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Service Manual MGKBC, MGKBD

WARNING:

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The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SAFETY PRECAUTIONS	iii
THE HAZARDS OF CARBON MONOXIDE	V
1. INTRODUCTION	1-1
About This Manual	1-1
Fuel Recommendations	1-2
Engine Oil Recommendations	1-2
Starting Batteries	1-2
Specifications	1-3
2. OPERATION	2-1
Genset Control Panel	2-1
Starting and Stopping the Genset	2-2
Operation, Exercise and Storage	2-3
3. PERIODIC MAINTENANCE	3-1
General Inspection	3-2
Checking Engine Oil Level	3-3
Changing Engine Oil and Filter	3-4
Battery and Battery Connections	3-5
Engine Cooling System	3-6
Flame Arrestor	3-13
Spark Plugs	3-14
4. ENCLOSURE, DRIP PAN AND MOUNTING SYSTEM	4-1
Enclosure Panels	4-1
Drip Pan and Vibration Isolators	4-2
5. CONTROL SYSTEM	5-1
Control Board (Controller)	5-2
Control Switch S4	5-4
Emergency Switch/Breaker CB1	5-4
Hour Meter M11	5-4
	5-4
Start Relay K5	5-4
	5-5
Engine Oil Pressure Sender E1	5-5
Engine Coolant Temperature Sender E2	5-5
Raw Water Flow Switch S6	5-6
High Exhaust Temperature Switch S5	5-6
Battery Charging Regulator A1	5-6
	5-7
	5-7
	5-7
Governor Actuator	5-1
	5-1

6. GENERATOR
Servicing the Generator
Servicing Brushes and Slip Rings 6-3
Testing Field Flash 6-3
Testing Generator Windings 6-4
Reconnecting the Generator 6-5
Changing Frequency 6-5
Adjusting Voltage 6-5
7. GENERATOR DRIVE
Inspecting Drive and Bearings 7-2
Service
8. ENGINE
Engine Service
Engine Mounting
Starter
Exhaust Manifold
Governor Actuator
Carburetor / Choke Assembly 8-6
Fuel Pump
9. TROUBLESHOOTING
Troubleshooting with the Blinking Amber Status Light
Troubleshooting with the e-Series Digital Display
10. E-SERIES DIGITAL DISPLAY
Turning On the Display 10-1
Start Button
Stop Button
Genset Status Screens 10-1
Fault Screens 10-2
Pre-Alarm Screens 10-3
Brightness and Contrast 10-4
Setup
Genset and Display Information 10-4
WIRING DIAGRAM—SHEET 1 A-1
WIRING DIAGRAM—SHEET 2 A-2
CONTROL WIRING HARNESS A-3

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

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

The following symbols in this manual alert you to potential hazards to operators, service personnel and equipment.

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

<u>AWARNING</u> alerts you to a hazard or unsafe practice which can result in severe personal injury or death.

ACAUTION alerts you to a hazard or unsafe practice which can result in personal injury or equipment damage.

GENERAL PRECAUTIONS

- Keep children away from the genset.
- 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.
- Do not use evaporative starting fluids such as ether. They are highly explosive.

- Keep the genset, drip pan and compartment clean. Oily rags can catch fire. Gear stowed in the compartment can cause the genset to overheat.
- 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.
- Benzene and lead in some gasolines have been identified by some U. S. state and federal agencies as causing cancer or reproductive toxicity. Do not to ingest, inhale or contact gasoline 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 USCG Approved multi-class ABC fire extinguishers on the boat. 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 national codes and regulations.

POST THESE SUGGESTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT

GENERATOR VOLTAGE IS DEADLY

- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- When the boat has provisions for connection to shore power, the genset must be connected to the boat electrical system through an approved transfer switch to prevent backfeed. Backfeed can lead to electric shock resulting in severe personal injury or death.
- 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 a boat while the genset is running unless the cabin is equipped with a properly working carbon monoxide detector-alarm.
- Inspect for exhaust leaks at every startup and after every eight hours of operation.
- The exhaust system must be installed in accordance with the genset Installation Manual.
- When modifying or repairing the boat, care must be taken to maintain sealing of the living quarters from spaces where exhaust gas can accumulate.
- The ventilation exhaust blowers must be kept in good working order to prevent the accumulations of engine exhaust.
- For more information about the hazards of carbon monoxide see American Boat and Yacht Council (ABYC) publication TH-22—Educational Information About Carbon Monoxide.

GASOLINE IS FLAMMABLE AND EXPLOSIVE

• Do not smoke where fuel vapors are present or in areas sharing ventilation with fuel tanks, engines and other such equipment. Keep flames, sparks, pilot lights, electrical switches, arc-producing equipment and all other sources of ignition well away.

- All electrical devices, such as switches, circuit breakers, meters and control panels used in areas where gasoline vapors can accumulate must be *Ignition Protected*.
- No substitutes are permitted for the parts listed in the *Critical Parts Index* of the genset Parts Catalog. They must be purchased from Onan and be installed in accordance with the genset Service Manual by those who are trained and experienced in marine gasoline genset service.
- Fuel lines must be secure, free of leaks and separated or shielded from electrical wiring.
- When modifying or repairing the boat, care must be taken to maintain sealing of the living quarters from spaces where gasoline vapors can accumulate.
- The ventilation exhaust blowers must be kept in good working order to prevent the accumulations of gasoline vapors.

BATTERY GAS IS EXPLOSIVE

- Do not smoke near batteries.
- Wear safety glasses while servicing batteries.
- 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 jewelry or loose clothing 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.

POST THESE SUGGESTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT

The Hazards of Carbon Monoxide

Most people know not to run a car in the garage. Many people know about the threat of carbon monoxide poisoning in the house. But few people are aware that this invisible killer is even more insidious aboard a boat.

Engine-driven generators can produce harmful levels of carbon monoxide that can injure or kill you. The nature of boating is such that you can be harmed by this poisonous gas despite good generator set maintenance and proper ventilation.

WHAT IS CARBON MONOXIDE POISONING?

Carbon Monoxide (CO) is an odorless and colorless gas. You cannot see it or smell it. Red blood cells, however, have a greater affinity for CO than for Oxygen. Therefore, exposure even to low levels of CO for a prolonged period can lead to asphyxiation (lack of oxygen) resulting in death. Mild effects of CO poisoning include eye irritation, dizziness, headaches, fatigue and the inability to think clearly. More extreme symptoms include vomiting, seizures and collapse.

WHAT ARE THE SPECIAL RISKS OF CO ON BOATS?

Depending on air temperature and wind, CO can accumulate between hulls, under an overhanging deck or rear swimming platform and in and around the boat. A swimmer can be exposed to lethal levels of CO when the genset is running. Passengers on deck and in the living quarters can also be exposed, especially when the boat is docked, beached or tied to a neighboring boat.

The risk of exposure to CO can be multiplied greatly by the "station wagon" effect, obstructions that block exhaust dissipation, and infiltration from neighboring boats. To protect against all three situations, Onan recommends that reliable CO detectoralarms be installed on your boat. • The Station Wagon Effect - A boat pushes aside the air through which it is moving, causing a zone of low pressure in the back of the boat and cabins into which exhaust gases can be drawn (see figure). A breeze across an anchored boat can have the same effect. Opening doors and windows so that air can flow through the boat can reduce the effect.



- **Obstructions** Anchoring near a large object such as a boat house or sea wall or in a confined space such as a canyon can cause exhaust gases to accumulate in and around the boat despite good generator set maintenance and proper ventilation. Don't run the generator set when anchored in such places.
- *Exhaust from Neighboring Boats* When boats are anchored in close quarters exhaust from neighboring boats can accumulate in and around yours.

ONLY YOU CAN PROTECT YOURSELF FROM CO POISONING!

- Watch constantly for swimmers when the generator set is running.
- Make sure exhaust cannot get under the deck, between hulls or enter the living quarters through a window, vent or door.
- Make sure all CO detectors are working.
- Pay attention to the signs of CO poisoning.
- Check the exhaust system for corrosion, obstruction and leaks each time you start the generator set and every eight hours if you run it continuously.

POST THESE SUGGESTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT

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1. Introduction

ABOUT THIS MANUAL

This is the service manual for the generator set (genset) models listed on the front cover. Read and carefully observe all of the instructions and precautions in this manual.

<u>AWARNING</u> 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.

AWARNING Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.

See the Installation Manual for important recommendations concerning the installation and for a list of the installation codes and standards for safety which may be applicable.

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

When contacting Onan for parts and product information, be ready to provide the model and serial numbers on the genset nameplate. The gray areas in Figure 1-1 illustrate where the model and serial numbers are printed on the nameplate. Each character is significant. The last character of the model number is the specification letter, which is important for obtaining the right parts.

AWARNING No substitutes are permitted for the parts identified in the Parts Catalog as Marine Critical Parts. They must be purchased from Onan and be installed in accordance with the genset Service Manual by those trained and experienced in marine gasoline genset service.



FIGURE 1-1 TYPICAL NAMEPLATE

FUEL RECOMMENDATIONS

AWARNING Gasoline is highly flammable and explosive and can cause severe personal injury or death. Do not smoke where fuel vapors are present or in areas sharing ventilation with fuel tanks, engines and other such equipment. Keep flames, sparks, pilot lights, electrical switches, arc-producing equipment and all other sources of ignition well away.

All electrical devices, such as switches, circuit breakers, meters and control panels used in areas where gasoline vapors can accumulate must be Ignition Protected.

Use clean, fresh unleaded gasoline having a minimum octane rating (Anti-Knock Index) of 87.

ACAUTION Do not use gasoline or gasoline additives containing Methanol or gasoline containing more than 10 percent Ethanol. These additives can lead to fuel system corrosion.

Do not use leaded gasoline because of the extra engine maintenance that will be required.

ENGINE OIL RECOMMENDATIONS

Use API (American Petroleum Institute) performance Class **SL** or **SJ** engine oil. Also look for the SAE (Society of Automotive Engineers) viscosity grade. Referring to Figure 1-2, choose the viscosity grade appropriate for the ambient temperatures expected until the next scheduled oil change. Multigrade oils such as SAE 15W-40 are recommended for year-round use.

STARTING BATTERIES

The genset requires a 12 volt battery to power its control and starting circuits. Reliable genset starting and starter service life depend upon adequate battery system capacity and maintenance. See *Specifications* (Page 1-3) for battery requirements and *Periodic Maintenance* (Page 3-5) for battery care.



