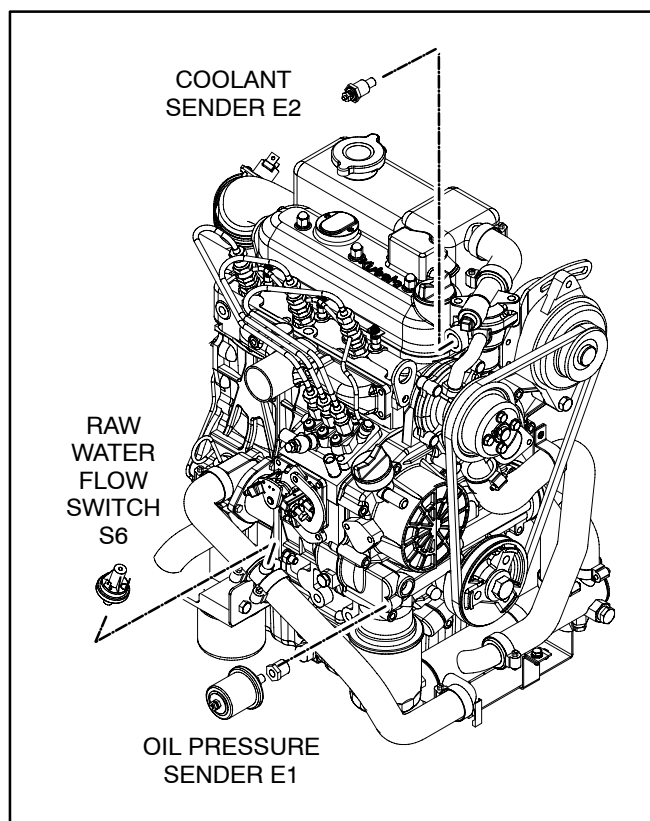


FIGURE 5-5. ENGINE SENSORS—MDK BK, MDK BL, MDK BM, MDK BN

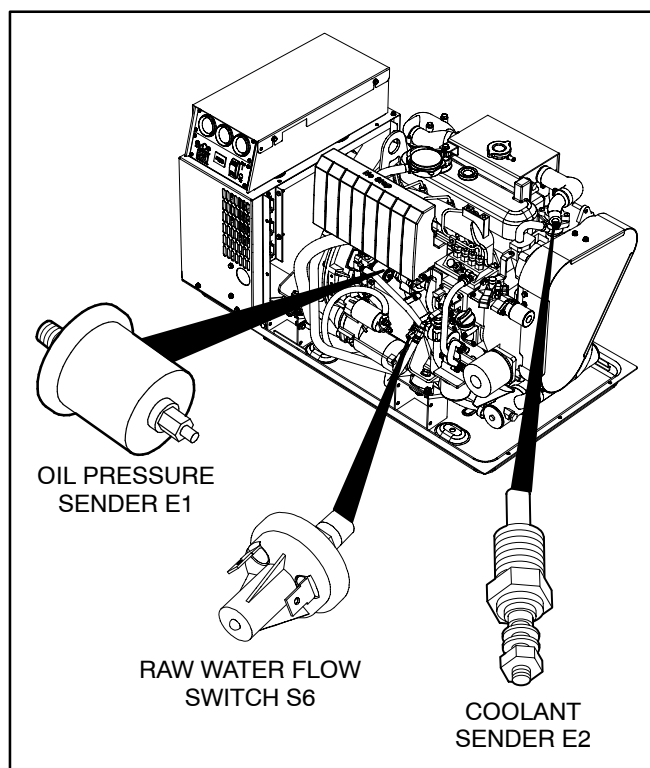


FIGURE 5-6. ENGINE SENSORS—MDK BP, MDK BR, MDK BS

⚠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.*

HIGH EXHAUST TEMPERATURE SWITCH (S5)

The high exhaust temperature switch is secured to the side of the water/exhaust mixer (Figure 5-7 or 5-8).

LOW COOLANT LEVEL SWITCH (S3)

When provided, this switch is threaded into the coolant reservoir (Figure 5-7 or 5-8). Use thread sealant when remounting the switch.

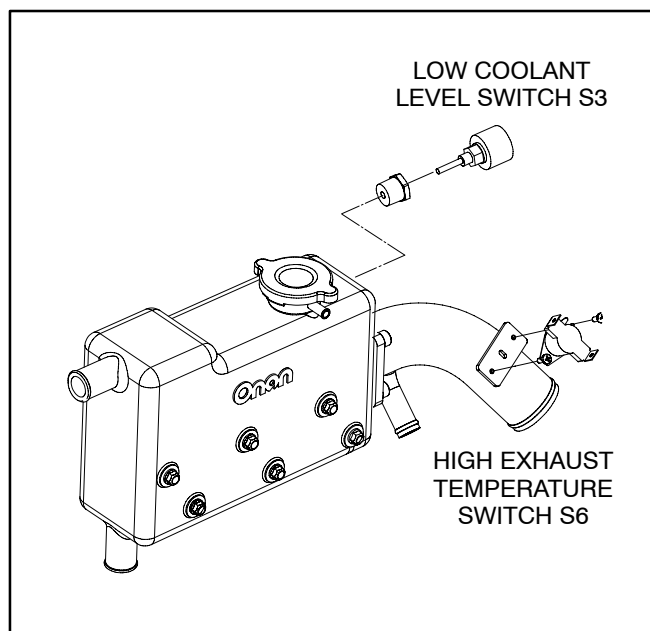


FIGURE 5-7. LOW COOLANT LEVEL & HIGH EXHAUST TEMPERATURE SWITCHES—MDKBL, MDKBK, MDKBM, MDKBN

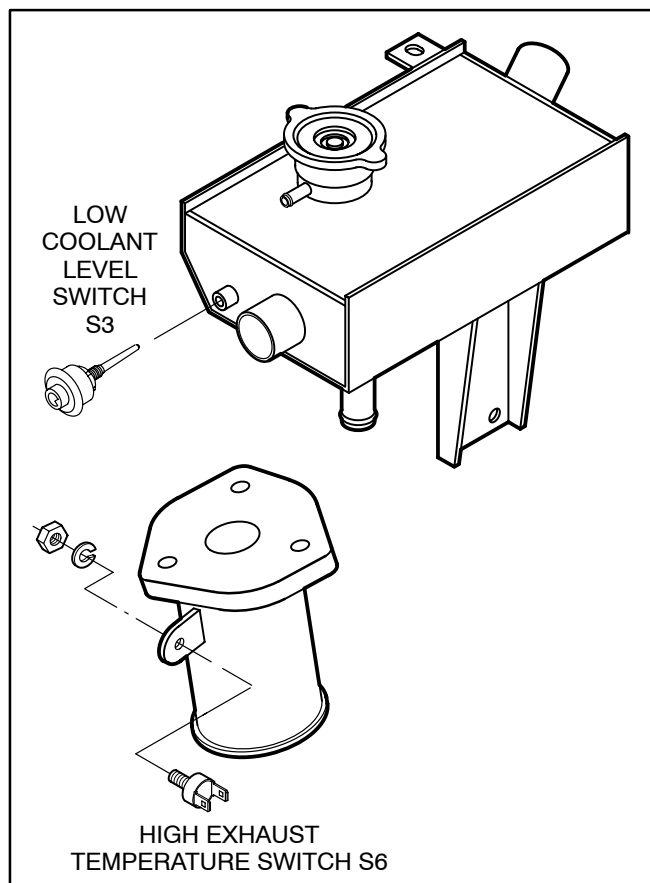


FIGURE 5-8. LOW COOLANT LEVEL & HIGH EXHAUST TEMPERATURE SWITCHES—MDKBP, MDKBR, MDKBS

⚠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.*

GOVERNOR ACTUATOR (A12)

The genset controller modulates the pulse width of the current it sends to governor actuator A12 (Figure 5-9 or 5-10), which positions the engine fuel rack accordingly.

If troubleshooting indicates that the actuator might be malfunctioning, disconnect its two leads and remove the actuator. Replace the actuator if the plunger does not move smoothly when pushed in or the internal spring does not return it smoothly. If the plunger moves smoothly without binding, apply battery voltage (12 or 24 volts, depending on the genset) and observe the plunger. Replace the actuator if the plunger does not pull in all the way and stay in while power is applied.

Reinstall the actuator with a new flange gasket. Torque the two mounting screws to 7-9 lb-ft (9.5-12.2 N-m).

GLOW PLUG RELAY (K3)

The glow plug relay is mounted on its wiring socket inside the genset control box. 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 inside the genset control box. 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.

GROUND ISOLATION RELAY (K9)

See GROUND ISOLATION RELAY K9 (Page 6-5).

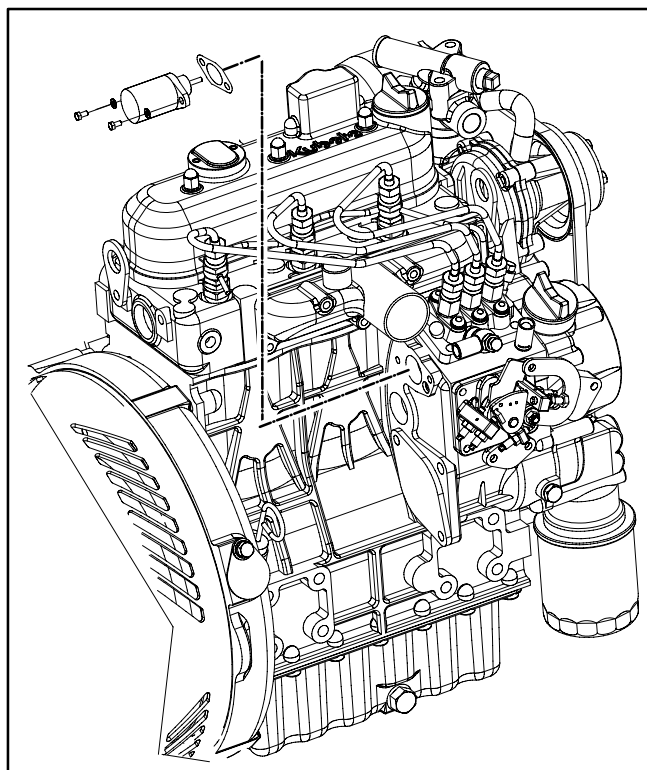


FIGURE 5-9. ACTUATOR A12—MDKBL, MDKBK, MDKBM, MDKBN

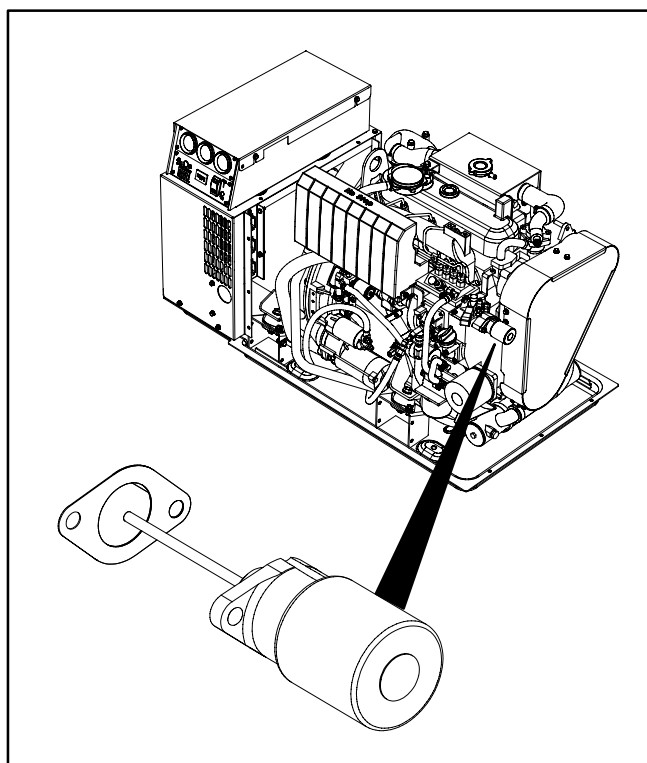


FIGURE 5-10. ACTUATOR A12—MDKBP, MDKBR, MDKBS

NETWORK INTERFACE MODULE (NIM)

The optional NIM board is mounted in the control box and is connected as shown on Page A-3. It has five jumpers to configure the board for the specific application (Figure 5-11). 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 5-1.

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

TABLE 5-1. 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.)

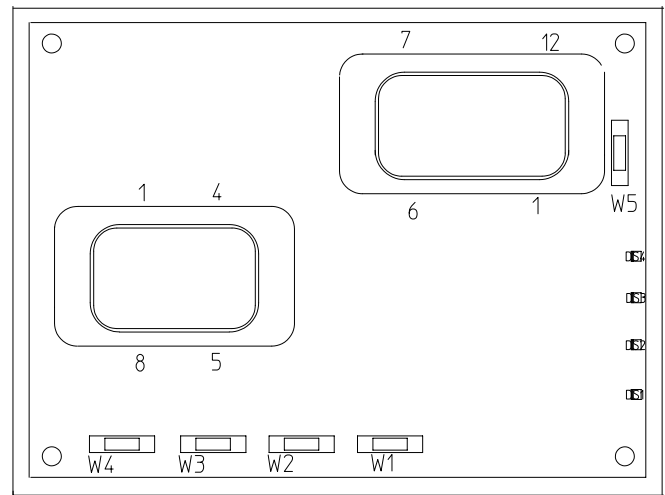


FIGURE 5-11. NIM CONFIGURATION JUMPERS

BONDING FOR ELECTROSTATIC DISCHARGE CONTROL

To prevent electrostatic discharge from interfering with genset control, genset controller, the generator,

and the surrounding panels are bonded with braided wire straps or panel screws with toothed washers (Figure 5-12). Make sure all bond straps and toothed washers are in place when reassembling components.

