

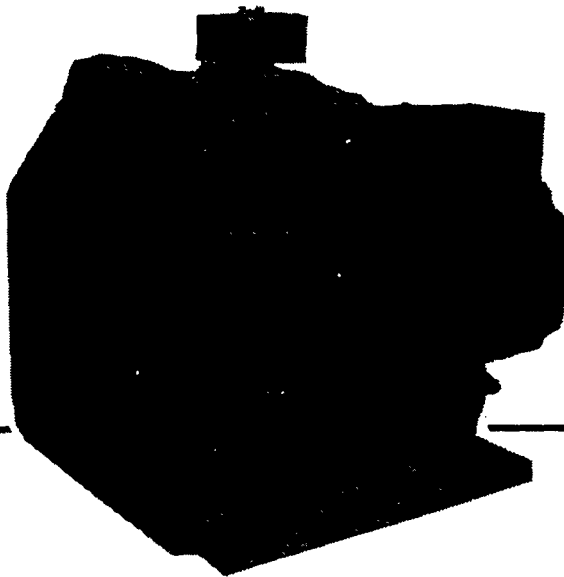
# Onan

## Operator's Manual

SERIES  
**MCCK**  
GenSet

**Marine Electric  
Generating Set**

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# Safety Precautions

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Before operating the generator set, read the Operator's Manual and become familiar with it and your unit. **Safe and efficient operation can be achieved only if the unit is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

Throughout this manual you will notice symbols which alert you to potentially dangerous conditions to the operator, service personnel, or the equipment itself.

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

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

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

**FUEL AND FUMES ARE FLAMMABLE.** Fire and explosion can result from improper practices.

- Do not fill fuel tanks with the engine running. Do not smoke around the generator set area. Wipe up any oil or gas spills. Do not leave oily rags in engine compartment or on the generator set. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip the engine fuel supply with a positive fuel shutoff.
- Disconnect the battery ground lead (-) first; reconnect the ground lead (-) last. Make sure you connect the battery correctly. A direct short across the battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is very explosive.
- Keep a fire extinguisher available in or near the engine compartment and in other areas throughout the vessel. Use the correct extinguisher for the area. For most types of fires, an extinguisher rated ABC by the NFPA is available and suitable for use on all types of fires except alcohol.

## EXHAUST GASES ARE DEADLY

- Provide adequate ventilation with power exhausters or bilge vapors from the engine compartment.
- Be sure propulsion and generator set engine exhaust systems are free of leaks. Perform thorough, periodic inspections of the exhaust system and repair leaks immediately. Exhaust gases are deadly.

- Never sleep in the vessel with the generator set running unless the vessel is equipped with an operating carbon monoxide detector.

## HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant under pressure has boiling points over 212°F (100°C). Do not open a coolant pressure cap while the engine is running. Always bleed off the system pressure first.

## MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any belt guards or covers with the unit running.
- Keep hands and loose clothing away from moving parts. Do not wear jewelry while servicing any part of the generator set.
- Never step on the generator set (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions. . .from leaking fuel, leaking exhaust fumes, etc.
- Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the generator set compartment thoroughly with the bilge blowers or power exhausters.

## ELECTRICAL SHOCK WILL CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not make adjustments in the control panel or on engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel standing on dry surfaces to reduce shock hazard.
- **DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM.** Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- **Copy and post these suggestions in potential hazard areas of the vessel.**



## Supplement 927-1135

**Date:** 5-88

**Insert with** - Operator's Manual

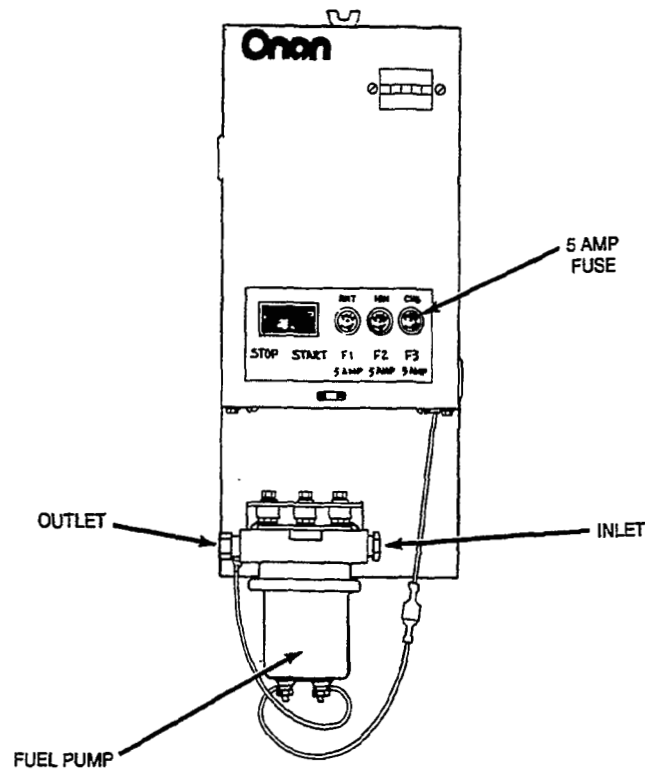
**Title:** MCKK Series GenSet

**Number:** 927-0121 (3-83, Spec H)

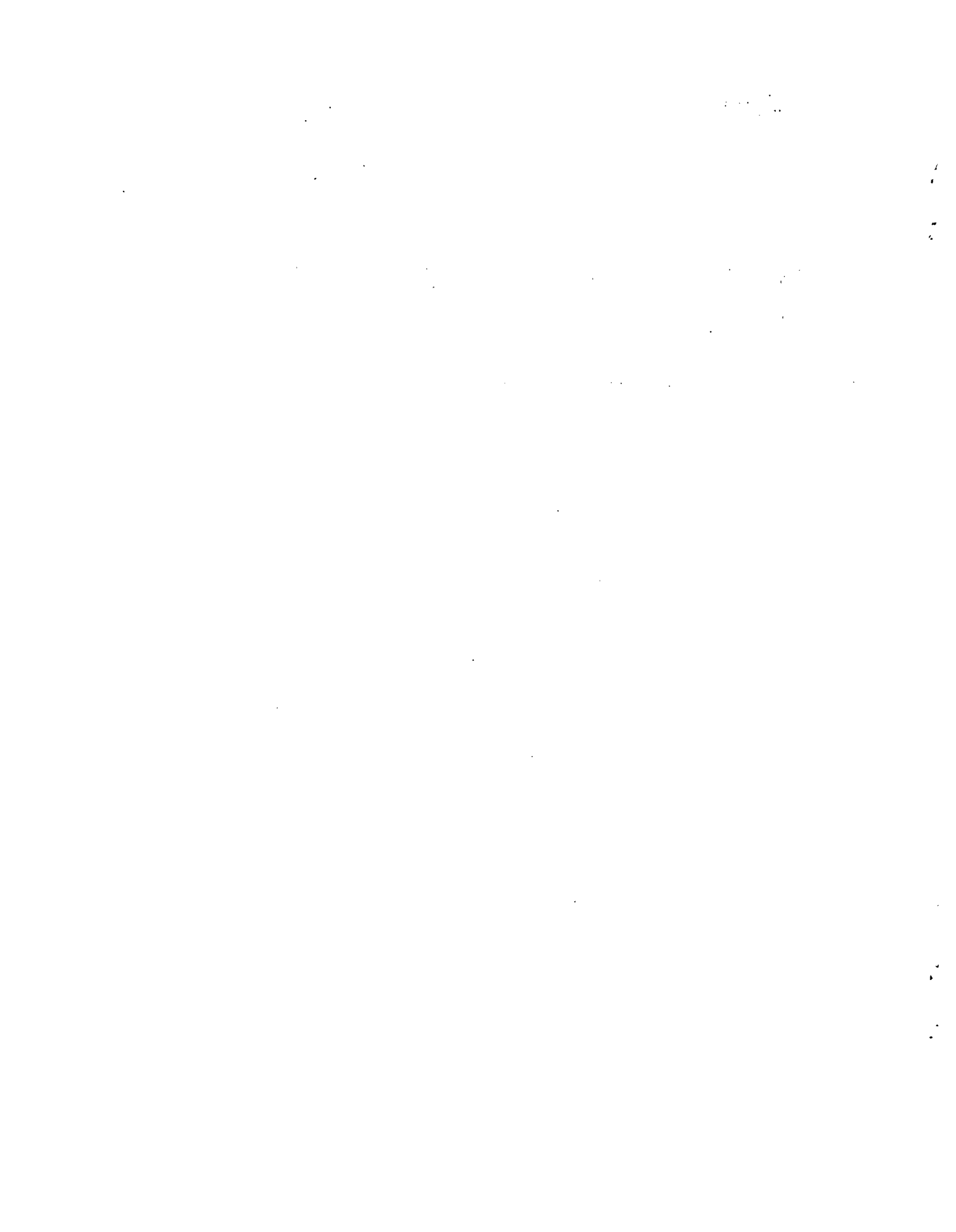
Starting with Spec J of the MCKK generator set, a different fuel pump is used. This pump is shown in the illustration below. Unlike the fuel pump shown on page 25 of the Operator's Manual, this pump is not serviceable and does not require periodic maintenance.

A larger F3 CHG fuse is used on Spec J generator sets for the upgraded battery charging circuit. The control panel fuse is rated at 5 amperes and is shown on the drawing.

Please keep this information with the Operator's Manual for reference.



FS-1768-1



# GENERAL INFORMATION

When instructions in this manual refer to a specific model of generating set, identify the model by referring to the MODEL and SPECIFICATION NO. as shown on the set nameplate. Electrical characteristics are shown on the lower portion of the set nameplate.

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### **WARNING**

*TO AVOID POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, A QUALIFIED ELECTRICIAN OR AN AUTHORIZED SERVICE REPRESENTATIVE MUST PERFORM INSTALLATION AND ALL SERVICE.*

# SPECIFICATIONS

This manual contains S1 metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

## GENERAL

### Nominal Dimensions

4.0 MCKK .....	24" H x 22" W x 29" L (610 H x 558 W x 734 mm L)
Weight (approx); Standard Unit .....	396 lbs (180 kg)
Heat Exchanger Cooling .....	406 lbs (184 kg)
6.5 MCKK .....	24" H x 22" W x 30" L (610 H x 558 W x 768 mm L)
Weight (approx); Standard Unit .....	421 lbs (191 kg)
Heat Exchanger Cooling .....	431 lbs (196 kg)

## ENGINE DETAILS

Number of Cylinders (Horizontally Opposed) .....	2
Displacement (Cubic Inch) .....	49.8 (816 cc)
Cylinder Bore .....	3.25" (82.55 mm)
Piston Stroke .....	3.00" (76.20 mm)
BHP at 1800 rpm .....	11
RPM (for 60 Hertz) .....	1800
Compression Ratio .....	7.0:1
Fuel Recommended .....	Unleaded or Regular Gasoline
Fuel Pump .....	Electric
Ignition Type .....	Battery
Starting System .....	SAE J1171 Sealed Starter Motor

## CAPACITIES AND REQUIREMENTS

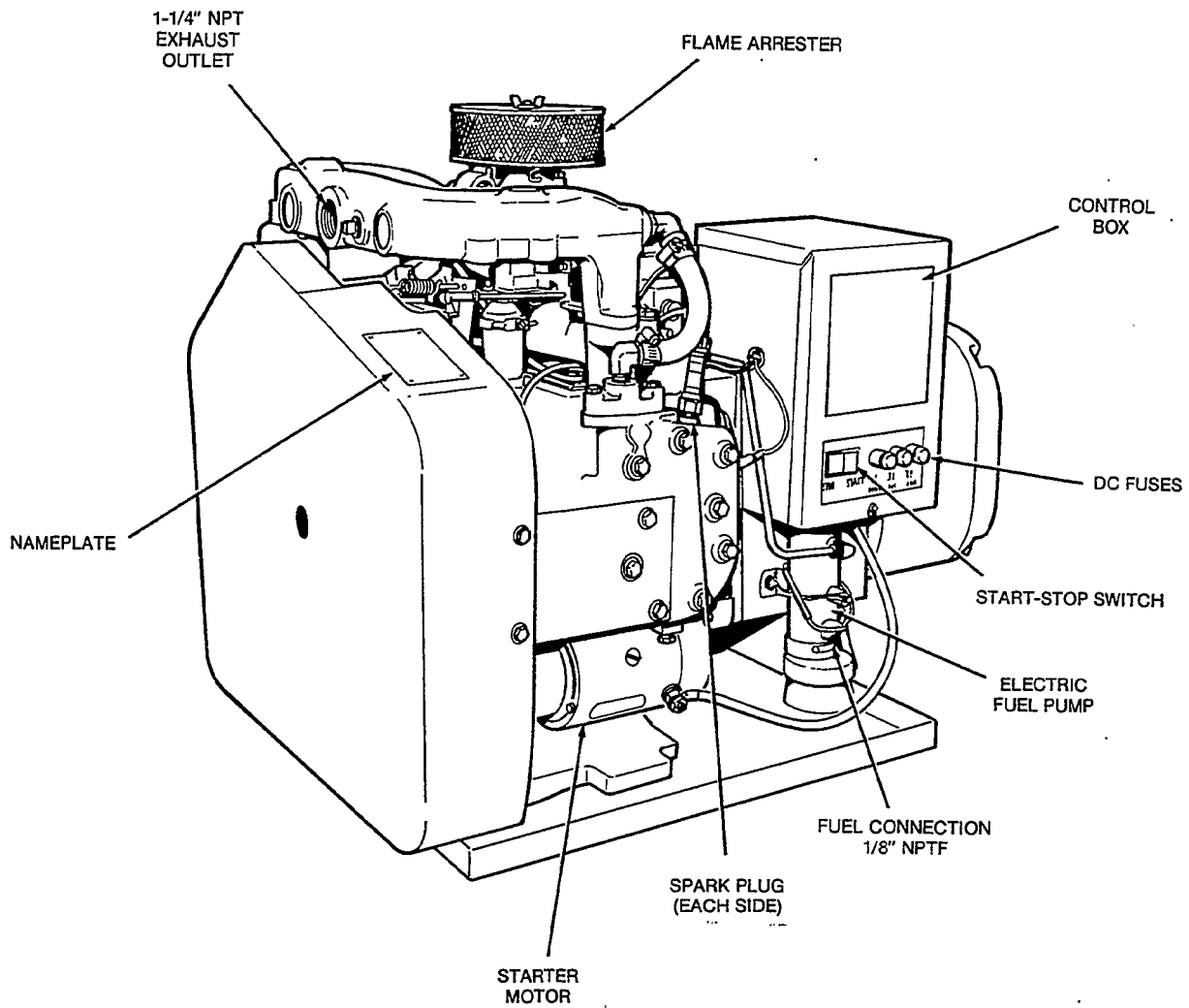
Battery Voltage .....	12 Volts
Battery Size (SAE Group 60)	
Amp-hr SAE 20-hr (Minimum) .....	74 (266 kC)
Battery Charge Rate in Amperes .....	1
Oil Capacity .....	3-1/2 qts. (3.3 litres)
Cooling Water Flow (Gallons per Minute) .....	4 (15 litres)
Cooling System Capacity (including heat exchanger) .....	3-1/2 qts. (3.3 litres)
Generator Cooling Air (CFM at 1800 rpm) .....	120 (3.40 m <sup>3</sup> )
Engine Combustion Air .....	32 (0.91 m <sup>3</sup> )
Total Cubic Feet of Air Required per Minute .....	152 (4.30 m <sup>3</sup> )
Fuel Consumption, Approximate Gallons per Hour at Full Load	
6.5 kW .....	1 gal. (3.8 litre)
4 kW .....	0.75 gal. (2.8 litre)