FIGURE 1-2. SAE VISCOSITY GRADE vs. AMBIENT TEMPERATURE

SPECIFICATIONS

		MGKBC	MGKBD					
GENERATOR: Two-Bearin	ig, 2-Pole Rot	ating Field, Microprocessor Regulated. See Ger	nset Nameplate for Rating					
FUEL CONSUMPTION:								
60 Hz:	Full Load Half Load	1.59 gph (6.0 liter/hr) 0.95 gph (3.6 liter/hr)	1.4 gph (5.3 liter/hr) 0.77 gph (2.9 liter/hr)					
50 Hz:	Full Load Half Load	1.4 gph (5.3 liter/hr) 0.77 gph (2.9 liter/hr)	-					
Engine/Generator Speed:	60 Hz 50 Hz	2900/3600 rpm 2400/3000 rpm	2400/3600 rpm -					
ENGINE: 4-Stroke Cycle, S	Spark-Ignited,	Water Cooled, Microprocessor Governed (Isoch	nronous)					
Number of Cylinders		3	3					
Bore		2.68 inch (68 mm)	2.68 inch (68 mm)					
Stroke		2.68 inch (68 mm)	2.68 inch (68 mm)					
Displacement		45.2 inch ³ (740 cm ³)	45.2 inch ³ (740 cm ³)					
Compression Ratio		9.2:1	9.2:1					
Firing Order (Clockwise Ro	otation)	1-2-3	1-2-3					
Ignition Timing		18° BTDC	18° BTDC					
Spark Plug Gap		0.039 - 0.043 inch (1.0 - 1.1 mm)	0.039 - 0.043 inch (1.0 - 1.1 mm)					
Valve Lash (cold)		0.0059 - 0.0073 inch (0.145 - 0.185 mm)	0.0059 - 0.0073 inch (0.145 - 0.185 mm)					
Engine Oil Capacity		2.0 quart (1.9 liter)	2.0 quart (1.9 liter)					
Engine Oil Drain Connection	n	3/8 NPT	3/8 NPT					
Coolant Capacity		3.3 quart (3.1 liter)	3.3 quart (3.1 liter)					
Coolant Flow:	60 Hz 50 Hz	3.5 gpm (13 liter/min) 3.0 gpm (16 liter/min)	3.5 gpm (13 liter/min) -					
Raw Water Flow:	60 Hz 50 Hz	5.0 gpm (19 liter/min) 4.0 gpm (15 liter/min)	5.0 gpm (19 liter/min) -					
Maximum Raw Water Pum	p Lift	4 feet (1.2 m) with 5/8 inch ID hose	4 feet (1.2 m) with 5/8 inch ID hose					
Raw Water Inlet Connectio	n	5/8 inch (15.9 mm) ID Hose	5/8 inch (15.9 mm) ID Hose					
Maximum Fuel Pump Lift		4 feet (1.2 m) with 1/4 inch ID fuel line	4 feet (1.2 m) with 1/4 inch ID fuel line					
Required Fuel Line Size		1/4 inch (6.4 mm) ID	1/4 inch (6.4 mm) ID					
Fuel Supply Connection		1/8 NPT female	1/8 NPT female					
Wet Exhaust Outlet Conne	ction	2.0 inch (50.8 mm) ID Hose	2.0 inch (50.8 mm) ID Hose					
Maximum Exhaust Back Pi	ressure	3 inch (76 mm) Hg	3 inch (76 mm) Hg					
Combustion Air Flow:	60 Hz 50 Hz	32 cfm (0.91 m ³ /min) 26.7 cfm (0.76 m ³ /min)	26.7 cfm (0.76 m ³ /min) -					
Generator Cooling Air:	60 Hz 50 Hz	100 cfm (2.83 m ³ /min) 80 cfm (2.26 m ³ /min)	100 cfm (2.83 m ³ /min) -					
BATTERIES:								
Nominal Battery Voltage		12 volts	12 volts					
Minimum CCA Rating		360 amps	360 amps					
Battery Charging Output (C	Optional)	3 amps	3 amps					
SIZE, WEIGHT, NOISE:			L					
Size: L x W x H		26.6 x 23 x 21.1 inch (676 x 583 x 535 mm)	26.6 x 23 x 21.1 inch (676 x 583 x 535 mm)					
Weight (dry)		425 lbs (193 kg)	425 lbs (193 kg)					
Noise (Full Load @ 1 m):	60 Hz 50 Hz	71 dB(A) 69 dB(A)	69 dB(A)					

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GENSET CONTROL PANEL

The control panel is located in the front, upper left hand corner of the genset (Figure 2-1).

Control Switch - This switch is used to prime the fuel system, start and stop the genset and display the shutdown codes.

- Press and hold **START** to crank and start the genset.
- Momentarily press **STOP (Prime)** to stop the genset.
- Press and hold **STOP (Prime)** to prime the fuel system. The *amber* status light will light in 2 seconds.
- See *Troubleshooting* (Page 9-1) about displaying the fault codes.

Status Indicator Lights - There are two LED (light emitting diode) lights in the control switch. The *am*-

ber status light lights during priming and blinks rapidly during cranking. If the genset shuts down abnormally it will slowly blink the fault code number. See *Troubleshooting* (Page 9-1). The *amber* status light goes out and the *green* status light lights when the genset starts producing AC voltage.

Emergency Stop Switch - In an emergency, push this rocker switch **OFF**. Push the switch **ON** after all necessary repairs to the genset and connected equipment have been made.

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

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

Oil Fill Neck- The oil fill neck is located on the control panel. The fill plug has a flexible dipstick attached for checking engine oil level.



FIGURE 2-1. GENSET CONTROL PANEL

AWARNING EXHAUST GAS IS DEADLY!

Engine exhaust contains carbon monoxide, a poisonous, odorless and colorless gas that can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

• Dizziness

• Weakness

- Throbbing in Temples
 Nausea
- Muscular Twitching
- Headache
 Vomiting
- Trouble Thinking Clearly Sleepiness

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

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.

STARTING AND STOPPING THE GENSET

Pre-Start Checks and Genset Compartment Ventilation

Conduct general inspections (Page 3-2) before the first start of the day and after every eight hours of operation. Perform periodic maintenance that may be due and maintenance required to return the genset to service if the boat has been in storage (Page 2-4). 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. Turn off air conditioners and other large appliances.
- 4. Operate the ventilation exhaust blower for 4 minutes and check the genset compartment and bilge for gasoline vapors.

AWARNING Gasoline vapors can explode. Before starting the genset, operate the exhaust blower for 4 minutes and check the genset compartment and bilge for gasoline vapors.

Starting the Genset

1. Press and hold **STOP (Prime)** for 30 seconds to prime the fuel system if the genset ran out of fuel. The *amber* status light will light in 2 seconds.

See Page 10-1 to prime the fuel system using the *e-Series Digital Display.*

2. Press and hold **START** until the genset starts. The *amber* status light will blink rapidly. The *amber* light will go out and the *green* status light will light when the genset starts producing AC voltage.

See Page 10-1 to start the genset using the *e*-Series Digital Display.

- 3. For longer engine life, let the engine warm up for two minutes before turning on air conditioners and other large appliances.
- 4. Check for water, coolant, fuel and exhaust leaks. Stop the genset immediately if there is a leak. *Stop fuel leaks immediately.*
- 5. If the boat is equipped with an *e-Series Digital Display*, observe engine coolant temperature, oil pressure and battery voltage. Perform maintenance or service as necessary if an abnormal engine condition is indicated. See *Periodic Maintenance* (Page 3-1).
- If the genset fails to start, cranking will discontinue in 20 to 60 seconds, depending on temperature, and the *amber* status light will blink Fault Code No. 4 (Page 9-4). See *Troubleshooting* (Page 9-1) if the genset does not start after two or three tries.

ACAUTION 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 the exhaust system). Find out why the genset does not start and make necessary repairs.

7. If the genset shuts down abnormally, the *amber* status light will slowly blink the fault code number. See *Troubleshooting* (Page 9-1) for step-by-step procedures to correct the fault that caused shutdown.

Stopping the Genset

Turn off air conditioners and other large appliances and let the genset run for two minutes to cool down. Then momentarily press **STOP (Prime)**.

See Page 10-1 to stop the genset using the *e-Se*ries Digital Display.

Emergency Stop

In an emergency, push the EMERGENCY STOP switch **OFF** (Page 2-1). Make all necessary repairs to the genset and connected equipment and then push it **ON** to allow genset operation.

OPERATION, EXERCISE AND STORAGE

Resetting Circuit Breakers

If a circuit breaker in the main power distribution panel of the boat or on the genset trips, either a circuit shorted or too many appliances were running. Note that the genset may continue to run after a circuit breaker trips.

If a circuit breaker trips, disconnect or turn off all connected loads and reset the circuit breaker. (It may be necessary to push the circuit breaker **OFF** to reset it and then **ON** to reconnect the circuit.) If the circuit breaker trips right away, either the electrical distribution system has a short circuit or the circuit breaker is faulty. Call a trained and experienced electrician.

If the circuit breaker does not trip, reconnect or turn on appliances one by one up to a total load that does not exceed genset or circuit breaker rating. If a circuit breaker trips right away when an appliance is connected, that appliance or circuit probably has a short.

Electric appliances and tools must be used and maintained in accordance their manufacturer's instructions and safety precautions. They must be properly grounded to reduce the risk of electric shock and fire.

AWARNING Short circuits in electric appliances and tools can cause fire and electric shock leading to severe personal injury or death. Read and follow the appliance and tool manufacturer's instructions and warnings regarding use, maintenance and proper grounding.

Shore Power

When the boat has provisions for connection to shore power, the genset must be connected to the boat electrical system through an approved transfer switch to prevent backfeed.

AWARNING Backfeed to shore power can lead to electric shock resulting in severe personal injury or death. Prevent backfeed by connecting the genset to the boat electrical system through an approved transfer switch.

New or Re-Built Engine Care

Change the oil and oil filter after the first 50 hours of operation with a new or re-built engine (Page 3-4).

Exercising the Genset

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

Cold Temperature Operation

Do not let raw water freeze in the heat exchanger (Page 3-11) or muffler during cold weather when the genset is not operating. Freezing water can damage the heat exchanger and muffler. Engine coolant, but not raw water, is protected from freezing. Drain the heat exchanger and muffler if there is a danger of freezing.

Storing the Genset

Storing the Genset: Proper storage is essential for preserving top genset performance and reliability when the genset will be idle for more than 120 days.

 Fill the fuel tank with fresh fuel and add a fuel preservative such as OnaFresh[™]. Follow the instructions on the container label. Unless a preservative (stabilizer) is added, the gasoline in the fuel system will deteriorate causing fuel system corrosion, gum formation and varnishlike deposits that can lead to hard starting and rough operation.

Then run the genset for about 10 minutes at approximately 1/2 rated power to fill the fuel lines with the fresh fuel and preservative.

AWARNING Gasoline preservatives (stabilizers) are toxic. Follow the instructions on the container. Avoid skin contact. Wash hands with soap and water after using.

- 2. Change the engine oil (Page 3-4) and attach a tag indicating viscosity grade (Page 1-2).
- 3. Disconnect the battery cables (negative [-] first) from the battery (Page 3-5). Follow the manufacturer's recommendations when storing the battery.

AWARNING Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.

- 4. Check coolant level and add as necessary (Page 3-7). Test the coolant mixture if freezing temperatures are possible and change if necessary.
- 5. If freezing temperatures are expected, drain the heat exchanger (Page 3-11), hoses and muffler to prevent damage from freezing water.
- 6. 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 (Page 3-4) if the viscosity is not appropriate for the temperatures expected (Page 1-2).
- 2. Reconnect the battery cables (negative [-] last) (Page 3-5).
- 3. Replace the raw water pump impeller if it was installed more than a year ago (Page 3-9).
- 4. Perform the maintenance required (Page 3-1), conduct the pre-start checks (Page 2-2) and prime the fuel system.
- 5. Start and run the genset (Page 2-2).

Periodic maintenance is essential for good performance and long genset life. Use Table 3-1 as a guide for normal periodic maintenance.

Maintenance, replacement or repair of emission

control devices and systems may be performed by any engine repair establishment or individual. However, warranty work must be completed by an authorized Onan dealer.

	FREQUENCY									
PROCEDURE	After first 50 Hrs	Every Day/ 8 Hrs	Every Month	Every Year	Every 150 Hrs	Every 450 Hrs	Every 2 Yrs	Every 900 Hrs	Every 3 Yrs	P a g e
General Inspection ¹		х								3-2
Check Battery			x ²							3-5
Check V-Belt Tension			x ³							3-9
Check Siphon Break			х							3-8
Change Oil & Oil Filter	х			х	х					3-4
Replace Raw Water Impeller				x						3-9
Check Brushes & Slip Rings ⁷				x ⁵						-
Check & Clean/Replace Flame Arrestor ⁷				x						3-13
Replace Spark Plugs						х				3-14
Replace External Fuel Filter						х				-
Adjust Valve Lash						x ⁵				-
Replace Coolant, Pressure Cap & Ther- mostat							х			3-7
Clean Heat Exchanger							x ⁴			3-11
Replace Fuel Filter at Carburetor								x ⁵		-
Clean Cylinder Head & Recondition Valves & Valve Seats								x ^{5, 6}		-
Inspect Ignition Cables, Distributor Cap and Rotor ⁷								x ^{5, 8}		-
Check Generator Bearings, Drive Belt, Belt Tensioner & Drive Coupling								x ⁵	x ⁵	-

TABLE 3-1. PERIODIC MAINTENANCE SCHEDULE

1 - Includes Oil and Coolant Level checks and checks for leaks and damage in fuel, exhaust, coolant and raw water systems.