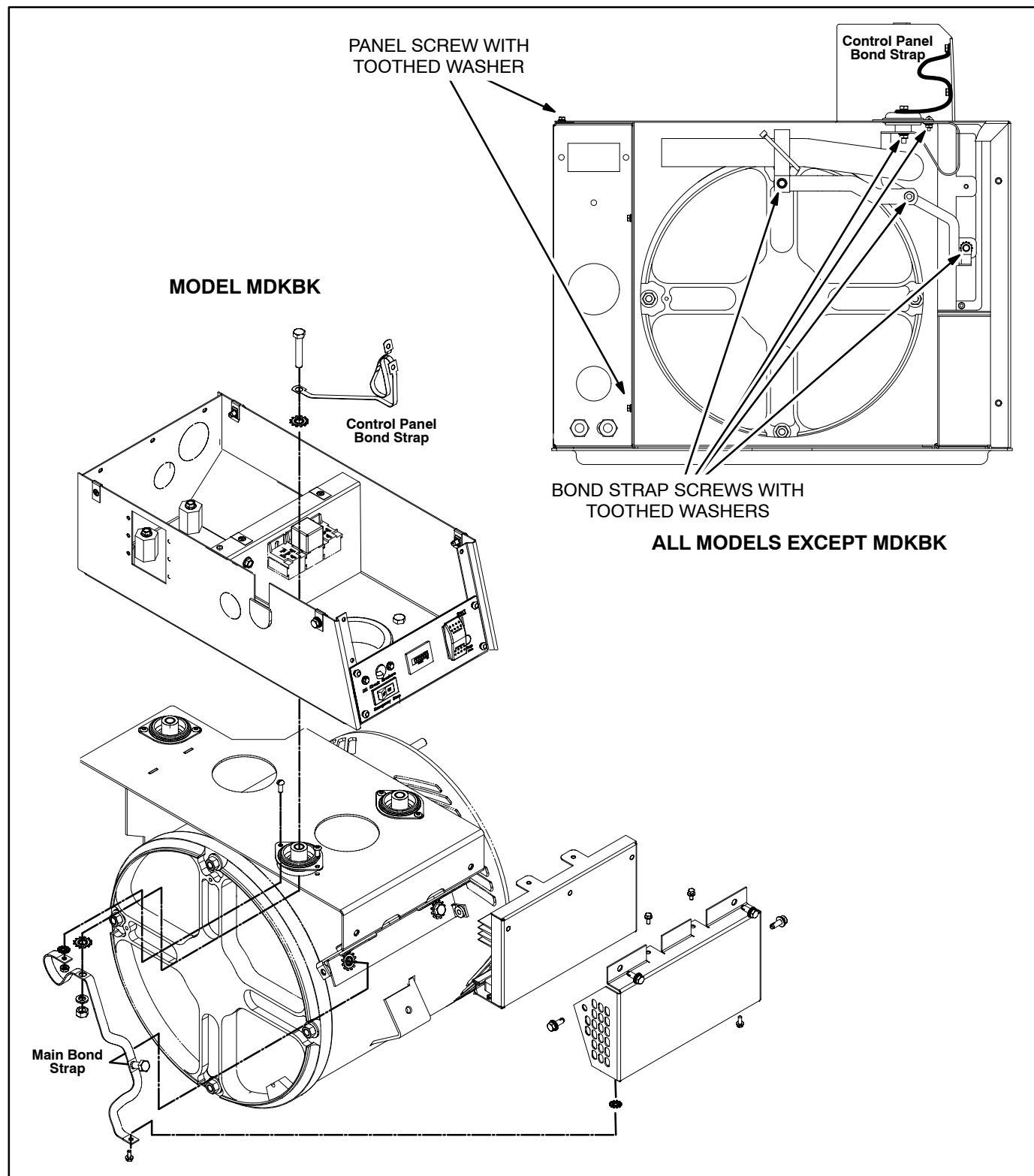


FIGURE 5-12. BONDING FOR ELECTROSTATIC DISCHARGE CONTROL

6. Engine and Accessories

MAJOR ENGINE SERVICE

See the Engine Workshop Manual (Table 6-1) for major engine service procedures. See *Specifications* (Section 10) in this manual to identify the engine model number for the genset.

TABLE 6-1. ENGINE WORKSHOP MANUAL

Genset	Manual
MDK BK, MDK BL, MDK BM, MDK BN	981-0528
MDK BP, MDK BR, MDK BS	981-0521

When remounting the engine torque the vibration isolator through bolts to 27-33 lb-ft (37-44.7 N-m).

ENGINE SENSORS

See Pages 5-6 and 5-7 for service.

GOVERNOR ACTUATOR

See Page 5-8 for service.

EXHAUST MANIFOLD

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

MDK BK, MDK BL, MDK BM, MDK BN: (Figure 6-1) Use new manifold and mixer gaskets when re-assembling. Torque the manifold nuts (2 per port) to 9.5-12.2 lb-ft (12.9-16.6 N-m) and the mixer flange bolts (4) to 15-19 lb-ft (20-25.7 N-m).

MDK BP, MDK BR, MDK BS: (Figure 6-2) Use new manifold and mixer gaskets when reassembling. Torque the manifold nuts (2 per port) and mixer or dry exhaust flange bolts (4) to 16-23 lb-ft (21-32 N-m). Torque the wet exhaust hose adapter flange bolts (3) to 6.4-9.6 lb-ft (8.7-13.0 N-m).

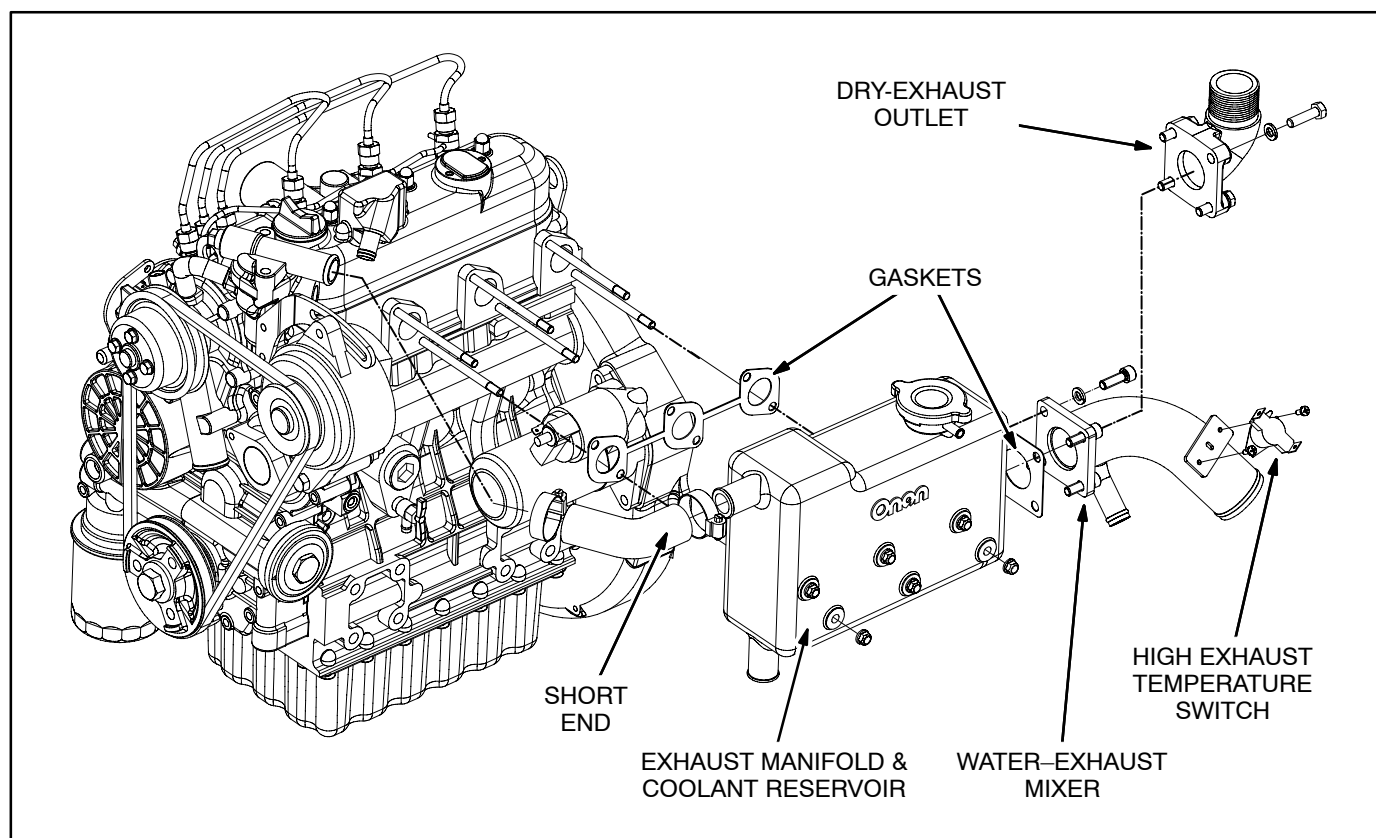


FIGURE 6-1. TYPICAL EXHAUST MANIFOLD / COOLANT RESERVOIR—MDK BK, MDK BL, MDK BM, MDK BN

DRY-EXHAUST ASSEMBLY

WET-EXHAUST ASSEMBLY

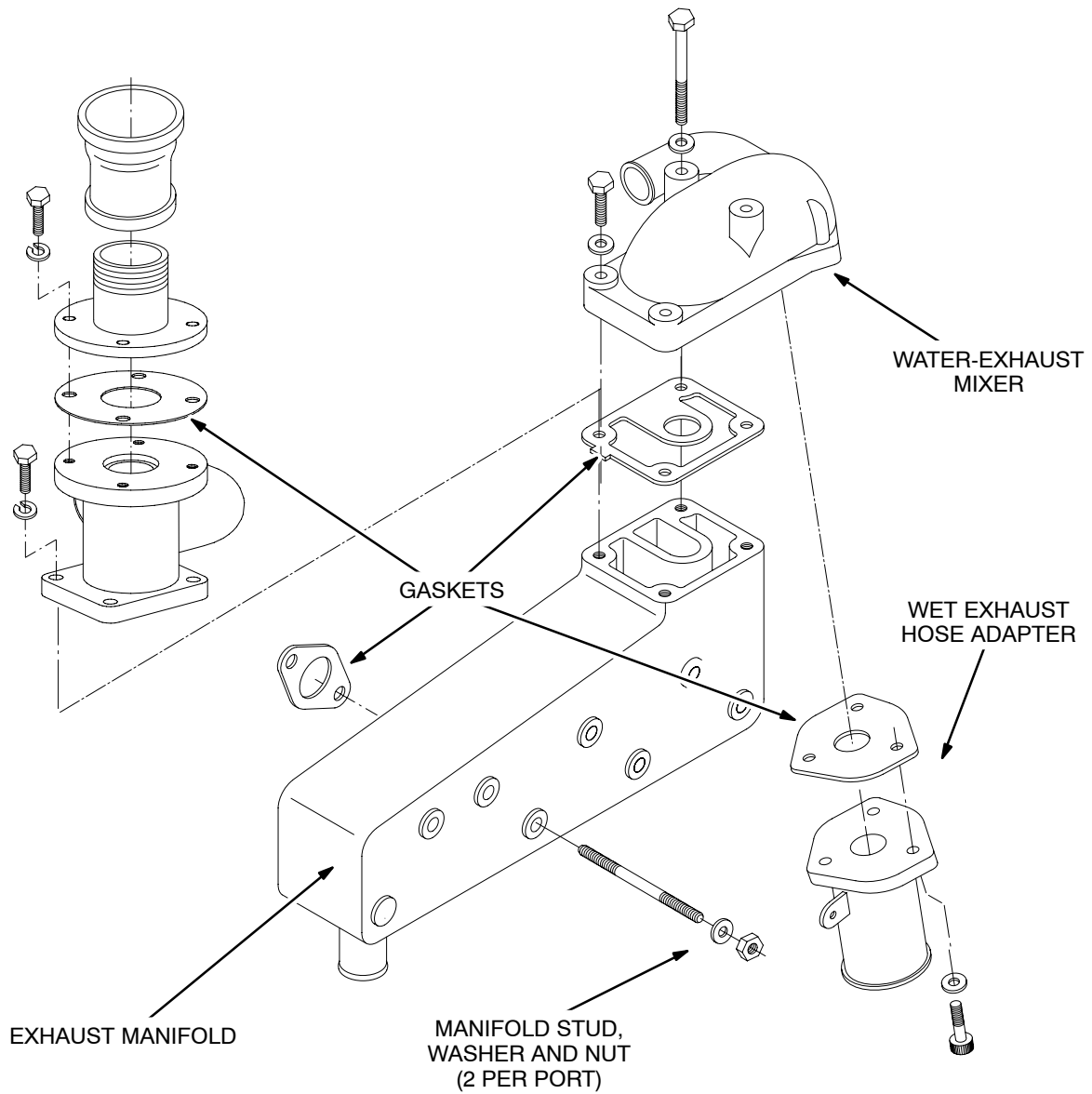


FIGURE 6-2. TYPICAL EXHAUST MANIFOLD—MDKBP, MDKBR, MDKBS

FUEL SYSTEM

⚠ 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 6-3 illustrates how the fuel system is assembled for delivering fuel to and from the fuel injection system. See the engine Workshop Manual for fuel injection system service.

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

Fuel Filter

See DRAINING / CHANGING FUEL FILTER (Page 4-5) regarding fuel filter maintenance.

Fuel Pump Test

First service all of the fuel filters in the system and repair any restrictions to fuel flow. If fuel delivery still appears to be weak, test for pump delivery as follows:

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. Replace the pump if flow is less than specified.

Fuel Fittings

The genset has bulkhead fittings on either end. 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 USCG TYPE A1 or ISO 7840-A1 fuel hose. The hoses must be long enough not to rub on the engine oil pan.

GLOW PLUGS

Refer to the Engine Workshop Manual when replacing the glow plugs (Figure 6-3).

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 preheat voltage is greater than the nominal 12 or 24 volts, such as when a battery booster is used for starting.

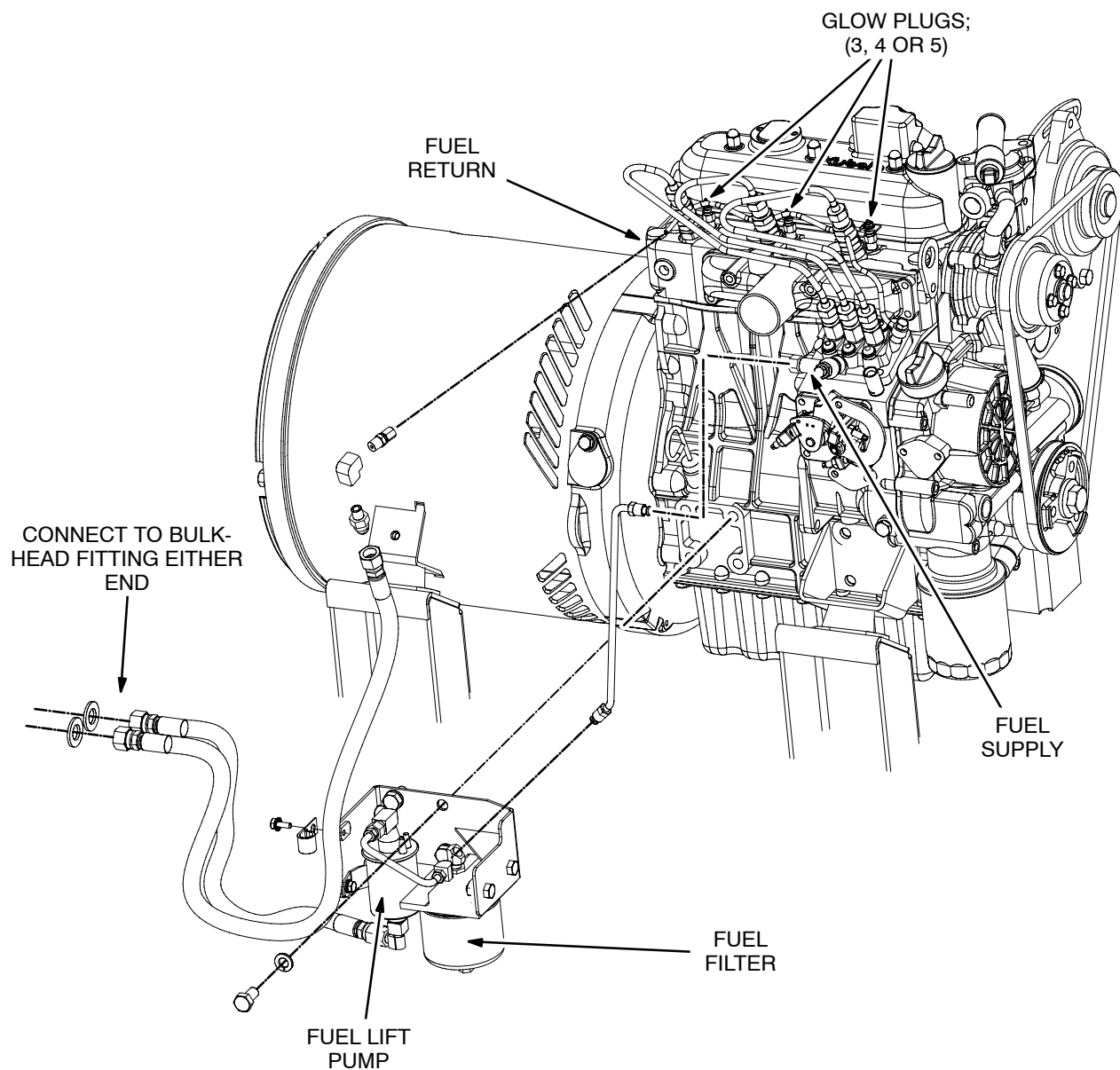


FIGURE 6-3. TYPICAL FUEL SYSTEM AND GLOW PLUGS

STARTER

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

The starter motor is bolted to the flywheel housing (Figure 6-4). See the Engine Workshop Manual (Table 6-1) for service or replacement. Parts are available for rebuilding the starter. Torque the mounting bolts to 29 lb-ft (39 N-m).