## GENERATOR DETAILS

Design .....	4-pole revolving armature, self-excited
Output Rated at Unity Power Factor .....	1-phase
AC Voltage Regulation .....	See Page 22
AC Frequency Regulation in % .....	5

## TUNE-UP SPECIFICATIONS

Breaker Point Gap (Full Separation) .....	0.020" (0.51 mm)
Spark Plug Gap .....	0.025" (0.64 mm)
Ignition Timing .....	20° BTC
Valve Clearance—	
Intake .....	Min. .011" (0.28 mm); Max. .013" (0.33 mm)
Exhaust .....	Min. .011" (0.28 mm); Max. .013" (0.33 mm)
Carburetor Float Level .....	1/8" (3.18 mm)
Cylinder Head Torque .....	29-31 lb.ft. (39-42 N•m)
Compression (PSI Sea Level) Cold .....	130-140 PSI (897-966 kPa)



**TYPICAL MCKK MARINE GENERATOR SET**

# INSTALLATION

## GENERAL

Proper installation is very important. Give attention to the following points:

1. Adequate generator cooling air
2. Discharge of circulated air
3. Adequate fresh air
4. Adequate engine cooling water
5. Discharge of circulated water
6. Discharge of exhaust gases
7. Electrical connections
8. Fuel connection
9. Sturdy and flat mounting base
10. Accessibility for operation and service.

Use this manual as a guide to help with the installation. Refer to typical installation, Figure 3. For more complete instructions, request Onan Technical Bulletin T-021 "Installation of Onan Marine Electric Generating Sets."

The unit must be installed in compliance with United States Coast Guard (USCG) 33CFR183. The installation should also follow recommendations of the American Boat and Yacht Council (ABYC) and the National Fire Protection Association (NFPA). Installations must be considered individually. Helpful guidance for the installer is available in the following publications:

USCG 33CFR183 from—  
*U.S. Government Printing Office*  
*Washington, D.C. 20402*

ABYC "Safety Standards for Small Craft" from—  
*ABYC*  
*15 East 26th St.*  
*New York, N.Y. 10010*

NFPA302 "Fire Protection Standard for Motor Craft" from—  
*NFPA*  
*470 Atlantic Ave.*  
*Boston, MA 02210*

## MOUNTING

The mounting base should be flat, and give support directly under the set mounting points shown in Figure 1. Select a dry, properly ventilated location preferably near the main keel, above low-lying vapors

and free from bilge splash. Provide accessibility for minor servicing operations, draining of the crankcase oil and the cooling system.

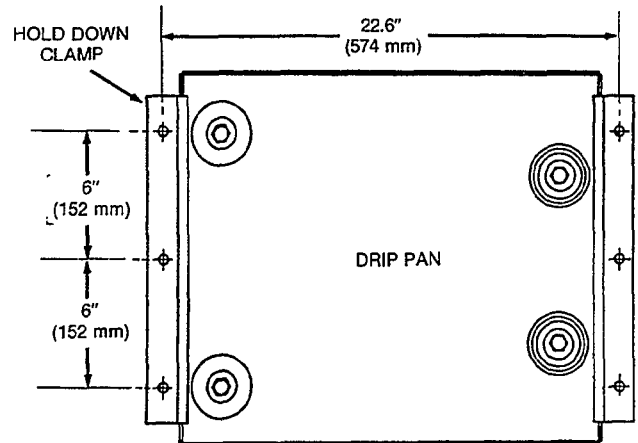
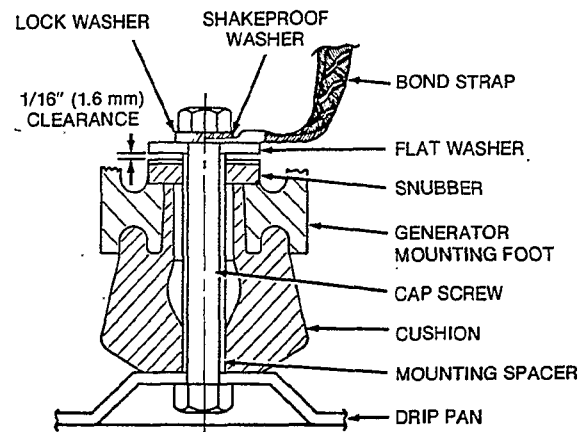
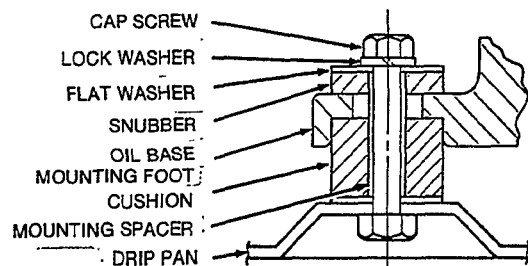


FIGURE 1. MOUNTING DIMENSIONS



GENERATOR END



ENGINE END

FIGURE 2. MOUNTING CUSHIONS

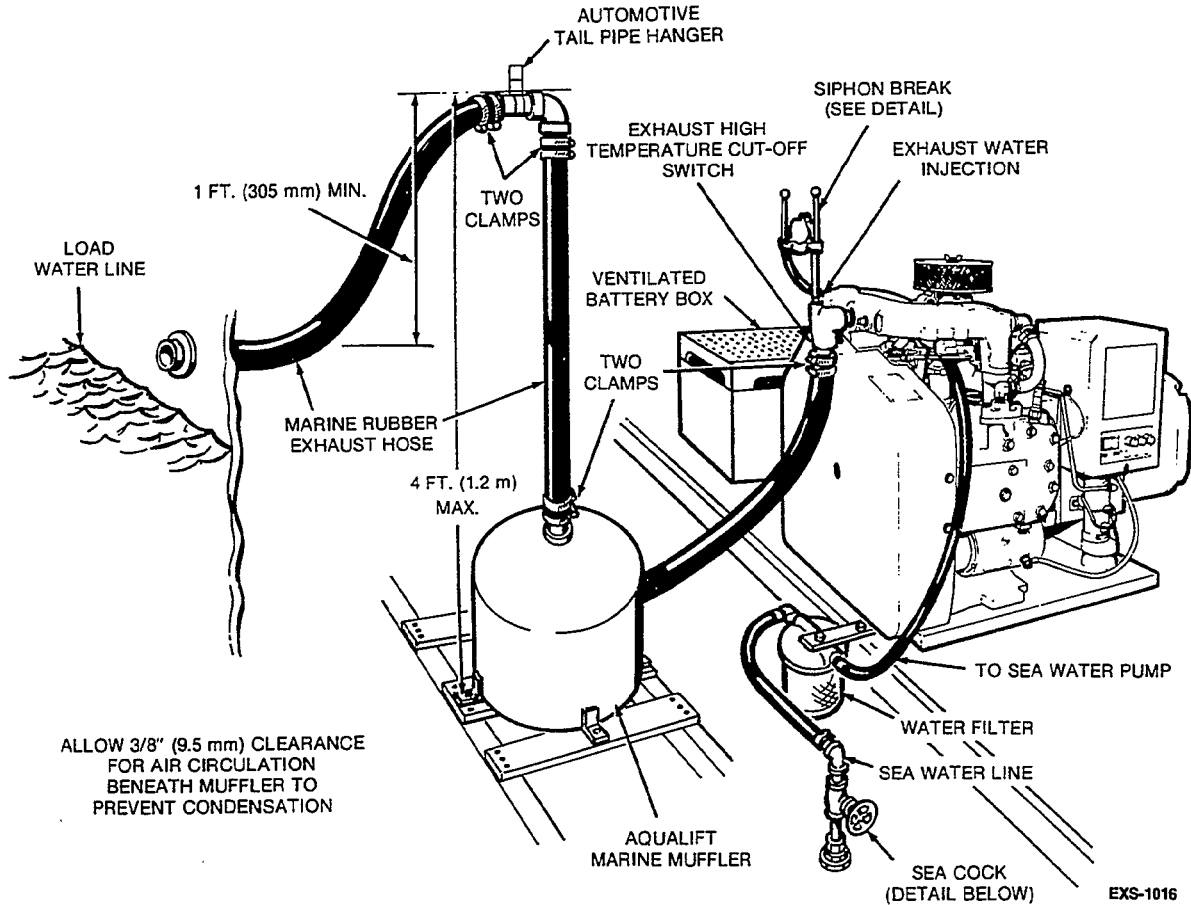


Allow a minimum clearance of one inch (25.4 mm) around the unit for inspection and air circulation. Use flexible exhaust line, fuel line, battery cables, and electrical wires which meet USCG requirements.

The Onan MCKK electric generating sets are supplied with vibration cushions and a drip pan as shown in Figures 1 and 2. The cone-type cushions are mounted under the generator, and the tubular-type

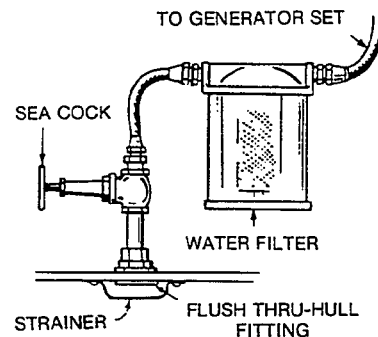
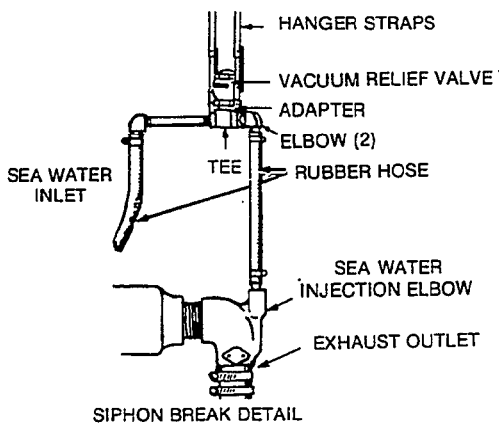
cushions under the engine end of set. Add thin flat washers between snubber washer and flat washer at the generator end to maintain about 1/16-inch (1.6 mm) clearance as shown in Figure 2. On the left side of generator, install the pan bonding strap under the cap screw. Use hardware as shown.

Install the hold-down clamps to the drip pan front and rear. Secure clamps to the mounting base.



**CAUTION** Install Siphon Break Kit #155-0950 if exhaust injection elbow is below load water line. Locate the Siphon Break at least 12 inches (305 mm) above load water line and in a vertical position. Remote mounting the siphon break is permissible within a 5 foot (1.5 m) radius of water injection exhaust elbow. Vertical position and height of valve must be maintained.

Recommended flush type thru-hull fitting and water filter.



**CAUTION** Do not use scoop type water inlet fittings on generator sets using Aqualift muffler systems.

FIGURE 3. TYPICAL INSTALLATION WITH AQUALIFT MUFFLER

## FUEL SYSTEM

### Fuel Tank and Lines

Fuel leakage in boats presents fire and explosion hazards. For this reason, it is important that the material, design, construction and installation of all fuel system components meet the highest possible standards. Use only products specified for marine applications.

The flexible fuel line between the engine and supply line must meet USCG requirement 183.558. Use a line without internal wire reinforcement to prevent DC or AC current flow through wire in the event of a failure in the engine grounding system.

Fuel distribution lines must have as few connections as practicable, and be protected against mechanical injury and vibration.

Whenever possible, it is recommended that the fuel line be run at or above level of the tank top to a point close to the engine connection. See Figure 4. The line should be supported throughout its length with clips or straps spaced at no more than 14-inch (355 mm) intervals.

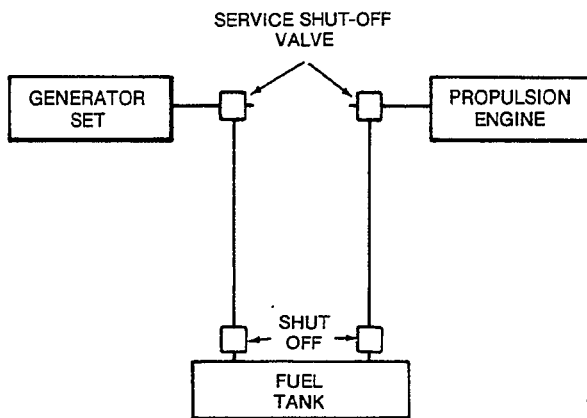


FIGURE 4. ABOVE TANK LEVEL INSTALLATION

If a fuel tank is shared, do not connect to an existing line at a point above the fuel supply level. This can cause fuel starvation. If the fuel tank outlet is large enough, a second dip tube may be installed as shown in Figure 5. The required fittings can be built by a machine shop.

