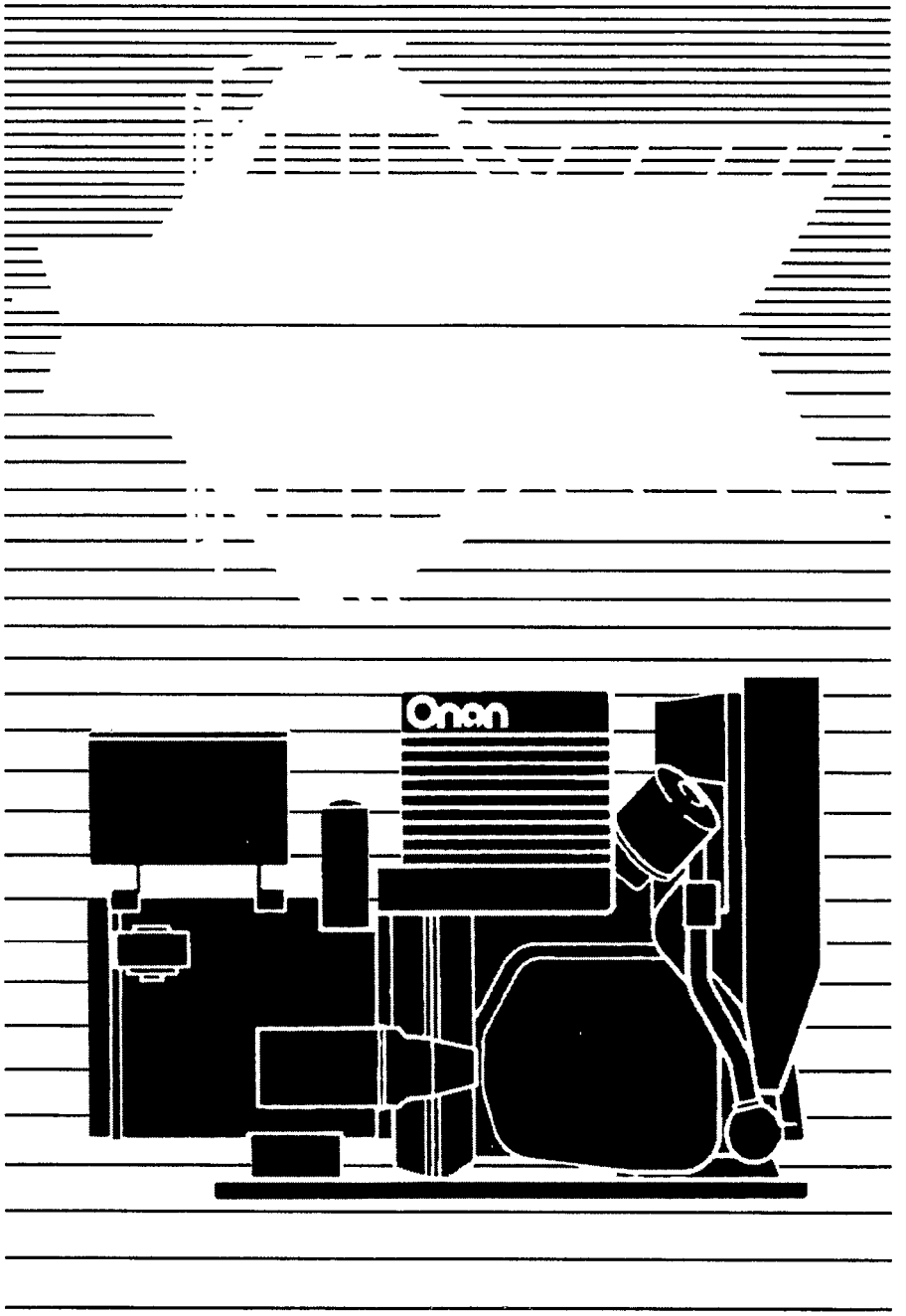
Onan MARINE

Operator's Manual

MME



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918-0100

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Introduction

ABOUT THIS MANUAL

This manual provides information for installing, operating and maintaining the generator set. Study this manual carefully and observe all warnings and cautions. Using the generator set properly and following a regular maintenance schedule will contribute to longer unit life, better performance, and safer operation.

HOW TO OBTAIN SERVICE

When the generator set requires service, contact your nearest authorized dealer or distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

If unable to locate a dealer or distributor, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS-ELECTRIC,
ENGINES-GASOLINE OR DIESEL, OR
RECREATIONAL VEHICLES-EQUIPMENT,
PARTS AND SERVICE.

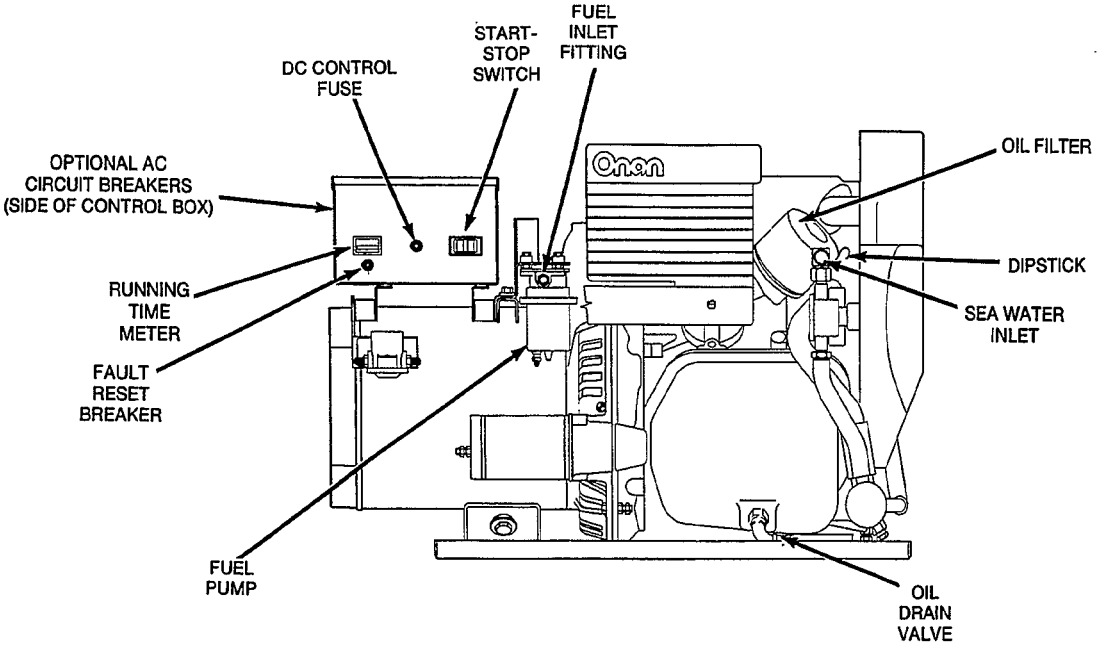
For the name of your local Cummins/Onan or Onan-only distributor in the United States or Canada, call 1-800-888-ONAN (this automated service utilizes touch-tone phones only). By entering your area code and the first three digits of your local telephone number, you will receive the name and telephone number of the distributor nearest you.

For the name of your local Cummins-only distributor, or if you need more assistance, please call Onan Corporation, 1-612-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday.

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

⚠WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.



M-1678-2

Specifications

GENERATOR DETAILS

Type	Onan YK, Revolving Field, 4-pole
Rating	See Nameplate
AC Voltage Regulation	± 5%

ENGINE DETAILS

Number of Cylinders (in-line)	2
Displacement	47.8 in³ (783 cm³)
Cylinder Bore	3.07 in. (78 mm)
Piston Stroke	3.23 in. (82 mm)
Engine Speed (r/min)	1800
Battery Recommendation	
12-Volt System	One 12-Volt Battery
Minimum Cranking Performance @ 0°F (-18°C)	500 Amps
Battery Charge Output	0.5 to 1.5 Amp
Oil Capacity with Filter	2.5 qt. (2.4 L)
Total Air Per Minute Required (Generator Cooling and Combustion)	125 ft³/min (3.5 m³/min)
Cooling System Capacity	3 quarts (2.8 L)
Cooling Water Flow Rate	
Engine Captive Water	Variable, Thermostatically Controlled
Sea Water Flow	3 gpm (11.4 L/min)
Exhaust Outlet Hose Fitting	2 in. (50.8 mm) OD
Fuel Consumption, Approximate Gallons per Hour at Full Load	1.4 gal. (5.3 litre)

TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.043 in. (1.09 mm)
Ignition Timing (Vacuum Advance Disconnected, 1800 r/min)	8°BTC

Installation

GENERAL

Proper installation is very important. Requirements to consider should include:

- Adequate cooling air
- Adequate combustion air
- Discharge of exhaust gases
- Discharge of circulated air
- Electrical connections and bonding
- Fuel connections
- Coolant connections
- Accessibility for operation and servicing
- Level mounting surface
- Noise levels

The installation should follow recommendations of the American Boat and Yacht Council (ABYC) and the National Fire Protection Association (NFPA).

The instructions in this section should be used only as a guide as each installation must be considered on an individual basis. The installer should be familiar with and follow the appropriate guidance found in the following publications:

ABYC *"Safety Standards for Small Craft"* from—

ABYC
15 East 26th St.
New York, NY 10010

NFPA302 "Fire Protection Standard for Motor Craft" from—

NFPA
470 Atlantic Ave.
Boston, MA 02210

USCG 33CFR183 from—
U.S. Government Printing Office
Washington, D.C. 20404

Onan Technical Bulletin T-021 *"Installation of Onan Marine Electric Generating Sets."*

LOCATION

Set location is preferable in the same room or compartment as the propulsion engine, as this is usually a well ventilated area, insulated, close to the fuel supply and is the center of electrical load distribution. A generator set cannot be installed in the propulsion engine compartment unless specific conditions are met.