GROUND ISOLATION RELAY K9

When required, the genset is equipped with isolation relay K9 (Figure 6-4) to isolate the negative (–)

battery terminal from the vessel grounding system. Replace the relay if its contacts do not close when battery voltage is applied to the coil terminals.

BATTERY CHARGING ALTERNATOR

See Page 4-11 to adjust or replace the alternator V-Belt (Figure 6-4). See the Engine Workshop Manual (Table 6-1) for service or replacement.

RAW WATER PUMP

See Page 4-10 to replace the impeller. Kits are available for servicing the raw water pump. Follow the instructions in the kit.

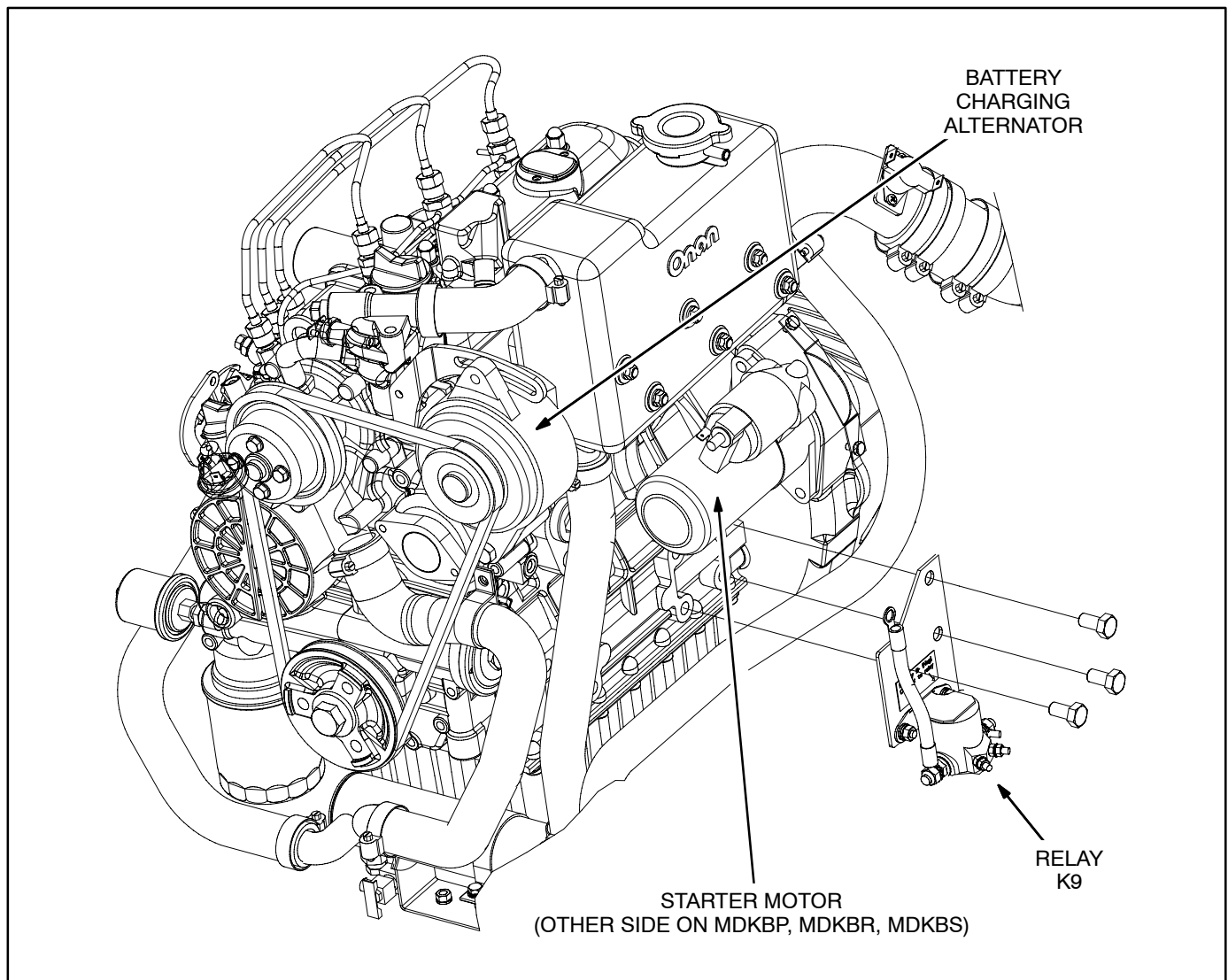


FIGURE 6-4. TYPICAL BATTERY CHARGING ALTERNATOR, STARTER MOTOR AND B– ISOLATING RELAY

7. Generator

OVERVIEW

These are 4-pole, rotating-field, brushless, single-bearing generators (Figure 7-1). Operation is as follows:

1. The engine rotates the generator field (main rotor) to induce output current (AC) in the main stator windings.
2. Generator output is proportional to the main rotor (field) current supplied by the exciter rotor through its full-wave rectifier bridge (rotating rectifiers).
3. The genset controller (p. 5-1) rectifies and modulates quadrature winding output (**Q1**, **Q2**) to supply the exciter stator (**F1**, **F2**). By comparing generator output voltage with a reference value, controller A1 regulates field current to maintain nominal output voltage under varying loads. Also, in response to transient loads, it lowers the voltage setpoint to allow for engine recovery.
4. Residual field magnetism and a permanent magnet in one of the exciter stator poles initiates "self-excitation" during startups.

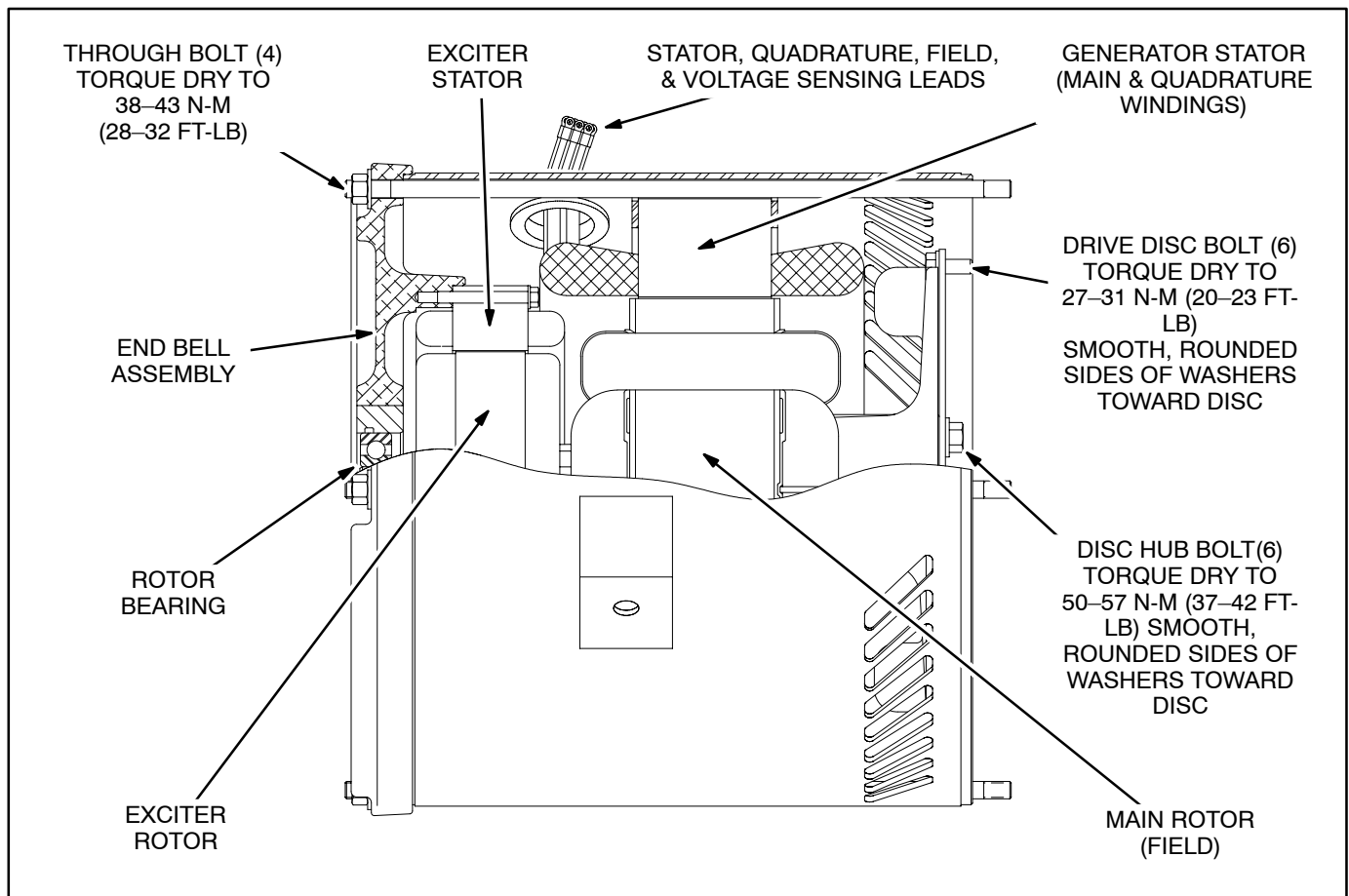


FIGURE 7-1. GENERATOR

TESTING

Testing Winding Insulation Resistance

A 500 VAC megger is recommended for the winding insulation resistance tests prescribed below. A test consists of applying the test potential between the winding and ground (winding laminations) for a period of 10 minutes and recording resistance at 1 minute and again at 10 minutes.

Resistance values of at least 5 megohms should be obtained for a new generator with dry windings. The polarization index should also be at least 2 (the ratio of the resistance reading at ten minutes to the reading at one minute). For a set that has been in service, the resistance reading should not be less than 1 megohm nor the polarization index less than 2.

Dry the windings if low readings are obtained or the set has been in standby for a long time in high humidity conditions and repeat the test.

Testing Winding Resistance

Use a digital ohmmeter or Wheatstone bridge to measure winding resistance. The device should have a precision of at least 0.01 ohm.

Exciter Stator

Winding Insulation Resistance: Disconnect gen-set controller connector **P3**. Connect pin **P3-7** or **P3-8** to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

Winding Resistance: Measure winding resistance between pins **P3-7** and **P3-8**. Replace the exciter stator if the resistance is not as specified in Table 7-1.

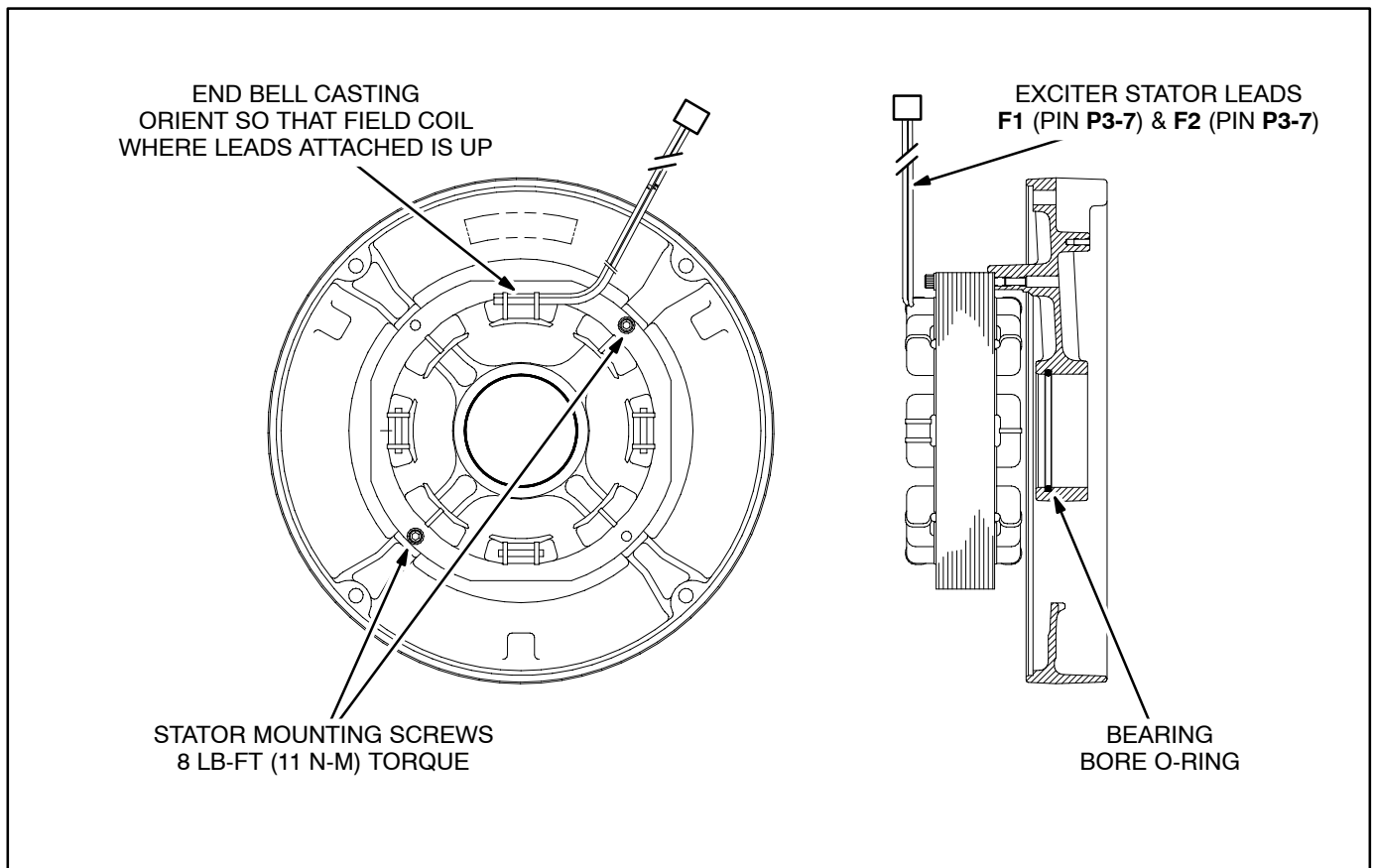


FIGURE 7-2. EXCITER STATOR AND END BELL

Exciter Rotor

Winding Insulation Resistance: Disconnect all six exciter rotor leads from diode terminals **CR1** through **CR6** and isolate them from ground. Connect any lead to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

Winding Resistance: Measure electrical resistance across each pair of rotor windings: **T11-T12**, **T21-T22**, **T12-T13**, **T22-T23**, **T13-T11** and **T23-T21**. See the connection schematic. Replace the exciter rotor if the resistance of any winding is not as specified in Table 7-1.