#### WARNING

Leakage of gasoline in or around the compartment is a definite hazard. The ventilation system should provide a constant flow of air to expel any accumulation of fuel vapor.

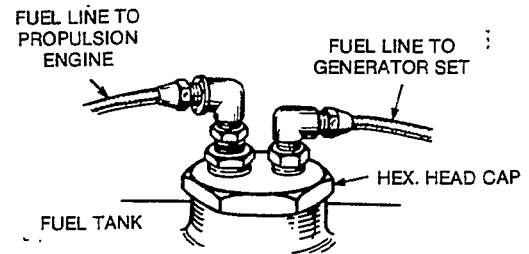


FIGURE 5. TWO FUEL LINES IN ONE TANK OUTLET

### Fuel System Siphon Protection

A carburetor float valve must not be trusted to hold back fuel if the tank is installed above engine level. Siphon protection is required. This will also prevent fuel from siphoning if the fuel line breaks below the fuel level.

Siphon protection can be provided by one of the following methods:

1. Keeping all parts of the fuel line (from the tank to the engine) above the tank top. See Figure 4.
2. Installing an anti-siphon valve at the tank withdrawal fitting. See Figure 6.
3. Installing an electrically operated fuel stop valve at the tank withdrawal fitting. The valve's solenoid is connected to the engine ignition circuit, allowing fuel flow only during engine operation. To comply with USCG regulations, the valve must have a manual override feature for emergency operation.

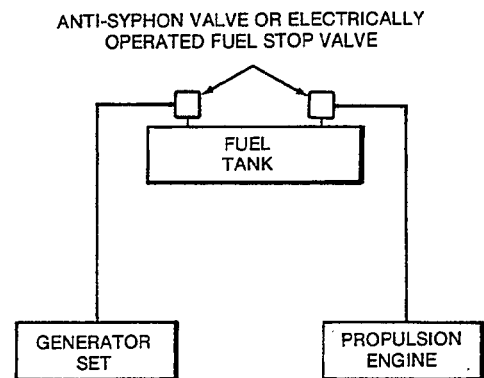


FIGURE 6. SIPHON PROTECTION

A shut-off valve at the tank and near the generator set is recommended for service convenience. Use an approved flexible, non-metallic fuel line next to the engine. See Figure 7.

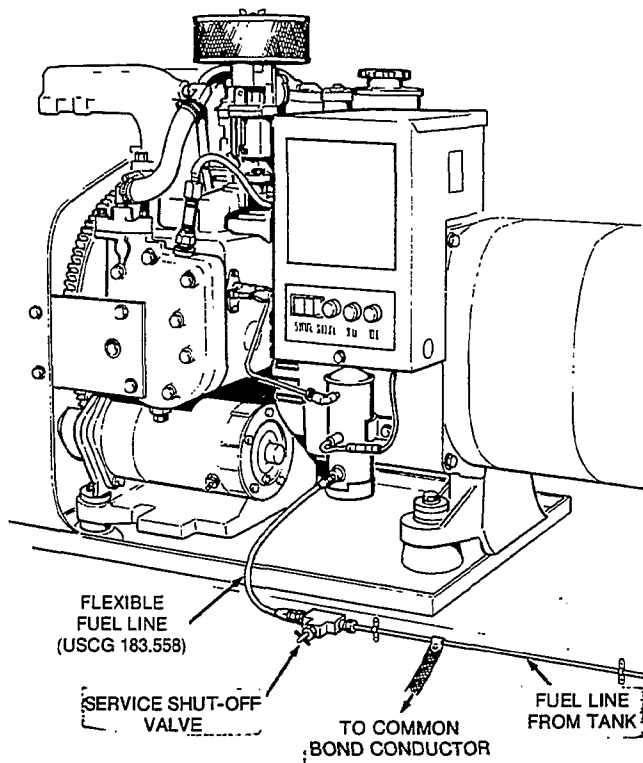


FIGURE 7. FUEL SHUT-OFF VALVE

## VENTILATION

Generator sets require fresh air for combustion and generator cooling. Onan recommends that the ventilation system be able to deliver 1-1/2 to 2 times the air required by the set. Use powered exhausters to provide ventilation when the generator set is in operation. For more information, refer to Onan Technical Bulletin T-021.

## OIL DRAIN

The oil drain may be extended to suit the installation. The oil base has a 1/2-inch pipe-tapped hole below the oil fill tube on the left side of the set. If preferred, the oil may be conveniently pumped out through the oil fill tube.

## EXHAUST SYSTEM

### General

All exhaust systems for water-cooled marine installations must meet these requirements:

1. Except for vertical dry stack systems, exhaust systems must be water cooled, the water injected as near to the generator set as possible.
2. All exhaust system sections preceding the point of cooling water injection must be either water jacketed or effectively insulated.
3. The exhaust line must be installed so as to prevent back flow of water to the engine under any conditions, and the exhaust outlet must be above the load waterline. Water flowing back to the engine will damage it.
4. The generator set's exhaust system must not be combined with the exhaust system of any other engine.
5. An approved, flexible, non-metallic exhaust line section should be used near the engine to allow for engine movement and vibration during operation.
6. Vertical dry stack exhaust systems must have spark arresters. The exhaust system between engine manifold and spark arrester must be either water jacketed or well insulated.
7. Be of sufficient size to prevent excessive back pressure.

### WARNING

Use extreme care during exhaust system installation to ensure a tight exhaust system. Exhaust gases are deadly.

### Material

Use only material recommended by ABYC in "Safety Standards for Small Craft," Section P1. Use exhaust line at least as large as the engine exhaust outlet, but increase the entire line one pipe size for each ten feet (3 m) in length.

To prevent vibration from transmitting to the hull, use automotive type tail pipe hangers. Most installations today use flexible rubber hose for the water cooled section of the exhaust line for ease of installation and flexibility. Be sure the rubber hose is designed and approved for marine exhaust line use. Provide adequate support for rubber hose to prevent sagging, bending and formation of water pockets. Use two hose clamps having a minimum width of 1/2 inch (12.7 mm) at each end of hose. See Figure 8.

The flexible section of the exhaust line should be installed between the engine and muffler (Figure 3). Do not connect the muffler directly to the exhaust manifold. Use rubber hose only in the water-cooled sections of the exhaust system.

### WARNING

Do not install rubber hose with sharp bends as this will reduce efficiency and may cause hose failure. Do not use rubber hose on dry type exhaust applications.

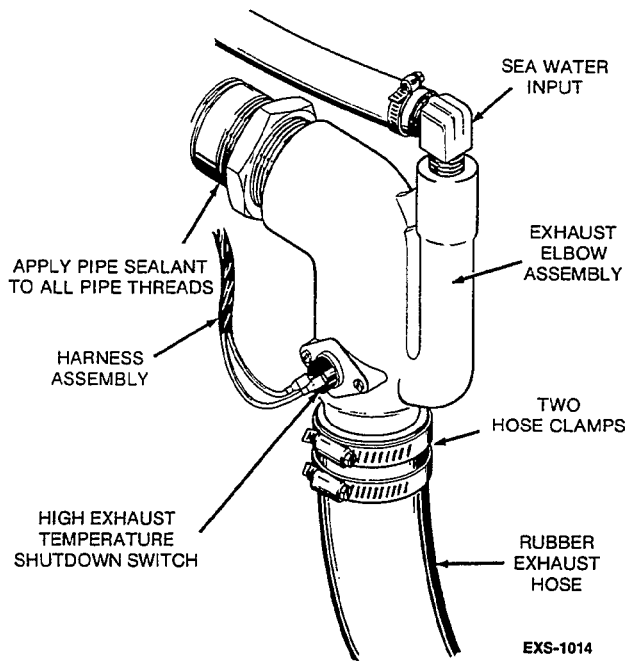


FIGURE 8. SEA WATER CONNECTIONS

**WARNING** Do not use the manifold as a muffler support because it puts excessive strain on the connecting exhaust line and can cause it to break or leak, resulting in the escape of deadly exhaust gases.

### High Exhaust Temperature Shutdown Switch

A high exhaust temperature shutdown switch should be used on all installations. The switch mounts on a raised boss on the exhaust elbow (Figure 8), and stops the generator set if the exhaust system overheats. The switch is wired in series with the high water temperature shutdown switch on the engine block (Figure 12).

**CAUTION** Install Siphon Break Kit #155-0950 if exhaust injection elbow is below load water line. Locate the Siphon Break at least 12 inches (305 mm) above load water line and in a vertical position. Remote mounting the siphon break is permissible within a 5-foot (1.5 m) radius of water injection exhaust elbow. Vertical position and height of vacuum relief valve must be maintained to prevent water from entering the cylinders through the exhaust manifold when the engine is stopped.

Be sure the slotted opening in the vacuum relief valve is open to atmospheric pressure. The siphon break will not function if the relief valve slot is closed in any way.

### Aqualift® Marine Muffler (Optional)

The Aqualift is a high efficiency marine muffler designed for above or below water line installations when water cooled exhaust systems are used. Because of installation variables, customers must provide the brackets, hoses and clamps required for installation. Complete instructions are included with the muffler. See Figure 3.

### Exhaust Back Pressure

The exhaust pipe should be increased one pipe size for every 10 feet (3 m) of length. If the installation is excessively long or questionable, back pressure should be checked before putting the unit into operation.

**CAUTION** Excessive back pressure will cause loss of power.

Back pressure at full load should not exceed 3 inches of Mercury (10 kPa). If reading is higher, carefully investigate the exhaust system for restrictions. Restriction is usually caused by small diameter pipe, excessively long exhaust line, sharp bends, pockets which allow water to collect or improper muffler.

### COOLING SYSTEM

Throughout this manual, flotation water drawn into the boat for engine cooling will be called *sea water*. Water recirculated through a closed system will be called *captive water*. Use of the term sea water does not necessarily imply that the water is salty. In fact, use of salt water in the engine block for cooling may result in severe corrosion problems. Units operating in a salt water environment should use either a keel type or heat exchanger type closed cooling system.

### Sea Water Pump

Before beginning operation, the sea water pump (Figure 9) should be checked for water flow. With the unit running, observe the exhaust outlet to be sure the pump is delivering water to the system.

**CAUTION** Do not use a scoop-type water inlet fitting. When the boat is underway and the generator set is not running, sufficient ram pressure can force water past the sea water pump, flooding the exhaust system, and possibly flood the engine cylinders.

If overheating occurs, check for a loose or defective pump belt. Also check for leaks or restrictions in the cooling system. Contact your local Onan dealer for further testing.

## Sea Water Cooling

This system (Figure 10) uses a continuous supply of cooling sea water. The water pump inlet is 1/4-inch pipe thread to 1/2-inch hose coupling. Use a section of flexible hose near the set to absorb vibrations. The inside diameter of the plumbing must be 1/2 inch or larger. Use Permatex or other pipe sealer on all pipe fittings in supply line.

Reduce resistance on pipe runs longer than five feet (1.5 m) by using larger inside diameter plumbing. Install a strainer in the water suction line inlet where it will be accessible for cleaning. Test the sea water pump before operation.

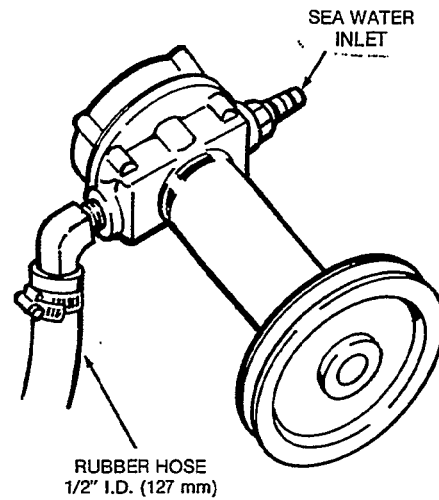


FIGURE 9. SEA WATER PUMP

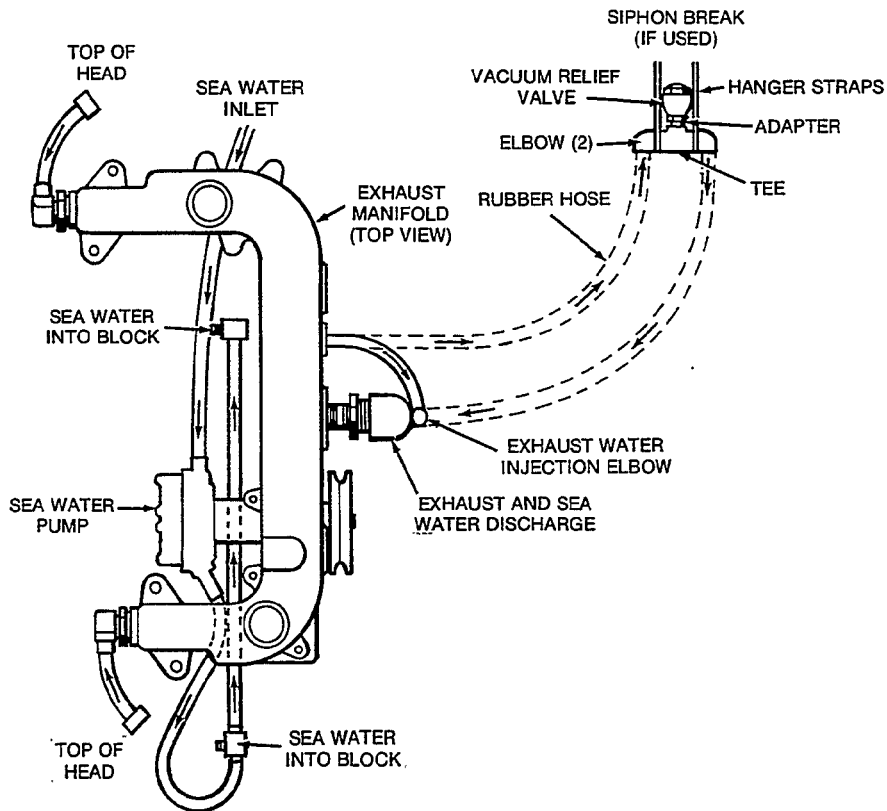


FIGURE 10. HOSE SCHEMATIC, SEA WATER COOLING

## Heat Exchanger Cooling (Optional)

This closed cooling system pumps captive water through the engine and exhaust manifold water jackets and into a heat exchanger. In the heat exchanger, this hot captive water is piped through a bath of sea water to cool it. The cooled captive water then returns to the captive water pump and is pumped back through the system. A sea water pump is used to constantly renew the sea bath in the heat exchanger and discharge the heated sea water into the exhaust line (Figure 11).