USCG regulation 33CFR183 pertains to gasoline fuel systems, and requires a generator set operating in a gasoline fuel environment to be "ignition protected." This means a set capable of operating in an explosive environment without igniting that environment. Properly installed and operated, the MME generator set can operate in an explosive environment.

⚠WARNING ***Gasoline fire or explosion can result in severe personal injury or death. Do not install a gasoline generator set in the same room or compartment of a diesel propulsion engine or generator set. The diesel unit may not be ignition protected and may ignite gasoline fumes. Be sure a gasoline generator set is installed in its own room or compartment.***

Keep the generator set away from living quarters, and away from bilge splash and vapors. Select a location that will allow adequate space on all sides for servicing the set, preferably on and parallel with the keel or vessel center line.

MOUNTING

The floor must be flat and give support directly under the set mounting points (Figures 1 and 2). A one inch (25 mm) clearance around the unit is required to permit rocking on its mounts without restraint. Use approved exhaust line, fuel line, battery cables and electrical wiring conduit or severe property damage and personal injury may result.

Install two hold-down clamps to the drip pan on both sides. Secure the clamps to the mounting base.

DIMENSIONS IN INCHES (MM)

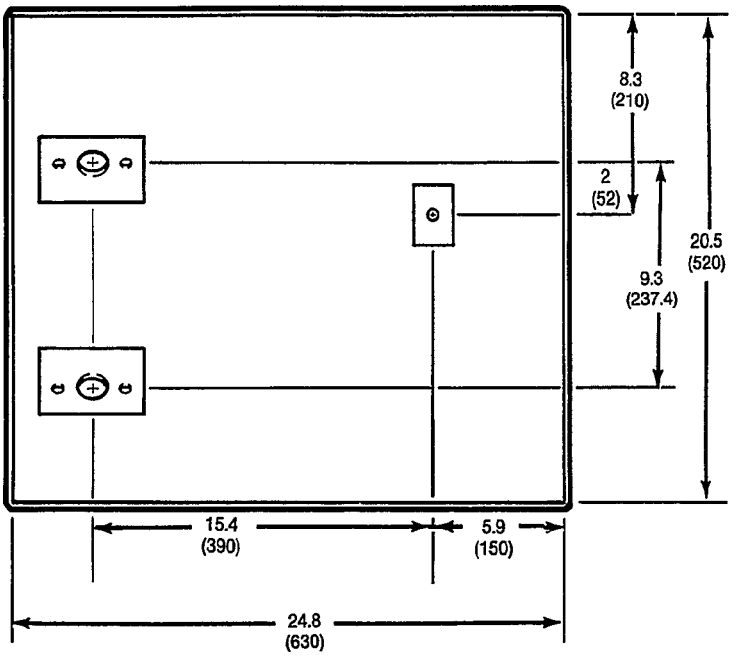


FIGURE 1. DRIP PAN DIMENSIONS

DIMENSIONS IN INCHES (MM)

DRY WEIGHT: 385 LBS (175 kg)

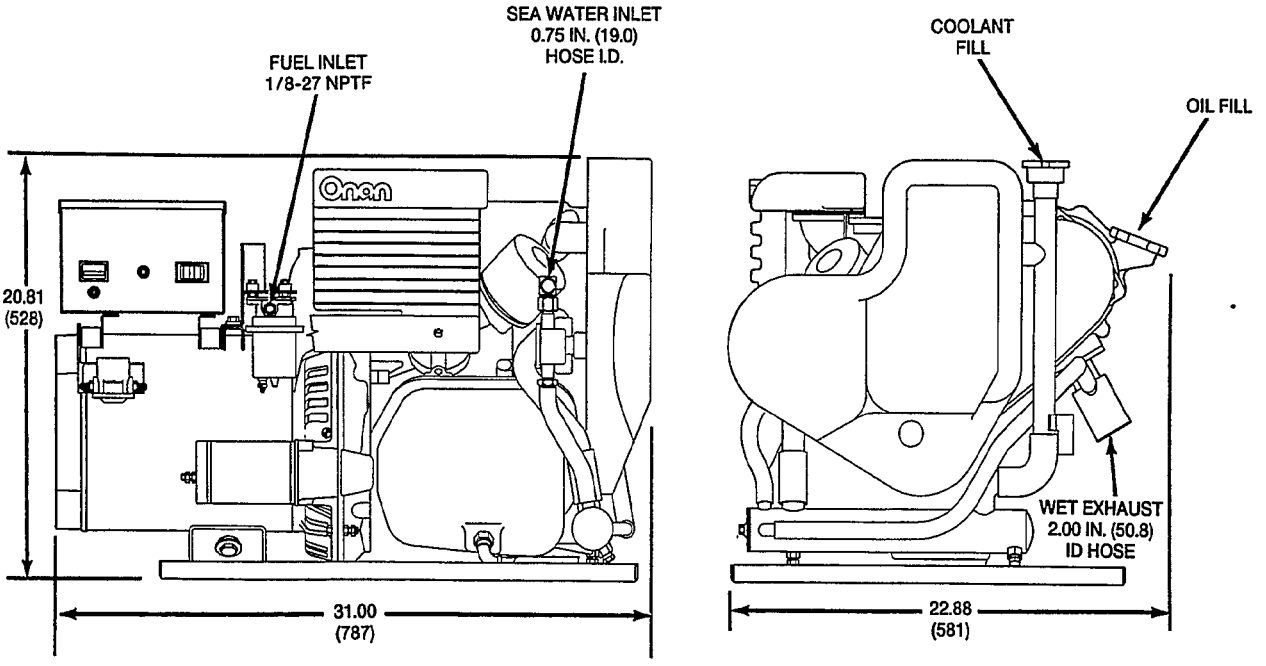


FIGURE 2. UNIT OVERALL DIMENSIONS

VENTILATION

The marine electric set requires fresh air for cooling the generator and for engine combustion. Onan recommends the ventilation system be capable of delivering 1-1/2 to 2 times the air required by the set. See *SPECIFICATIONS*. When ventilation depends on wind or boat motion, use powered exhausters to provide ventilating air when the vessel is not underway.

EXHAUST SYSTEM

General

All exhaust systems for water-cooled marine installations must meet each of the following requirements. Failure to meet these requirements could result in severe property damage, personal injury or death.

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 exhaust system must not be combined with the exhaust system of another engine.
5. An approved, flexible 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. The exhaust system must be of sufficient size to prevent excessive back pressure. See Back Pressure section on this page.
8. Install exhaust through hull fitting aft of sink, shower or other cabin drains to prevent backflow of exhaust gases.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Use extreme care during installation to secure a tight exhaust system.***

Material

Use material recommended by ABYC in *"Safety Standard for Small Craft,"* Section P1. The exhaust line should be at least as large as the engine exhaust manifold outlet. See following section on *Back Pressure.*

⚠WARNING ***Exhaust gas presents the hazard of severe personal injury or death. Place special emphasis on the following:***

1. ***Be sure the flexible exhaust hose is designed and approved for marine exhaust line use.***
2. ***Use two clamps at each end of all flexible exhaust hose connections.***
3. ***Do not make sharp bends in the exhaust hose.***
4. ***Position exhaust outlet to prevent backflow of exhaust gases into the boat.***

Use flexible hose designed for marine exhaust line use to ease installation and for flexibility. A flexible exhaust elbow furnished with the generator set is connected to the engine exhaust manifold shown in Figure 3. The muffler must be at the lowest point of the entire exhaust system. The muffler top should not be less than 12 inches (305 mm) below the exhaust manifold outlet for optimum performance. Less difference of elevation will provide a narrower margin of safety for preventing reverse flow of cooling water toward the manifold.

Make sure the hose from the elbow to the muffler drains toward the muffler at a minimum downgrade of 1/2 inch per lineal foot (42 mm/m). An uphill section between the manifold and muffler is not permissible - NO EXCEPTIONS.

Provide adequate support for the flexible hose to prevent sagging, bending, and formation of water pockets. Use automotive type pipe hangers to prevent vibration transmitting to the boat hull. Use two clamps at each end of hose as shown in Figure 3.

Be sure that the vertical rise of the exhaust hose measured from the bottom of the muffler to its peak is not more than 48 inches (1.2 m) as shown in Figure 3. The exhaust tubing on both above and below load water line installations must be pitched downward to the exhaust discharge port as shown. There must also be a 12-inch (305 mm) minimum drop from this peak to the through-hull fitting.

Back Pressure

Exhaust back pressure is an important criteria of an adequate exhaust system. If the exhaust installation requires a long run of pipe (more than 30 feet [9 m] overall), back pressure should be checked. Exhaust back pressure should not exceed 3 inches (76 mm) of mercury (10 kPa).

Increase the exhaust pipe diameter from the muffler to the outlet one standard pipe size for every 10 feet (3 m) beyond 30 feet (9 m) overall length.

Exhaust Cooling Water Injection

The neoprene impeller pump moves the sea water through the cooling system and into the exhaust elbow. The injected water cools the exhaust and prevents exhaust system damage from heat. A temperature operated switch on the exhaust elbow shuts the unit down if overheating occurs. See Figure 3. The switch closes if temperature reaches 185° to 195°F (85° to 91°C) and actuates the Fault Reset breaker on the control panel.

⚠CAUTION ***DO NOT USE SCOOP TYPE WATER INLET FITTINGS. Forward facing scoops can develop sufficient ram pressure to force water past the generator set's sea water pump. This can flood the exhaust system and the engine cylinders. This happens when the generator set is not running and the boat is underway. Rear facing scoops develop vacuum which can impede cooling water flow.***

Install a siphon break (anti-siphon) if the sea water injection port on the exhaust manifold is at or below load water line. Locate the siphon break in a vertical position at least 12 inches (305 mm) above the load water line. Remote mounting is permissible within a 5 foot (1.5 m) radius of the injection port. The vertical position and height of valve must be maintained.