2 - See battery manufacturer's maintenance recommendations.

3 - Check for slippage, cracking and wear and adjust or replace as necessary (pump drive belt only).

4 - There is no zinc anode to replace.

5 - Must be performed by someone trained and experienced in marine gasoline genset service (Onan Dealer).

6 - EPA emissions requirement.

7 - Ignition Protected component. No substitutes for Onan supplied parts are permitted. See genset Parts Catalog.

8 - Inspect cables for hardening, cracks and chaffing. Inspect cap and rotor for cracks, pitting and corrosion. REPLACE EVERY 1800 HRS.

GENERAL INSPECTION

AWARNING 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.

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

Oil Level

Check engine oil level (Page 3-3).

Coolant Level

Keep the level of coolant in the recovery tank between COLD and HOT. 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 (Filling the System, Page 3-7). Then refill the recovery tank up to the COLD mark. Use the recommended mixture of antifreeze (Page 3-7).

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.

AWARNING 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 system 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 fuel hose.

AWARNING Fuel leaks can lead to fire or explosion. Stop leaks immediately. Do not run the genset if it causes fuel to leak.

Raw Water System

Clean out the sea water strainer if necessary and make sure the sea cock is open for genset operation. Also, when a water/exhaust separator is provided (see Installation Manual), open the sea cock for the water drain hose.

Battery Connections

Check the battery terminals and keep them clean and tight (Page 3-5). Loose or corroded terminals have high electrical resistance, which can cause hard starting and short starter life.

Mechanical

Look for mechanical damage. Start the genset and look and listen for any unusual noises and vibrations.

Check the genset mounting bolts to make sure they are secure.

Check to see that the genset air inlet and outlet openings are not clogged with debris or blocked. Keep the genset and generator compartment clean.

If the boat is equipped with an *e-Series Digital Display* (Page 10-1), monitor engine coolant temperature, oil pressure and battery voltage whenever the genset is running.

Ventilation Exhaust Blowers

The ventilation exhaust blowers must be kept in good working order to prevent accumulations of engine exhaust and gasoline vapors. Check for proper operation.

AWARNING Starting the genset without being able to ventilate the genset compartment could cause an explosion of gasoline vapors. Have the exhaust blowers repaired before starting the genset.

CHECKING ENGINE OIL LEVEL

Shut off the genset before checking engine oil level.

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

- 1. Pull the plug and dipstick out of the oil fill neck (Figure 3-1). The plug may be difficult to pull straight out. It is easier if you tilt the plug in its socket while pulling out. Wipe off the dipstick and thread it back into the fill neck and seat the plug, which snaps into its socket. Remove the plug and dipstick again and check the oil level on the dip stick.
- 2. Add or drain oil as necessary. See ENGINE OIL RECOMMENDATIONS (Page 1-2). Keep the oil level between the high and low beads on the end of the dipstick, as shown. It is not necessary to add oil between oil changes if the oil has not dropped more than 1/3 of the way between the high and low beads. A full quart (0.9 liter) can be added if the oil level is at the lower bead.

ACAUTION Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the high and low beads on the dipstick.

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



FIGURE 3-1. OIL FILL NECK AND DIPSTICK

CHANGING ENGINE OIL AND FILTER

AWARNING U. S. 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.

See Table 3-1 for scheduled oil change.

1. Run the genset until it is up to operating temperature, stop it and disconnect the negative (-) battery cable at the battery.

AWARNING 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 oil fill plug (Figure 3-1), open the front access door and drain the engine oil into a container by opening the drain valve (Figure 3-2). (The drain valve has a 3/8 NPT outlet for connecting a hose fitting to facilitate oil draining.) If an oil pump-out system is installed, follow the instructions provided.
- 3. Close the oil drain valve.
- 4. Spin off the old oil filter (Figure 3-2) 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 spin the new filter on by hand until the gasket just touches the mounting pad and tighten 3/4 turn.
- 6. Refill with 2 quarts (1.9 liters) of oil. See EN-GINE OIL RECOMMENDATIONS (Page 1-2). Check the level (Page 3-3) and add or drain oil as necessary.

ACAUTION Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the high and low beads on the dipstick.

- 7. Close the front access door and reconnect the battery cables (negative [-] last).
- 8. Dispose of the used oil and oil filter in accordance with local environmental regulations.



FIGURE 3-2. OIL FILTER AND DRAIN VALVE

BATTERY AND BATTERY CONNECTIONS

AWARNING Flames, sparks or arcing at battery terminals, light switches or other equipment can ignite battery gas causing severe personal injury — Ventilate the battery area before working on or near the battery — Wear safety glasses — Do not smoke — Switch a work lamp ON and OFF away from the battery — Do not disconnect the battery cables while the genset is running or a battery charger is on — Always disconnect the negative (-) cable first and reconnect it last.

See Table 3-1 for scheduled maintenance. Follow the battery manufacturer's instructions. Have the battery charging system serviced if DC system voltage is consistently low or high. Always:

- 9. Keep the battery case, terminals and cables clean and dry and the terminals tight at the battery and at the genset (Figure 3-3). Torque the battery cable terminals on the genset to 6.5 lb-ft (8.8 N-m).
- 10. Remove battery cables with a battery terminal puller.
- Make sure which terminal is positive (+) and which is negative (-) before making battery connections. Always remove the negative (-) cable first and reconnecting it last to reduce arcing.
- 12. Follow the manufacturer's recommendations when storing the battery. Disconnect the battery so that it does not discharge through the genset control during storage.
- Replace the insulting boots over the positive (+) terminals at the battery and at the genset.



FIGURE 3-3. BATTERY CABLE TERMINALS

ENGINE COOLING SYSTEM

Cooling System Overview

Refer to Figure 3-4. The engine is cooled by a pressurized, closed-loop liquid cooling system. Coolant is pumped through passages in the engine block, head and exhaust manifold. The exhaust manifold also serves as the engine coolant reservoir. The heat exchanger is mounted inside the exhaust manifold. Raw water (the flotation water) is pumped through tubes in the heat exchanger to cool the engine coolant. The raw water then passes through a hose into the exhaust-water mixer where it cools the exhaust gases and is expelled. The V-belt drives the coolant and the raw water pumps.



Pressure Cap

See Table 3-1 for scheduled replacement. The pressure cap is necessary for optimal engine cooling and reduced coolant loss.

Replenishing Normal Coolant Loss

Keep the level of coolant in the recovery tank between COLD and HOT. 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. Then refill the recovery tank up to the COLD mark. Use the recommended mixture of antifreeze.

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

Recommended Coolant Mixture

Use the best quality ethylene glycol antifreeze solution available. It should be fully formulated with rust inhibitors and coolant stabilizers. Use fresh water that is low in minerals and corrosive chemicals. Distilled water is best. Unless prohibited by shipping regulations, the genset is shipped with the recommended 50 / 50 mixture of water / ethylene glycol, which is good for -34° F (-37° C). In warmer climates and sea water environments a 60 / 40 mixture of water / ethylene glycol is recommended. Coolant capacity is 3.3 quarts (3.1 liters).

AWARNING Ethylene glycol antifreeze is considered toxic. Dispose of it according to local regulations for hazardous substances.

Changing Coolant

See Table 3-1 for scheduled change of coolant.

Draining the System: Have towels and containers ready to wipe up, collect and properly dispose of the coolant.

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable from the battery to prevent the engine from starting.

AWARNING Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.

- Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool, remove the front access door, top of the enclosure (Figure 3-7) and coolant pressure cap.
- 2. Drain the exhaust manifold/coolant reservoir by disconnecting the hose at the coolant pump inlet (Figure 3-4) and twisting it down into a container.
- 3. Drain the block by removing the cap on the drain fitting on the left side of the block (Figure 3-4). Use an 11/16 inch socket on a swivel and 12 to 18 inch extension. To catch the coolant and direct it into a container, insert the socket and extension through a piece of hose large enough to fit over the socket but shorter than the extension. The hose will catch the coolant as the cap is being unscrewed.

Coolant Hoses: Inspect and replace hoses that leak or are damaged.

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

ACAUTION 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.

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

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

Secure the top of the enclosure and front access door and reconnect the battery cables (negative [-] last) when done.

Siphon Break

AWARNING Bypassing a siphon break or failing to properly maintain it can lead to major engine damage due to flooding, which will not be covered by Warranty.

A siphon break is installed when the exhaust-water mixer (Figure 3-4) is below or less than 6 inches above the water line. Replace the siphon break if it is encrusted with deposits, which indicates leakage. 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 breaks.

Replacing the Thermostat

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

AWARNING Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.

See Table 3-1 for scheduled replacement. Referring to Figure 3-5, replace the thermostat as follows:

- 1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and remove the front access door, top of the enclosure (Figure 3-7) and pressure cap.
- 2. Remove the two thermostat housing bolts and pull off the housing, thermostat and gasket. The hose does not need to come off.
- 3. Clean off the gasket area and install the new thermostat and gasket. Apply Three Bond 1215 liquid sealant or equivalent to the top side of the gasket.
- 4. Replenish any lost coolant, secure the pressure cap, secure the top of the enclosure and front access door and reconnect the battery cables (negative [-] last).



FIGURE 3-5. THERMOSTAT

Adjusting V-Belt Tension

Referring to Figures 3-6 and 3-7, readjust belt tension as follows:

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

- 1. Disconnect the negative (-) cable at the battery to prevent the engine from starting.
- 2. For access, remove the front access door and belt guard, which is secure by 3 wing nuts.
- 3. Loosen both bolts so that the pump can pivot.
- 4. Pivot the pump out to tighten belt tension and then tighten the tension adjusting bolt. 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).
- 5. Tighten the bolts, secure the belt guard and front access door and reconnect the battery cables (negative [-] last).

Replacing the Raw Water Pump Impeller

See Table 3-1 for scheduled replacement. Have towels and containers ready and avoid spilling raw water on the electrical components below the pump. Referring to Figures 3-7, 3-8 and 3-9, replace the impeller as follows:

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

- 1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and *close the sea cock*.
- 2. For access, remove the front access door, belt guard and top of the enclosure, and if work space is limited, the end panel (Figure 3-7).



FIGURE 3-6. ADJUSTING V-BELT TENSION



FIGURE 3-7. ENCLOSURE PANEL SCREWS

- 3. Loosen the hose clamps shown in Figure 3-8 and disconnect the hoses.
- 4. Remove the two pump mounting bolts and belt and pull out the pump.
- 5. Remove the 4 pump cover screws (Figure 3-9) and remove the impeller and O-ring. Use two pliers to grip vanes on opposite sides if the impeller is difficult to remove. *It will be necessary to check for and cleanout pieces of the impeller from the heat exchanger and exhaust elbow if vanes have broken off.*
- 6. Install the new impeller. It helps to twist the impeller counter-clockwise (the way it turns) while squeezing it into the housing.
- 7. 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 and secure the O-ring and cover.

ACAUTION Do not lubricate with petroleum products like grease and oil which chemically attack impeller materials.