**WARNING** Never remove pressure cap on heat exchanger until all pressure has been carefully vented. Otherwise, serious personal injury from scalding water or steam could result.

Fill the closed cooling system with clean, alkali-free water and rust inhibitor or antifreeze. Onan

recommends the use of clean ethylene glycol antifreeze solutions in closed cooling systems during normal operation and storage periods. If freezing hazards exist, an antifreeze solution strong enough to prevent freezing must be used. Test antifreeze solutions periodically following antifreeze manufacturer's recommendations. The engine block has drain plugs for changing coolant as shown in Figure 12. Sea water can be drained from the heat exchanger by removing the hose from the sea water outlet fitting.

**CAUTION** Do not use existing neoprene impeller sea water pump for captive water side of cooling system. Heat, or soluble oil in many rust inhibitors and antifreezes, will damage the impeller. Always connect the neoprene impeller pump to the sea water side. Use a centrifugal metal impeller water pump (Onan No. 132-0110 or equal) in the captive water side. Drive it with a belt from the set power take-off as shown in Figure 12.

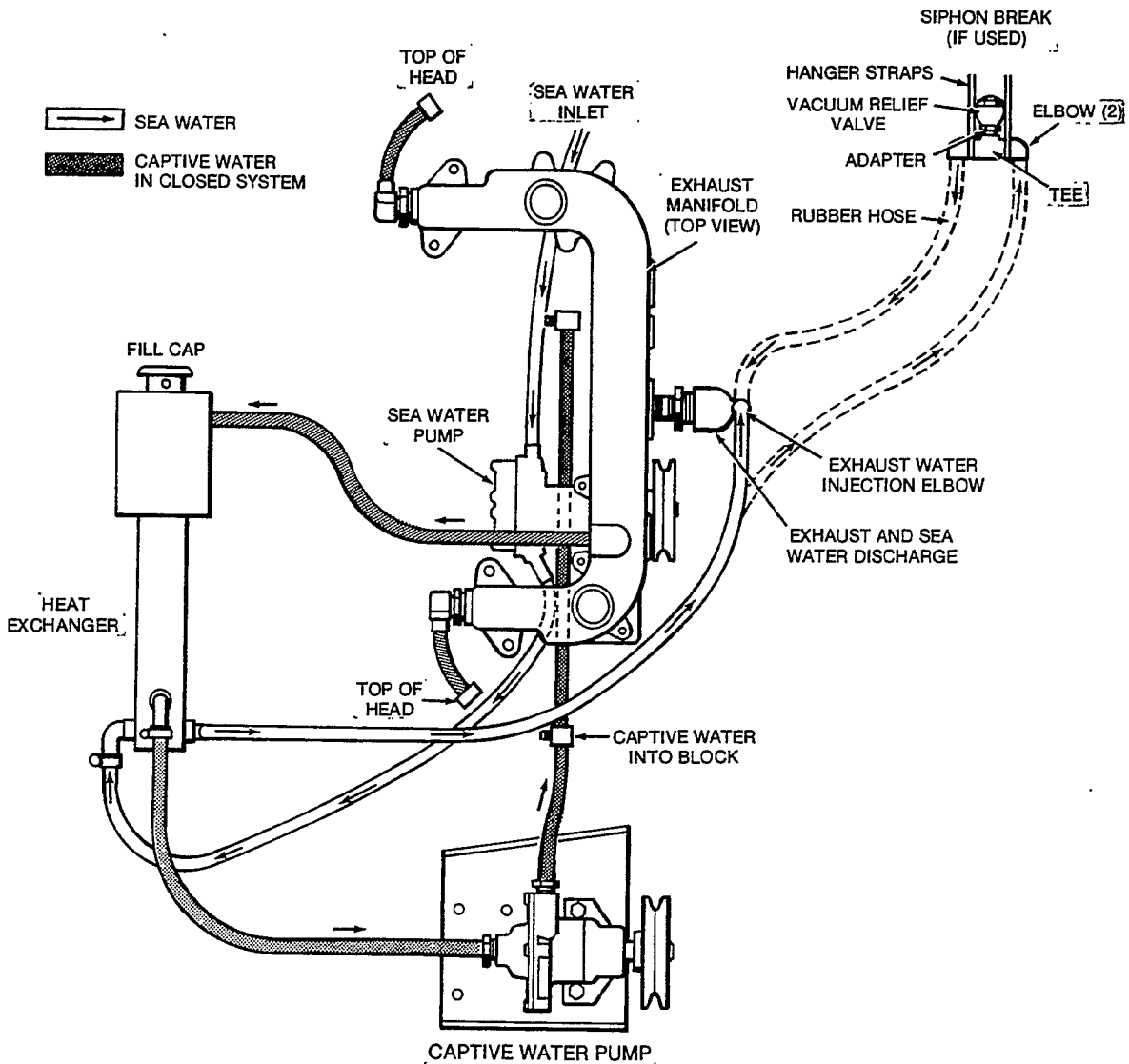


FIGURE 11. HOSE SCHEMATIC, HEAT EXCHANGER COOLING

### Keel Cooling (Optional)

This closed cooling system uses the same type of captive water cooling found in the heat exchanger system described above. However, rather than cooling the captive water in a heat exchanger, the water is pumped under the boat hull to a keel cooler, providing direct sea water cooling. A sea water pump supplies sea water to the exhaust for cooling.

Onan has available the necessary water pumps and other hardware for a keel cooling system. However,

the keel cooler, expansion tank and plumbing must be obtained from another source. Onan recommends that a keel cooler manufacturer be consulted for help in selecting the proper keel cooler for the generator set. Onan Technical Bulletin T-021 provides further information on keel cooling requirements.

Recommendations for protecting this system are the same as those given for the heat exchanger system explained previously.

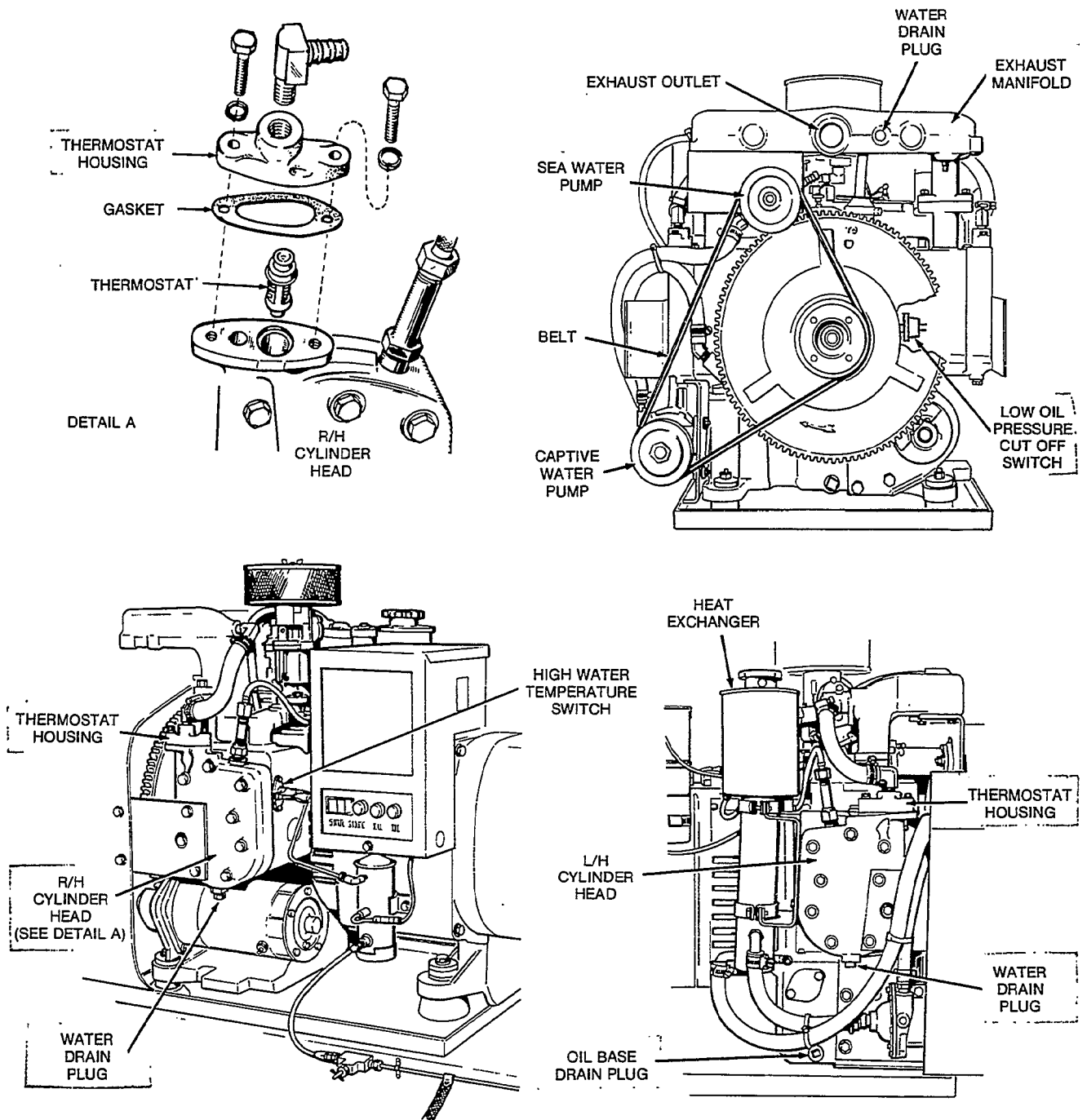


FIGURE 12. COOLING SYSTEM COMPONENT DETAILS

## Drain Plug Locations

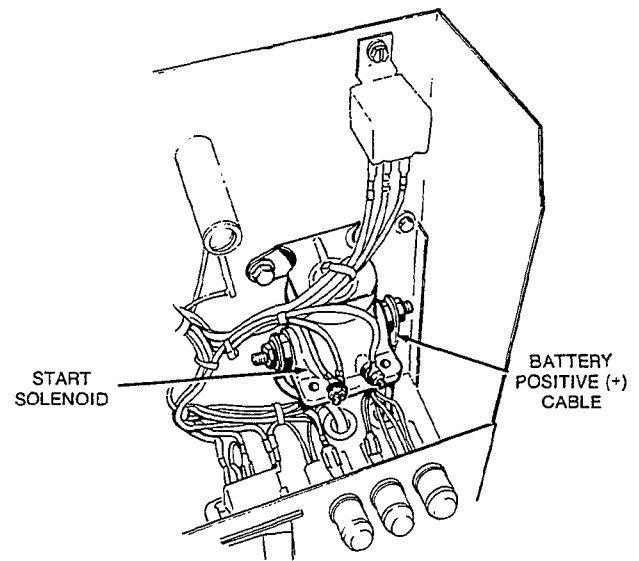
The standard MCKK unit has sea water cooling which should be cleaned and flushed at least once annually. This is especially true in cold weather conditions or when preparing the unit for off-season storage (over 30 days or more).

Refer to Figure 12 for the location of all drain plugs which should be removed to flush the cooling system.

There is a drain plug under each cylinder head and one in the exhaust manifold near exhaust pipe outlet on units without heat exchangers. The Onan sea water pump can be drained by loosening the end cover over the impeller area.

The oil base drain plug is also shown in this illustration.

**Thermostats:** Thermostats are located on the top of each cylinder head. These thermostats are connected by tubing to the water-cooled manifold. Replace all thermostats that are damaged from corrosion or other causes. See Figure 12.

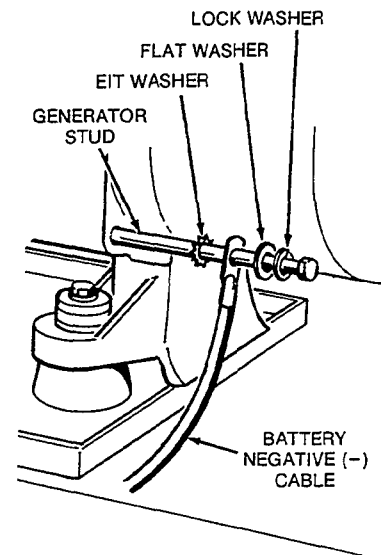


## ELECTRICAL CONNECTIONS

### Battery Connection

Follow Onan battery recommendations. Use one 12-volt, 74 amp./hr. battery connected for negative ground operation. See Figure 13. Connect battery positive (+) terminal to the start solenoid located in the control box. Connect the negative (-) terminal to a good ground on the generator frame.

**CAUTION** Do not disconnect starting battery while set is running. The resulting over-voltage condition will damage electric choke and control components.



### Grounding

The generator set and propulsion engine must be grounded in accordance with USCG regulation 33C-FR183.415. The regulation requires a common conductor connected between the generator set and propulsion engine grounded cranking motor circuits. See Figure 13. The conductor prevents accidental passage of cranking current through fuel systems and smaller electrical conductors common to the engines. The conductor must be the same size as the largest battery cable.