Rotating Rectifiers

The rotating rectifier assembly is mounted on the back face of the exciter rotor. It consists of one positive (+) and one negative (–) diode assembly. Each assembly carries three diodes in an epoxy potting. Each diode has a terminal for connecting the ap-

propriate lead from the exciter rotor (**CR1-CR6**). Each assembly has a field terminal (**F1+** or **F2–**) for connecting the leads from the main rotor (generator field).

Diode Resistance: Measure electrical resistance between diode terminals **CR1**, **CR2** and **CR3** and field terminal **F1+** on the positive diode assembly and between diode terminals **CR4**, **CR5** and **CR6** and field terminal **F2–** on the negative diode assembly. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the whole diode assembly.

Replacing Diode Assembly: Make sure the replacement diode assembly is of the correct polarity, positive (+) or negative (–). Then disconnect all leads from the defective diode assembly and remove the two mounting screws. Mount the new diode assembly, reconnect all leads and torque the terminal screws to 24 lb-in (2.6 N-m).

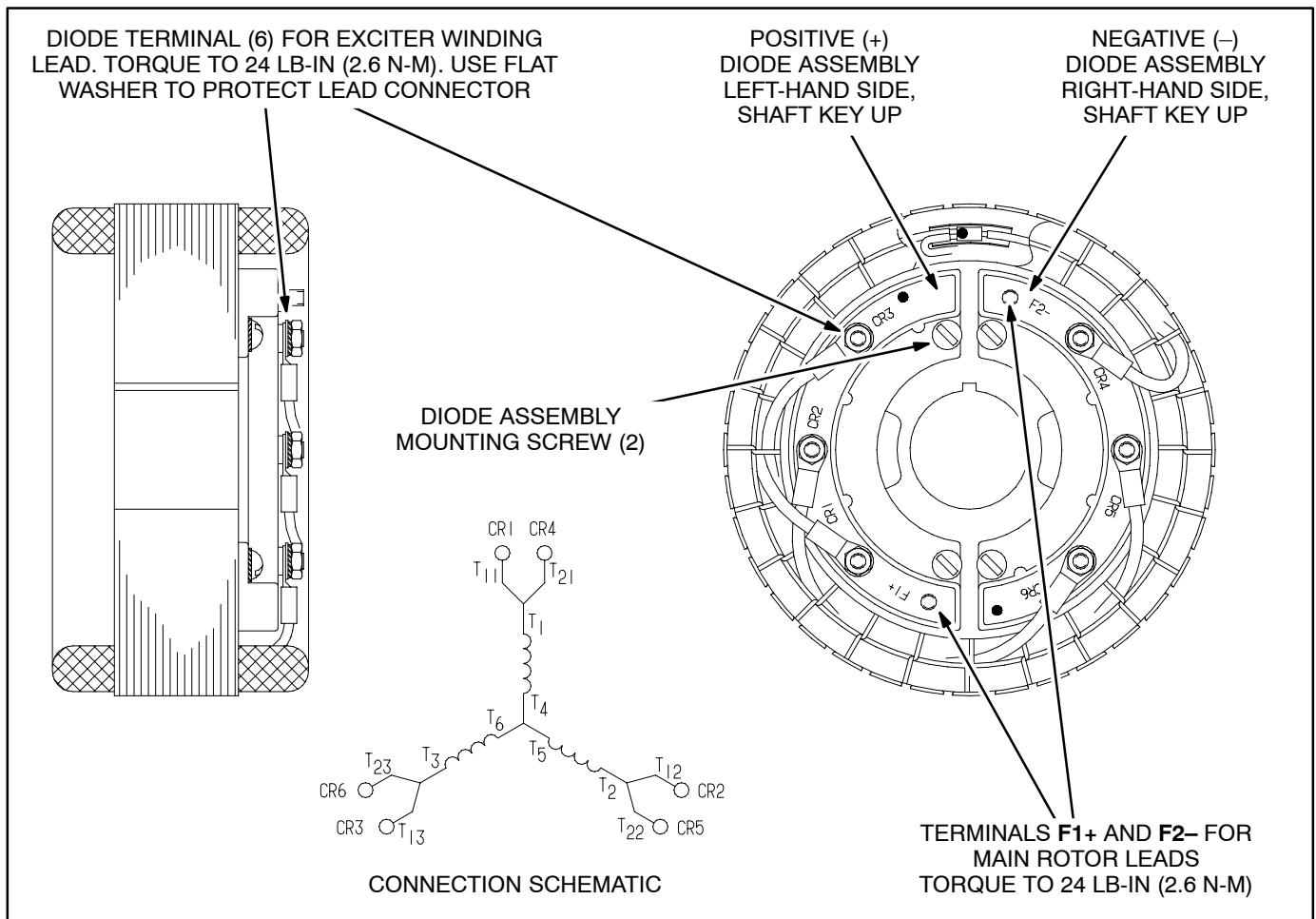


FIGURE 7-3. ROTATING RECTIFIER ASSEMBLY

Main Rotor

Winding Insulation Resistance: Disconnect the main rotor leads from terminals **F1+** and **F2+** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2+**).

⚠ CAUTION *Because of the opposing residual magnetism of the rotor, it might be difficult to re-establish self excitation if the polarity of the main rotor leads is reversed upon reassembly.*

Connect either or both leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

Winding Resistance: Disconnect the main rotor leads from terminals **F1+** and **F2+** on the rotating rectifier assemblies and measure electrical resistance between them. Replace the rotor if the resistance is not as specified in Table 7-1.

Reconnect the rotor leads and torque the terminals to 24 lb-in (2.7 N-m) when reassembling.

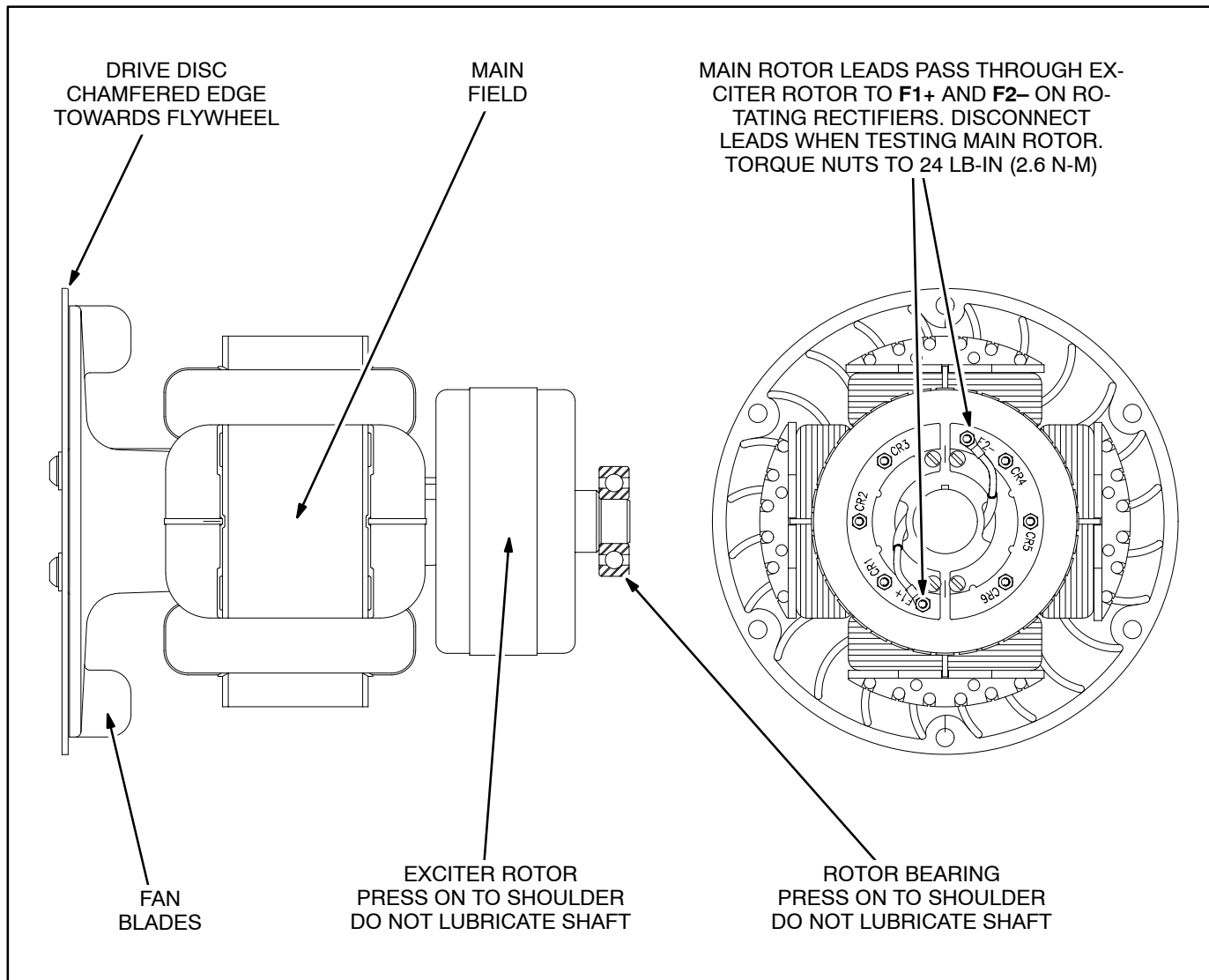


FIGURE 7-4. ROTOR ASSEMBLY

Main Stator

Quadrature Winding Insulation Resistance: Disconnect genset controller connector **P3**. Connect pin **P3-4** or **P3-5** to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

Quadrature Winding Resistance: Measure winding resistance between pins **P3-4** and **P3-5** with a Wheatstone bridge. Replace the stator assembly if the resistance is not as specified in Table 7-1.

Main Winding Insulation Resistance: Test each winding separately. Disconnect the winding lead from its grounded neutral connection and isolate it. Leave the other windings grounded. Connect either

or both winding leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

Main Winding Resistance: Disconnect all main stator leads from the terminals to which they are connected.

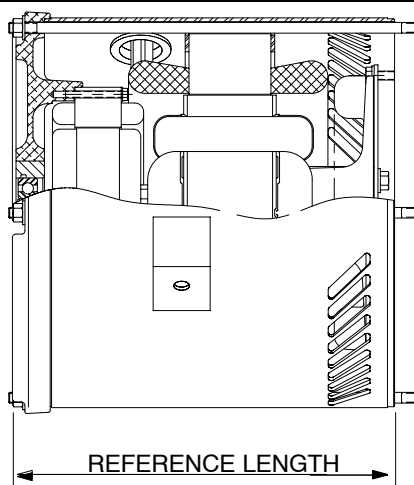
For **4-Lead generators** measure resistance across lead pairs: **T1-T2, T3-T4**.

For **12-Lead generators** measure resistance across lead pairs: **T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, T9-T12**.

Replace the stator assembly if the resistance of any winding is not as specified in Table 7-1.

TABLE 7-1. GENERATOR STATOR AND ROTOR WINDING RESISTANCES

REFERENCE LENGTH MILLIMETERS (INCHES) ¹	MAIN WINDING RESISTANCE OHMS ^{2, 3}	QUADRATURE WINDING RESISTANCE OHMS ²	MAIN ROTOR WINDING RE- SISTANCE OHMS ²	EXCITER ROTOR WINDING RE- SISTANCE OHMS ²	EXCITER STATOR WINDING RE- SISTANCE OHMS ²
4-Lead Generators (Single-Phase)					
341 (13.4)	0.179–0.197	1.716–1.864	2.54–3.10	0.58–0.71	13–16
378 (14.9)	0.097–0.108	1.010–1.110	2.17–2.65	0.58–0.71	13–16
376 (14.8)	0.078–0.086	0.807–0.897	2.12–2.59	0.58–0.71	13–16
412 (16.2)	TBD	0.658–0.728	1.89–2.32	0.58–0.71	13–16
485 (19.1)	TBD	0.506–0.560	2.20–2.68	0.58–0.71	13–16
12-Lead Generators (Three-Phase)					
341 (13.4)	0.36–0.44	2.961–3.219	2.54–3.10	0.58–0.71	13–16
378 (14.9)	0.15–0.19	2.356–2.593	2.17–2.65	0.58–0.71	13–16
412 (16.2)	0.105–0.117	1.852–2.047	1.89–2.32	0.58–0.71	13–16
485 (19.1)	0.056–0.062	1.605–1.774	2.20–2.68	0.58–0.71	13–16



1. Measure this length to identify the generator.
2. If high, recheck winding resistance after the windings have cooled to room temperature.
3. The main windings are probably good if some of the resistances fall outside the range but are all within 10 percent of each other.

DISASSEMBLY

The generator is heavy. You will need an assistant and hoist of sufficient capacity.

⚠WARNING *Accidentally dropping the generator can damage it and cause severe personal injury or death. Use a hoist and straps of sufficient capacity and attach them so that the load cannot shift.*

Disconnect the negative (–) cable(s) at the battery(ies) to prevent the genset from starting.

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

1. Disconnect all power output and remote control connections and conduit at the generator. For easier reconnections later, make sure each lead is clearly marked.
2. Disconnect all engine harness connections and grounding straps in the control box, all generator leads from connections in the output box, and Connectors P1, P2 and P3 from the genset controller. Disassemble the pins for generator leads Q1, Q2, F1, F2, S1, S2 from

connector P3. Remove the control box, output box and saddle as an assembly.