- 8. Remount the pump, reconnect the hoses, adjust V-belt tension (Page 3-9) secure the belt guard, the top of the enclosure and front access door.
- 9. If the sea water strainer is above the water line, fill it for faster prime and secure its cover.
- Open the sea cock, reconnect the battery cables (negative [-] last) and start the genset. The genset will shut down within 8 seconds if there is no raw water flow and the *amber* status lamp will blink shutdown Code No. 7 (Page 9-5). If it shuts down, find out why, remove any blockage and restart the genset.



FIGURE 3-8. REMOVING RAW WATER PUMP



FIGURE 3-9. REPLACING THE IMPELLER

Heat Exchanger

The heat exchanger has a cleanout cover and drain plug (Figure 3-10). Clean the raw water tubes if the engine keeps shutting down (Code No. 1) or the *e-Series Digital Display* indicates abnormally high engine temperatures. Drain the heat exchanger if there is a danger of freezing. (Freezing water can damage the heat exchanger raw water tubes. Unlike engine coolant, raw water will freeze in the heat exchanger.)

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

Cleaning and Draining the Heat Exchanger: To clean the tubes or to drain raw water:

- 1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and *close the sea cock*.
- 2. For access, remove the front access door, belt guard, top of the enclosure and end panel (Figure 3-7).
- 3. Have towels and containers ready to prevent spilling raw water on the electrical components below the heat exchanger.
- 4. Removing the raw water pump will make cleaning the tubes easier. (See Replacing the Raw Water Pump Impeller, Page 3-9.)
- 5. Remove the drain plug or cleanout cover. Clean and flush the tubes. The drain plug must be removed to get all the water out of the tubes. Do not use metal rods to clean the tubes. The tubes are made of relatively soft copper alloy and can be damaged.
- Use thread sealant on the drain plug and a new clean out cover gasket if the old one is torn or otherwise damaged. Reassemble all the parts that were disassembled for access. When reconnecting the battery, connect the negative (-) cable last.



FIGURE 3-10. HEAT EXCHANGER

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

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

- 1. Perform Steps 1 through 4 under *Cleaning and Draining the Heat Exchanger.*
- 2. Disconnect the two leads at the flow sensor and remove the sensor.
- 3. Disconnect the three hoses. (To work the coolant hose elbow off the fitting on the heat exchanger, it will be necessary to loosen the hose clamps on both ends.)

4. Remove the four mounting bolts and withdraw the heat exchanger.

Installing the Heat Exchanger:

- 1. Clean the mating gasket faces, taking special care not to scratch the face on the aluminum manifold.
- 2. Use a new gasket and insert the heat exchanger into the manifold. Torque the mounting bolts to 19 lb-ft (26 N-m).
- 3. Install the flow sensor using pipe thread sealant and reconnect the two leads in the harness.
- 4. Reconnect the hoses and reassemble all the parts that were disassembled for access. When reconnecting the battery connect the negative (-) cable last.

FLAME ARRESTOR

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

See Table 3-1 for scheduled maintenance.

- 1. For access, remove the front access door and top of the enclosure (Figure 3-7).
- 2. Remove the 3 screws that secure the intake resonator and lift if off (Figure 3-11).
- 3. Remove the 2 screws that secure the flame arrestor to the carburetor inlet elbow and lift it off. Block the intake to prevent objects from falling in while the flame arrestor is off.
- 4. Carefully clean and examine the flame arrestor. Replace it if it is warped, corroded or has enlarged holes in the steel mesh. Enlarged holes or gaps can let flame through to ignite flammable vapors outside the engine.

AWARNING Always replace a damaged flame arrestor to prevent ignition of gasoline vapors, which can result in severe personal injury or death.

- 5. Replace the gaskets if torn and reassemble the parts removed. Torque the 5 assembly screws to 8 lb-ft (11 N-m).
- 6. Secure the top of the enclosure and front access door and reconnect the battery cables (negative [-] last).



FIGURE 3-11. FLAME ARRESTOR

SPARK PLUGS

AWARNING Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.

See Table 3-1 for scheduled replacement. For access, remove the front access door and top of the enclosure (Figure 3-7).

The 3 spark plugs (Figure 3-12) must be in good condition for proper engine starting and performance. A spark plug that fouls frequently indicates the need for engine service.

Clear the spark plug wells of dirt and liquid before removing the spark plugs.

Set spark gap at 0.039-0.043 inches (1.0-1.1 mm). To prevent cross threading, always thread a spark plug in by hand until it seats and then torque to 15-18 lbs-ft (20-24 N-m).

Secure the top of the enclosure and front access door and reconnect the battery cables (negative [-] last).



FIGURE 3-12. SPARK PLUGS

4. Enclosure, Drip Pan and Mounting System

ENCLOSURE PANELS

The genset enclosure panels and access door are assembled as shown (Figure 4-1).

AWARNING 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. *Front Access Door:* The access door has two latches and provides access for most of the periodic maintenance procedures.

Top Panel: The top panel is secured by 5 screws to the rear and end panels. Remove it for access to the spark plugs, flame arrestor, carburetor, governor, rocker arm cover, etc.



FIGURE 4-1. GENSET ENCLOSURE

Right End Panel: The main panel is secured by 5 screws, 1 near each corner and 1 near the center. The sub-panel is secured by 3 screws. Remove these panels for access to the engine components on the right side (Page 3-6).

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

Left End Panel Assembly: This panel assembly is secured by 3 screws to the drip pan, 3 along its back edge, and 1 at the top. The AC output box is secured at the top by 4 screw. To remove the assembly, re-

move all of the other panels (except the back), disconnect all connections in the AC output box, disconnect all internal wiring, disconnect the flexible air tube and remove the two screws that secure the oil fill neck to the control panel (Page 8-9).

DRIP PAN AND VIBRATION ISOLATORS

Two of the three vibration isolation mounts (Figure 4-2) are bolted to the engine-generator adapter (Page 7-1) and one to the front engine mounting bracket (Page 8-2). Torque the isolator through bolts and the two isolator flange screws to 20 lb-ft (27 N-m). *Note that the green-dot isolators (2) are for the rear mounts and the blue-dot isolator for the front mount.*



FIGURE 4-2. DRIP PAN AND VIBRATION ISOLATION MOUNTS

5. Control System

The control board is an integrated microcontrollerbased engine and generator control (Figure 5-1). It provides all the control, monitoring and diagnostic functions required to operate the genset. All connections to the controller are through connectors P1 (black), P2 (grey) and P3 (green). Refer to the wiring diagrams and wiring harness drawings on Pages A-1 through A-3.



FIGURE 5-1. CONTROL SYSTEM COMPONENTS

CONTROL BOARD (CONTROLLER)

Control Board Removal / Replacement

AWARNING 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 control board is secured to the access cover by 2 screws (Figure 5-1). The cover is secured by 4 screws to the enclosure end panel. To remove the control board, first disconnect the 3 connectors (P1, P2, P3) by squeezing the locking tabs on the sides of the connectors while pulling out. The connectors are accessible by removing the front access door. Then remove the 4 cover screws and withdraw the control board with the cover.

When reinstalling a connector plug, make sure the seal is in place and that the locking tabs snap into position.

Major Functions

Figure 5-2 is a block diagram of control board functions.

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 3 seconds to cause fuel pump E5 to prime the fuel lines and carburetor float bowl.

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

- 1. Energizes fuel lift pump E5.
- 2. Enables ignition.
- 3. Enables the *amber* status lamp to blink rapidly.
- 4. Enables some fault detection.
- 5. Enables cranking. The maximum allowed duration of cranking is 20 to 60 seconds depending on temperature.
- 6. Enables field flash (F1-F2).

- 7. Enables governor actuator A12. See Operation During Cranking, Page 8-4.
- 8. Disconnects the starter (B1) at 800 rpm.
- 9. When operating speed is reached:
 - A. Enables output voltage.
 - B. Energizes choke heater relay K4.
 - C. Turns off field flash.
 - D. Turns off amber status lamp.
 - E. Turns on green run lamp.
 - F. Enables Switched B+ (J7).
 - G. Enables complete fault detection.

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

- 1. Disables output voltage.
- 2. Deenergizes the fuel lift pump, ignition and governor actuator.
- 3. Turns off the green run lamp.
- 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.

Fuel Control: The controller maintains nominal frequency as load varies by modulating the pulse width of the current energizing governor actuator A12, which moves the throttle.

Voltage Control: The controller maintains nominal AC output voltage during steady state operation by modulating field current as load varies. In response to transient loads it lowers the voltage setpoint to allow engine recovery. Field power (DC) is supplied by the quadrature windings (AC) through the controller.

Voltage Adjustments: See ADJUSTING VOLT-AGE (Page 6-5).

Changing Frequency: See CHANGING FRE-QUENCY (Page 6-5).

Fault Monitoring, Shutdown and Diagnostics: See *Troubleshooting* (Page 9-1).



FIGURE 5-2. CONTROLLER BLOCK DIAGRAM
CONTROL SWITCH S4

The switch is mounted on the control panel (Figure 5-1). Unsnap the connector for access to its terminals. 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 12 VDC is applied across terminals 7 (-) and 8 (+), or *Amber* when 12 VDC is applied to terminals 7 (-) and 6 (+).

Note: The switch snaps in either way on the control panel. The row with 2 terminals must be up, otherwise Start and Stop will be reversed.

EMERGENCY SWITCH/BREAKER CB1

The switch/circuit breaker is mounted on the control panel (Figure 5-1). 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.

HOUR METER M11

The hour meter is mounted on the control panel (Figure 5-1).

LINE CIRCUIT BREAKER

AWARNING 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 breaker is mounted in the AC output box (Figure 5-1). Disconnect all leads and check electrical continuity across each pole. Replace the circuit breaker if either pole does not reset or turn ON and OFF. Reconnect the generator and load wires properly (Page A-2).

START RELAY K5

This relay is mounted in its socket inside the enclosure (Figure 5-1), accessible through the front. To test the relay, remove it from its socket. Apply 12 VDC across coil terminals **85-86**. Replace the relay if the contacts across terminals **30-87** do not close.



FIGURE 5-3. CONTROL SWITCH S4

CHOKE RELAY K4

This relay is mounted in its socket inside the enclosure (Figure 5-1), accessible through the front. To test the relay, remove it from its socket. Apply 12 VDC across coil terminals **85-86**. Replace the relay if the contacts across terminals **30-87** do not close.

ENGINE OIL PRESSURE SENDER E1

The oil pressure sender is threaded into the side of the block with pipe fittings (Figure 5-5) and is accessible by removing the right side panel or the raw water pump (Page 3-9). Use thread sealant and engage at least two full threads when installing.

Replace the sender if resistance is not between 227 and 257 ohms when the engine is idle (0 psi), or is not reasonably steady between 50 and 200 ohms when the engine is running and known to have normal oil pressure.

ENGINE COOLANT TEMPERATURE SENDER E2

The engine coolant temperature sender is threaded into the top of the head (Figure 5-5) and is accessible by removing the top panel. Use thread sealant and engage at least two full threads when installing.

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



FIGURE 5-4. OIL PRESSURE SENDER



FIGURE 5-5. COOLANT TEMPERATURE SENDER

RAW WATER FLOW SWITCH S6

AWARNING 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 raw water flow switch is threaded into the heat exchanger (Figure 5-6) and is accessible by removing the top panel. 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. It is a normally closed switch.

HIGH EXHAUST TEMPERATURE SWITCH S5

The high exhaust temperature switch is bolted to the ear on the side of the water/exhaust mixer (Figure 5-6). The switch is accessible by removing the enclosure end or rear panel. It is a normally closed switch.

BATTERY CHARGING REGULATOR A1

Mounting: The regulator and heat sink are mounted on the generator air intake duct (Figure 5-1). It is accessible by removing the front access door.