**WARNING** Without the common conductor, the cranking current could melt fuel lines or burn up conductors if a cranking motor ground circuit opens from corrosion, vibration, etc. Both hazards could lead to fire and explosion accidents.

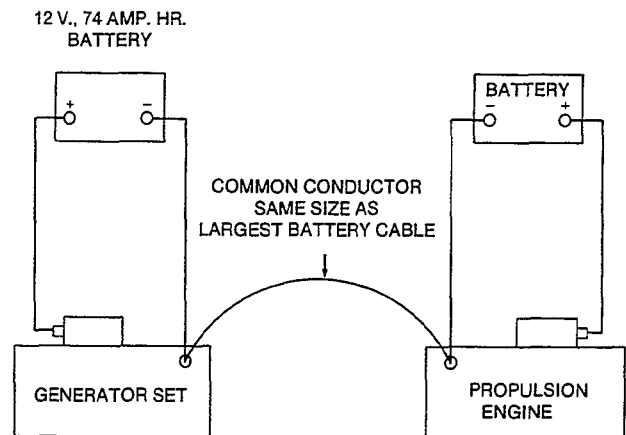


FIGURE 13. BATTERY CONNECTIONS

Be sure the drip pan bonding strap is installed under the mounting cushion cap screw on the left side of the generator as shown on page 4.



## Remote Start-Stop Switch (Optional)

The MCKK generator set can be connected for remote starting and stopping. Two controls available from Onan are shown in Figure 14. The standard control (300-0985) includes the control panel, start-stop switch and indicator lamp. The deluxe control (300-0986) contains these items, plus a running time meter and a battery condition meter. Installation instructions are included.

The remote control is connected to the terminal block on the set control box using 18 gauge or larger insulated wire. Use wiring diagram shown in Figure 16 following national and local electrical codes. Ensure that leads from remote control connect to corresponding terminals on the generator set. Additional remote controls may be added by extending the leads shown below.

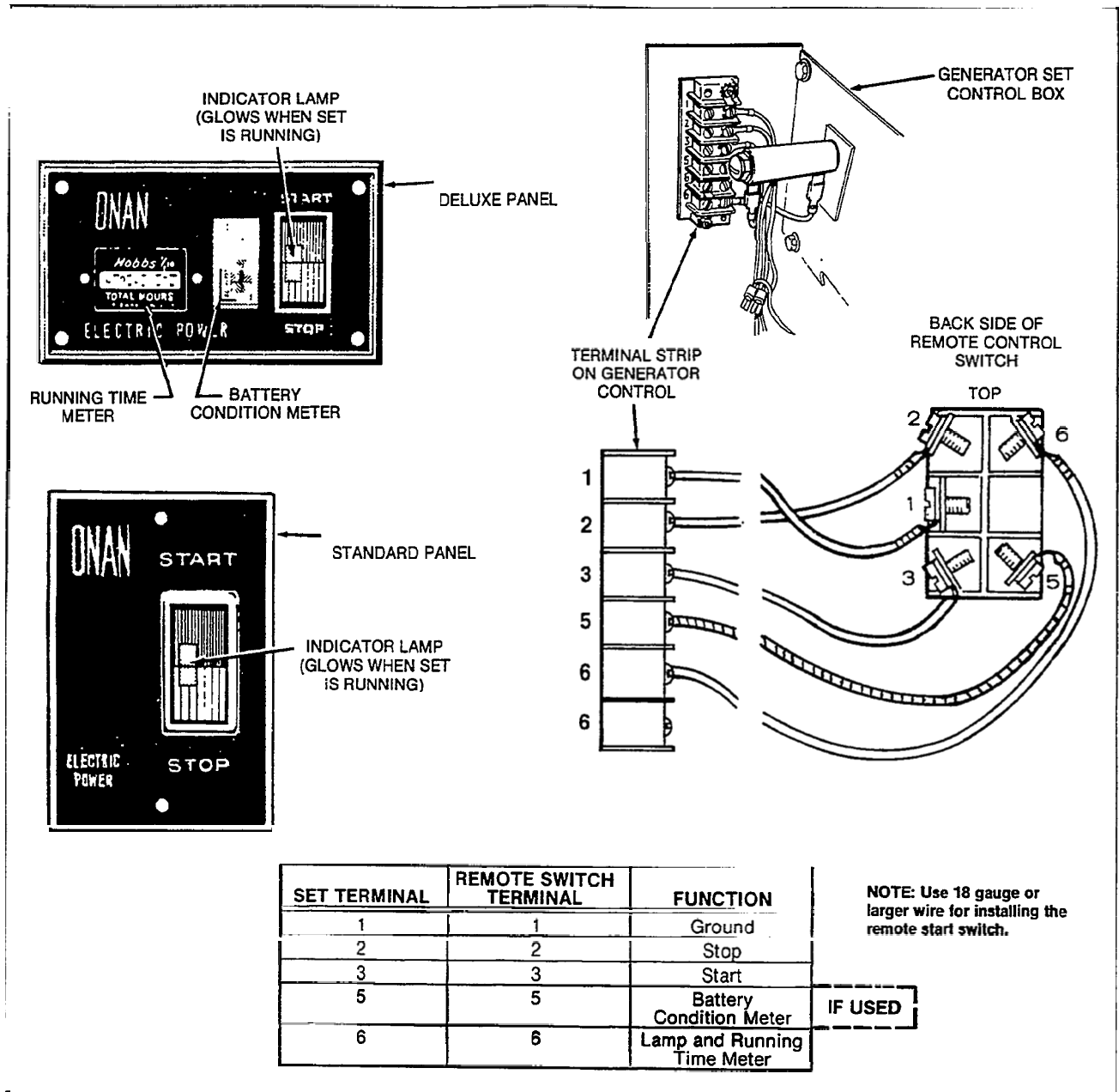


FIGURE 14. WIRING CONNECTIONS FOR REMOTE CONTROLS

## Load Wire Connections

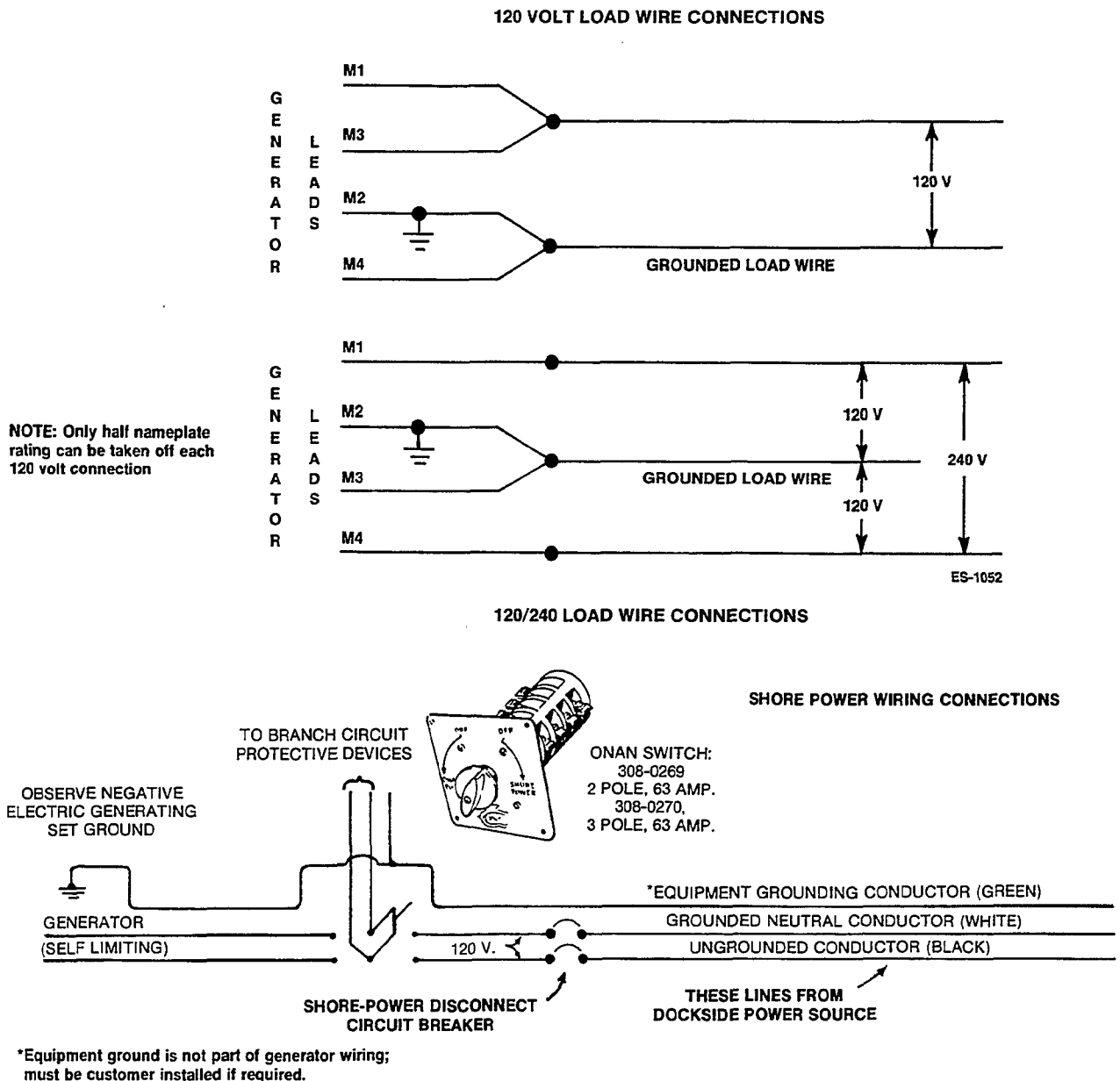
The set nameplate shows the electrical output rating of the set in watts, volts, and hertz. The set wiring diagram shows the electrical circuits and connections necessary for the available output voltage. Also see Figure 15.

Meet all applicable electrical code requirements. Work should be done by a qualified serviceman or electrician because the installation may be inspected for official approval. Set control boxes have knockout sections to accommodate load wires. Use flexible conduit and stranded load wires near the set to absorb vibration.

**Output Lead Markings:** Revolving armature generator leads are marked M1, M2, etc. These identifying marks also appear on the Wiring Diagram.

**Shore Power:** If the installation connects to shore power, install a double-throw transfer switch (either manual or automatic type), such as Onan No.'s 308-0269 - 2-pole; 308-0270 - 3-pole; to prevent commercial power and generator output from being connected to the load at the same time. Instructions for connecting an automatic load transfer switch are included with such equipment. See Figure 15.

**Automatic Control:** Use with negative ground electrical system only. If the electrical system is positive ground and cannot be converted, use a separate battery connected to negative ground for set and control operation. Use a suitable grounding system for the entire vessel to prevent electrolytic action which may be caused by improper connections of mixed-polarity grounding systems.



# OPERATION

## PRE-STARTING

Preparations for operation should include checks of the oil, fuel, cooling, and electrical systems. Before the generator set is put in operation, check all components for mechanical security. If an abnormal condition, defective part, or operating difficulty is detected, repair or service as required. The generator set should be kept free of dust, dirt, and spilled oil or fuel.

### Crankcase Oil

Use a good quality detergent oil with the designation SE, SE/CC. Do not use service DS oil at any time. Do not mix brands nor grades.

Refer to the *MAINTENANCE* section for recommended oil changes and complete lubrication oil recommendations. Use the proper SAE number for expected temperature conditions as shown in the *Oil Recommendation Chart*, Figure 24.

**WARNING** Never check oil with the engine running. Hot oil discharged from the engine could cause personal injury.

### Recommended Fuel

Use clean, fresh, unleaded or regular grade gasoline. Do not use highly leaded premium fuels. Using unleaded gasoline results in less maintenance.

If the use of unleaded gasoline is desired, use regular gasoline for the first 25 hours to allow the rings to seat well for best performance. Then use unleaded gasoline thereafter.

If regular gasoline is used continually, carbon and lead deposits must be removed from the cylinder heads as required because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

**CAUTION** If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, pre-ignition could occur causing severe damage to the engine.

**WARNING** Never fill the tank when the engine is running. Overflowing gasoline fumes may ignite causing a fire or explosion. Leave some space in the tank for fuel expansion.

## STARTING

The bilge blower should be operated for about five minutes before cranking the engine. The optional HA automatic demand control performs this function automatically. Complete instructions are included with the control.

**WARNING** The bilge blower circuit is a safety feature for your protection. The blower removes gas vapors which have explosive potential.

## **▲WARNING**

### **EXHAUST GAS IS DEADLY!**

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

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

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

**Never sleep in the vessel with the generator set running unless the vessel interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.**

Press the Start switch until the engine comes up to speed. If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs—remove, clean in a suitable solvent, dry thoroughly and reinstall. Heavy exhaust smoke when the engine is first started is normal, and is caused by the inhibitor oil. Check sea water pump operation after engine starts by observing the exhaust outlet. A steady stream of water should be observed under normal operating conditions.

### **APPLYING LOAD**

Allow set to warm up before connecting a heavy load and keep the load within nameplate rating. Continuous generator overloading may cause high operating temperatures that can damage the generator.

### **BATTERY CHARGING**

The battery charge rate is preset and is not adjustable. *Note:* Charge rate is 1 ampere. If continuous starts are encountered, a separate solid state battery charger will be required.

### **SAFETY DEVICES**

A high-water-temperature switch in the cooling system stops the set if the engine overheats.

The engine has a low-oil-pressure switch which will stop the set through an ignition relay in the control if oil pressure drops below a safe operating pressure. After an emergency stop, investigate and correct the cause.

The three fuses on the control panel protect battery DC control wiring and components as follows:

- *Fuse F1* protects wiring to optional remote accessories connected to terminal 5 of the terminal block.
- *Fuse F2* protects wiring and components of the cranking and ignition circuits. If blown, these functions are disabled. The fuse also protects wiring of remote accessories connected to terminal 6 of the terminal block, such as running time meter or running light.
- *Fuse F3* protects the battery charging circuit. If blown, the battery will not receive any charging current, and the carburetor choke will not open and result in poor engine performance after warm-up.