3. Hook the genset lifting eye with a hoist, remove the throughbolts in the two generator mounts, tip the generator end up slightly with the hoist and block the flywheel housing to support the engine while the generator is being serviced.
4. Cinch a strap around the middle of the generator stator and take up slack with the hoist.
5. Scribe lines before separating the end bell from the stator and the stator from the flywheel housing to register the parts for reassembly.
6. Remove the four nuts on the throughbolts and tap the end bell free of the stator.
7. Tap the stator free of the flywheel housing, carefully draw the stator straight back until it clears the ends of the throughbolts and remove the throughbolts.
8. Cinch a strap around the rotor and remove the six disc-to-flywheel bolts (Figure 7-1). When removed, cradle the rotor horizontally in wooden blocks to prevent damage to windings, laminations and drive disc.
9. Use a gear puller to remove the rotor bearing or exciter rotor (Figure 7-1).

REASSEMBLY

Reassembly is the reverse of disassembly. Note the following when reassembling the generator:

1. Press a new exciter rotor or rotor shaft bearing on up to its locating shoulder on the shaft. Do not lubricate the shaft (Figure 7-1).
2. Torque the six disc-to-hub bolts (Figure 7-1) to 50–57 N-m (37–42 lb-ft). Make sure that:
 - A. The chamfered edge on the drive disc perimeter faces out to make assembly with the flywheel easier.
 - B. The rounded edges of the washers are on the disc side.
3. Torque the six disc-to-flywheel bolts (Figure 7-1) to 27–31 N-m (20–23 lb-ft). Make sure the rounded edges of the washers are on the disc side.
4. Use the four throughbolts to help guide the stator on. Thread the ends with less thread into the flywheel housing and make sure the threads bottom.
5. Make sure the scribed stator-flywheel index lines (Step 5, Disassembly) register.
6. Torque the two exciter stator screws (Figure 7-1) to 11 N-m (8 lb-ft). The pole to which the leads are tied must be up.
7. Wipe the bearing bore in the end bell lightly with molybdenum disulfide grease and make sure the rubber O-ring (Figure 7-1) is in place.
8. Assemble the end bell to the stator, making sure the scribed index lines (Step 5, Disassembly) register and the rotor bearing seats fully in the bore. Pull the field leads out the same open-

ing as the stator leads. Torque the nuts on the generator throughbolts to 38–43 N-m (28–32 lb-ft).

9. Secure the end bell cover plate and torque the four screws to 3.8 N-m (8 lb-in).
10. Reassemble all the remaining components. Make sure to resecure the ring terminals of grounding straps and leads with two star washers, one on each side, for good electrical continuity. Torque the vibration isolator through bolts to 27–33 lb-ft (37–44.7 N-m).

RECONNECTING THE GENERATOR

Reconnect the generator properly for the application. See Page A-2.

LINE CIRCUIT BREAKERS

⚠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 line circuit breakers are mounted in the AC output box. Disconnect all leads and check electrical continuity across each pole. Replace a circuit breaker if either pole does not reset or turn ON and OFF. Reconnect the generator and load wires properly (Page A-2).

TO CHANGE FREQUENCY

See CHANGING FREQUENCY (Page 8-1).

TO ADJUST VOLTAGE

See ADJUSTING VOLTAGE (Page 8-2).

8. Reconfiguring Voltage and Frequency

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 8-1). If it is necessary to reconfigure voltage and/or frequency for the application, follow the instructions in this section.

RECONNECTION LABEL

The genset manuals were shipped with a sheet with peel-off reconnection labels (Figure 8-2) to apply over the “As Manufactured” block on the genset nameplate (Figure 8-1) 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 jumper leads marked **HZ SEL** and **60 HZ**.

- 1. Connect for **60 HZ**; disconnect for **50 HZ**.
- 2. Apply the appropriate reconfiguration label.


RECONNECTING GENERATOR

If necessary:

- 1. Reconnect the generator for the application voltage in accordance with the appropriate generator connection schematic on Page A-2.
- 2. Apply the appropriate reconfiguration label.
- 3. Adjust voltage, if necessary. See **ADJUSTING VOLTAGE** (p. 8-2).

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:

KVA

Pf

KW

PH

RPM

50 Hz:

60 Hz:

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 8-1. “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: **13.5/17 MDKBP**

THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 115/230V	Amps: 117.4/58.7
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 60HZ	AC Volts: 120/240V	Amps: 141.7/70.8
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 120/240V	Amps: 112.5/56.3

FOR GENERATOR SET MODEL: **17.5/21.5 MDKBR**

THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 115/230V	Amps: 152.2/76.1
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 60HZ	AC Volts: 120/240V	Amps: 179/89.6
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 120/240V	Amps: 145.8/72.9

FOR GENERATOR SET MODEL: **22.5/27.5 MDKBS**

THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 115/230V	Amps: 195.7/97.8
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 60HZ	AC Volts: 120/240V	Amps: 229.2/114.6
THIS SET HAS BEEN RECONFIGURED TO:		
Freq: 50HZ	AC Volts: 120/240V	Amps: 187.5/93.8

FIGURE 8-2. TYPICAL RECONNECTION LABELS

8-1

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 8-3. 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.
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 8-3).
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 2-7.

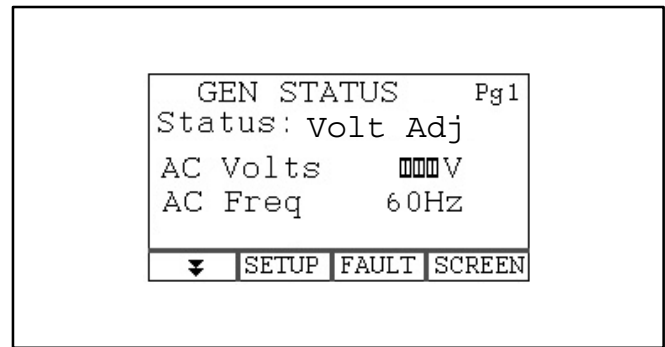


FIGURE 8-3. VOLTAGE ADJUSTMENT SCREEN

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 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 *amber* lamp to stop blinking and then press **STOP** to stop the genset and save the adjustment.
6. Restart the genset and check voltage.

9. Troubleshooting

Use TABLE 9-1. TROUBLESHOOTING GENSET FAULTS in conjunction with the *e*-Series Digital Display or blinking control switch status lamp to troubleshoot the genset. 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 pickup 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 until it is cleared. Touch any button to clear the fault. The display will turn off in 5 minutes after the fault has been cleared.

Last Five Faults: See Page 2-6 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, **Low Voltage Code No. 13** appears as: **blink—pause—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 9-1. 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

(Faulty switch, poor or missing connections, dead battery)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

1. Push the Emergency Stop and/or DC Circuit 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. 5-1) 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 the DC Circuit Breaker (CB2) and replace if necessary (p. 5-5). If there still is no voltage, check for and repair faulty wiring and connectors between: P2-1 and CB2-LOAD; CB2-LINE and CB1-LOAD; CB1-LINE and B1-BAT; and P2-6 and GND-ENG.
7. Test for and replace a faulty Display or control switch (p. 5-5) and repair faulty wiring and connectors. See Page A-3.

THE STARTER ENGAGES AND DISENGAGES

(Low cranking voltage)

Corrective Action:

1. De-energize the PTO clutch, if so equipped.
2. Service as necessary by cleaning and tightening battery connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
3. Service the starter (p. 6-5). See Table 6-1 for the appropriate engine workshop manual.

THE STARTING BATTERIES DO NOT MAINTAIN A CHARGE

(Marginal battery, battery connections or charging system)

Corrective Action:

1. Service as necessary by cleaning and tightening battery connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
2. Check the V-belt that drives the charging alternator and service as necessary (p. 4-11).
3. Check for and disconnect parasitic battery loads.
4. Service the battery charging alternator (p. 6-5). See Table 6-1 for the appropriate engine workshop manual.

TABLE 9-1. 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.

NO AC POWER WHEN GENSET IS RUNNING

(A Circuit Breaker is OFF, tripped or malfunctioning or the generator is not connected properly)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

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

HIGH ENGINE TEMPERATURE—CODE NO. 1

(Engine coolant temperature exceed design limit)

Corrective Action:

1. Check for and clean a blocked sea water strainer. If above the water line, fill the strainer with water to assist priming.
2. Check engine coolant level and add coolant as necessary.
3. Check for kinked or leaking hoses and reconnect, reroute or replace.
4. Check the V-belt that drives the coolant pump and service as necessary (p. 4-11).
5. Inspect the siphon break for proper operation (p. 4-7).
6. Check for a worn raw water impeller and replace as necessary (p. 4-10).
7. Clean the heat exchanger (p. 4-7).
8. Check the bottom of the hull for any blockage at the through-hull fitting.
9. Replace the coolant thermostat, which might not be opening fully (p. 4-12).
10. Drain and clean the coolant system to remove coolant passage fouling (Page 4-6).
11. Test coolant sender **E2** and replace if necessary (p. 5-6).
12. Disconnect connector **P1** (black) from the genset controller (Page 5-1) 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.
13. Replace the genset controller (Page 5-1).

LOW OIL PRESSURE—CODE NO. 2

(Low oil pressure)

Corrective Action: *Refer to Pages A-1 through A-5, 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** (Page 5-6).
3. Check electrical resistance through sender **E1**. Replace the sender if resistance is not between 227 and 257 ohms (0 psi) when the engine is stopped.
4. Disconnect connector **P1** (black) from the genset controller (Page 5-1) 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. Service the engine lubricating system. See Table 6-1 for the appropriate engine workshop manual.
6. Replace the genset controller (Page 5-1).

TABLE 9-1. 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

(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

(Cranking time exceeded 20 to 60 seconds, depending on engine temperature)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

1. De-energize the PTO clutch, if so equipped.
2. Check fuel level and refill as necessary. (Note: The genset fuel pickups are probably higher than the propulsion engine fuel pickups.)
3. Open any closed fuel supply and return valves.
4. Prime the engine fuel system for at least 30 seconds (p. 3-3).
5. Service as necessary by cleaning and tightening battery connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
6. Replace fuel filters (p. 4-5).
7. Check all fuel fittings for fuel and air leaks and tighten as necessary.
8. Change the engine oil to oil of the proper viscosity for the ambient temperature. High oil viscosity can slow down cranking speed.
9. Conduct a fuel pump test and replace if necessary (p. 6-3).
10. Inspect and service the glow plugs as follows (Page 6-3):
 - A. If loose, tighten the glow plug terminals.
 - B. Check for **B+** at the glow plug terminals during cranking. If there is no **B+**, remove glow plug relay K3 from its socket in the control box, test for proper operation (Page 5-8) 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.
 - C. Check for **B+** at relay socket terminal 85 while cranking. If there is no **B+**, disconnect connector P1 (black) from the genset controller (Page 5-1) and check for a missing, bent or corroded pin (P1-1) and faulty wire and repair as necessary. If the wire and connections are good, replace the genset controller.
 - D. Remove the glow plug bus bar and check for electrical continuity between each glow plug terminal and **B–** (ground). Replace any open glow plug (Page 6-3).
11. Service the fuel injectors. See Table 6-1 for the appropriate engine workshop manual.
12. Service a worn engine. See Table 6-1 for the appropriate engine workshop manual.

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

(Dangerous levels of Carbon Monoxide in Vessel)

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

TABLE 9-1. 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

(Low raw water pressure in heat exchanger)

Corrective Action:

1. Open the sea cock.
2. Check for a blocked sea water strainer and clean it out. If above the water line, fill the strainer with water to assist priming.
3. Check for kinked or leaking hoses and reconnect, reroute or replace.
4. Check for a worn raw water impeller and replace as necessary (p. 4-10).
5. Check the bottom of the hull for any blockage at the through-hull fitting.

HIGH AC VOLTAGE—CODE NO. 12

(After voltage regulation was enabled Output Voltage jumped to more than 125% of rated for 75 milliseconds or to more than 115% of rated for 3 seconds)

Corrective Action:

1. Push the genset line circuit breaker OFF, start the genset and measure output voltage. If output voltage is normal, the problem is in the circuits external to the genset. If there is no voltage, test for grounded or shorted main, field or quadrature windings and service as necessary (p.7-2).
2. Replace the genset controller (p. 5-1).

LOW AC VOLTAGE—CODE NO. 13

(After voltage regulation was enabled Output Voltage fell to less than 90% of rated for 5 seconds)

Corrective Action:

1. Push the genset line circuit breaker OFF and de-energize the PTO clutch, if so equipped. If the genset now runs and voltage and frequency are normal, reduce the number of electrical and mechanical (PTO) loads. If there is no voltage, test for grounded or shorted main, field or quadrature windings and service as necessary (p. 7-2).
2. Replace the genset controller (p. 5-1).

HIGH AC FREQUENCY—CODE NO. 14

(After the starter was engaged Frequency jumped to more than 70 Hz for 40 milliseconds or to more than 2% over nominal for 6 seconds)

Corrective Action:

1. Check for a tripped genset circuit breaker, reset if necessary, and run with fewer loads. (A breaker tripping under load can cause genset frequency to overshoot.)
2. Check all fuel fittings for fuel and air leaks and tighten as necessary. (Air bubbles can disrupt frequency.)
3. Check for proper operation of the governor actuator and replace if necessary (Page 5-8).
4. Check for proper operation of the internal governor mechanism. See Table 6-1 for the appropriate engine workshop manual.
5. Replace the genset controller (p. 5-1).

TABLE 9-1. 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

(During normal operation Frequency fell to less than 90% of nominal for more than 8 seconds)

Corrective Action:

1. Push the genset line circuit breaker OFF and de-energize the PTO clutch, if so equipped. If the genset now runs, reduce the number of electrical and mechanical (PTO) 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. Prime the engine fuel system for at least 30 seconds (p. 3-3).
4. Check all fuel fittings for fuel and air leaks and tighten as necessary. (Air bubbles can disrupt frequency.)
5. Replace fuel filters (p. 4-5).
6. Remove combustion air or exhaust system blockages.
7. Conduct a fuel pump test and replace if necessary (p. 6-3).
8. Check for proper operation of the governor actuator and replace if necessary (Page 5-8).
9. Service the fuel injectors. See Table 6-1 for the appropriate engine workshop manual.
10. Check for proper operation of the internal governor mechanism. See Table 6-1 for the appropriate engine workshop manual.
11. Service a worn engine. See Table 6-1 for the appropriate engine workshop manual.
12. Replace the genset controller (p. 5-1).

GOVERNOR OVERLOAD—CODE NO. 22

(Maximum allowable time at full-duty cycle was exceeded)

Corrective Action:

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. Check all fuel fittings for fuel and air leaks and tighten as necessary.
4. Replace fuel filters (p. 4-5).
5. Remove combustion air or exhaust system blockages.
6. Conduct a fuel pump test and replace if necessary (p. 6-3).
7. Check for proper operation of the governor actuator and replace if necessary (Page 5-8).
8. Service the fuel injectors. See Table 6-1 for the appropriate engine workshop manual.
9. Check fuel injection timing. See Table 6-1 for the appropriate engine workshop manual.
10. Check for proper operation of the internal governor mechanism. See Table 6-1 for the appropriate engine workshop manual.
11. Service a worn engine. See Table 6-1 for the appropriate engine workshop manual.
12. Replace the genset controller (p. 5-1).