Testing: See Page 6-4 to test the battery charge winding B1-B2. To test the regulator:

- 1. Disconnect any external battery chargers.
- 2. Start the genset and check DC voltage across the battery terminals on the genset.
- 3. Replace the regulator if the battery charge windings are good but DC voltage does not increase to 12.5 volts while the genset is running.



FIGURE 5-6.RAW WATER FLOW AND HIGH EX-HAUST TEMPERATURE SWITCHES

IGNITION COIL

AWARNING 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 ignition coil (Page 5-1) is mounted on the left bulkhead inside the front access door.

To test the coil, disconnect the high-tension cable and the leads at the + and - terminals. Replace the coil if resistances are not as specified in Table 5-1.

TABLE 5-1 IGNITION COIL WINDING RESISTANCES

	Resistance (Ohms)	
Primary Coil (+ to -)	1.3 to 1.6	
Secondary Coil	10.7 to 14.5	

EXTERNAL SHUTDOWN DEVICES

External Shutdown Device Connectors

The genset wiring harness has leads with quickconnect terminals labeled **SWB+**, **ESTOP** and **CO** (Page A-3) for connecting external shutdown devices. They are accessible by removing the access cover on the left end of the genset (Page 4-1). **ES-TOP** can be connected to have a fire suppression or other emergency system shut down the genset. **CO** can be connected to have a CO detector shut down the genset.

External Shutdown Devices

The genset will stop running if the circuit is opened between **SWB+** and either of the other two connectors, **ESTOP** or **CO**. Therefore use normally closed (NC) shutdown devices. The total load on **SWB+** must not exceed 0.5 amps.

Factory Jumpers

The genset leaves the factory with **SWB+** jumpered to the other two connectors, **ESTOP** and **CO**. Leave the jumpers connected when no external shutdown devices are to be connected, otherwise the genset will not run.

Shutdown Indication

If shutdown occurs due to either device, the *e-Series Digital Displays* will display, respectively, **Code No. 5: Warning—Shutdown due to Vessel CO** or **Code No. 61: Emergency Shutdown**. See *Troubleshooting* (Page 9-1). (All of the status indicator lights in the control circuit will also blink the fault code.)

FUEL ANTI-SIPHON DEVICE

If any part of the fuel line is routed below the top of the fuel tank, a fuel anti-siphon device must be installed at the tank fitting to prevent accidental discharge of gasoline.

Check Valve-Type Anti-Siphon Devices

A fuel check valve used as an anti-siphon device must not require a pull-off vacuum of more than 1.6 inches Hg (5.5 kPa or 0.8 psi).

Solenoid-Type Anti-Siphon Devices

The genset wiring harness has leads with quickconnect terminals labeled **SWB+** and **CUSTOMER GND** (Page A-3) that can be connected to power a pilot relay for a fuel solenoid stop valve at the fuel tank fitting. They are accessible by removing the access cover on the left end of the genset (Page 4-1). The total load on **SWB+** must not exceed 0.5 amps.

Note: The genset leaves the factory with SWB+ jumpered to two other connectors, ESTOP and CO. When making connections for a fuel solenoid pilot relay, SWB+ must continue to be jumpered to ESTOP and CO unless they are connected to normally closed external shutdown devices, otherwise the genset will not run.

GOVERNOR ACTUATOR

See Page 8-4.

FUEL SOLENOID E3

See Page 8-6.

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6. Generator

These are 2-bearing, belt-driven, 2-pole revolvingfield generators with brushes and slip rings (Figure 6-1). Output voltage is regulated by the microcontroller-based genset controller (Page 5-1).

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

Rotor: The rotor consists of a shaft with steel laminations wrapped with field windings. A molded slip ring assembly is pressed on to supply field current to the rotor windings through the brush block assem-

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

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

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



FIGURE 6-1. GENERATOR

SERVICING THE GENERATOR

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

Stator Removal

- 1. Disconnect the generator leads inside the AC outlet box and remove the front access door and top and left-end panels (Page 4-1).
- 2. Remove the brush block (Figure 5-1).

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

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

10. Block the rotor to support its hanging weight to prevent damage to the adapter and bearing.

Stator Reassembly

Reassembly is the reverse of removal. Note the following:

- 1. Loosen the end bell support bracket bolts, if not already removed, so that the bracket does not interfere with proper stator and end bell alignment.
- 2. Align the stator and end bell with the lines scribed on them during disassembly.
- 3. Relubricate the bearing bore in the end bell with molybdenum disulfide paste (Onan PN 524-0118 or equivalent).
- 4. Make sure the wave washer and O-ring are in place in the bearing bore.
- 5. Torque the stator through bolts and end bell bracket bolts to 8 lb-ft (11 N-m) and the fan hub bolt to 45 lb-ft (61 N-m). (To keep the rotor from turning while tightening the fan bolt, hold the pulley bolt with a wrench.)

Rotor

To remove the rotor, remove the stator and then the drive pulley (Page 7-2) and pull the rotor straight out to the front. When reassembling, lubricate the bearing bores in the end bell and adapter with molybdenum disulfide paste (Onan PN 524-0118 or equivalent). Make sure that the O-rings are in place in the bearing bore groves in both ends and that the wave washer is in place in the bearing bore in the enginegenerator adapter (Page 7-1).

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

ACAUTION Apply force only to the bearing inner race to avoid damage to the bearing.

SERVICING BRUSHES AND SLIP RINGS

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

Brush Block

Access: For access to the brush block (Figure 5-1), remove the access panel on the left-end panel of the the enclosure (Page 4-1) and the brush block cover.

Service: Disconnect the field leads from the brush block (Figure 6-2), remove the mounting screw and withdraw the brush block from the generator end bell. Replace the brush block assembly if either brush is shorter than 7/16 inch (11 mm), binds in the brush block or is damaged in any way.

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

Make sure to replace the brush block cover, which is an integral part of the ignition protection system.

Slip Rings

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

TESTING FIELD FLASH

Field flash can be tested by measuring output voltage while cranking with the carburetor fuel solenoid disconnected (Page 8-4) to keep the engine from starting. If output voltage increases at least 1 volt while cranking, the whole field excitation system controller, brushes, slip rings and rotor—are probably in working order and the problem lies elsewhere. See *Troubleshooting* (Page 9-1).



FIGURE 6-2. BRUSH BLOCK

TESTING GENERATOR WINDINGS

Testing the Rotor

Field Resistance Test: Disconnect field leads F1 and F2 from the controller by pulling green connector P3 and measure resistance across pins 6 and 7. If resistance is not as specified in Table 6-1:

- 1. Check for and repair faulty field leads.
- 2. Service brush block and slip rings (Page 6-3).
- 3. Check rotor resistance across the slip rings (Figure 6-3). Replace the rotor if resistance is not as specified.

Ground Test: Using a megger or the highest scale on a digital ohmmeter, measure resistance between the rotor and either slip ring (Figure 6-4). Replace the rotor if its winding has less than one megohm resistance to ground.

Testing the Stator

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

Note: To measure resistance across the full quadrature winding (Q1-Q2) on a 60 Hz genset, measure resistance across P3-4 and P7-2. P7-2 (Page A-3) is accessible in the wiring harness behind the ignition coil.

Open Winding Test: Measure resistance across each winding lead pair (Table 6-1). Replace the stator if any winding is open (zero ohms).

Winding Resistance Test: Use a meter (Wheatstone Bridge) having 0.001 ohm precision to measure resistance across each winding lead pair (Table 6-1). Replace the stator if resistance in any winding is not as specified.

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

TABLE 6-1. GENERATOR WINDING RESISTANCES

WINDING	RESISTANCE (OHMS) @ 77° F (25° C) ± 10%		
	107 mm Stack	150 mm Stack	
T1-T2, T3-4	0.154	0.111	
Q1-Q2	1.89	1.66	
B1-B2	0.061	0.037	
F1-F2	21.6	25.5	



FIGURE 6-3. OPEN OR SHORTED ROTOR TEST



FIGURE 6-4. GROUNDED ROTOR TEST

RECONNECTING THE GENERATOR

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

CHANGING FREQUENCY

When it is necessary to change the output frequency for the application, remove the front access door and find connectors **P6** and **P7** (Page A-3) in the wiring harness just behind the ignition coil. Connect **P6** to **J5** for **60 HZ** or **P7** to **J5** for **50 HZ**.

Note 1: When it is necessary to change frequency, make sure the line circuit breakers are suitable for the new output. Replace them if necessary with ones of appropriate rating.

Note 2: Check and adjust voltage as necessary after frequency has been changed.

ADJUSTING VOLTAGE

AWARNING HAZARDOUS VOLTAGE! Touching uninsulated live parts inside the genset or connected equipment can result in severe personal injury or death. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands and use tools with insulated handles.

Output voltage may need to be readjusted for the application, especially if it was necessary to change the frequency and/or reconnect the generator (Page A-2). Recheck generator reconnections and reconsider whether frequency needs to be changed before attempting voltage adjustments.

Using Start Switch

- 1. Start the genset and let voltage and frequency stabilize for 5 to 10 seconds.
- 2. Rapidly press **START** 6 times *during the first minute after startup* to put the genset controller into *voltage adjust mode*. The amber status light will begin blinking about once every second to indicate the change to voltage adjust mode. The green status light 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 light to stop blinking and then press **STOP** to save the adjustment.
- 6. Restart the genset and check voltage.

Using e-Series Digital Display

See *e-Series Digital Display* (Page 10-1) for details regarding use of the e-Series Digital Display.

- 1. Start the genset and let voltage and frequency stabilize for 5 to 10 seconds.
- Rapidly press START 6 times during the first minute after startup to put the genset controller into voltage adjust mode. The green status light will begin blinking about once every second and the Display will indicate a Status change from Running to Volt Adj (Figure 6-5).
- 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 save the adjustment.
- 6. Restart the genset and check voltage.

GEN STATUS Pg1 Status: Volt Adj AC Volts 120V AC Freq 60Hz SETUP FAULT SCREEN Ŧ

FIGURE 6-5. VOLTAGE ADJUSTMENT SCREEN

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7. Generator Drive

The engine drives the generator by means of a 6-rib "Poly-Vee" belt (Figure 7-1). The drive pulley is mounted on the engine flywheel by means of a flexible coupling. The generator pulley is center-bolted to the tapered end of the rotor shaft. The pulley must be removed to remove the generator rotor from the engine-generator adapter.



FIGURE 7-1. GENERATOR DRIVE

INSPECTING DRIVE AND BEARINGS

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

Remove the rear panel (Page 4-1) to inspect the drive and bearings:

- 1. Pivot the belt tensioner away from the belt with a 3/8 inch drive and remove the belt. Examine the belt for cracks, worn spots and other signs of deterioration. Replace the belt if necessary or if it has been in service 5 years or 2000 hours.
- 2. Remove the drive pulley and coupling as an assembly from the flywheel and then the pulley from the coupling. Examine the coupling for wear and deterioration and replace it if necessary. Examine the two split-sleeve bearings in the pulley hub for wear and scoring and replace them if necessary. Replace the rubber coupling if it has been in service 5 years or 2000 hours.

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

- 3. Spin the idler pulley. Replace the bearing if it does not spin smoothly or is noisy. Replace the idler assembly if it does not pivot smoothly from one end of its travel to the other.
- 4. Spin the generator pulley by hand to determine if there is any noise, looseness or grinding. Check for side-to-side and up-and-down looseness of the bearing. If necessary, disassemble the generator (Page 6-2) to determine the cause of the looseness or noise. Replace the rotor assembly if it is evident that either bearing has spun on the shaft. Replace the end bell or adapter if it is evident that the bearing has spun in the bore. Replace the bearings if they have been in service 5 years or 2000 hours.

SERVICE

Generator Pulley

Remove the belt and pulley center bolt and use a claw-type wheel puller to break the pulley free of the generator shaft taper. (To keep the rotor from turning while loosening the pulley bolt, hold the fan bolt with a wrench.) Torque the center bolt to 45 lb-ft (60 N-m) when reassembling. Make sure to install the generator inlet air duct before installing the pulley.