### **GENERATING SET EXERCISE**

Infrequent use may result in hard starting. Operate generator set one 30-minute period each week. If necessary, keep battery charged with a separate solid state charger.

### **EMERGENCY OPERATION IF BATTERY FAILS**

The generator set needs a battery for the electric choke and fuel pump, ignition and cranking. If the battery fails completely and the set must be operated during an emergency, a battery can be shared with other equipment having an alternator. Do not disconnect the set charging circuit, as damage will occur to components from the increased voltage. Instead, consider disconnecting other equipment and using that battery.

### **BREAK-IN PROCEDURE**

The unit should be run in the following sequence using SE or SE/CC oil (see oil requirements for correct viscosity).

1. One half hour at half load.
2. One half hour at three quarter load.
3. Full load.

This method of load application speeds piston ring seating. Continuous running at half (light) load for the first few hundred hours usually results in poor piston ring seating, causing higher than normal oil consumption and blowby.

### **EXTENDED OUT-OF-SERVICE PROTECTION—GASOLINE ENGINES**

Generator sets removed from service for extended periods of time (over 30 days) should be protected from rust and corrosion. Onan recommends the following protective procedure:

1. Check coolant level, add if necessary using recommended anti-freeze.
2. Run set until thoroughly warm with generator under at least 50 percent load. Stop engine by shutting off fuel supply to allow engine to drain fuel lines and carburetor.
3. Drain oil base while still warm. Refill and attach a tag indicating viscosity of oil used.
4. Remove spark plugs. Pour 1-ounce of rust inhibiting oil (or SAE #10 oil) into each cylinder. Crank engine over several times. Install spark plugs.
5. Clean throttle and governor linkage; protect by wrapping with a clean cloth.
6. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
7. Clean off dirt and dry entire unit. Coat parts likely to rust with a light film of oil or grease.
8. Disconnect battery and follow standard battery storage procedure. Apply a film of nonconductive grease (e.g., vaseline) to battery cable terminal lugs.
9. Fill fuel tank to prevent condensate contamination.

10. Provide a suitable protective cover for the entire unit.
11. Drain sea water cooling system.

### RETURNING UNIT TO SERVICE

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check battery. Measure specific gravity and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. **DO NOT OVERCHARGE.**
4. Open fuel line.

#### **WARNING**

Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.

5. Connect batteries.
6. Check coolant level and add as required.
7. Verify that no loads are connected to the generator.
8. Start engine.
9. Check sea water pump operation.

After engine has started, excessive blue smoke will be exhausted and the engine will run rough until the rust inhibitor or oil has burned away.

10. After start, apply load to at least 50 percent of rated capacity.
11. Check all gauges for proper reading. Unit is ready for service.

### DIRTY CONDITIONS

1. Keep set clean. Keep cooling system clean.
2. Service flame arrester as frequently as necessary.
3. Change crankcase oil every 50 operating hours.
4. Keep oil and fuel supplies in dust-tight containers.
5. Keep governor linkage clean.
6. Clean generator slip rings. Do not remove normal (dark brown) film. Do not polish.

### LOW TEMPERATURES

1. Use correct SAE oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh regular grade (not premium) gasoline. Protect against moisture condensation. Below 0° F, adjust main jet for slightly richer fuel mixture.
3. Keep ignition system clean, properly adjusted, and the batteries in a well-charged condition. Keep battery terminals clean and tight.
4. Add good quality antifreeze if danger of freezing exists.

### HIGH TEMPERATURES

1. Check sea water pump operation.
2. See that nothing obstructs air flow across the set.
3. Keep cooling system clean. Maintain coolant level in captive cooling system.
4. Keep ignition timing properly adjusted.
5. Maintain correct tension on pump belts.

# ENGINE TROUBLESHOOTING GUIDE

<b>TROUBLE</b>		<b>CAUSE</b>
<b>Backfire at Carburetor</b>		<b>STARTING SYSTEM</b>
<b>Bearing Wear</b>		Loose or Corroded Battery Connection
<b>Black Exhaust</b>		Low or Discharged Battery
<b>Blue Exhaust</b>		Faulty Starter
<b>Burned Valves</b>		Faulty Start Solenoid
<b>Connecting Rod Wear</b>		<b>IGNITION SYSTEM</b>
<b>Crankshaft Slowly</b>		Ignition Timing Wrong
<b>Cylinder Wear</b>		Wrong Spark Plug Gap
<b>Engine Stops</b>		Worn Points or Improper Gap Setting
<b>Failure to Start</b>		Bad Ignition Coil or Condenser
<b>Governor Hunting</b>		Faulty Spark Plug Wires
<b>High Oil Pressure</b>		<b>FUEL SYSTEM</b>
<b>Loss of Coolant (Water Cooled)</b>		Out of Fuel - Check
<b>Mechanical Knocks</b>		Lean Fuel Mixture - Readjust
<b>Misfiring</b>		Rich Fuel Mixture or Choke Stuck
<b>Overheating (Air Cooled)</b>		Engine Flooded
<b>Overheating (Water Cooled)</b>		Poor Quality Fuel
<b>Piston Wear</b>		Dirty Carburetor
<b>Poor Compression</b>		Dirty Air Cleaner
<b>Ring Wear</b>		Dirty Fuel Filter
<b>Sticking Valves</b>		Defective Fuel Pump
		<b>INTERNAL ENGINE</b>
		Wrong Valve Clearance
		Broken Valve Spring
		Valve or Valve Seal Leaking
		Piston Rings Worn or Broken
		Wrong Bearing Clearance
		<b>COOLING SYSTEM (AIR COOLED)</b>
		Poor Air Circulation
		Dirty or Oily Cooling Fins
		Blown Head Gasket
		<b>COOLING SYSTEM (WATER COOLED)</b>
		Insufficient Coolant
		Faulty Thermostat
		Worn Water Pump or Pump Seal
		Water Passages Restricted
		Defective Gaskets
		Blown Head Gasket
		<b>LUBRICATION SYSTEM</b>
		Defective Oil Gauge
		Relief Valve Stuck
		Faulty Oil Pump
		Dirty Oil or Filter
		Oil Too Light or Diluted
		Oil Level Low
		Oil Too Heavy
		Dirty Crankcase Breather Valve
		<b>THROTTLE AND GOVERNOR</b>
		Linkage Out of Adjustment
		Linkage Worn or Disconnected
		Governor Spring Sensitivity Too Great
		Linkage Binding

# ADJUSTMENTS

## CHECK BREAKER POINTS

Replace burned or faulty points. If only slightly burned, dress smooth with file or fine stone. Do not use emery paper or emery cloth. Measure gap with thickness gauge; gap points at .020-inch (0.51 mm).

Ignition breaker points, Figure 16, must be correctly gapped. Crank engine to fully open breaker points (1/4 turn after top center). Loosen locking screws (A) and turn cam (B) to adjust. Tighten breaker points and recheck gap.

Ignition points should break contact just as the 20-degree timing mark aligns with the flywheel timing mark. Final timing is corrected by properly shifting the breaker point box on its mounting and using a timing light. If specified timing cannot be obtained by positioning the breaker box, make sure timing marks on gears are aligned.

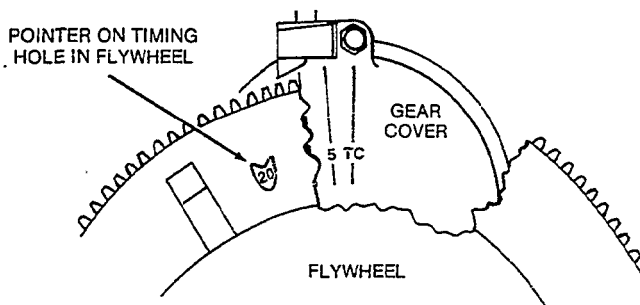
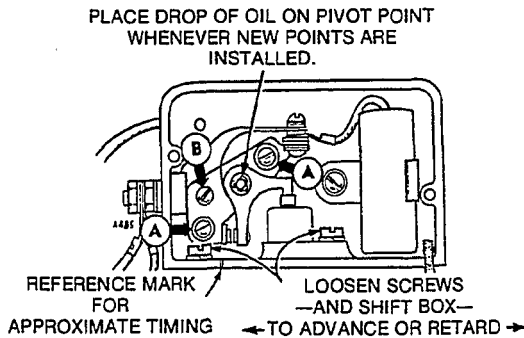


FIGURE 16. IGNITION POINTS AND TIMING

## CARBURETOR

The downdraft carburetor, shown in Figure 17, has main and idle fuel adjustments. The main fuel adjustment affects operation at full load. The idle fuel adjustment affects operation under light or no load conditions. Under normal circumstances, factory carburetor adjustments should not be disturbed. If adjustments have been disturbed, turn idle adjustment screw  $1 \pm 1/8$  turns open, and main fuel adjustment screw  $1-3/8 \pm 1/8$  turns open (off of needle seat). Then readjust them for smooth engine operation.

If carburetor adjustments do not correct a "hunting" condition (sudden increases and decreases in speed) at no load or full load, check governor adjustments and linkage as referenced in the *Governor* section. A hunting condition at no load can usually be corrected by an idle fuel adjustment.

**CAUTION** When determining fuel mixture settings, never force the fuel mixture adjustment needles against their seats (damages the seats and needles).

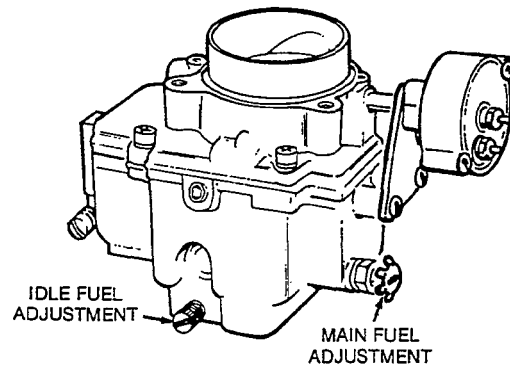


FIGURE 17. CARBURETOR FUEL MIXTURE ADJUSTMENTS

Before final adjustment, allow engine to warm up. Make idle adjustment with no load connected to the generator. Use a tachometer, or connect a frequency meter to generator output to observe speed or frequency. Slowly turn idle adjustment out until engine speed (or generator frequency) drops slightly below normal. Then turn needle in until speed (or frequency) returns to normal.

To set main fuel adjustment, apply a FULL electrical load to the generator. Carefully turn main adjustment screw in until engine speed (or output frequency) drops slightly below normal. Then turn needle out until speed (or frequency) returns to normal. Proper carburetor adjustment cannot be assured unless the governor is properly adjusted.

### Throttle Stop Screw

The throttle stop screw is located on the base of the carburetor (opposite side from main power adjustment needle) near the crankcase breather valve. It must be adjusted to obtain 56 hertz at no load with the throttle closed as far as possible (throttle shaft lever touching adjustment screw). See Figure 18.

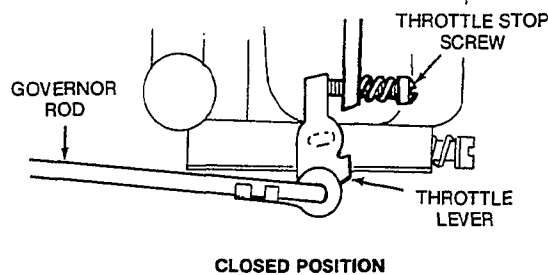


FIGURE 18. THROTTLE STOP SCREW SETTING

### Electric Choke

This choke uses a heating element and a heat sensitive bimetal spring to open the choke valve. The choke valve closes according to surrounding temperature.

The choke valve should be open about 3/8-inch (9.5 mm) on a cool engine at room temperature of 70°F (21°C), and 1/4-inch (6.4 mm) at temperature of 40°F (4.5°C). See Figure 19.

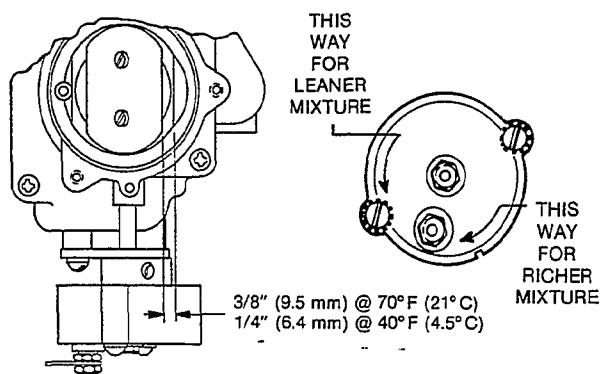


FIGURE 19. ELECTRIC CHOKE

If extremes in starting temperatures require a readjustment of the choke, slightly loosen the two cover retaining screws. For more choking action, turn the cover assembly a few degrees in a clockwise direction. For less choking action, turn counterclockwise. Retighten the cover screws. See Figure 19.

**WARNING** It is normal for the choke cover to be very warm during operation. A burn may result if hand is placed on choke.

### Carburetor Float Adjustment

1. Normal operation seldom requires any adjustment of the float level. Disconnect governor, choke leads, flame arrester and fuel line from carburetor.
2. Remove the two bolts that hold the carburetor in place on the intake manifold assembly.
3. Remove the four Phillips head screws on the top of the carburetor and lift it off.
4. Invert the carburetor and check the float setting (see Figure 20). The float should be  $0.02 \pm 0.02$  inch ( $0.51 \pm 0.51$  mm) above the machined mating surface (without gasket). Bend the float tab as required.
5. If it is necessary to reset the float level, loosen the screw near float valve axle (pin) and bend the float arm near float valve axle (pin) to position float flush with top edge of carburetor float bowl. See Figure 20.

**CAUTION** If float adjustment is necessary, be careful not to lose the buoyancy spring or the tension spring on the viton tip float needle and seat assembly.