TABLE 9-1. 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 OIL PRESSURE SENDER—CODE NO. 23

(Controller sensed grounded sender)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

1. If loose, tighten the ring terminal on oil pressure sender **E1** (Page 5-6). (This fault will occur if a loose ring terminal touches grounded metal.)
 - A. Repair wiring as necessary to eliminate the ground path.
 - B. Check electrical resistance through sender **E1**. Replace the sender if resistance is not between 227 and 257 ohms (0 psi) when the engine is stopped.
2. Replace the genset controller (p. 5-1).

FAULTY TEMPERATURE SENDER—CODE NO. 24

(Controller sensed open sender)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

1. If loose, tighten the ring terminal on sender **E2** (Page 5-6). 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 5-1) 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 5-6).
4. Replace the genset controller (p. 5-1).

LOSS OF AC VOLTAGE SENSE—CODE NO. 27

(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-5, as appropriate.*

1. Disconnect connector **P3** (green) from the genset controller (Page 5-1) 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. Test and service the generator as necessary (Page 7-2).
3. Replace the genset controller (p. 5-1).

HIGH BATTERY VOLTAGE—CODE NO. 29

(During startup the genset Controller sensed that battery system voltage was greater than 19.2 volts if 12 VDC system or 32.2 volts if 24 volt system)

Corrective Action:

1. Check battery bank connections and reconnect if necessary for 12 volts or 24 volts, depending on genset model.
2. Select a lower battery booster charge rate (external charging system).

TABLE 9-1. 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.

STARTING FAULT—CODE NO. 32

(The genset Controller could not detect cranking speed [quadrature zero crossings] for 3 seconds)

Corrective Action: *Refer to Pages A-1 through A-5, as appropriate.*

1. De-energize the PTO clutch, if so equipped.
2. Have the propulsion engines running while trying to start the genset. Their charging alternators may be able to maintain a high enough battery terminal voltage to start the genset.
3. Service as necessary by cleaning and tightening battery connections, recharging or replacing the battery or replacing damaged battery cables (p. 4-2).
4. Change the engine oil to oil of the proper viscosity for the ambient temperature. High oil viscosity can slow down cranking speed.
5. Check for proper operation of starter relay **K4** and replace if necessary (p. 5-8).
6. Disconnect connector **P3** (green) from the genset controller (Page 5-1) and measure resistance between **Pin 10** and **K4-86** and between **K4-85** and **CB2-2**. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.
7. Service the starter motor (p. 6-5). See Table 6-1 for the appropriate engine workshop manual.
8. Service the engine if the crankshaft is unusually hard to rotate manually. See Table 6-1 for the appropriate engine workshop manual.
9. Replace the genset controller (p. 5-1).

CONTROL CARD FAILURE—EE—CODE NO. 35

(During startup the genset Controller detected a EE memory error)

Corrective Action: Replace the genset controller (p. 5-1).

TABLE 9-1. 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

(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: *Refer to Pages A-1 through A-5, as appropriate.*

1. Check for mechanical damage and service as necessary.
2. De-energize the PTO clutch, if so equipped.
3. Check fuel level and refill as necessary. (Note: The genset fuel pickups are probably higher than the propulsion engine fuel pickups.)
4. Prime the engine fuel system for at least 30 seconds (p. 3-3).
5. Check all fuel fittings for fuel and air leaks and tighten as necessary.
6. Replace fuel filters (p. 4-5).
7. Remove combustion air or exhaust system blockages.
8. Conduct a fuel pump test and replace if necessary (p. 6-3).
9. Disconnect connector **P1** (black) from the genset controller (Page 5-1) 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.
10. Check for proper operation of the governor actuator and replace if necessary (Page 5-8).
11. Check for a malfunctioning exciter (Page 7-2) or rotor (Page 7-3, 7-4) or open or grounded quadrature circuit (Page 7-5), and service as necessary.
12. Service the fuel injectors. See Table 6-1 for the appropriate engine workshop manual.
13. Check for proper operation of the internal governor mechanism. See Table 6-1 for the appropriate engine workshop manual.
14. Service a worn or damaged engine. See Table 6-1 for the appropriate engine workshop manual.
15. Replace the genset controller (p. 5-1).

INVALID GENSET CONFIGURATION—CODE NO. 37

(The genset Controller is not configured properly for the genset)

Corrective Action:

1. Make sure the ends of the two leads marked CONFIG 1 and CONFIG2 in the control box are not connected and that they are terminated with insulated connectors. See Page A-4 or A-5.
2. Reconfigure the genset controller (p. 5-1).
3. Replace the genset controller (p. 5-1).

TABLE 9-1. 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

(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 air grill.
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. Test and service the generator as necessary (Page 7-2).

CONTROL CARD FAILURE—RAM—CODE NO. 43

(During startup the genset Controller detected a RAM memory error)

Corrective Action: Replace the genset controller (p. 5-1).

SPEED SENSE LOST—CODE NO. 45

(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-5, as appropriate.*

1. Disconnect connector **P3** (green) from the genset controller (p. 5-1) and check for open or shorted field (**P3-7** to **P3-8**) and quadrature (**P3-4** to **P3-5**) windings. Service the generator as necessary (Page 7-2).
2. Replace the genset controller (p. 5-1).

OVERPRIME—CODE NO. 57

(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. 5-5).

TABLE 9-1. 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 EXHAUST TEMPERATURE—CODE NO. 58

(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-5, as appropriate.*

1. Check for and reconnect or replace any disconnected, kinked or leaking raw water hoses.
2. Check for and clean a blocked sea water strainer. If above the water line, fill the strainer with water to assist priming.
3. Inspect the siphon break (if provided) for proper operation.
4. Check for a worn raw water impeller and replace as necessary (p. 4-10).
5. Clean the heat exchanger (p. 4-7).
6. Disconnect connector **P1** (black) from the genset controller (Page 5-1) and check continuity between Pin **11** and **B–** (ground). If open, check for a missing, bent or corroded pin, faulty wiring or open exhaust temperature switch **S6** (p. 5-7). Repair as necessary.

LOW COOLANT LEVEL—CODE NO. 59

(The engine coolant level fell below the optional coolant level sensor)

Corrective Action: Add coolant as necessary and repair leaks.

EXTERNAL SHUTDOWN—CODE NO. 61

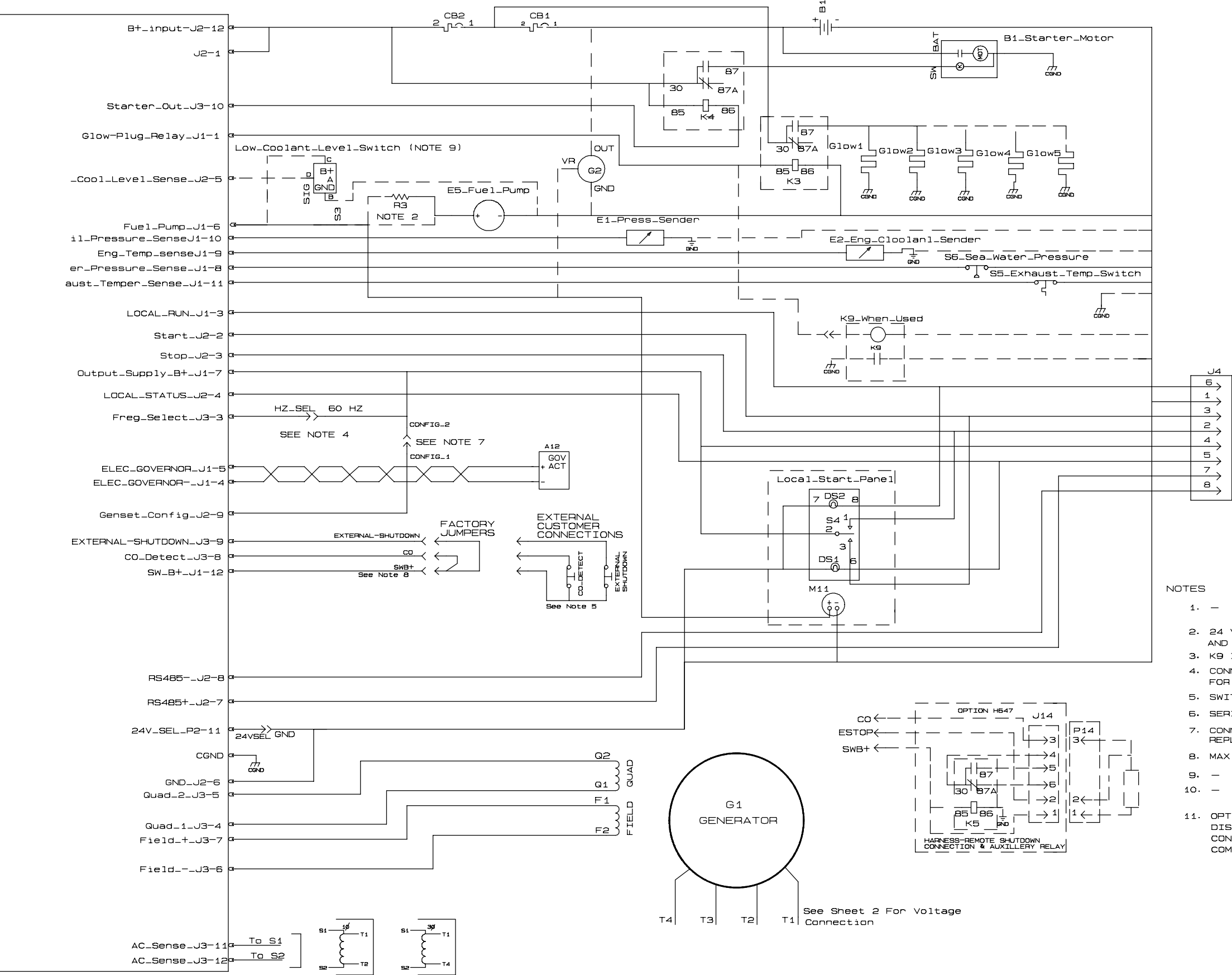
(Genset was shut down by a fire suppression system or other external control)

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

10. Specifications

		MDKKBK	MDKBL	MDKBM	MDKBN
ALTERNATOR: Single-Bearing, Brushless 4-Pole Rotating Field with Digital Electronic Regulation. See Genset Nameplate for Rating.					
FUEL CONSUMPTION:					
60 Hz:	Full Load	0.8 gph (3.0 liter/hr)	0.8 gph (3.0 liter/hr)	1.0 gph (3.8 liter/hr)	1.2 gph (4.5 liter/hr)
	Half Load	0.5 gph (1.9 liter/hr)	0.5 gph (1.9 liter/hr)	0.6 gph (2.3 liter/hr)	0.7 gph (2.7 liter/hr)
50 Hz:	Full Load	0.7 gph (2.7 liter/hr)	0.7 gph (2.7 liter/hr)	0.8 gph (3.0 liter/hr)	0.9 gph (3.4 liter/hr)
	Half Load	0.4 gph (1.5 liter/hr)	0.4 gph (1.5 liter/hr)	0.5 gph (1.9 liter/hr)	0.5 gph (1.9 liter/hr)
ENGINE: Kubota 4-Stroke Cycle, Indirect Injection, Water Cooled Diesel with Digital Electronic Governing					
Model		D1105	D1105	V1305	V1505
Number of Cylinders		3	3	4	4
Displacement		68.58 in ³ (1124 cm ³)	68.58 in ³ (1124 cm ³)	81.47 in ³ (1335 cm ³)	91.44 in ³ (1499 cm ³)
Bore		3.07 in (78 mm)	3.07 in (78 mm)	2.99 in (76 mm)	3.07 in (78 mm)
Stroke		3.09 in (78.4 mm)	3.09 in (78.4 mm)	2.90 in (73.6 mm)	3.09 in (78.4 mm)
Compression Ratio		22:1	22:1	22:1	22:1
Firing Order (Clockwise Rotation)		1-2-3	1-2-3	1-2-4-3	1-2-4-3
Fuel Injection Timing		16.5° BTDC	16.5° BTDC	16.5° BTDC	16.5° BTDC
Valve Lash (cold)		0.0071 – 0.0087 in (0.18 – 0.22 mm)	0.0071 – 0.0087 in (0.18 – 0.22 mm)	0.0071 – 0.0087 in (0.18 – 0.22 mm)	0.0071 – 0.0087 in (0.18 – 0.22 mm)
Lube Oil Capacity		4.2 quart (4.0 liter)	4.2 quart (4.0 liter)	4.5 quart (4.3 liter)	4.5 quart (4.3 liter)
Lube Oil Drain Connection		3/8 NPT	3/8 NPT	3/8 NPT	3/8 NPT
Coolant Capacity		4.2 quart (4.0 liter)	4.2 quart (4.0 liter)	5.3 quart (5.0 liter)	5.3 quart (5.0 liter)
Coolant Flow Rate:	60 Hz	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)
	50 Hz	4.2 gpm (15.9 liter/min)	4.2 gpm (15.9 liter/min)	4.2 gpm (15.9 liter/min)	4.2 gpm (15.9 liter/min)
Raw Water Flow Rate:	60 Hz	6.0 gpm (22.7 liter/min)	6.0 gpm (22.7 liter/min)	6.0 gpm (22.7 liter/min)	6.0 gpm (22.7 liter/min)
	50 Hz	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)	5.0 gpm (18.9 liter/min)
Combustion Air Flow:	60 Hz	30 cfm (0.85 m ³ /min)	30 cfm (0.85 m ³ /min)	36 cfm (1.02 m ³ /min)	41 cfm (1.16 m ³ /min)
	50 Hz	25 cfm (0.71 m ³ /min)	25 cfm (0.71 m ³ /min)	30 cfm (0.85 m ³ /min)	34 cfm (0.96 m ³ /min)
Heat Rejection to Ambient:	60 Hz	200 Btu/min (50 kcal/min)	200 Btu/min (50 kcal/min)	230 Btu/min (58 kcal/min)	280 Btu/min (71 kcal/min)
	50 Hz	179 Btu/min (45 kcal/min)	179 Btu/min (45 kcal/min)	190 Btu/min (48 kcal/min)	210 Btu/min (53 kcal/min)
CONNECTIONS:					
Max Fuel Pump Lift		4 ft (1.2 m)	4 ft (1.2 m)	4 ft (1.2 m)	4 ft (1.2 m)
Fuel Supply		1/4 NPT female	1/4 NPT female	1/4 NPT female	1/4 NPT female
Fuel Return		1/4 NPT female	1/4 NPT female	1/4 NPT female	1/4 NPT female
Max Raw Water Pump Lift		4 ft (1.22 m)	4 ft (1.22 m)	4 ft (1.22 m)	4 ft (1.22 m)
Raw Water Inlet		1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose
Wet Exhaust Outlet		2 in (50.8 mm) ID Hose	2 in (50.8 mm) ID Hose	2 in (50.8 mm) ID Hose	2 in (50.8 mm) ID Hose
Dry Exhaust Outlet		1-1/4 NPT	1-1/4 NPT	1-1/4 NPT	1-1/4 NPT
Max Exhaust Back Pressure		3 in (76 mm) Hg	3 in (76 mm) Hg	3 in (76 mm) Hg	3 in (76 mm) Hg
KEEL COOLING:					
Coolant Inlet & Outlet		1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose
Max Coolant Friction Head		1 psi (6.9 kPa)	1 psi (6.9 kPa)	1 psi (6.9 kPa)	1 psi (6.9 kPa)
Heat Rejection to Coolant:	60 Hz	950 Btu/min (239 kcal/min)	950 Btu/min (239 kcal/min)	1220 Btu/min (307 kcal/min)	1420 Btu/min (358 kcal/min)
	50 Hz	780 Btu/min (197 kcal/min)	780 Btu/min (197 kcal/min)	980 Btu/min (247 kcal/min)	1160 Btu/min (292 kcal/min)
Thermostat Opening Temperature		185° F (85° C)	185° F (85° C)	185° F (85° C)	185° F (85° C)
BATTERIES:					
Nominal Battery Voltage		12 volts*	12 volts*	12 volts*	12 volts*
Min CCA Rating – SAE @ 32° F (0° C)		360 amps	360 amps	500 amps	500 amps
Battery Charging @ 12/24 VDC		5/10 amps	5/10 amps	5/10 amps	5/10 amps
SIZE, WEIGHT, NOISE:					
Without Enclosure					
Dry Weight		525 lbs (238 kg)	555 lbs (252 kg)	640 lbs (290 kg)	640 lbs (290 kg)
Dimensions: L x W x H		32.4 x 18.9 x 22.1 in (479.1 x 822.6 x 560.9 mm)	35.9 x 22.3 x 23.0 in (911 x 566 x 585 mm)	40.7 x 22.3 x 23.0 in (1033 x 566 x 585 mm)	40.7 x 22.3 x 23.0 in (1033 x 566 x 585 mm)
With Enclosure					
Noise		–	66/65 dB(A) @ 60/50HZ	66/65 dB(A) @ 60/50HZ	66/65 dB(A) @ 60/50HZ
Dry Weight			600 lbs (272 kg)	695 lbs (315 kg)	695 lbs (315 kg)
Dimensions: L x W x H			35.9 x 22.3 x 23.4 in (911 x 566 x 593 mm)	40.7 x 22.3 x 23.4 in (1033 x 566 x 593 mm)	40.7 x 22.3 x 23.4 in (1033 x 566 x 593 mm)
* - 24 volts optional					