Generator Inlet Air Duct

Torque the 4 mounting bolts to 8 lb-ft (12 N-m). *Make sure to install the air inlet duct and its air seal-ing gasket before installing the pulley.*

Tensioner Pulley Assembly

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

Drive Pulley and Coupling

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

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

Flywheel

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

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

Engine-Generator Adapter

To remove the adapter, first remove the engine-generator assembly from its mounting (Page 4-2), the generator (Page 6-2) from the adapter and the flywheel from the engine. Torque the 6 mounting bolts to 21 lb-ft (29 N-m) when reassembling.

ENGINE SERVICE

AWARNING 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.

Major Engine Service

Refer to engine Workshop Manual 981-0538 for major engine service and for adjusting valve clearance (lash), setting ignition timing, cleaning the crankcase breather assembly and replacing the coolant pump.

Cooling System

Refer to ENGINE COOLING SYSTEM (Page 3-6) for replacing thermostat, raw water impeller, heat exchanger and V-belt.

Ignition Timing Marks

Note the ignition timing marks (Figure 8-1), which line up at 18° BTDC. They are visible when the top, rear or end panel is removed (Page 4-1).

Adjusting Valve Lash

Do not use the ignition timing marks (Figure 8-1) when adjusting valve lash. Using them could lead to misadjustments.

The rocker arm cover is accessible when the top panel is removed (Page 4-1).

Valve lash should be adjusted when both valves are closed at TDC for the cylinder power stroke (every other revolution). To locate this position for any cylinder, rotate the engine clockwise (looking from the front) until the intake valve push rod (Figure 8-2) just stops moving down (valve closed). Then turn the engine one half turn more and adjust lash for both valves (intake and exhaust). Repeat this procedure for the other cylinders. Adjust valve lash to 0.0059-0.0073 inch (0.145-0.185 mm).



FIGURE 8-1. IGNITION TIMING MARKS



FIGURE 8-2. ROCKER ARMS AND PUSH RODS

ENGINE MOUNTING

Figure 8-3 illustrates the front engine mounting bracket. Torque the 4 bracket bolts to 20 lb-ft (27 N-m). The other 2 mounting points are on the engine-generator adaptor (Page 7-1). See Page 4-2 regarding assembly to the vibration isolation mounts.

STARTER

AWARNING 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 starter motor (Figure 8-4) is accessible for removal and installation by removing the right-end panel of the enclosure (Page 4-1). Alternatively, it can be removed and installed through the front access opening if the raw water pump is removed (Page 3-9). Parts are available for rebuilding the starter.

Torque the mounting bolts to 29 lb-ft (39 N-m).

Make sure starter B+ is connected to genset B+.



FIGURE 8-3. ENGINE MOUNTING BRACKET



FIGURE 8-4. STARTER MOTOR

EXHAUST MANIFOLD

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

Figure 8-5 illustrates how the exhaust system is assembled. For access remove the front access door and top and right-end panels of the enclosure (Page 4-1).

Use new manifold and mixer gaskets when reassembling. Torque the 6 manifold nuts and the 3 mixer bolts to 8 lb-ft (11 N-m).



FIGURE 8-5. EXHAUST MANIFOLD/COOLANT RESERVOIR

GOVERNOR ACTUATOR

The governor actuator (Figure 8-6) is secured by three screws to the intake manifold. The actuator and throttle levers are connected by a link and spring. Remove the top panel of the enclosure (Page 4-1) for access to the actuator.

AWARNING 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.

Connecting the Throttle Link

Make sure that the throttle link passes through the spring and that both link and spring hook into the grommets in the throttle and actuator levers. When reassembling, hook the link and spring on both ends and then secure the actuator with its 3 mounting screws. Torque the actuator mounting bracket screws to 8 lb-ft (11 N-m).

Testing the Actuator

To test the actuator:

- 1. Disconnect the 2 leads and measure coil resistance. Replace the actuator if resistance is not between 2.47 and 2.67 ohms at room temperature.
- Connect the 2 leads to 12 VDC, observing + and - polarity. The actuator should sweep smoothly from closed throttle to wide open throttle without binding, and return smoothly when power is disconnected. Replace the actuator if it does not function or provide smooth, full travel when 12 VDC is applied.

Operation During Cranking

During cranking the genset controller causes the actuator to drive the throttle wide open for 3 seconds. If the engine has not started, the actuator will quickly close the throttle and then slowly ramp it open and closed until the engine starts.

If the engine fails to start, remove the top panel of the enclosure and watch the throttle while cranking. If the actuator functions as described, the problem is not with the actuator or genset controller.



FIGURE 8-6. GOVERNOR ACTUATOR

CARBURETOR / CHOKE ASSEMBLY

Remove the top panel of the enclosure (Page 4-1) for access to the carburetor/choke assembly.

AWARNING 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.

Carburetor

The carburetor (Figure 8-7) is not likely to cause problems and should be replaced only after all other problems have been eliminated (see Section 9. *Troubleshooting*). The carburetor fuel mixture adjustments are sealed at the factory. See Page 8-5 to connect the throttle link.

When replacing the carburetor make sure to install the insulating jacket (in the kit) around the float bowl to prevent fuel vapor lock. Torque the mounting nuts to 8 lb-ft (11 N-m).

Automatic Choke

The automatic choke is operated by a bi-metal/heater assembly and a vacuum breaker assembly (Figure 8-7). Conduct the following checks before replacing the carburetor/choke assembly:

- 1. Apply 12 VDC across the heater terminals. The choke should open fully in 1 to 2 minutes.
- The choke should be closed at temperatures below 70° F (21° C). It may be partly open above 70° F (21° C), but should close almost completely when vibrated (engine cranked).
- 3. The vacuum breaker diaphragm must not leak under a vacuum of 30 inches Hg (100 kPa). It should not take a vacuum greater than 2.4 inches Hg (8 kPa) to fully open the choke.

Fuel Solenoid E3

The fuel solenoid is threaded into the side of the carburetor float bowl (Figure 8-7). If the engine does not start because it is not getting fuel, but fuel can be drained from the carburetor float bowl, the solenoid probably is not opening and should be replaced.

Flame Arrestor

See Page 3-13 regarding scheduled maintenance of the flame arrestor, which is mounted on the carburetor adaptor.



FIGURE 8-7. CARBURETOR/CHOKE ASSEMBLY

FUEL PUMP

Figure 8-9 illustrates the fuel system for delivering fuel to the carburetor. The incoming fuel is cooled by the incoming raw water used to cool the engine.

AWARNING 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.

AWARNING Gasoline is flammable and explosive and can cause severe personal injury or death — Do not smoke — Keep flames, sparks, pilot lights, switches, arc-producing equipment and all other ignition sources away from fuel, fuel components and areas sharing ventilation — Keep an ABC fire extinguisher handy.

AWARNING Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.

Fuel Filters

See Table 3-1 for scheduled fuel filter replacement. A fuel filter is installed at the inlet to the carburetor (Figure 8-9). An external in-line fuel filter should also be installed. This filter must be readily accessible for regular replacement and be install as close as possible to the genset.

When replacing the fuel filter at the carburetor make sure to install the insulating jacket around it to prevent fuel vapor lock.

Use only *liquid-type* pipe thread sealant Listed as suitable for gasoline on the threads of the carburetor

filter. Apply the sealant sparingly to the male threads only. Debris from Teflon tape or excess liquid sealant can clog the small fuel orifices in the carburetor or cause the float valve not to seat properly.

Fuel Hose

Replace worn or damaged fuel hose with with USCG TYPE A1 fuel hose. The hose between the fuel pump and carburetor (Figure 8-9) must be long enough to be routed over the front engine mounting bracket. Also, make sure to install the insulating jacket around the hose to prevent fuel vapor lock.

Maximum Fuel Pump Lift

The genset fuel inlet fitting must not be more than 48 inches (122 cm) higher than the bottom of the fuel pickup tube. The suction required at the genset fuel inlet to overcome lift and line flow resistance (including fittings, filters and valves) must not exceed 3 inches Hg (10 kPa).

Testing Fuel Pump Delivery

To test fuel lift pump delivery:

- 1. Disconnect the fuel hose from the fuel filter at the carburetor and point the end into a container of known volume, such as a 1 or 2 liter (quart) bottle.
- Prime the genset by pushing the Start/Stop switch to STOP(Prime) and holding it there for the duration of the test. It should not take longer than 1-1/2 minutes to fill a 1 liter container (2/3 liter per minute).
- 3. If flow is less than specified, service all of the fuel filters in the system and repair any restrictions to fuel flow. If fuel delivery is still weak, replace the fuel lift pump.

Replacing Fuel Pump

To remove the fuel pump only, leaving the external fuel and water connections intact:

- 1. Remove the right-end panel of the enclosure (Page 4-1).
- 2. Disconnect the fuel outlet tubing.
- 3. Remove the 2 U-tube clamp screws and the 2 fuel pump mounting screws and slide the bracket out of the way so that the pump can be unscrewed from the inlet fitting (Figure 8-8).
- 4. Unscrew the pump using 2 wrenches, one on the pump and the other on the fitting so that the fuel cooler is not damaged.

Installation is the reverse of removal.

Pipe Thread Fuel Fittings

Use only *liquid-type* pipe thread sealant Listed as suitable for gasoline. Apply the sealant sparingly to the male threads only. Debris from Teflon tape or excess liquid sealant can clog the fuel pump and filters.



FIGURE 8-8. REMOVING FUEL PUMP



FIGURE 8-9. FUEL SYSTEM

This page is intentionally blank.

TABLE 9-1 lists the shutdown codes in numerical order along with step-by-step corrective actions. First note the following:

- Maintaining engine oil and coolant levels, cleaning the sea water strainer, keeping battery connections clean and tight, watching the fuel gauge and not overloading the genset will prevent most shutdowns.
- When the genset and propulsion engines share a common fuel tank, the fuel dip tubes are usually arranged so that the genset will run out of fuel first. Marking the genset empty point on the fuel gauge will make it easier to tell when to stop the genset before running it out of fuel.

TROUBLESHOOTING WITH THE BLINKING AMBER STATUS LIGHT

For the purposes of diagnostics, the genset controller causes the *amber* status light (LED) on the control switch to blink the fault code number when the genset shuts down abnormally. The light will blink 1, 2, 3, 4, 5 or 7 times, pause, and then repeat the blinking. *The number of blinks corresponds to the Fault Number in TABLE 9-1.*

- **One blink** indicates shutdown due to high engine temperature.
- **Two blinks** indicate shutdown due to low oil pressure.
- Three blinks indicate shutdown due to a condition normally requiring service by someone trained and experienced in marine gasoline genset service. Before assistance arrives, you may be asked to help by accessing the second-level, two-digit shutdown code. To do so, press STOP once. The two-digit code consists of 1 to 6 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, the light blinks Fault Code No. 24 as follows:

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

- Four blinks indicate shutdown due to a failure to start within the time allowed for cranking.
- Five blinks indicate shutdown initiated by a CO monitor in the vessel.
- Seven blinks indicate shutdown due to a loss of raw water flow for engine and exhaust cooling.

Blinking continues for five minutes and stops. Pressing **STOP** three times restores blinking. (If you press **STOP** again, blinking stops entirely and you have to start over by pressing **STOP** three times.)

Note: The last shutdown logged will blink, even though the condition that caused shutdown has been serviced.

TROUBLESHOOTING WITH THE E-SERIES DIGITAL DISPLAY

When a fault occurs, the genset controller will cause the *e-Series Digital Display* (Page 10-1) to flash the red ALARM LED and display the Fault Number and a brief description of the Fault (Figure 9-1). Find the corresponding Fault Number in *TABLE 9-1* and follow the step-by-step procedures to correct the fault.