The siphon break is a vacuum operated vent valve that opens the exhaust water discharge line to the atmosphere when the engine shuts down. The open vent valve prevents sea water (flotation water) from being siphoned into the exhaust manifold and cylinders on engines installed below the load waterline.

In all installations, the siphon break must be mounted vertically with the threaded end of valve pointing down. Use pipe straps to secure the assembly to the frame or bulkhead.

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

⚠CAUTION ***Failure to use a siphon break when the exhaust manifold injection port is below load water line will result in sea water entering the engine and damaging cylinders.***

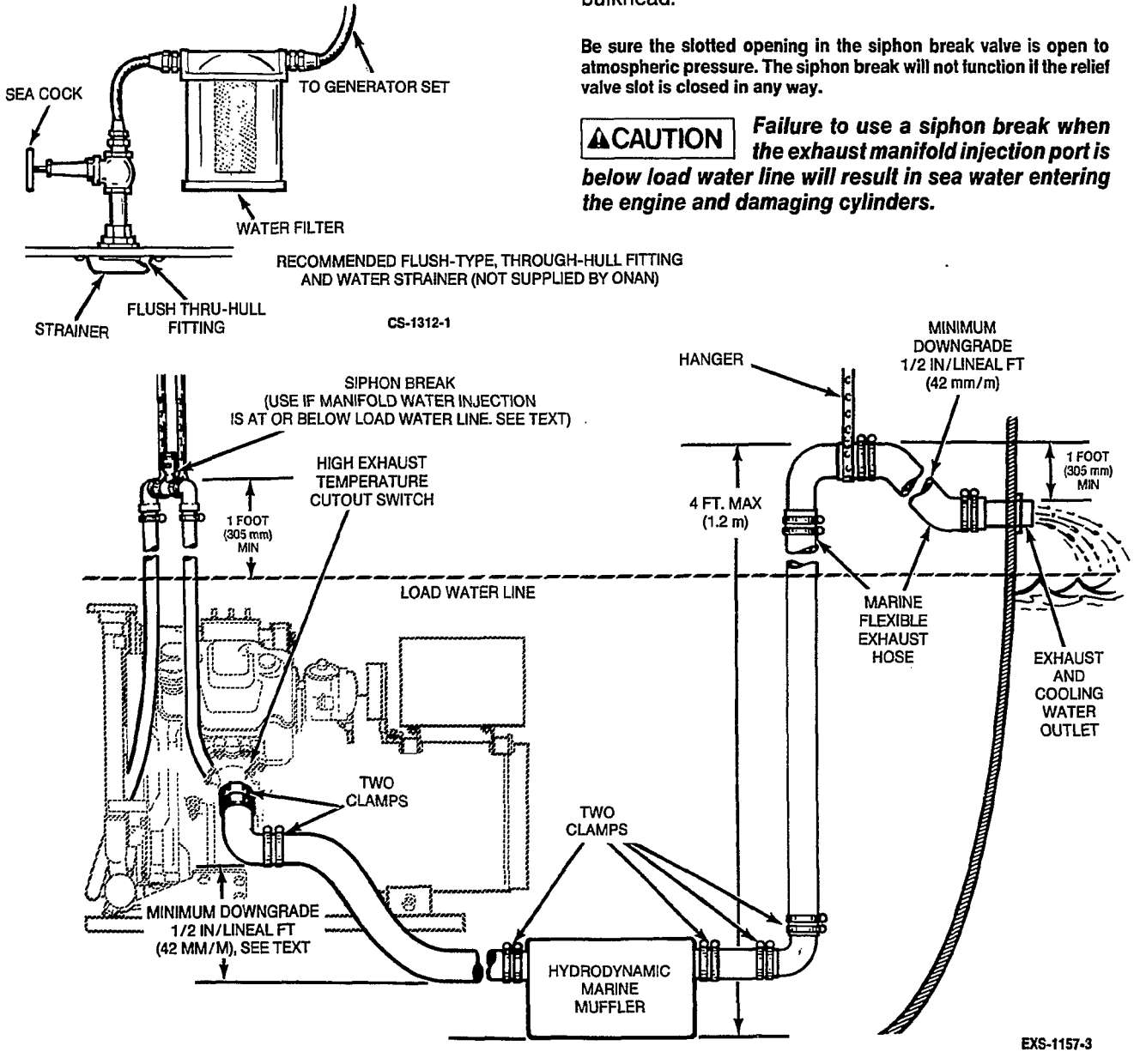


FIGURE 3. RECOMMENDED BELOW LOAD WATER LINE EXHAUST INSTALLATION

An important consideration of water insertion is keeping water from flowing back through the exhaust system into the engine. When the boat pitches forward, water sloshing in the exhaust line can enter the engine. This is especially true where there is a considerable length of straight exhaust line or where pockets allow water to gather. The exhaust line must be installed to prevent backflow of water to the engine under all conditions.

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.*

The generator set uses heat exchanger cooling. This closed cooling system pumps captive water through the engine water jacket, exhaust manifold and heat exchanger. In the heat exchanger, the hot captive water is piped through a bath of cool sea water. See Figure 4.

The cooled captive water than returns to the captive water pump and sent back through the system. Captive water temperature/flow rate is regulated by a thermostat.

A sea water pump is used to constantly renew the water bath in the heat exchanger and discharge the heated sea water into the exhaust line. The maximum lift of the pump is 3 feet (0.9 m).

The engine cooling is at proper level when the recovery tank level stabilizes between Full and Low (engine cold). Remove the recovery tank cap and add coolant as required.

To prevent corrosion, always use a mixture of antifreeze and distilled or soft water as an engine coolant; even when freezing temperatures are not expected. In addition to lowering the freezing point of water, antifreeze contains rust inhibitors that prevent corrosion. Onan recommends a 50-50 mix of ethylene glycol antifreeze and water for winter and summer in closed water systems, with a complete change every year. See Maintenance section for filling instructions.

⚠CAUTION ***Do not exceed a 50-50 mixture of ethylene glycol and water. A stronger mixture of ethylene glycol will alter heat transfer properties of the coolant.***

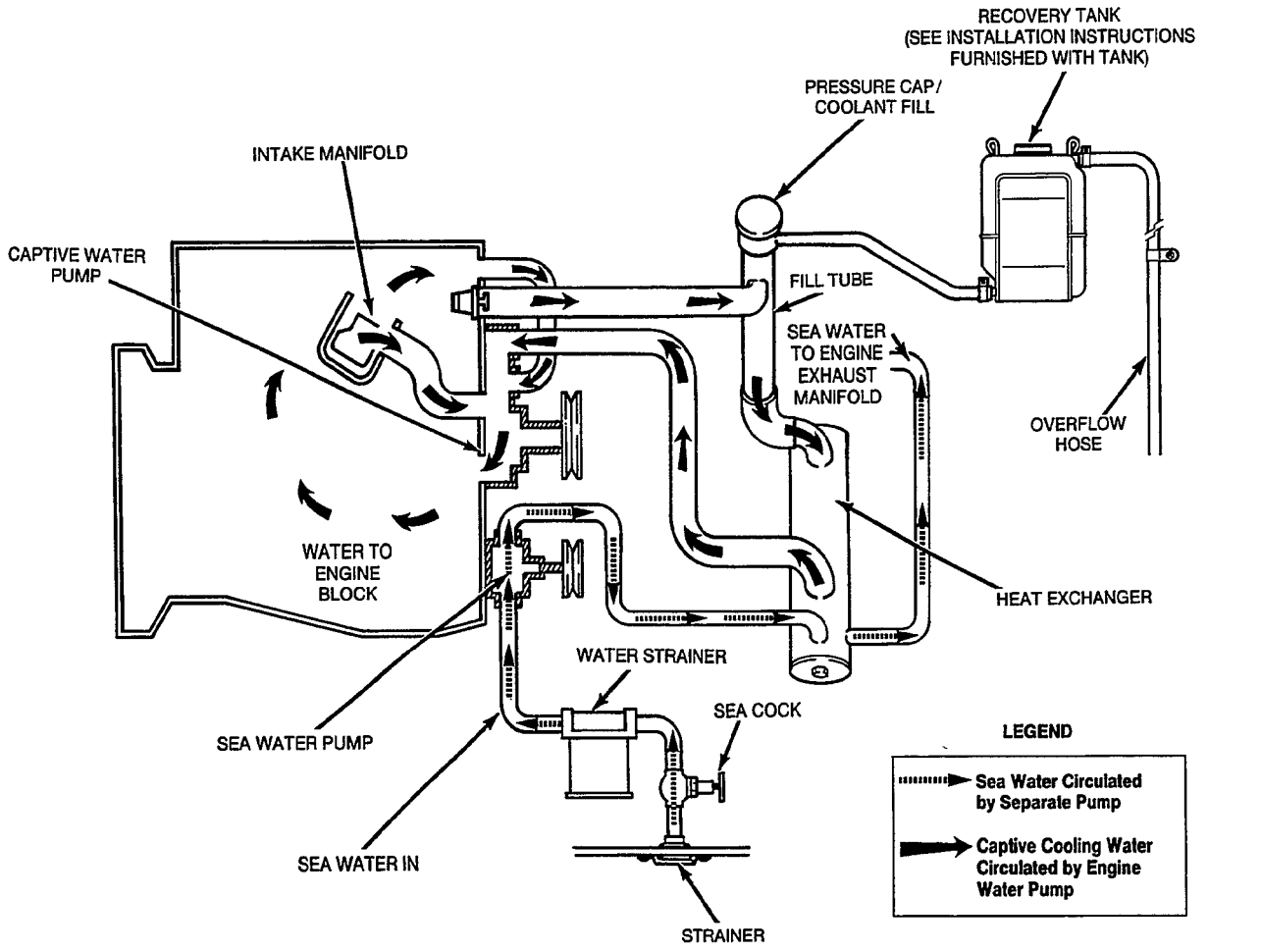


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FIGURE 4. HEAT EXCHANGER COOLING

FUEL SYSTEM

⚠WARNING ***Fuel leakage in boats presents fire and explosion hazards that can result in severe personal injury or death. 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.***

Fuel Tank and Lines

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 5. The line should be supported throughout its length with clips or straps spaced at no more than 14-inch (356 mm). The maximum fuel lift capacity of the fuel pump is 45 inches (1.14 m), minus the requirement of an anti-siphon valve when used.