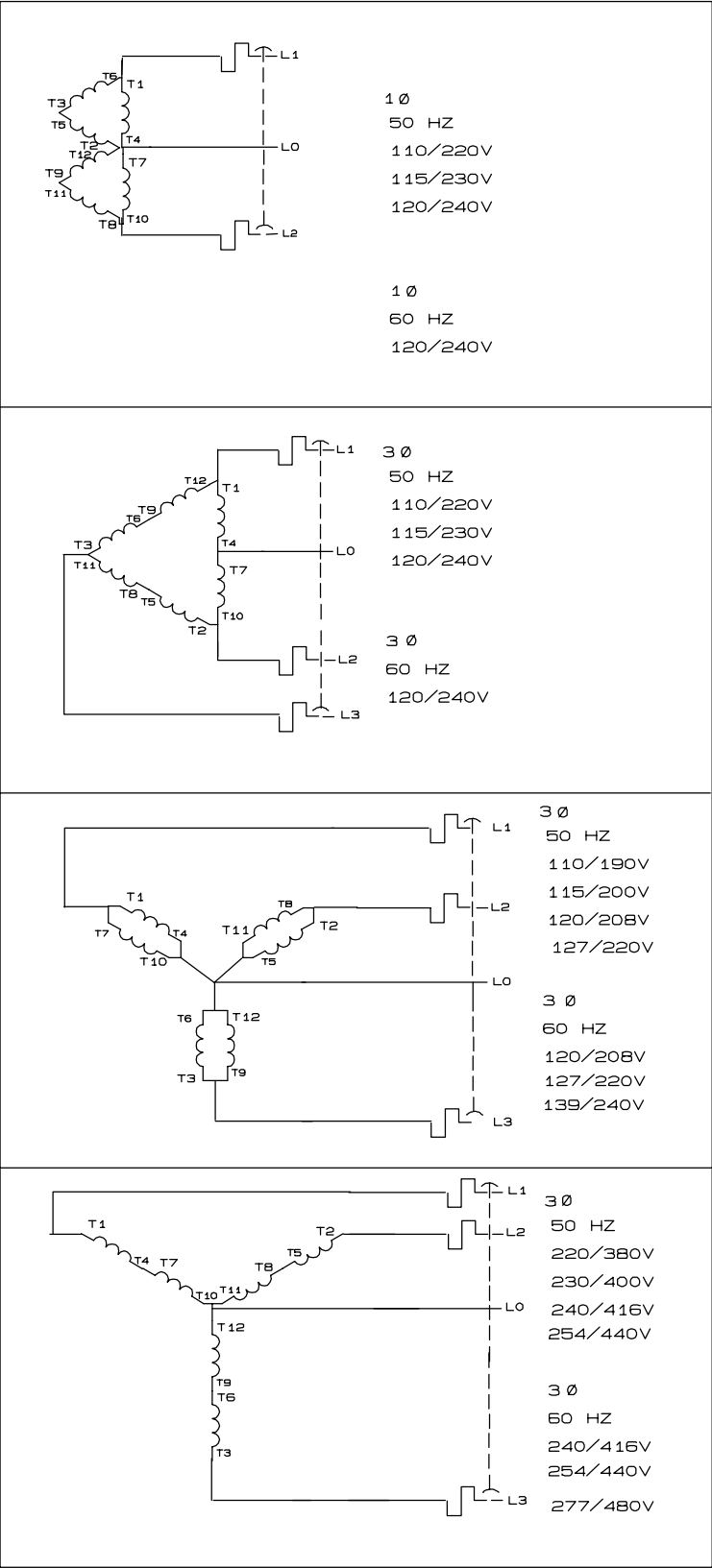
		MDKBP	MDKBR	MDKBS
ALTERNATOR: Single-Bearing, Brushless 4-Pole Rotating Field with Digital Electronic Regulation. See Genset Nameplate for Rating.				
FUEL CONSUMPTION:				
60 Hz:	Full Load	1.3 gph (4.9 liter/hr)	1.9 gph (7.2 liter/hr)	2.5 gph (9.5 liter/hr)
	Half Load	0.8 gph (3.0 liter/hr)	1.1 gph (4.2 liter/hr)	1.5 gph (5.7 liter/hr)
50 Hz:	Full Load	1.1 gph (4.2 liter/hr)	1.6 gph (6.1 liter/hr)	2.1 gph (8.0 liter/hr)
	Half Load	0.7 gph (2.7 liter/hr)	0.9 gph (3.4 liter/hr)	1.3 gph (4.9 liter/hr)
ENGINE: Kubota 4-Stroke Cycle, Indirect Injection, Water Cooled Diesel with Digital Electronic Governing				
Model		V1903B	V2203B	V2803B
Number of Cylinders		4	4	5
Displacement		113.37 in ³ (1857 cm ³)	134.07 in ³ (2197cm ³)	167.57 in ³ (2748 cm ³)
Bore		3.15 in (80 mm)	3.43 in (87 mm)	3.43 in (87 mm)
Stroke		3.64 in (92.4 mm)	3.64 in (92.4 mm)	3.64 in (92.4 mm)
Compression Ratio		23:1	23:1	23:1
Firing Order (Clockwise Rotation)		1-3-4-2	1-3-4-2	1-3-5-4-2
Fuel Injection Timing		14.5° BTDC	16° BTDC	16° BTDC
Valve Lash (cold)		0.0071 – 0.0087 in (0.18 – 0.22 mm)	0.0071 – 0.0087 in (0.18 – 0.22 mm)	0.0071 – 0.0087 in (0.18 – 0.22 mm)
Lube Oil Capacity		8 quart (7.6 liter)	8 quart (7.6 liter)	12.7 quart (12 liter)
Lube Oil Drain Connection		3/8 NPT	3/8 NPT	3/8 NPT
Coolant Capacity		8 quart (7.6 liter)	8 quart (7.6 liter)	8 quart (7.6 liter)
Coolant Flow Rate:	60 Hz	14.0 gpm (53.0 liter/min)	14.0 gpm (53.0 liter/min)	14.0 gpm (53.0 liter/min)
	50 Hz	10.0 gpm (37.9 liter/min)	10.0 gpm (37.9 liter/min)	10.0 gpm (37.9 liter/min)
Raw Water Flow Rate:	60 Hz	9.0 gpm (34.1 liter/min)	9.0 gpm (34.1 liter/min)	9.0 gpm (34.1 liter/min)
	50 Hz	7.0 gpm (26.5 liter/min)	7.0 gpm (26.5 liter/min)	7.0 gpm (26.5 liter/min)
Combustion Air Flow:	60 Hz	52 cfm (1.45 m ³ /min)	60 cfm (1.72 m ³ /min)	75 cfm (2.12 m ³ /min)
	50 Hz	42 cfm (1.21 m ³ /min)	50 cfm (1.43 m ³ /min)	63 cfm (1.78 m ³ /min)
Heat Rejection to Ambient:	60 Hz	350 Btu/min (88 kcal/min)	420 Btu/min (106 kcal/min)	530 Btu/min (134 kcal/min)
	50 Hz	285 Btu/min (72 kcal/min)	350 Btu/min (88 kcal/min)	450 Btu/min (114 kcal/min)
CONNECTIONS:				
Max Fuel Pump Lift		4 ft (1.2 m)	4 ft (1.2 m)	4 ft (1.2 m)
Fuel Supply		1/4 NPT female	1/4 NPT female	1/4 NPT female
Fuel Return		1/4 NPT female	1/4 NPT female	1/4 NPT female
Max Raw Water Pump Lift		4 ft (1.22 m)	4 ft (1.22 m)	4 ft (1.22 m)
Raw Water Inlet		1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose
Wet Exhaust Outlet		2 in (50.8 mm) ID Hose	2 in (50.8 mm) ID Hose	2 in (50.8 mm) ID Hose
Dry Exhaust Outlet		1-1/2 NPT	1-1/2 NPT	1-1/2 NPT
Max Exhaust Back Pressure		3 in (76 mm) Hg	3 in (76 mm) Hg	3 in (76 mm) Hg
KEEL COOLING:				
Coolant Inlet & Outlet		1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose	1 in (25.4 mm) ID Hose
Max Coolant Friction Head		1 psi (6.9 kPa)	1 psi (6.9 kPa)	1 psi (6.9 kPa)
Heat Rejection to Coolant:	60 Hz	1590 Btu/min (402 kcal/min)	1980 Btu/min (500 kcal/min)	2490 Btu/min (629 kcal/min)
	50 Hz	1500 Btu/min (379 kcal/min)	1670 Btu/min (422 kcal/min)	2090 Btu/min (528 kcal/min)
Thermostat Opening Temperature		185° F (85° C)	185° F (85° C)	185° F (85° C)
BATTERIES:				
Nominal Battery Voltage		12 volts*	12 volts*	12 volts*
Min CCA Rating – SAE @ 32° F (0° C)		500 amps	625 amps	625 amps
Battery Charging @ 12/24 VDC		40/20 amps	40/20 amps	40/20 amps
SIZE, WEIGHT, NOISE:				
Without Enclosure Dry Weight Dimensions: L x W x H		830 lbs (377 kg) 44.4 x 23.7 x 26.1 in (1127 x 602 x 663 mm)	870 lbs (375 kg) 44.4 x 23.7 x 26.1 in (1127 x 602 x 663 mm)	1090 lbs (494 kg) 53.5 x 23.7 x 28.8 in (1358 x 602 x 732 mm)
With Enclosure Noise Dry Weight Dimensions: L x W x H		67/64 dB(A) @ 60/50 HZ 890 lbs (404 kg) 44.4 x 23.7 x 27.5 in (1127 x 602 x 698 mm)	67/64 dB(A) @ 60/50 HZ 930 lbs (422 kg) 44.4 x 23.7 x 27.5 in (1127 x 602 x 698 mm)	68/67 dB(A) @ 60/50 HZ 1175 lbs (533 kg) 53.5 x 23.7 x 30.0 in (1358 x 602 x 763 mm)
* - 24 volts optional				



SEE SHEET 3

- NOTES
- 1. —
 - 2. 24 VOLT SETS, R3 IS NEEDED AT E5 AND CONNECT 24V SEL TO GND FASTON.
 - 3. K9 IS USED FOR ISOLATED GROUND
 - 4. CONNECT 60HZ FASTON TO HZSEL FOR 60HZ. DISCONNECT FOR 50HZ. (NON MDKBH)
 - 5. SWITCHES SHOWN IN NORMAL RUNNING POSITION.
 - 6. SERIAL DATA FOR e-SERIES DIGITAL DISPLAY.
 - 7. CONNECT CONFIG WIRES TO RECONFIGURE THE CONTROL. REPLACE INSULATING CONNECTOR WHEN DONE.
 - 8. MAX SWB+ LOAD = 0.5A.
 - 9. —
 - 10. —
 - 11. OPTIONAL CUSTOMER WAKE-UP INPUT. IF USED. DISCONNECT RUN SIGNAL (P10-6) & INSULATE. CONNECT INPUT TO OPEN P10-6. COMMUNICATIONS ARE ACTIVE WHILE INPUT = B+.