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 [**4**BACK] to go back to the GEN STATUS screen.

See Page 10-2 to display the last fault.

FAULT Eng coolant temp sensor fault				
Fault No. 24				
▲BACK	ALARM	LAST		

FIGURE 9-1. TYPICAL FAULT SCREEN

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

NO LIGHTS, NO RESPONSE

(Faulty connections, no battery voltage)

Corrective Action: (Refer to Pages A-1 and A-3.)

- Try the local genset control switch (S4) if the remote control switch (S11) or *e-Series Digital Display* does not work, and vice versa. If neither works, go to Step 2. If only local switch S4 works, go to Step 11. If only remote switch S11 or *e-Series Digital Display* work, go to Step 13.
- **2**. At the genset control panel, push emergency stop switch CB1 to ON.
- 3. Clean and tighten the positive (+) and negative (-) battery cable terminals at the battery and genset (Page 3-5).
- 4. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
- Disconnect both leads from emergency stop switch CB1 (Page 5-1). Check for B+ at lead CB1-1. If there is no B+, clean and tighten connections and replace wiring as necessary. If there is B+, test CB1 and replace if necessary.
- 6. Disconnect connector P2 (grey) from genset controller (Page 5-1) and check for B+ at Pins 1 and 12. If there is no B+, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
- 7. While P2 is disconnected, check for continuity between Pins 6 and 10 and B- (ground). If open, check for a missing, bent or corroded pins and faulty wiring and repair as necessary.
- 8. While P2 is disconnected, disconnect P1 (black) and the connector on control switch S4 (Page 5-4). Check continuity between between the following points: P1-7 and S4-2, P2-3 and S4-1, P2-2 and S4-3, P2-4 and S4-6, and P1-3 and S4-8. If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
- 9. Test switch S4 and replace if necessary (Page 5-4).
- 10. Replace genset controller (Page 5-2).
- **11**. Disconnect remote connector P4 and check for continuity in the remote wiring by checking continuity between pins 4 and 3 when the remote switch is held at START and between Pins 4 and 2 when the remote switch is held at STOP. Repair or reconnect the remote wiring as necessary.
- 12. Disconnect connectors P1 (black) and P2 (grey) and check continuity between between the following points: P1-3 and J4-6, P1-7 and J4-4, P2-2 and J4-3, P2-3 and J4-2, P2-4 and J4-5, P2-7 and J4-7 P2-8 and J4-8, and J4-1 and B- (ground). If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
- **13**. Disconnect connectors P1 (black) and P2 (grey) and check continuity between between the following points: P1-7 and S4-2, P2-3 and S4-1, P2-2 and S4-3, P2-4 and S4-6, and P1-3 and S4-8. If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
- 14. Test switch S4 and replace if necessary (Page 5-4).

STARTER ENGAGES-DISENGAGES

(Cranking voltage dips below 6 volts—low battery charge, poor connections, long cables)

Corrective Action:

- 1. Clean and tighten the positive (+) and negative (-) battery cable connections at the battery and genset (Page 3-5).
- 2. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
- 3. Increase battery cable size or run parallel cables.

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

STATUS INDICATOR LIGHT STOPS BLINKING OR GOES OUT DURING CRANKING

(Internal short circuit caused automatic-reset circuit protective device to trip)

Corrective Action:

- 1. Try starting again.
- 2. Replace genset controller (Page 5-1) if the *amber* lamp flashes and then goes out again without the engine starting, or does not light at all with good batteries.

NO POWER—GENSET RUNNING, STATUS LIGHT ON

(Line circuit breaker OFF or tripped)

Corrective Action:

- 1. Turn on, reset or repair line circuit breaker CB3 on the genset (Page 5-4).
- 2. Turn on, reset or repair the line circuit breakers on the main distribution panel in the boat.

ENGINE CRANKS, STARTS, ACCELERATES, BUT STOPS WHEN START SWITCH RELEASED

(Open field or open or grounded quadrature circuit)

Corrective Action: Check for an open field or open or grounded quadrature circuit (Page 6-4) and service as necessary.

HIGH ENGINE TEMPERATURE: NO. 1

(First-level shutdown—Engine coolant temperature exceed design limit)

Corrective Action:

- 1. Add coolant as necessary and repair leaks (Page 3-6).
- 2. Clean the raw water tubes in the heat exchanger, which might be clogged with scale (Page 3-11).
- 3. Replace the engine thermostat, which might not be opening fully (Page 3-8).
- 4. Flush the coolant system to remove coolant passage fouling (Page 3-7).
- 5. Test coolant sender E2 (Page 5-5) and replace if necessary.

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

LOW OIL PRESSURE: NO. 2

(First-level shutdown—Low oil pressure)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Add engine oil as necessary (Page 3-3) and repair any leaks.
- 2. Drain excess oil (above top bead on dipstick).
- Disconnect connector P1 (black) from genset controller (Page 5-1) and measure resistance between Pin 10 and B- (ground). If resistance is greater than 257 Ohms, check for a missing, bent or corroded pin or faulty wiring or loose ring terminal on sender E1 (Page 5-5). Repair as necessary.
- 4. Replace the sender with a gauge, ground the sender wire (to keep engine running) and start the engine. *Shut down the engine immediately if there is no oil pressure.*
 - A. If engine oil pressure is less than 14 psi (98 kPa), service the oil lubricating system (Page 8-1).
 - B. If engine oil pressure is at least 14 psi (98 kPa), test oil pressure sender E1 (Page 5-5) and replace if necessary.

SERVICE CHECK: NO. 3

(First-level shutdown—Indicates presence of second-level shutdown)

Corrective Action: Check the second-level shutdown code by pressing **STOP** once. The second-level shutdown code will have two-digits. The shutdowns are listed below in numerical order. **Note:** Does not apply to the e-Series Digital Display.

OVERCRANK: NO. 4

(First-level shutdown—Cranking exceeded 20 to 60 seconds [temperature dependent] without start)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. 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.)
- 2. Open any closed fuel valves.
- 3. Press and hold **STOP (Prime)** for 30 seconds to fill the carburetor float bowl. If the fuel pump does not function, go to Step **9**.
- 4. Try restarting. The thermal choke may not have reset completely.
- 5. Reconnect any loose spark plug or ignition coil lead (Page 3-14).
- 6. Replace the in-line fuel filter and prime the fuel system.
- 7. Replace the spark plugs (Page 3-14).
- 8. Check the ignition coil and replace if necessary (Page 5-7).
- 9. Conduct a fuel pump flow test and service as necessary (Page 8-8).
- 10. Check that any fuel anti-siphon device is functioning properly (Page 5-7).
- 11. Check governor actuator operation and service as necessary (Page 8-4).
- 12. Check for and replace contaminated fuel.
- 13. Check fuel solenoid E3 and replace if necessary (Page 8-7).
- 14. Check choke operation and replace the carburetor/choke assembly if necessary (Page 8-7).
- 15. Replace the carburetor/choke assembly (Page 8-7).
- 16. Service the engine ignition system (Page 8-1).
- 17. Service the engine (Page 8-1).

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

WARNING—SHUTDOWN DUE TO VESSEL CO: NO. 5

(First-level shutdown—Genset was shut down by a Carbon Monoxide Detector)

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

LOSS OF RAW WATER FLOW: NO. 7

(First-level shutdown—Low raw water pressure in heat exchanger)

Corrective Action: (Refer to Pages A-1 and A-3.)

- 1. Open the sea cock.
- 2. Close the sea cock and clean the sea water strainer. If the strainer is above the water line, fill it with water to assist priming. Secure the strainer cover and reopen the sea cock.
- 3. Reconnect or replace any disconnected or leaking raw water hoses (Page 3-6).
- 4. Replace the raw water impeller (Page 3-9).
- 5. Reconnect the two leads to flow switch S6 (Page 5-6) if loose or corroded.
- 6. Check for continuity between S6-2 and B- (ground). If open, clean and tighten connections and replace wiring as necessary.
- 7. Disconnect connector P1 (black) from genset controller (Page 5-1) and check for continuity between Pin 8 and S6-2. If open, check for a missing, bent or corroded pin and faulty wiring and repair as necessary.
- 8. Test flow switch S6 (Page 5-6) and replace if necessary.
- 9. Have the bottom of the hull inspected for blockage of the raw water strainer.

HIGH AC VOLTAGE: NO. 12

(Controller unable to maintain rated voltage)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Push the line circuit breaker (Page 2-1) 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 field, stator or quadrature windings (Page 6-4). Replace a stator or rotor with faulty windings.
- 2. Check for proper connections of the field sense leads (S1, S2) and reconnect as necessary.
- 3. Replace genset controller (Page 5-1).

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

LOW AC VOLTAGE: NO. 13

(Controller unable to maintain rated voltage)

Corrective Action:

- 1. Push the line circuit breaker (Page 2-1) OFF, start the genset and measure output voltage. If output voltage is normal, go to Step **2**. If output voltage is low, go to Step **6**.
- 2. Reduce the number of connected appliances, especially when air conditioners and battery chargers are running.
- 3. 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.)
- 4. Reconnect any loose spark plug or ignition coil lead (Page 3-14).
- 5. Replace the in-line fuel filter.
- 6. Service the brushes and slip rings as necessary (Page 6-3) and test the generator field, stator and quadrature windings for opens and shorts (Page 6-4). Replace a stator or rotor with faulty windings.
- 7. Replace genset controller (Page 5-1).

HIGH AC FREQUENCY: NO. 14

(Engine governor unable to maintain rated frequency)

Corrective Action:

- 1. If the line circuit breaker or any other circuit breaker has tripped, start the genset before resetting the breaker. (Frequency can overshoot when a circuit breaker trips under load.) *If the genset continues to run*, turn off or disconnect all loads, reset the breaker and bring the loads on one at a time without overloading the genset.
- 2. Check governor actuator operation and service as necessary (Page 8-4).
- 3. Replace genset controller (Page 5-1).

LOW AC FREQUENCY: NO. 15

(Engine governor unable to maintain rated frequency)

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. Reconnect any loose spark plug or ignition coil lead (Page 3-14).
- 4. Replace the in-line fuel filter and prime the fuel system.
- 5. Replace the spark plugs (Page 3-14).
- 6. Check the ignition coil and replace if necessary (Page 5-7).
- 7. Conduct a fuel pump flow test and service as necessary (Page 8-8).
- 8. Check governor actuator operation and service as necessary (Page 8-4).
- 9. Check for and replace contaminated fuel.
- 10. Replace the carburetor/choke assembly (Page 8-7).
- 11. Service the engine ignition system (Page 8-1).
- 12. Service the engine (Page 8-1).
- 13. Replace genset controller (Page 5-1).

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

GOVERNOR SHORT OR OPEN: NO. 19

(Controller sensed an open or short circuit in actuator circuit)

Corrective Action:

- 1. Disconnect the 2 governor actuator leads, test the actuator and replace it if necessary (Page 8-4).
- 2. Disconnect connector P2 (grey) from genset controller (Page 5-1) and check for electrical continuity of the leads connected to Pins 4 and 5. If there is no continuity, check for missing, bent or corroded pins and faulty wiring and repair as necessary.

GOVERNOR OVERLOAD: 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. Reconnect any loose spark plug or ignition coil lead (Page 3-14).
- 4. Replace the in-line fuel filter and prime the fuel system.
- 5. Replace the spark plugs (Page 3-14).
- 6. Check the ignition coil and replace if necessary (Page 5-7).
- 7. Conduct a fuel pump flow test and service as necessary (Page 8-8).
- 8. Check governor actuator operation and service as necessary (Page 8-4).
- 9. Check for and replace contaminated fuel.
- 10. Replace the carburetor/choke assembly (Page 8-7).
- 11. Service the engine ignition system (Page 8-1).
- 12. Service the engine (Page 8-1).
- 13. Replace genset controller (Page 5-1).