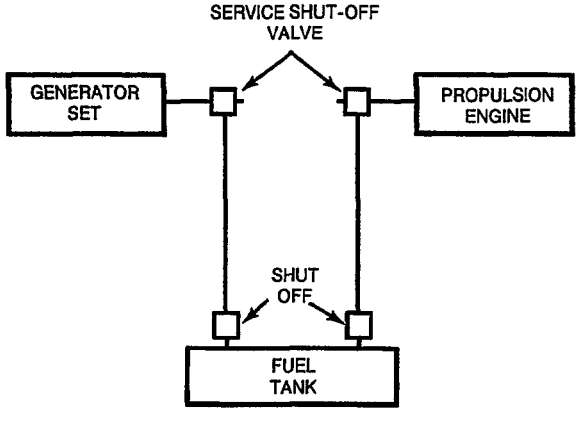


FIGURE 5. ABOVE TANK LEVEL INSTALLATION

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 6. The tube should be cut shorter to prevent depletion of fuel for the propulsion engine. The required fittings can be built by a machine shop.

⚠WARNING ***Leakage of gasoline in or around the compartment presents a hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, cigarette, pilot light, or other ignition source near the generator. Repair any fuel leak immediately.***

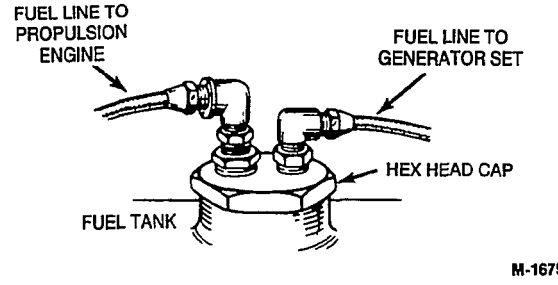


FIGURE 6. TWO FUEL LINES IN ONE TANK OUTLET

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.

Siphoning protection is provided by the following methods:

1. Keeping all parts of the fuel line (from the tank to the engine) above the tank top. See Figure 5.
2. Installing an anti-siphon valve at the tank withdrawal fitting. See Figure 7.
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.

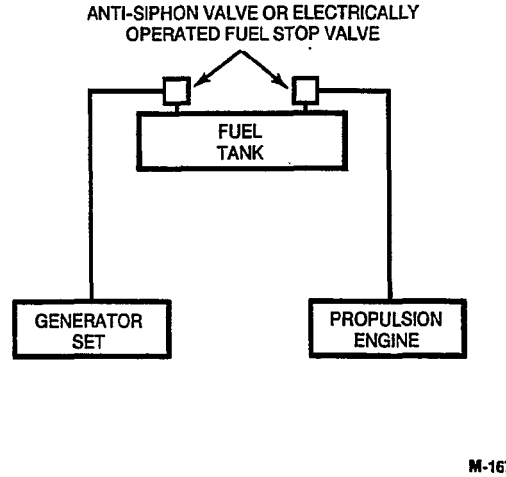


FIGURE 7. SIPHON PROTECTION

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 8.

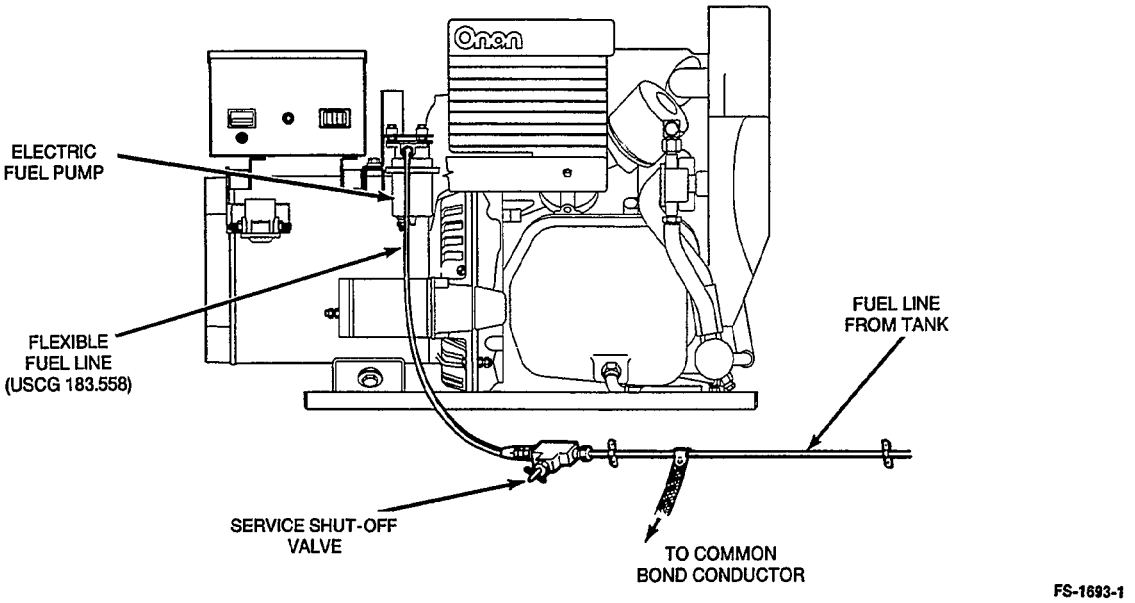


FIGURE 8. FUEL SHUT-OFF VALVE

ELECTRICAL CONNECTIONS

General

Installing the generator set electrical system includes connecting the load, installing the remote start control (if used), and connecting the starting battery. The battery must always be connected last to avoid accidental starting of the generator set during installation.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first). Do not connect the starting battery until instructed to later in this section.***

Load Connections

All wiring *must* meet the ABYC, Coast Guard, NFPA and any other applicable codes. Have a qualified electrician install and inspect the boat wiring. The Onan wiring diagram does not include components added by customers. When installing the wiring to the generator set, use a section of flexible cable next to it to absorb vibration. Use flexible multistrand wire throughout the boat to reduce the danger of breakage from vibration.

The generator output voltage and maximum current rating is specified on the generator nameplate. Line-to-neutral voltage is always the lower voltage as shown on the nameplate and line-to-line voltage is the higher rating.

Connecting the Load: The load is connected to the circuit breaker CB22 inside the control box as shown in the wiring diagram Figure 10. Use flexible conduit at the control box to permit movement of the generator set. Grounding procedure must comply with codes.

⚠WARNING ***Contact with electrically "hot" equipment can result in severe personal injury or death. It is extremely important that bonding and equipment grounding be properly done. All metallic parts which could become energized under abnormal conditions must be properly grounded.***

⚠WARNING ***Improper wiring can result in fire and severe personal injury or death. Do not connect electrical wiring to the fuel line.***

Dockside Power Connection

Most boats incorporate a dockside connection so the boat can be plugged directly into a commercial source while at dock. If this is done, include a switch to transfer the load between the generator set and dock power (Figure 9). The switch must never permit the generator and power line source to be connected together, nor permit arc-over between them. Doing so will damage the generator. All current carrying conductors must be switched including the neutral.

Use a shoreline power transfer switch of proper rating in accordance with ABYC paragraph 8.4.

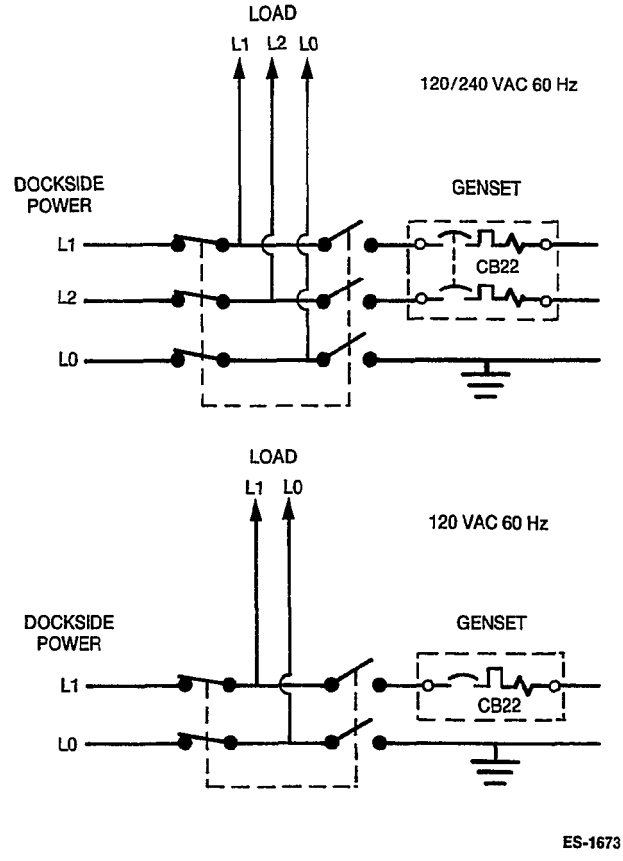


FIGURE 9. LOAD TRANSFER SWITCH

Remote Control Connections

Provision is made for addition of optional remote starting and stopping of the generator set. Onan has kits for remote control panels with or without meters. Each comes with complete installation instructions. Also available are harnesses (in three different lengths) that plug into connectors on the control box and remote control. These are recommended for ease of installation.