WIRING DIAGRAM (SHEET 1)

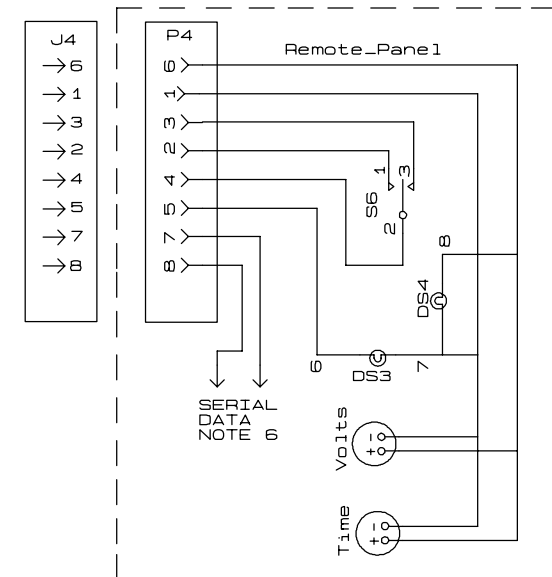
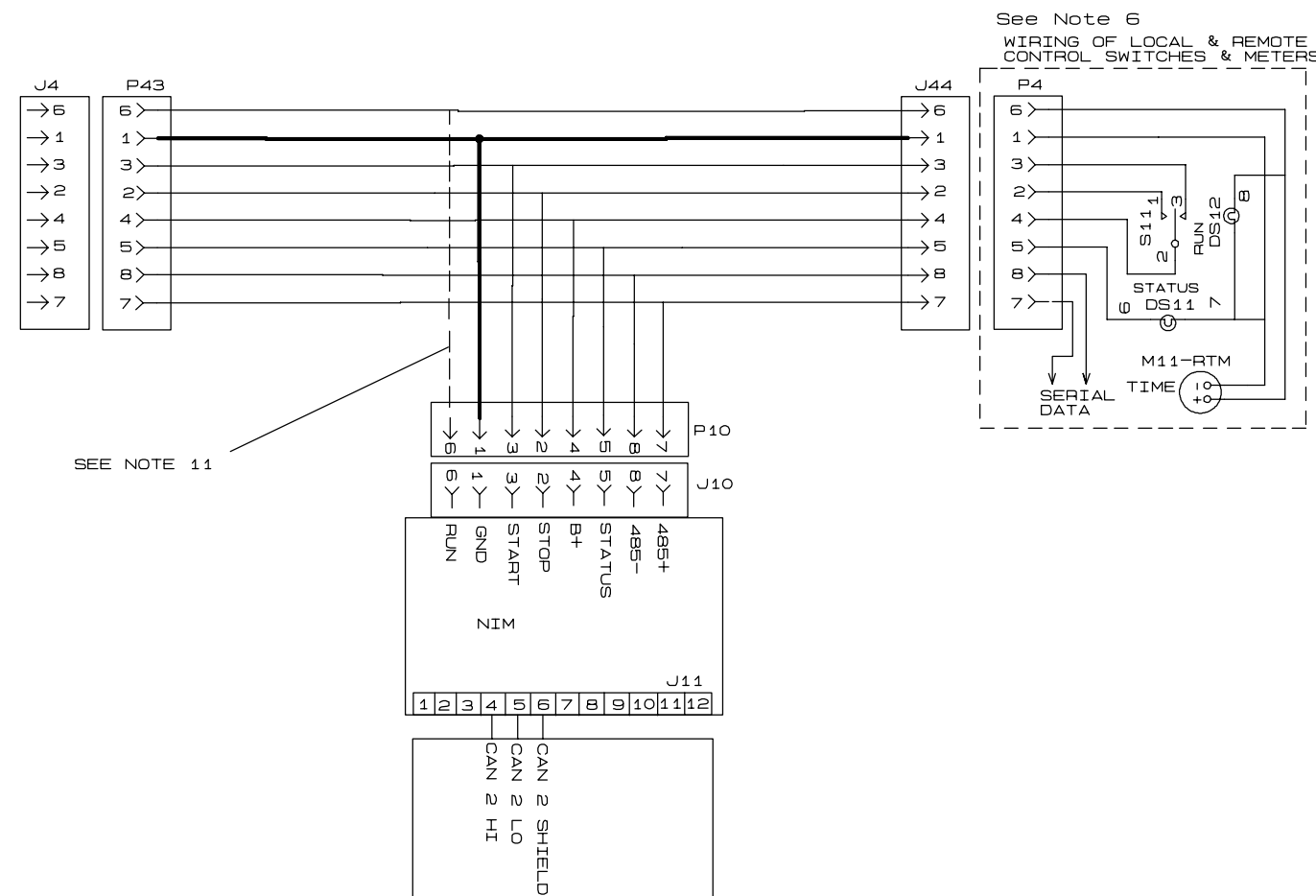
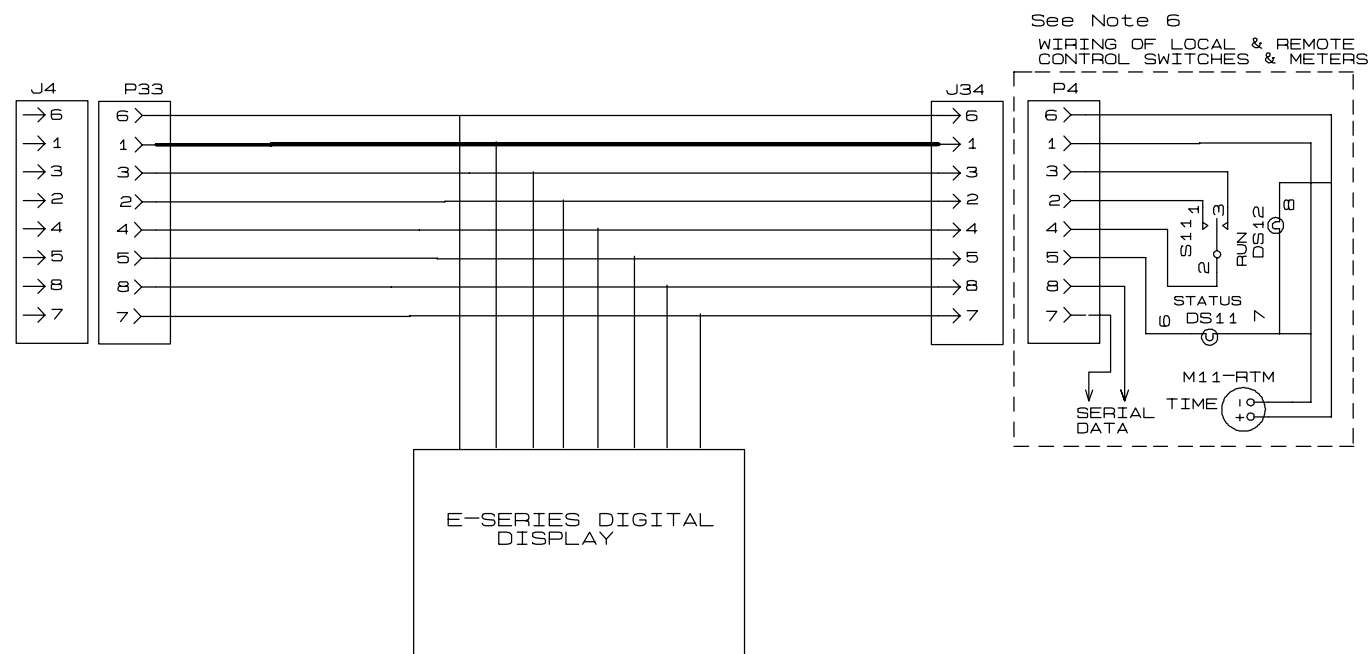


3Ø Generator Reconnection

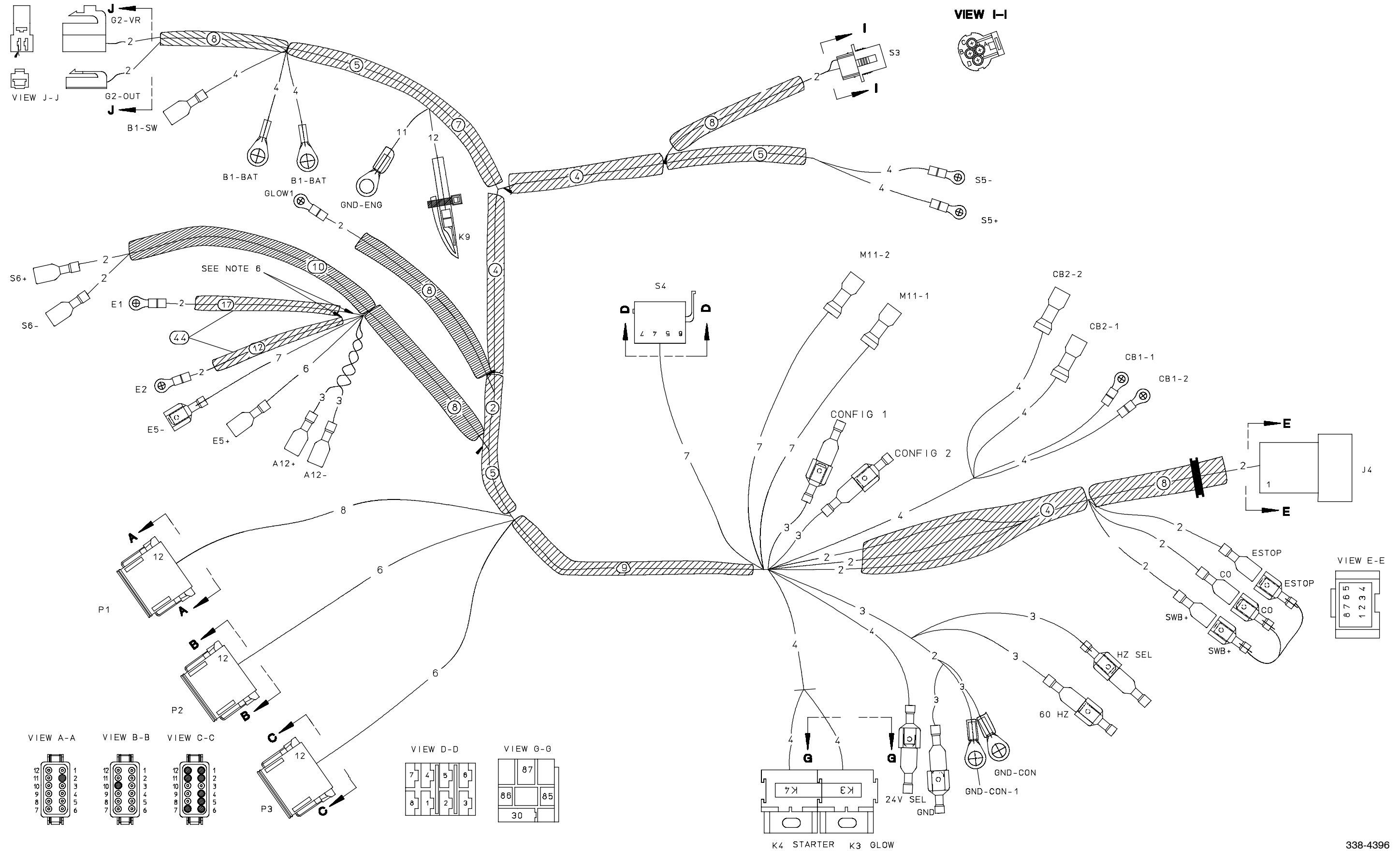
	A	B	C	HZ
VOLTAGE	120	240	120/240	60
	110	220	110/220	50
	115	230	115/230	
	120	240	120/240	
SCHEMATIC				
DIAGRAM GROUNDED NEUTRAL				
DIAGRAM ISOLATED NEUTRAL				

NOTES:
(GND) INDICATES GROUND. CONNECTION SHOULD BE MADE AT THE GROUND STUD IN THE CONTROL BOX. (ISO) INDICATES ISOLATED. CONNECTION SHOULD BE MADE AT THE ISOLATION STANDOFF IN THE CONTROL BOX.

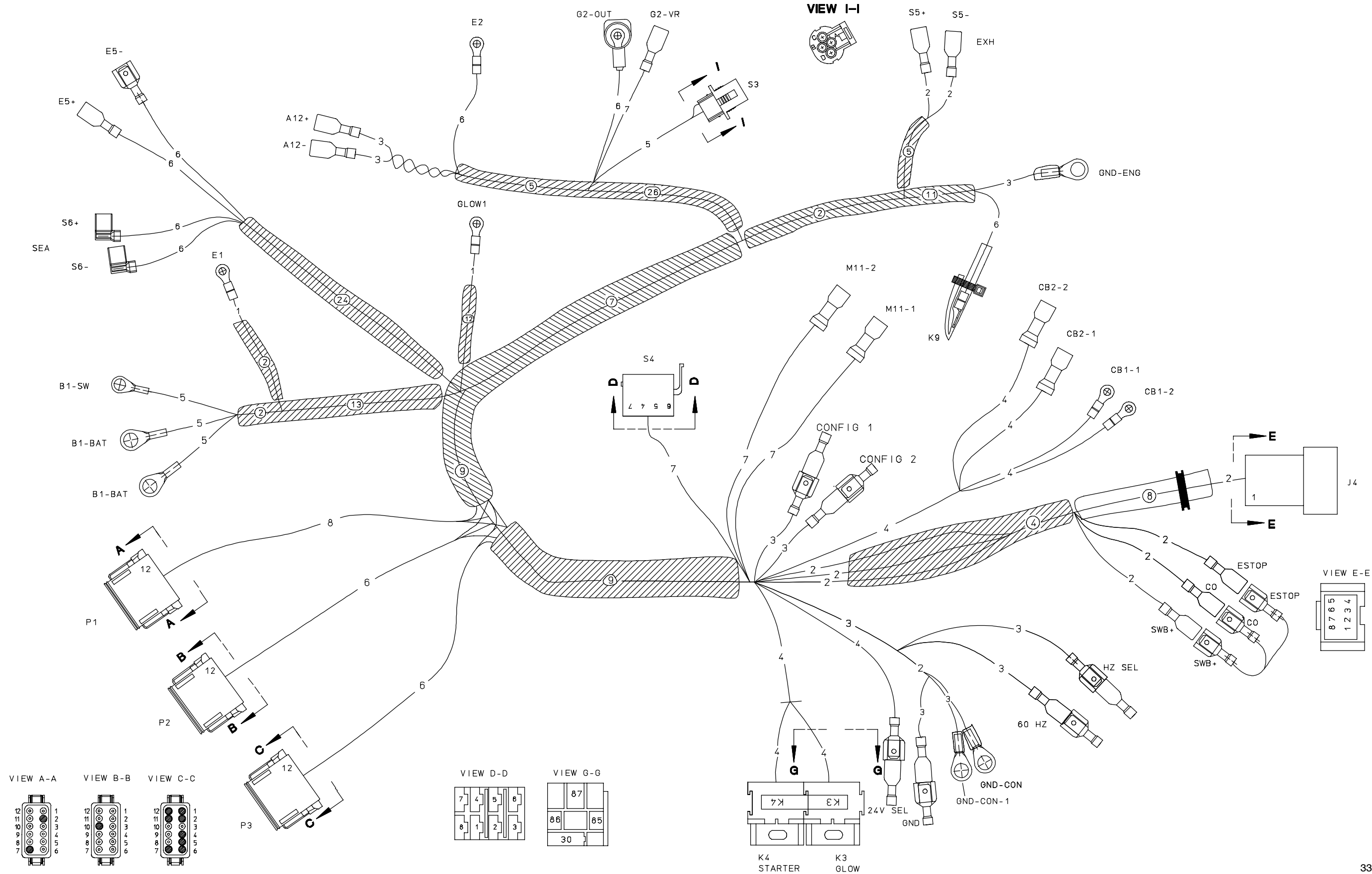
1Ø Generator Reconnection



WIRING DIAGRAM (SHEET 3)



CONTROL WIRING HARNESS—MODELS MDKBK, MDKBL, MDKBM, MDKBN



CONTROL WIRING HARNESS—MODELS MDKBP, MDKBR, MDKBS