FAULTY OIL PRESSURE SENDER: NO. 23

(Controller sensed shorted or grounded sender)

Corrective Action: Disconnect connector P1 (black) from genset controller (Page 5-1) and measure resistance between Pin 10 and B- (ground). If there is a short to ground, repair the wiring or test and replace sender E1 (Page 5-5), as necessary. (*Refer to Pages A-1 and A-3*.)

FAULTY ENGINE TEMP SENDER: NO. 24

(Controller sensed open or grounded sender)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Tighten the ring terminal on sender E2 (Page 5-5) if loose.
- 2. Measure resistance across sender E2 (Page 5-5) and replace it if open.
- 3. Disconnect connector P1 (black) from genset controller (Page 5-1) and check continuity between Pin 9 and ring terminal E2-1. Repair the wiring as necessary if open.

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

LOSS OF AC VOLTAGE SENSE: NO. 27

(Controller unable to sense output voltage)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Check for and properly reconnect voltage sense leads S1 and S2.
- 2. Disconnect connector P3 (green) from genset controller (Page 5-1) and check continuity between Pin 11 and S2 and between Pin 12 and S1. If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
- 3. Service the brushes and slip rings as necessary (Page 6-3) and test the generator field, stator and quadrature windings for opens and shorts (Page 6-4). Replace a stator or rotor with faulty windings.
- 4. Replace genset controller (Page 5-1).

HIGH BATTERY VOLTAGE: NO. 29

(Battery system at more than 19.2 volts)

Corrective Action:

- 1. Check battery bank connections and reconnect if necessary to supply 12 volts.
- 2. Select a lower external battery boost charge rate.

STARTING FAULT: NO. 32

(Cranking not detected)

Corrective Action:

1.

2.

CONTROL CARD FAILURE-EE: NO. 35

(Microprocessor EEPROM error during self-test)

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

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

UNKNOWN SHUTDOWN—SEE MANUAL: NO. 36

(Engine stopped without command by controller)

Corrective Action:

- 1. Open any closed fuel supply valves.
- 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 for mechanical damage and service as necessary.
- 4. Remove any blockage in the combustion air inlet (left end of genset).
- 5. Reconnect any loose spark plug or ignition coil lead (Page 3-14).
- 6. Replace the in-line fuel filter and prime the fuel system.
- 7. Replace the spark plugs (Page 3-14).
- 8. Check the ignition coil and replace if necessary (Page 5-7).
- 9. Conduct a fuel pump flow test and service as necessary (Page 8-8).
- 10. Check governor actuator operation and service as necessary (Page 8-4).
- 11. Check for and replace contaminated fuel.
- 12. Check that any fuel anti-siphon device is functioning properly (Page 5-7).
- 13. Replace the carburetor/choke assembly (Page 8-7).
- 14. Check for an open field or open or grounded quadrature circuit (Page 6-4) and service as necessary.
- 15. Service the engine ignition system (Page 8-1).
- 16. Service the engine (Page 8-1).

INVALID GENSET CONFIGURATION: NO. 37

(Controller cannot determine genset operating parameters)

Corrective Action:

- 1. Disconnect connector P2 (grey) from genset controller (Page 5-1) and check continuity between Pin 9 and B- (ground). *P2-9 should not be grounded*. Repair the wiring as necessary.
- 2. Replace genset controller (Page 5-1).

HIGH FIELD VOLTAGE: NO. 38

(High field voltage required for low power factor loads or high rotor temperature)

Corrective Action:

- 1. Remove blockages to generator air flow at the left side and front of genset.
- 2. Check for a loose generator fan (Page 6-1) and repair or replace as necessary.
- 3. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
- 4. Have air conditioners and other appliances checked for proper operation. (A locked compressor rotor can cause very low power factor.)
- 5. Service the brushes and slip rings as necessary (Page 6-3) and test the generator field, stator and quadrature windings for opens and shorts (Page 6-4). Replace a stator or rotor with faulty windings.

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

LOW BATTERY VOLTAGE: NO. 39

(Marginal battery, connections, or charging system, or parasitic loads)

Corrective Action:

- 1. Clean and tighten the positive (+) and negative (-) battery cable connections at the battery and genset (Page 3-5).
- 2. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
- 3. If the genset is so equipped, test battery charging regulator A1 (Page 5-6).

GROUNDED FIELD: NO. 41

(F+ grounded)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- Disconnect connector P3 (green) from genset controller (Page 5-1) and check for continuity between Pin 7 (F+) and B- (ground). *P3-7 should not be grounded.* Repair or replace wiring, brushes and slip rings (Page 6-3) or rotor (Page 6-4), as necessary.
- 2. Replace genset controller (Page 5-1).

CONTROL CARD FAILURE-ROM: NO. 42

(Microprocessor ROM error during self-test)

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

CONTROL CARD FAILURE-RAM: NO. 43

(Microprocessor RAM error during self-test)

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

SPEED SENSE LOST: NO. 45

(Controller unable to sense field voltage)

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

CONTROL CARD FIELD SENSE LOST: NO. 48

(Controller unable to sense field voltage)

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

OVERPRIME: NO. 57

(Prime mode exceeded 5 minutes)

Corrective Action: Check for and remove any object that may be holding any control switch in the prime position.

WARNING Some genset service procedures present hazards that can result in severe personal injury or death. Only those trained and experienced in marine gasoline genset service may perform service. See Safety Precautions.

HIGH EXHAUST TEMPERATURE: NO. 58

(Exhaust temperature exceeded design limits)

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Check for and reconnect or replace any disconnected or leaking raw water hoses (Page 3-6).
- 2. Check for a and replace a worn raw water impeller(Page 3-9).
- 3. Disconnect connector P1 (black) from 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 S5 (Page 5-6). Repair as necessary.

EMERGENCY SHUTDOWN: NO. 61

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

Corrective Action: (*Refer to Pages A-1 and A-3.*)

- 1. Make all necessary repairs to the genset and connected equipment and reset the external control which shut down the genset.
- 2. Disconnect the external wiring connected at connector ESTOP and check for B+. If there is B+, find out why and reconnect or repair the external control circuit.

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10. e-Series Digital Display

The *e-Series Digital Display* (Figure 10-1) has an LCD panel with 4 navigation buttons, 3 LEDs, a **START** button, and a **STOP** button.

TURNING ON THE DISPLAY

Touch any button to turn on the *e-Series Digital Display*. The LCD back light will turn on. All connected *e-Series Digital Displays* will turn on automatically when the genset is started at any station. They will all turn off 5 minutes after the genset shuts down.

START BUTTON

BEFORE PUSHING START, go to Page 2-2 and review the Exhaust Gas Warning, Pre-start Checks, Genset Compartment Ventilation and Starting.

Push and hold the **START** button until the blinking **GENSET** LED (green) stays on, indicating that the genset is producing AC voltage. *Status* on the GEN STATUS screen will change from *Starting* to *Running* (Figure 10-2).

STOP BUTTON

Stopping Genset: Momentarily press the **STOP** button. See STOPPING THE GENSET (Page 2-3). *Status* on the GEN STATUS screen will change to *Stopped* (Figure 10-2).

Priming Fuel System: Press and hold the **STOP** button. *Status* on the GEN STATUS screen will display *Priming* (Figure 10-2).

GENSET STATUS SCREENS

Genset status is displayed on 3 screens (Figure 10-2). GEN STATUS PG1 will display when the display is turned on. Press the double arrows [¥] to go to GEN STATUS PG2, again to go to GEN STATUS PG3 and again to go to GEN STATUS PG1.

The *Status* line will display the word *Priming, Starting, Running* or *Stopped*. The status screens also display engine coolant temperature and oil pressure, battery voltage and total genset running time.

Note: The total time on the master hour meter on the genset control panel (Page) prevails if the total time on the e-Series Digital Display is different.



FIGURE 10-1. E-SERIES DIGITAL DISPLAY



FIGURE 10-2. TYPICAL GENSET STATUS SCREENS
FAULT SCREENS

Active Fault

When a fault occurs, the genset controller will cause the *e-Series Digital Display* to flash the red ALARM LED and display the Fault Number and a brief description of the Fault (Figure 10-3). Find the corresponding Fault Number in *TABLE 9-1. TROUBLE-SHOOTING* and follow the step-by-step procedures to correct the fault.

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 [**4**BACK] to go back to the GEN STATUS screen.

Last Fault

Touch any button again to turn on the *e-Series Digital Display.* Press the FAULT button on the GEN STATUS screen to display the FAULT screen (Figure 10-4). If there is an active fault, the FAULT screen will display the *Fault Number* and description of the fault. If there is no active fault, the fault screen will display *No Active Fault*.

To display the LAST FAULT screen, press the LAST button on the FAULT screen. The LAST FAULT screen will display the *Fault Number* and description of the last Fault. Press [**4**BACK] to go back to GEN STATUS.

FAULT Eng coolant temp sensor fault		
Fault No.	24	
▲BACK	ALARM	LAST

FIGURE 10-3. TYPICAL FAULT SCREEN

GEN STAT Status: St	US Pg1 arting		
AC Volts AC Freq	120V 60Hz		
▼ SETUP FAULT SCREEN			
FAULT Eng coolant temp sensor fault			
Fault No.	24		
<back td="" ₽<=""><td>ALARM LAST</td></back>	ALARM LAST		
OR			
FAULT			
No Active Faults			
<back a<="" td=""><td>ALARM LAST</td></back>	ALARM LAST		
Eng coolant temp			
sensor fault Fault No 24			
Hour 1	234.5		
▲BACK	3		

FIGURE 10-4. LAST FAULT

PRE-ALARM SCREENS

When engine oil pressure or temperature reach set points near the limits where the control shuts down the genset, the *e-Series Digital Display* will flash the amber PRE-ALARM LED and display *Low Oil Pressure* or *High Engine Temperature* on the PRE-ALARM screen (Figure 10-5). Press [4BACK] to go back to GEN STATUS to monitor the engine temperature or oil pressure.

Shut down the genset and perform the maintenance or service required to restore normal operation.



FIGURE 10-5. PRE-ALARM SCREENS

BRIGHTNESS AND CONTRAST

To adjust the brightness and contrast of the LCD screen and LEDs, go to the SCREEN ADJUST screen by pressing SCREEN on any GEN STATUS screen (Figure 10-6). Press NEXT to toggle between *Brightness* and *Contrast*. Increase or decrease the selected item by pressing the increase-decrease buttons [◀▶]. Press [◀BACK] to save the settings and go back to GEN STATUS.

SETUP

To change the units of measure for engine temperature and pressure (GEN STATUS PG2), press the SETUP button (Figure 10-7). Press the up-down arrows [▼ ▲] to toggle between SAE and METRIC units. Press [∢BACK] to save the selection and go back to GEN STATUS.

GENSET AND DISPLAY INFORMATION

To display genset information, press the INFO button on the SETUP screen (Figure 10-7). To display Display information, press the DISP button on the GENSET INFO screen. Keep pressing [4BACK] to get back to GEN STATUS.



FIGURE 10-6. SCREEN BRIGHTNESS & CONTRAST



FIGURE 10-7. SETUP & GENSET & DISPLAY INFO



WIRING DIAGRAM—SHEET 1

630-2528



10 Generator Reconnection

1. (GND) INDICATES GROUND, CONNECTION SHOULD BE MADE AT THE GROUND STUD IN THE AC CONNECTION BOX.

CONNECTION SHOULD BE MADE AT THE ISOLATION STANDOFF IN THE AC CONNECTION BOX.

630-2528

WIRING DIAGRAM-SHEET 2



CONTROL WIRING HARNESS