If desired, a remote control may be hard-wired with 16 AWG (or larger) stranded wire as shown in Figure 11. The wires can either be terminated in a male connector, or brought in through a knockout in the control box and connected to the Engine Monitor Board terminal block. Be sure all wire connections are correct or damage to control components can result when power is applied.

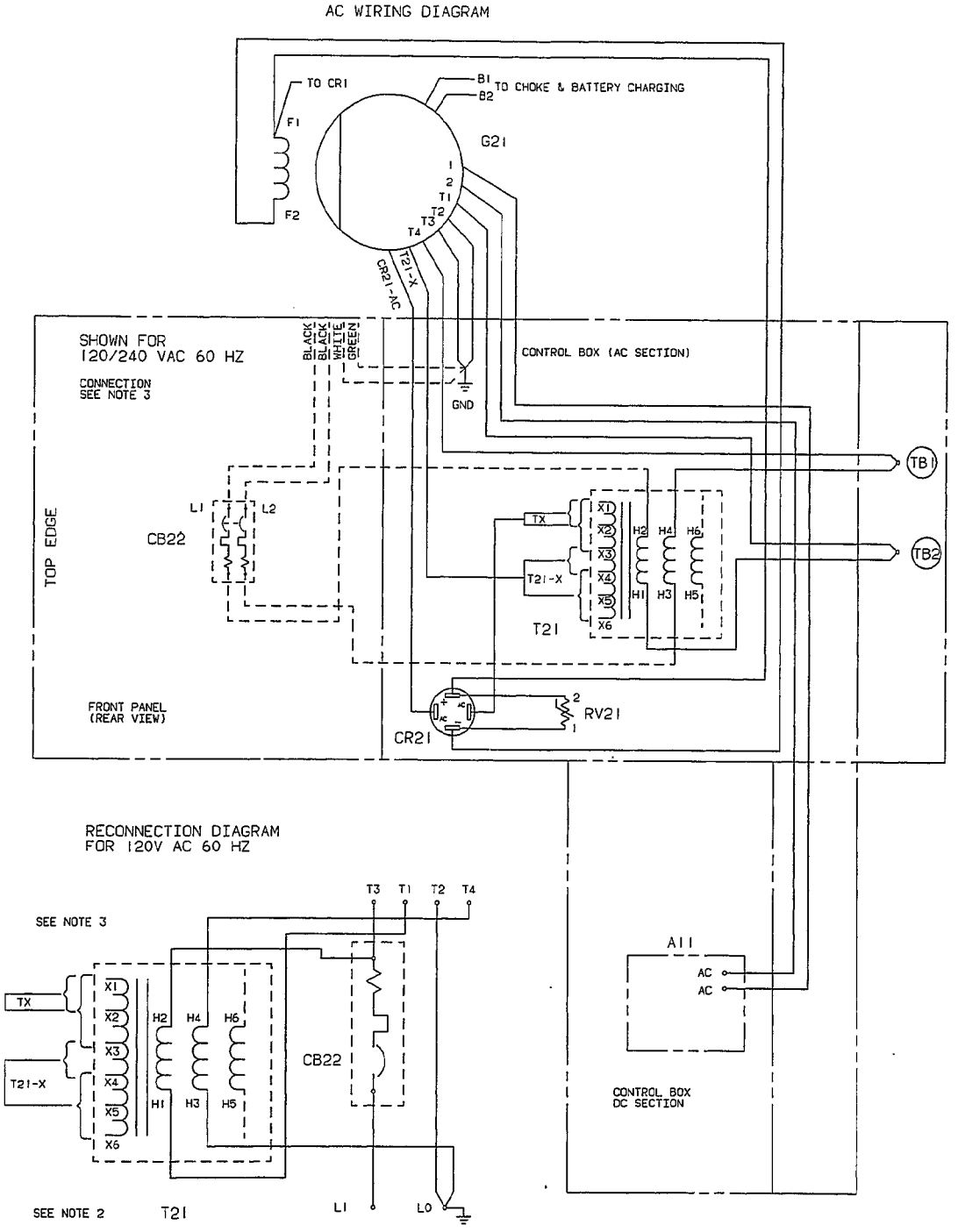
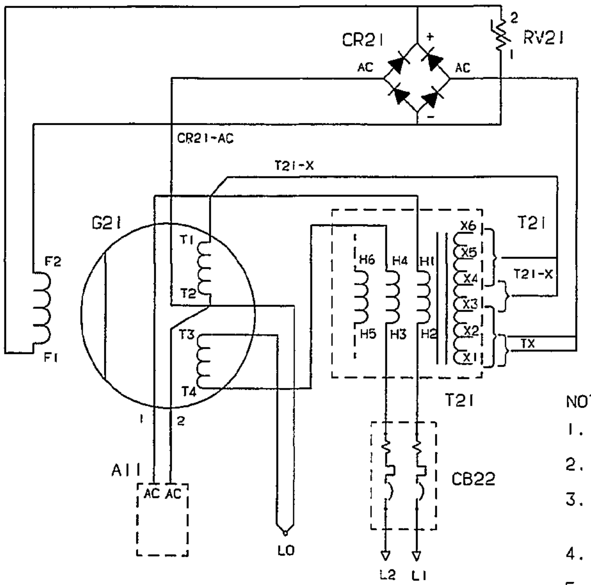


FIGURE 10. GENERATOR RECONNECTION WIRING DIAGRAMS

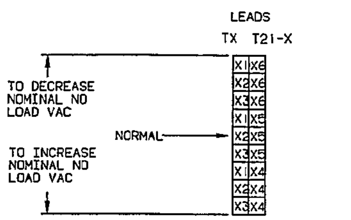
ER NO	LTR	NO	REVISION	ZONE	DR	CHKD	APPROVED	DATE
34853	F	1	REVISED & REDRAWN SEE ER	-	JC	GS	WMH	6-8-89

AC SCHEMATIC (SINGLE PHASE TRANSFORMER REG)



NOTES:

1. TO ADJUST OUTPUT VOLTAGE MOVE TAPS ON T21 ACCORDING TO TABLES
2. IN ALL VOLTAGE CONNECTIONS LEAVE T1 AND T4 CONNECTED TO H1 AND H4 RESPECTIVELY
3. FOR 60 HZ: USE TX LEAD ON TAPS X1-2 (4 TAPS) USE T21-X (FROM GEN) LEAD ON TAPS X3-4
4. UNLESS OTHERWISE NOTED ALL COMPONENTS ARE ARE SHOWN IN THE DE-ENERGIZED POSITION
5. DASHED LINES INDICATE WHEN USED



NOMINAL NO LOAD VAC 127±4.5

COMPONENT IDENTIFICATION

REF.	DESCRIPTION
A11	PCB Assy - Engine Monitor
CB22	Circuit Breaker-Load
CR21	Bridge Rectifier
G21	AC Generator
RV21	Suppressor Assy
TB1,2	Standoff Insulator
T21	Transformer-Regulation

CADAM DWG

TABULATION		
MODEL	60HZ	50HZ
MME	-01	

DR JIM CAMERON 6-7-89
CHKD C. Salmonson 6-27-89
APPROVED M. Hooper 6-19-89
SCALE NONE
MODEL FIRST USED ON MME

MINNEAPOLIS, MINNESOTA 55432
Onan
TITLE CONTROL-GEN SET AC(1PH)
DWG NO 612-6434
SHEET 1 of 1 SIZE D

FIGURE 10A. GENERATOR RECONNECTION SCHEMATIC DIAGRAM

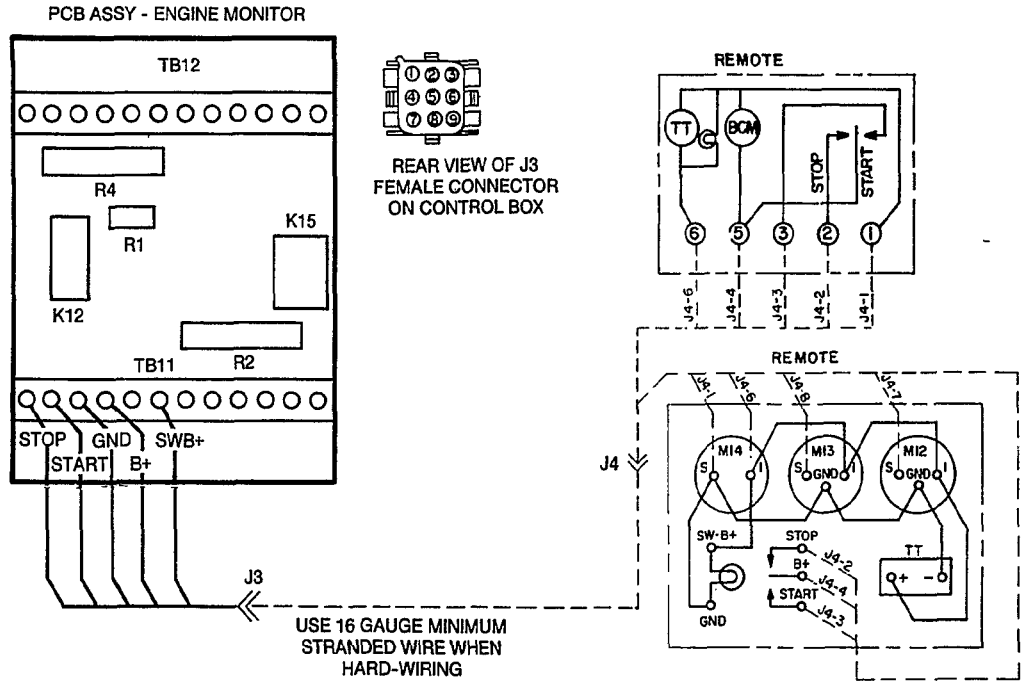


FIGURE 11. REMOTE CONTROL CONNECTIONS

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PREPARING GENERATOR SET FOR OPERATION

Inspect the engine visually. Check for loose or missing parts and any damage that may have occurred in shipment.