6. Reassemble carburetor. Reinstall carburetor on intake manifold assembly, connect fuel line and install flame arrester.
7. Check carburetor for proper operation.

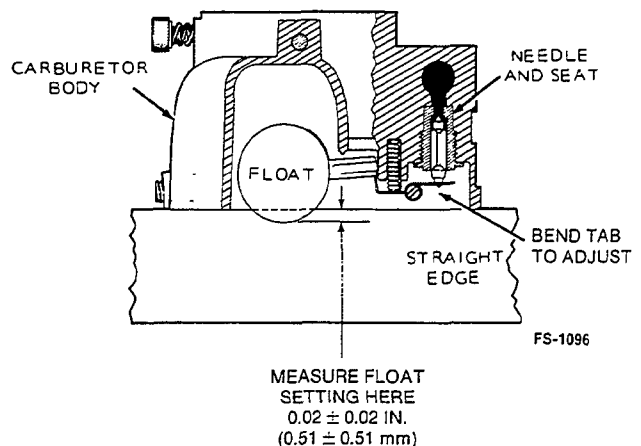


FIGURE 20. CARBURETOR FLOAT SETTING



## GOVERNOR

The governor controls the engine speed under varying load conditions. Rated speed and voltage appear on the nameplate (see *SPECIFICATIONS*). On a 4-pole generator, engine speed equals frequency multiplied by 30. Thus, 1800 rpm gives a 60 hertz frequency.

Preferred speed varies approximately 3 hertz from no load to full load operation. Be sure throttle, linkage, and governor mechanism operate smoothly.

### Governor Adjustment

Before making adjustments, run the set about 15 minutes with a light load connected to reach normal operating temperature. (If governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage operating range.)

Engine speed determines the output voltage and frequency of the generator. By increasing the engine speed, generator voltage and frequency are increased, and by decreasing the engine speed, generator voltage and frequency are decreased. Connect an accurate voltmeter or frequency meter (preferably both) to the generator output in order to correctly adjust the governor. A small speed drop not noticeable without instruments may result in an objectionable voltage drop. Use a tachometer to check engine speed.

A binding in the bearings of the governor shaft, in the ball joint, or in the carburetor throttle assembly causes erratic governor action, or alternate increase and decrease in speed (hunting). A lean carburetor adjustment may also cause hunting. Springs of all kinds have a tendency to lose their calibrated tension after long usage. If all governor and carburetor adjustments are properly made, and the governor action is still erratic, replacing the spring with a new one and resetting the adjustments will usually correct the trouble.

1. Adjust the carburetor main jet for the best fuel mixture while operating the set with a full rated load connected.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage, and check linkage and throttle shaft for binding or excessive looseness.
4. Adjust the governor spring tension for rated speed at no load operation.
5. Adjust the governor sensitivity.
6. Recheck the speed adjustment.
7. Set the carburetor throttle stop screw.

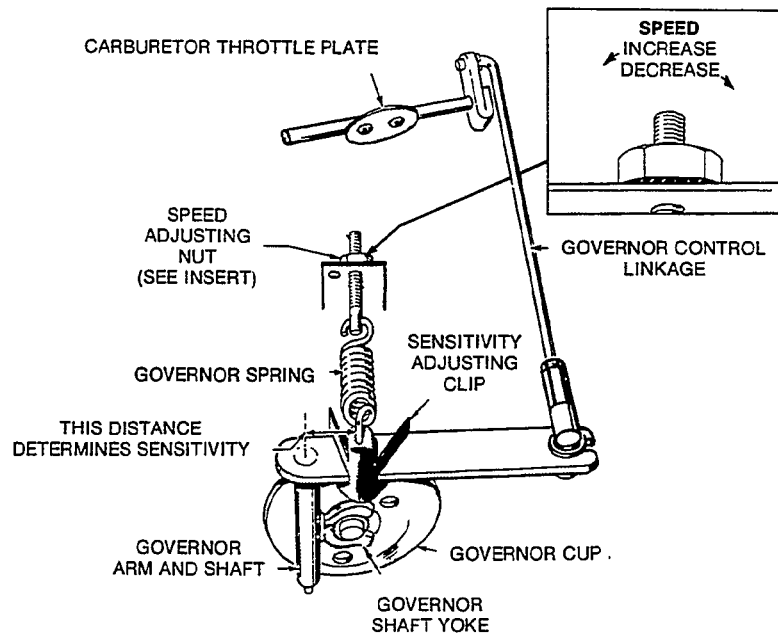


FIGURE 21. GOVERNOR ADJUSTMENTS

**VOLTAGE CHART  
FOR CHECKING GOVERNOR REGULATION**

AC GENERATING SETS	120 VOLT (1PH, 2W) OR 120/240V (1PH, 3W)	240 VOLT (1PH, 2W)
Maximum No-Load Volts	126	252
Minimum Full-Load Volts	110	220

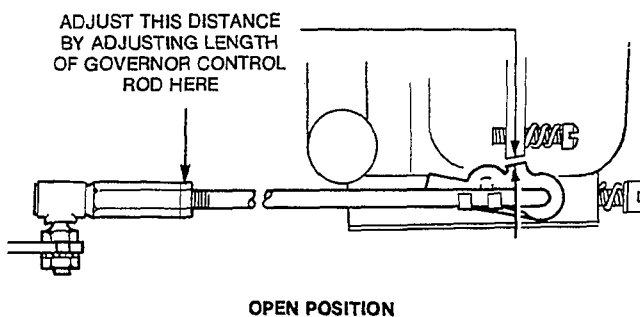
**NOTE:** Output rating is at UNITY power factor load.

**SPEED CHART  
FOR CHECKING GOVERNOR REGULATION**

AC GENERATING SETS	60 HERTZ
Maximum No-Load Speed RPM Hertz (Frequency)	1890 63
Minimum Full-Load Speed RPM Hertz (Frequency)	1770 59

**Linkage**

The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle shaft and lever is adjusted by rotating the ball joint. Adjust this length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever just contacts the underside of the carburetor bowl. This setting allows immediate control by the governor after starting. It also synchronizes travel of the governor arm and the throttle shaft. See Figure 22.



**FIGURE 22. LINKAGE ADJUSTMENT**

**Speed Adjustment**

With the warmed-up unit operating at no load, adjust the governor spring tension. Refer to *Voltage Chart* and *Speed Chart* and select the column which corresponds to the nameplate of the unit in question. Turn the speed adjusting nut to obtain a voltage and speed reading within the limits shown.

**Sensitivity Adjustment**

Refer to the Governor Adjustment illustration, and to the Voltage and Speed Charts. Check the voltage and speed, first with no load connected and again with a full load. Adjust the sensitivity to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition.

To increase sensitivity (closer regulation), shift the adjusting clip toward the governor shaft.

An adjustment for too much sensitivity will cause alternate increase and decrease of engine speed (hunting).

To decrease sensitivity, shift the adjusting clip toward the outer end of the governor arm. Too little sensitivity will result in too much difference in speed between no load and full load conditions.

Any change in the sensitivity adjustment usually requires a compensating speed (spring tension) adjustment.

# SERVICE AND MAINTENANCE

## GENERAL

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The schedule shown in Table 1 can be used as a guide. However, actual operating conditions under which the unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of

the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc., frequently until the proper service time periods can be established.

For any abnormalities in operation, unusual noises from engine or accessories, loss of power, overheating, etc., contact your nearest dealer.

**TABLE 1. OPERATOR AND SERVICE MAINTENANCE SCHEDULE**

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS					
	8	50	100	200	500	1000
Inspect Set	x					
Check Fuel Supply	x6					
Check Oil Level	x					
Check Cooling System		x5				
Check Flame Arrester		x1				
Inspect Exhaust System	x2					
Check Spark Plugs			x3			
Clean Governor Linkage			x4			
Change Crankcase Oil			x4			
Check Battery Water Level		x				
Check Brushes				x		
Inspect Breaker Points				x		
Clean Crankcase Breather				x		
Clean Carburetor					x	
Remove Lead Deposits.				x		
Check Valve Clearance					x	
Clean Generator						x
Remove and Clean Oil Base						x
Grind Valves (If Required)						x

- x1 - Inspect for physical damage. Wash in suitable solvent.
- x2 - With set running, visually and audibly check exhaust for leaks.
- x3 - Replace at 250 hours.
- x4 - Perform more often in extremely dusty conditions.
- x5 - Check pump pulley set screws and tighten. Replace antifreeze annually.
- x6 - Check fuel system for leaks or damage.

**WARNING** All exhaust system connections **MUST** be checked regularly for any leaks and tightened as necessary. Do **NOT** terminate exhaust pipe near any window or bulkhead (door) openings. Do **NOT** use the air cleaner/flame arrester as a supporting step. Always operate bilge blower for 5 minutes after refueling or anytime prior to starting engines or generator set.

**WARNING** Before performing any maintenance work on the engine, generator, control panel, automatic demand control or associated wiring, disconnect batteries. Failure to do so could result in damage to the unit or serious personal injury from electric shock or inadvertent starting.

A periodic visual inspection should be made by the operator with the set running at rated load. This inspection should include:

1. Checking all fuel, oil and cooling system components for leakage.
2. Visually and audibly inspecting exhaust lines and mufflers for possible leakage and cracks.
3. Inspecting electrical wires and connections for possible arcing, fray damage or interference with moving parts.

### CRANKCASE OIL

The oil level dipstick is located on top of the engine. Fill crankcase to the FULL mark on the dipstick with a good quality detergent oil that meets the API (American Petroleum Institute) service designations SE or SE/CC. Use the proper SAE number of oil for the expected temperature conditions as shown in Figure 24. Do not mix oil brands or grades because they may not be compatible. Extremely dusty or low temperature conditions require oil changes more often than normal.

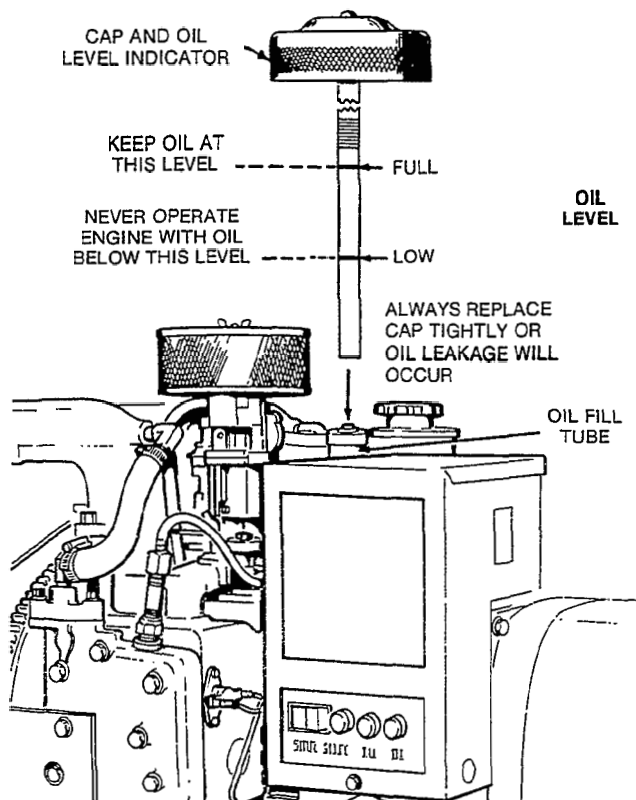


FIGURE 23. OIL LEVEL INDICATOR

The engine oil capacity is 3.5 quarts (3.3 litre). Do not overfill crankcase. Engine oil should be drained when warm at recommended interval shown in Table 1. Remove the oil base drain plug, or if preferred, pump the oil out through the oil fill tube.

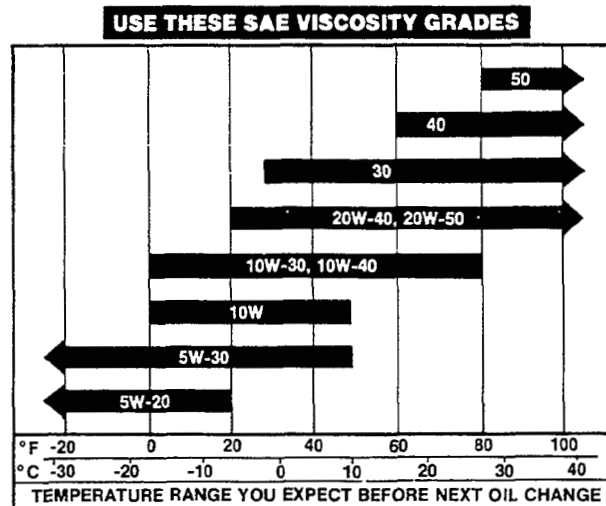


FIGURE 24. OIL RECOMMENDATION CHART

### Crankcase Breather

This unit is equipped with a ball check valve for maintaining crankcase vacuum. The only maintenance required is to clean the components periodically. Remove the hose clamp, breather hose and breather cap clamp to release the breather cap and valve assembly. Wash the cap, valve assembly and filter in a suitable solvent and reinstall (see Figure 25).

Do not disassemble the cap and four-ball valve assembly, the ball travel clearance is critical and must not be changed.

**WARNING** Use extreme care when cleaning with a petroleum-base solvent due to fire hazard.

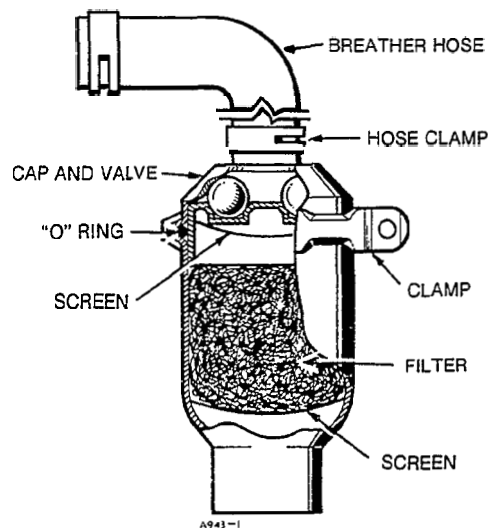


FIGURE 25. CRANKCASE BREATHER

## ELECTRIC FUEL PUMP

An electric fuel pump is used on this unit as shown in Figure 26. Service to the pump is limited to cleaning or replacement of the filter element and gasket. Every 500 hours, drain the fuel pump and check the filter element. Turn the hex nut on the base of the pump to release the cover from bayonet fittings. If the element is dirty, wash it in suitable solvent. Be sure to replace gaskets when reassembling.