⚠CAUTION ***Oil, fuel, and coolant have been drained from the engine prior to shipping from factory. Operation without oil or coolant will damage engine.***

Before attempting the initial start of the generator set, be sure it is serviced for operation. Refer to the Maintenance section of this manual for the proper procedures.

Connect Starting Battery

⚠WARNING ***Leakage of fuel in or around the generator set compartment presents a hazard of fire or explosion that can cause severe personal injury or death. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the compartment thoroughly with the bilge blowers or power exhausters.***

Starting battery requirements are 12-volts (see Specifications section). Figure 12 shows the battery connections. Battery cables are optional accessories supplied on special order.

Infrequent unit use may allow the batteries to self-discharge to where they cannot start the generator set. This condition will require a special float charger powered by shoreline power when the boat is docked.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. While servicing batteries, keep away from cigarettes, open flames, pilot lights, or other sources of ignition.***

INITIAL STARTING AND CHECKS

Before trying to start the generator set, prime the sea water pump, open the sea water cock and the fuel line shut-off.

Before applying load, perform the following to verify the set will perform correctly:

1. Start the generator set by holding the Start-Stop switch on the engine control panel to the Start position. The starter should crank and the engine start within a few seconds. Release Start button.
2. Monitor the engine control panel and note the oil pressure, coolant temperature, and battery charge voltage (if equipped). Refer to the Operation section of this manual for normal readings. At operating temperature, all readings should stay within the normal range.
3. Check the exhaust system for leaks, visually and audibly. Note the security of the exhaust system supports. If any leaks are found, shut down the generator set immediately and repair.

⚠WARNING ***Exhaust gas is deadly. For this reason, shut down the generator set immediately if you discover an exhaust leak or exhaust component needing replacement. Do not use the generator set until you have the exhaust system repaired.***

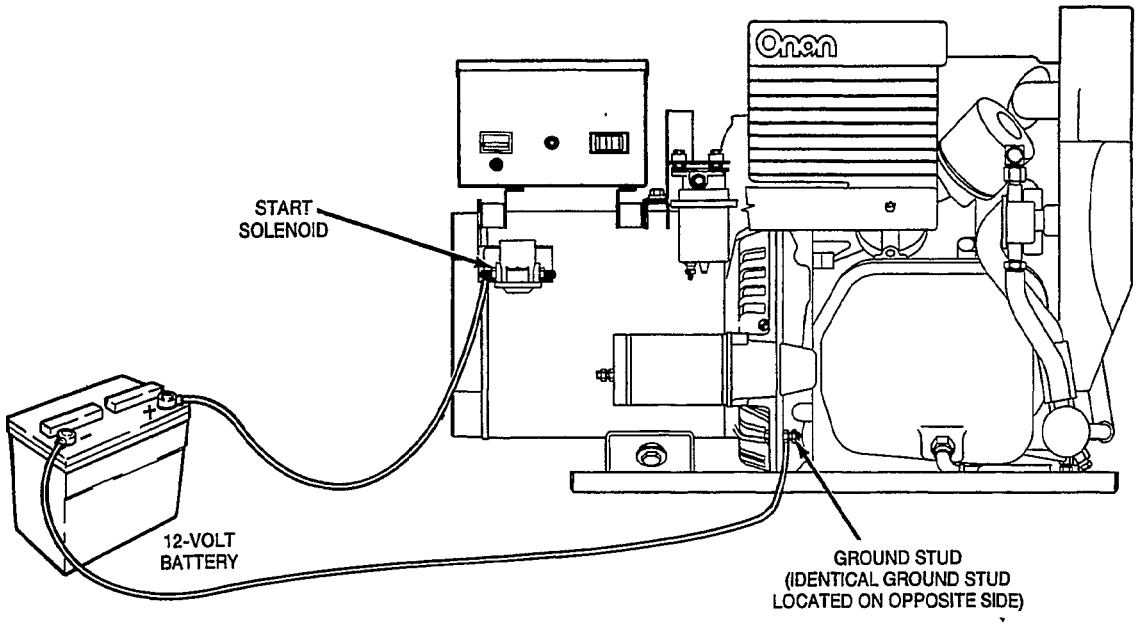


FIGURE 12. BATTERY CONNECTIONS

4. Check the generator set for fuel, oil or coolant leaks. If any are found, shut down the generator set and repair leak before making any more checks.
5. Check generator output frequency and voltage. Connect an accurate frequency meter and AC voltmeter across two line terminals.

⚠WARNING ***High voltages present within the control box can cause severe personal injury or death. Do not touch any exposed wiring or components with body parts, jewelry, or clothing. Use insulated tools and stand on an insulating mat or dry wood platform when working inside the control.***

Output Frequency: Determined by engine speed and normally does not require adjustment. Call the authorized Onan Service Center for assistance if needed. Be sure engine speed is correct before attempting Voltage Regulator Adjustment.

Voltage Regulator Adjustment: Voltage adjustment is made by wiring changes to regulator transformer T21 inside the control box. Refer to Figures 10 and 13.

A. With the generator set running at correct r/min, note if voltage needs to be increased or decreased.
B. Stop generator set. Disconnect starting battery cables.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first) when repairs are made to the engine, controls, or generator.***

C. Move taps on transformer T21 per data provided in the chart and notes on Figure 10A.
D. Reconnect starting battery cables (positive [+] cable first). Operate the generator set and recheck output voltage.

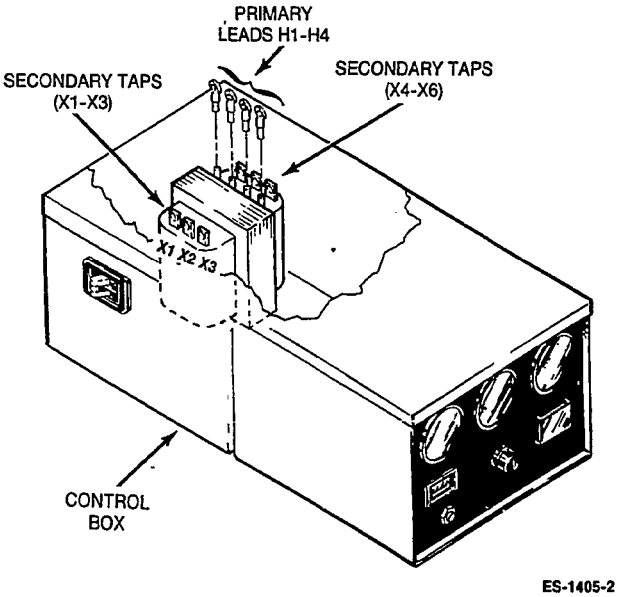


FIGURE 13. VOLTAGE REGULATOR TRANSFORMER

Operation

⚠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.

GENERAL

This section covers starting and operating the generator set. It is recommended that the operator read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set to provide safe operation.

PRE-START CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. Refer to the MAINTENANCE section for the proper procedures.

Lubrication

Check the engine oil level. Keep oil level near as possible to the dipstick max mark. Do not overfill.

Coolant

The coolant level should be between the Full and Add marks on the coolant recovery tank. Add proper coolant if low.

Fuel

Make sure the fuel tanks are full and the service shut-off valve is open.

Sea Water Pump Priming

Before beginning operation (initial start-up) the sea water pump should be primed. The priming water provides an impeller surface lubricant until flotation water is pulled into the pump.

To prime pump, close sea cock and remove the hose from water filter outlet. Fill hose and pump with clean water. Replace hose and open sea cock. Check for pump operation on start-up by observing water discharge from exhaust outlet.

CONTROL PANEL

The following describes the function and operation of the generator set controls. All instruments and control switches are located on the face of the control panel as illustrated in Figure 14.

Gauges/Meters and Switches

Start-Stop Switch: Starts and stops the unit locally. When released, unit may be operated from a remote switch wired to the control panel.

Running Time Meter: Registers the total number of hours that the unit has run.

Use it to keep a record for periodic servicing. Time is cumulative; meter cannot be reset.

DC Voltmeter (Optional): Monitors B+ voltage useful to determine battery condition and charge system operation. See Battery portion of Maintenance section.

Coolant Temperature Gauge (Optional): Shows engine coolant temperature. The gauge is wired to a sensor on the engine and has a range of 100° to 250°F (40° to 121°C).

Oil Pressure Gauge (Optional): Shows engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa) and is connected to an engine sensor.

Fault Reset: A manual reset breaker that shuts down the engine for low oil pressure, high coolant temperature and high exhaust temperature.

DC Control Fuse: A 10 ampere fuse protecting the control engine monitor board, remote start circuit (if used) and associated wiring.

Line Circuit Breaker: Protects the generator from a short circuit or other overload. It is mounted on the side of the control box. Replacements must meet ABYC specs for proper protection.

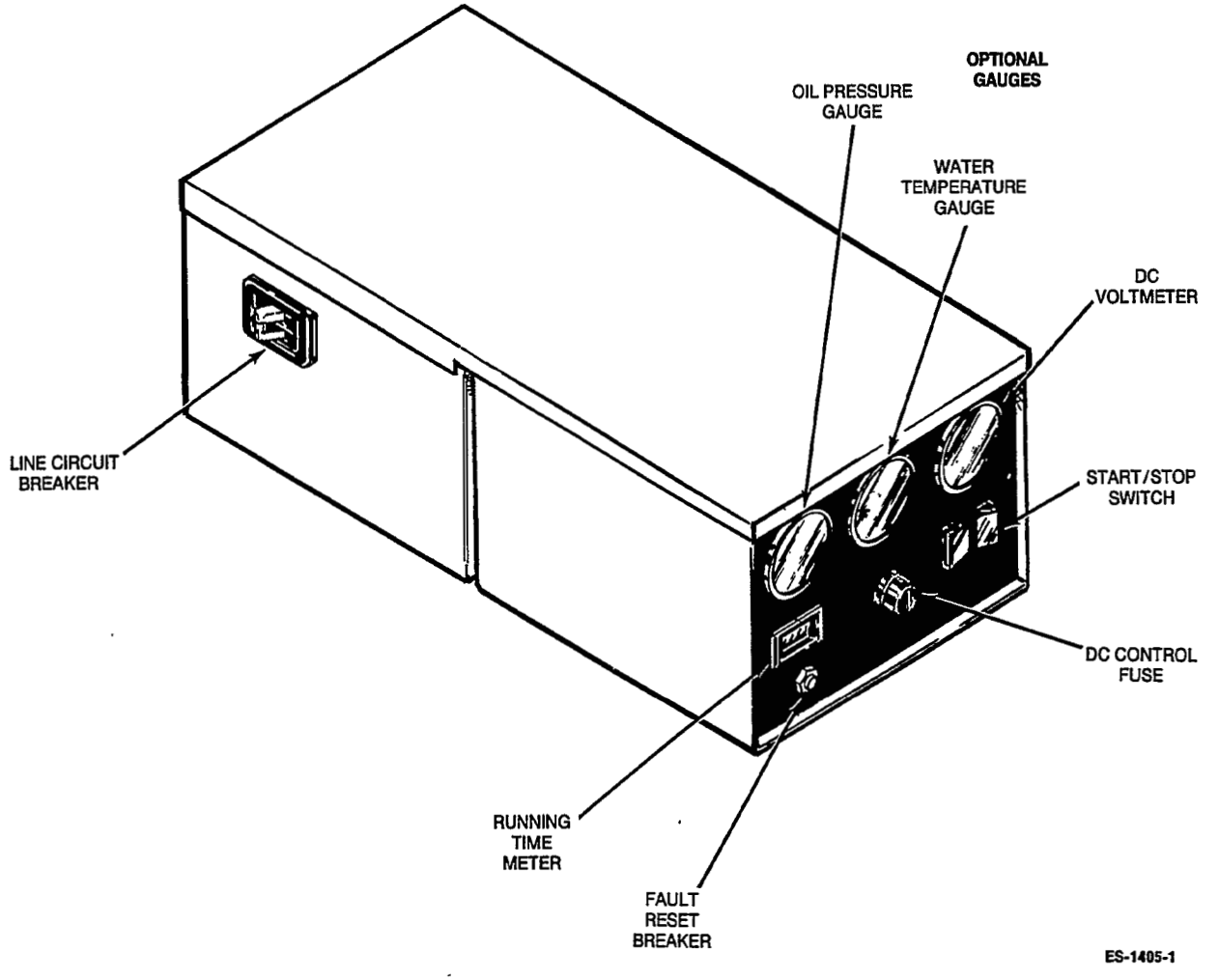


FIGURE 14. CONTROL BOX FRONT PANEL

STARTING

This section covers starting of the generator set at the control panel and remote starting.

⚠WARNING ***Gasoline vapors can cause an explosion and fire resulting in severe personal injury or death. Before starting the generator set, operate the bilge blower for a minimum of 4 minutes. If fuel fumes are present, locate source and correct prior to generator set operation.***

Starting at Control Panel

The following steps outline the correct procedures for starting the generator set at the generator control panel.

1. Hold the Start/Stop switch in the Start position. This activates the engine control and starting system. The starter will crank and after a few seconds the engine should start. The starter will automatically disconnect when the generator AC voltage builds up.
2. If the engine does not start after cranking 30 seconds, release start switch. Wait two minutes and then try starting again.

   ⚠CAUTION ***Excessive cranking periods can overheat and damage the starter. Do not engage starter for periods longer than 30 seconds without allowing two minutes for starter to cool.***

   ⚠CAUTION ***When a marine lifting muffler is used, excessive engine cranking without starting can fill the muffler with water and back this water into the combustion system causing engine damage. If prolonged cranking is necessary in excess of two to three minutes, check exhaust system for excessive water and drain prior to repeated starting attempts.***

3. If the engine does not start on second try, check the fuel supply and be sure the fuel valves are open.

Remote Starting

If the generator set is started from a remote location, the same procedures and caution for starting at the control panel apply.

Start-up Checks

Check optional gauges on control box after the engine is started.

Oil Pressure Gauge: The oil pressure should be in the range of 35 to 50 psi (241 to 345 kPa) when the engine is at operating temperature.

DC Voltmeter: Normal B+ battery voltage during operation should be 13.5 to 15 volts.

Coolant Temperature Gauge: The coolant temperature should be in the range of 180° to 203°F (82° to 95°C) depending on the load and ambient temperature.

STOPPING

Before Stopping

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

⚠CAUTION ***Failure to allow running time for engine cooling without load can result in engine damage. Make sure generator set runs unloaded for at least three minutes.***

To Stop: Press the Stop position of the control Start/Stop switch or the remote switch.

OPERATING RECOMMENDATIONS

Break-In

Drain and replace the crankcase oil after the first 35 hours of operation on new generator sets. Refer to the Maintenance section of this manual for the recommended procedures.

After the first 100 hours of operation, Onan recommends that verification of the generator frequency may be necessary. Due to the normal break-in of the engine, verify if the frequency is within 58 hertz full load to 63 hertz no load. Contact an authorized Onan service center for adjustment if required.

No Load Operation

Hold periods of no-load operations to a minimum and avoid if possible. No-load operation allows combustion chamber temperatures to drop so low that the fuel does not burn completely. This results in carbon deposits which can cause piston rings and valves to stick.

Exercise Period

Infrequent generator set use can result in hard starting. Exercise the generator set at least once a month for a minimum of 30 minutes. Run the set with load applied to allow the engine to reach normal operating temperature. Exercising will keep the engine parts lubricated and maintain fuel prime. Top off fuel tank after eac exercise period.

TROUBLESHOOTING

DC Control

The DC control has a number of sensors that continuously monitor the engine for abnormal conditions such as low oil pressure, high coolant temperature and high exhaust temperature. If any one of these conditions occur, the Fault reset breaker trips and stops the unit. See Figure 15.

The following sections describe operation of the fault systems and suggested items the operator can check. If a major problem is indicated, contact an Onan Dealer or Distributor for help or service.

The control panel Fault reset breaker will trip for any one of the fault conditions described separately below. The breaker button pops out about 1/4 inch (6 mm) when a fault occurs. Locate the problem and make the necessary corrections before resetting breaker and starting the generator set. The high exhaust temperature and low oil pressure faults are delayed 5 seconds to avoid nuisance tripping.

Low Oil Pressure: Remove dipstick and check oil level. If low, add oil to bring level up to the Max mark. Inspect engine exterior for leaks and repair as necessary. The oil pressure switch actuates the fault circuit if pressure drops below 9 psi (62 kPa).

High Coolant Temperature: Observe coolant temperature gauge (option) for indication of temperature over 221°F (105°C). The coolant thermostat switch closes at this temperature (±3%) and actuates the fault circuit.

Check coolant level in the recovery tank after allowing engine to cool down.

Ensure pump belt is OK and has proper tension; ensure sea water flow at exhaust outlet is about 3 gal/min (11 litre/min). Also check cooling system cleanliness (freedom from contaminants, rust, sludge build-up, etc.).

High Exhaust Temperature: The high exhaust temperature switch is mounted on the exhaust manifold and closes on temperature rise. It opens automatically when the generator set cools down.

High exhaust manifold temperature is caused by failure of the sea water cooling system. Sea water flow at the exhaust outlet should be about 3 gal/min (11 litre/min). Failure can be caused by a defective sea water pump, heat exchanger, drive belt, inlet filter or a closed sea water valve. Whenever a shutdown occurs, a thorough inspection of the complete exhaust system must be made by an experienced serviceperson.

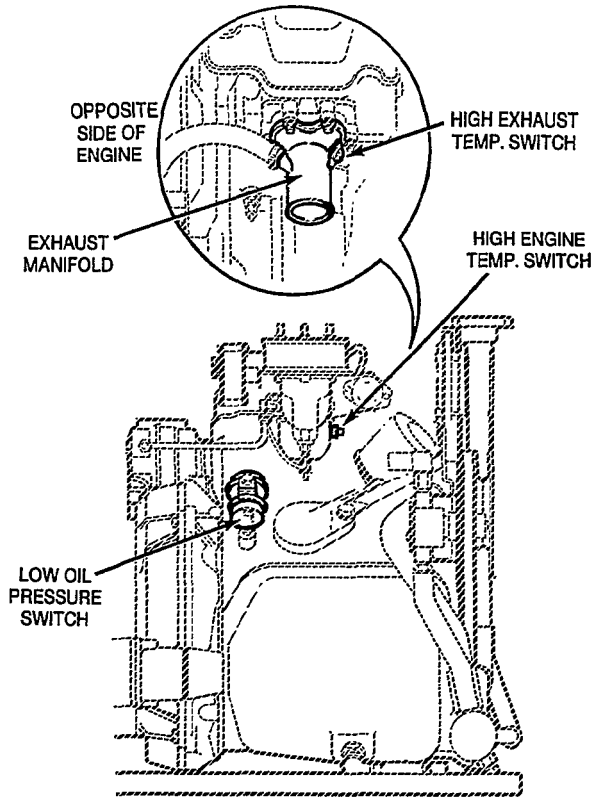


FIGURE 15. FAULT SENSOR LOCATION

⚠WARNING ***Inhalation of exhaust gas can result in severe personal injury or death. Thoroughly inspect the exhaust system after a shutdown. Do not disconnect or bypass the exhaust manifold switch. Excessive heat can damage exhaust hoses and allow exhaust gas to escape.***

AC Control

The AC control has a line circuit breaker on the side of the control box. See Figure 16. It is connected in series with the load and opens if a short or overload occurs.