**WARNING** Do not permit any flame, spark, cigarette, or other igniter near the fuel system. Gasoline is highly flammable and potentially explosive in confined spaces.

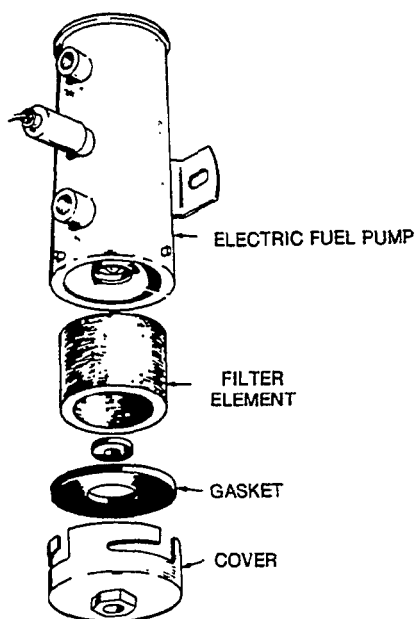


FIGURE 26. ELECTRIC FUEL PUMP

## SPARK PLUGS

Replace spark plugs every 250 hours. A badly leaded plug will cause misfiring, poor operation or stopping when a load is applied.

- Black deposits indicate a rich mixture.
- Wet plug indicates misfiring.
- Badly or frequently fouled plug indicates the need for a major tune-up.

Each time the spark plugs are removed, inspect, clean and regap (Figure 27). If the plug looks discolored or has fouled, replace it.

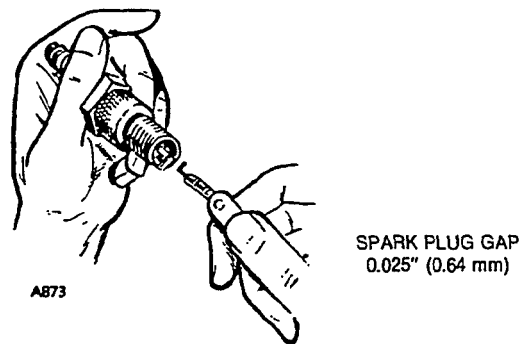


FIGURE 27. SPARK PLUG GAP

## GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Every 50 hours of operation, clean the joints and lubricate as shown in Figure 28. Also inspect the linkage for binding, excessive slack and wear.

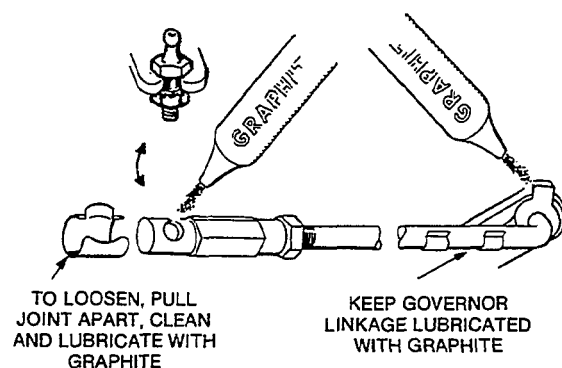


FIGURE 28. GOVERNOR LINKAGE

## COOLING SYSTEM

The cooling system works efficiently only when it is clean. Scale and rust in the cooling system slows heat absorption and restricts water flow. Clean and flush the system at least once a year and more often if operation indicates clogged passages or overheating. Clean the cooling system with a dependable cleaning compound and follow the procedure recommended by the supplier.

## Antifreeze

Onan recommends the use of clean ethylene glycol antifreeze solutions in closed cooling systems during normal operation and storage periods. Be sure antifreeze solution will protect the cooling system during the coldest winter weather.

Most antifreeze manufacturers recommend a minimum 50-50 mix of ethylene glycol antifreeze and water for winter and summer in closed water systems with a complete change every year to avoid corrosion and more expensive damage.

### Pressure Cap

Closed cooling systems make use of a pressurized cap to increase the boiling point of the coolant and allow higher operating temperatures. Pressure caps should be replaced every two years or whenever they malfunction.

### Sea Water Pump Impeller

Improper functioning of the sea water pump is usually caused by failure of the neoprene impeller. Because of continuous flexing, the impeller deteriorates with time and must be replaced. If, however, the impeller fails after short service (under 500 hours), check for possible defects in the pump or the system. The pump is shown disassembled in Figure 29. Pump should discharge a nominal 4 U.S. gallons per minute when thermostat is open.

Remove the cover of the water pump and check for pock marks on the end surfaces of the impeller. Pock marks are a sign of air in the cooling system, which reduces pump lubrication and causes overheating. Replace the impeller if such conditions exist and seal off all air leaks. When re-installing the pump cover, coat the inside with grease to insure proper pump lubrication during initial operation. Make sure the cover is installed airtight and torque the screws to 15 to 17 inch-pounds (1.70 to 1.92 N•m).

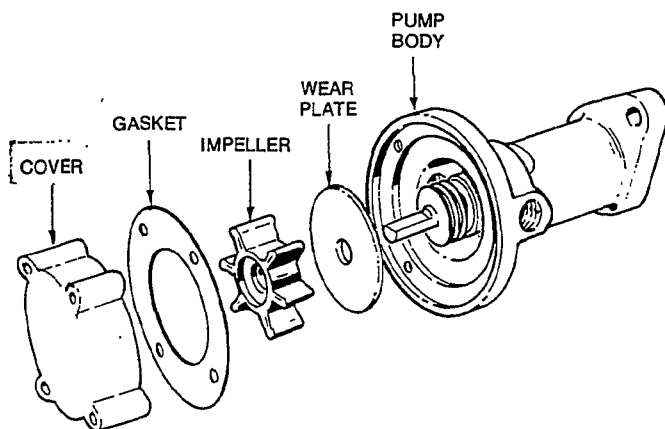


FIGURE 29. SEA WATER PUMP

### Water Pump Belt

Improper belt tension will result in a slipping or broken belt. This in turn will result in overheating of the engine caused by reduced coolant flow.

To adjust the tension, loosen the sea pump mounting bolts and slide pump along bolt slots. A force of 15 pounds (67 N) applied between the pump pulley and the engine pulley should deflect the belt about 1/2 inch (13 mm). Be sure to tighten mounting bolts when tension is correct.

If the belt is frayed, cracked or glazed, it should be replaced.

### Thermostat

The temperature of the cooling system is thermostatically controlled. The thermostat mounts on the cylinder head and is housed in a thermostat cover (Figure 12). Replace the thermostat if corroded, damaged or opening improperly. Check the opening of the thermostat by immersing it in a bath of water and heating the water. The thermostat should just start to open around 145°F (63°C) on sea water cooled systems and around 180°F (82°C) on heat exchanger and keel cooling systems.

### High Temperature Cut-Off Switch

This normally closed switch, mounted on the rear of the cylinder head, senses coolant temperature in the engine coolant jacket. When engine temperature rises beyond a specific point, the switch opens and stops the engine. When coolant temperature lowers to a safe operating range, the switch closes, permitting engine restarting. If high temperature shutdown occurs, check the sea water pump, belt, thermostat, etc.

An optional high exhaust temperature cut-off switch may be connected in the exhaust system. This switch, connected in series with the engine temperature switch, stops the engine if exhaust temperature exceeds 230°F (111°C). If shutdown occurs, check the sea water pump, filter, hoses and connections.

### BATTERY

Check the condition of the starting battery at least once a week. See that connections are clean and tight. A light coating of nonconductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity; recharge if below 1.260 at 77°F (25°C).

#### WARNING

Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.

## GENERATOR MAINTENANCE

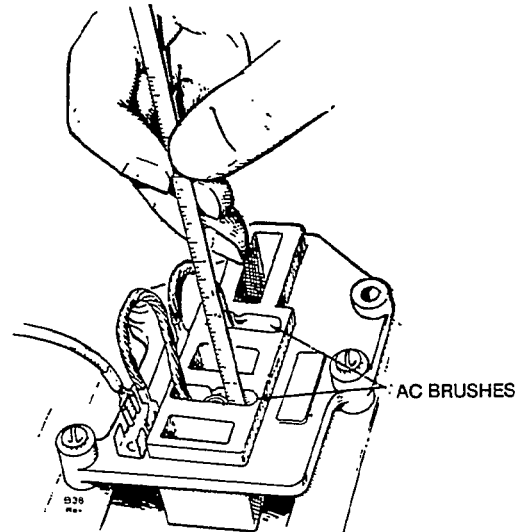
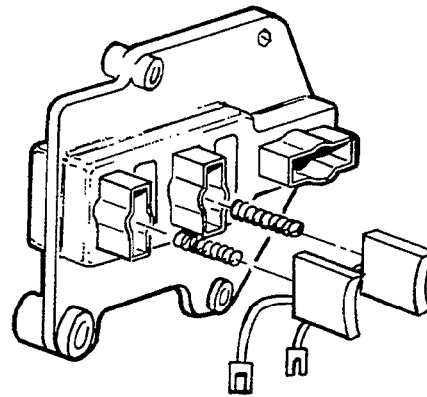
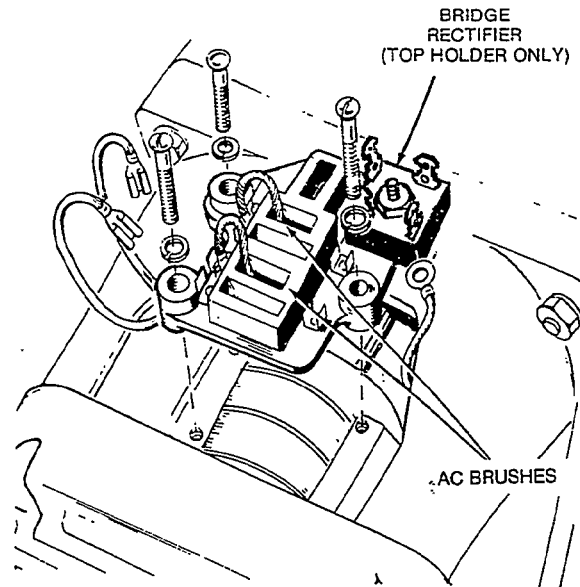
The generator normally needs little care other than a periodic check of the brushes and collector rings. If major repair on the generator should become necessary, have the equipment checked by a competent electrician who is thoroughly familiar with the operation of electric generating equipment.

### Brush Replacement

With the generator set turned off and negative (-) battery lead disconnected, remove the end bell cover. Install new brushes when the old ones are worn to the dimensions shown in Figure 30. Remove the three screws holding each brush holder in place. Remove the old brushes and clean the holders so the new brushes can move easily in their holders. Install the new brushes in the same manner as the old ones. New brushes are shaped to fit the collector rings. Always use the correct brush as listed in the Parts Catalog number 927-0224.

**Never substitute a brush which may appear to be the same, for it may have different electrical characteristics.**

Collector rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright newly machined appearing surface. Ordinary cleaning with a dry, lint free cloth is usually sufficient. Clean out all carbon dust from the generator.



MEASURE FROM TOP FACE OF BRUSH BLOCK TO TOP OF BRUSH

NEW	1 1/16" (17.5 mm)
1/2 WEAR	7/8" (22 mm)
REPLACE	1-1/16" (27 mm)

FIGURE 30. GENERATOR BRUSHES

## POWER REQUIREMENTS FOR APPLIANCES

Appliance	Approximate Running Wattage
Air Conditioner .....	1400-2200
Coffee Percolator .....	550-700
Electric Blanket .....	50-200
Electric Frying Pan .....	1000-1350
Electric Iron .....	500-1200
Electric Water Heater .....	1000-1500
Electric Water Pump .....	500-600
Hair Dryer .....	350-500
Microwave Oven .....	700-1500
Radio .....	50-200
Refrigerator .....	600-1000
Space Heater .....	1000-1500
Television .....	200-600
Vacuum Cleaner .....	500-1500

## GENERATOR TROUBLESHOOTING GUIDE

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
NO AC OUTPUT VOLTAGE	1. Disconnected wire or lead on brushes.	1. Reconnect wire, or wires.
	2. Brushes not making contact with collector rings.	2. Check brush springs for free movement, or brushes which may be excessively worn.
	3. Defective bridge rectifier.	3. Replace bridge rectifier, or contact Onan dealer.
	4. Loose wire to bridge rectifier.	4. Replace wire.
	5. Open, grounded or short circuit in shunt field or armature winding.	5. Test with ohmmeter, or contact Onan dealer.
LOW AC OUTPUT VOLTAGE	1. External short circuit on line.	1. Locate and eliminate short circuit problem.
	2. Generator overloaded.	2. Remove part of load.
	3. Shorted or grounded circuit in field or armature winding.	3. Test with ohmmeter, or contact Onan dealer.
	4. Engine not running properly causing generator to slow down.	4. Refer to Engine Troubleshooting guide.
NOISY GENERATOR	1. Defective bearing in end bell.	1. Replace bearing. Contact Onan dealer.
	2. Brush rig loose.	2. Retorque.
	3. Armature and field frame rubbing together.	3. Contact Onan dealer.
GENERATOR OVERHEATS	1. Generator overloaded.	1. Remove part of load.
	2. Windings and parts covered with oil or dirt.	2. Clean generator.
	3. Air intake restricted or incoming air too hot.	3. Take necessary steps to allow for proper cooling.
	4. Shorted, open or grounded circuit in armature or field windings.	4. Test with ohmmeter, or contact Onan dealer.





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