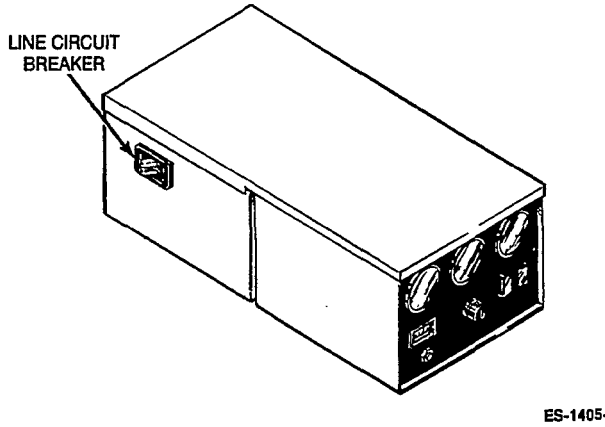


FIGURE 16. AC LINE CIRCUIT BREAKER

Maintenance

Establish and adhere to a definite schedule for maintenance and service. If the set will be subjected to extreme operation conditions, the service intervals should be reduced accordingly. The authorized Onan Distributor can help determine a suitable schedule of maintenance.

Use the running time meter to keep a log of all service performed for warranty support. Perform service at the time period or after the number of operating hours shown, whichever comes first. Use the schedule to determine maintenance required and then refer to the sections that follow for the correct service procedures.

⚠WARNING ***Leakage of fuel in or around the generator set compartment presents a hazard of fire or explosion that can cause severe personal injury or death. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the compartment thoroughly with the bilge blowers or power exhausters.***

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first) when repairs are made to the engine, controls, or generator.***

PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	SERVICE TIME				PAGE
	Daily or after 8 hours	Monthly or after 100 hours	6 Months or after 250 hours	Yearly or after 500 hours	
Inspect Set, Exhaust System	X[1]				21
Check Oil Level	X				22
Check Coolant Level	X				23
Check Fuel Level	X				25
Check Battery Specific Gravity/Electrolyte Level		X			25
Change Crankcase Oil and Filter		X[2,3]			22
Check Drive Belt Tension			X[4]		24
Check Coolant/Anti-Freeze			X		22
Clean Generator Assembly, Check Brushes			X		26
Check Fuel System			X[5]		25
Inspect and Adjust Spark Plugs			X		25
Clean Cooling System				X	23
Replace Spark Plugs				X	25

1 - Check for oil, fuel, cooling and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately.
2 - Perform after first 35 hours of operation on new sets.
3 - Perform more often in extremely dusty conditions.
4 - Visually check belts for evidence of slippage.
5 - Drain 1 cup of fuel from tank to remove water and sediment.

SET INSPECTION

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

Engine Gauges (Optional)

Check the following optional gauges while the generator set is operating.

Oil Pressure Gauge: The oil pressure should be in the range of 35 to 50 psi (241 to 345 kPa) when the engine is at operating temperature.

Coolant Temperature Gauge: The coolant temperature should be in the range of 180° to 203°F (82° to 95°C) depending on the load and ambient temperature.

DC Voltmeter: Normal battery B+ voltage during operation should be 13.5 to 15 volts on a 12-volt system. Voltage reading changes with battery state-of-charge.

Exhaust System

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, flexible hose, muffler and exhaust pipe. Check the sea water pump operation by observing sea water discharge from the exhaust outlet. It should be 3 gal/min (11 litre/min). Visually and audibly check for leaks at all connections, welds, gaskets, and joints. If any leaks are detected, have them corrected immediately.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair any leaks immediately.***

Fuel System

With the generator set operating, inspect the fuel supply lines, fuel pump, carburetor and fittings for leaks. Check flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage.

⚠WARNING ***Leaking fuel will create a fire hazard which can result in severe personal injury or death if ignited by a spark. If any leaks are detected, have them corrected immediately.***

DC Electrical System

With the generator set off, check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if corroded or loose. The negative battery cable should always be the first removed and the last reconnected to reduce possibility of arcing.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. Do not smoke while servicing batteries.***

Mechanical

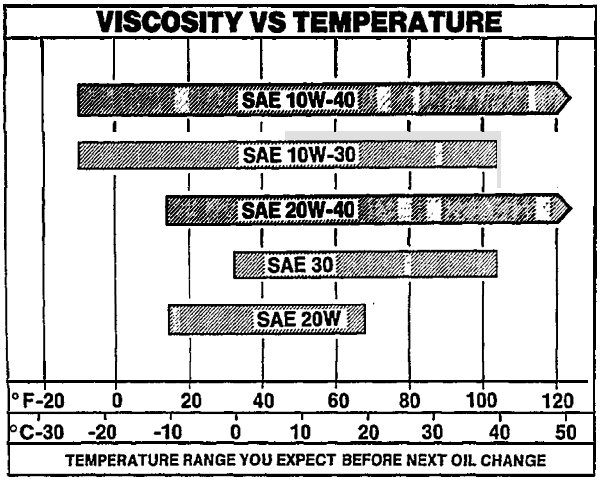
With the generator set stopped, check for loose belts, fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately. Check the governor linkage for dust and dirt accumulation and clean if necessary. With the set running, listen for unusual noises that may indicate mechanical problems. Investigate anything that indicates a mechanical malfunction.

LUBRICATION SYSTEM

The engine oil was drained from the crankcase prior to shipment. Before the initial start, the lubrication system must be filled with oil of the recommended classification and viscosity. Refer to the Specifications section for the lubricating oil capacity.

Oil Recommendations

Use oils with the American Petroleum Institute (API) classification SF/CD in viscosities per temperature as shown in the chart below.



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When selecting the oil viscosity, pick the viscosity that is right for the lowest temperature expected. Oil that is too thick may result in a lack of lubrication when the engine is started. Use a lower viscosity oil as the ambient temperature reaches the lower end of the scale.

Do not use synthetic oil or non-detergent oil; and do not mix different brands of oil.

Engine Oil Level

Check the engine oil level during engine shut-down periods at the intervals specified in the Periodic Maintenance Schedule. The oil dipstick and oil fill are located on the side of the engine (see Figure 17). The dipstick is stamped with MAX and MIN to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

Keep the oil level as near as possible to the MAX mark on the dipstick. Remove the oil fill cap and add oil of the same quality and brand when necessary.

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

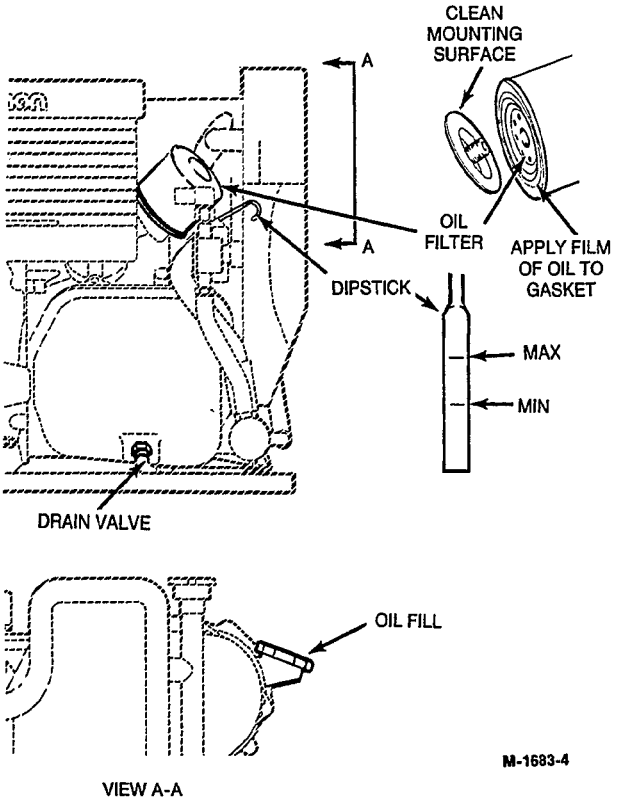

FIGURE 17. ENGINE OIL

Oil and Filter Change

Change the oil and filter at the intervals recommended in the Periodic Maintenance Schedule. Use oil th meets the API classification and viscosity requiremer as shown in the Oil Recommendations section.

Engine Oil Change: Run the engine until thoroughly warm before draining oil. Stop engine, open the drain valve (Figure 17) and drain oil into a container. When completely drained, close valve and refill crankcase with oil of the correct API classification and appropriate SAE viscosity.

Oil Filter Change: Spin off oil filter and discard it. Thoroughy clean filter mounting surface (Figure 17). Apply a thin film of oil to filter gasket and spin filter on by hand until gasket just touches mounting pad. Then turn an additional 1/2 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter gasket. Retighten only as much as necessary to eliminate leaks.

COOLING SYSTEM

The cooling system is drained prior to shipping and must be refilled before generator set is operated. The cooling system capacity is 3 quarts (2.8 L).

Coolant Requirements

A satisfactory engine coolant inhibits corrosion and pr tects against freezing. A 50/50 solution of ethyler glycol anti-freeze and water is recommended for normal operation and storage periods. Choose ony a reliable brand of anti-freeze that contains a rust and corrosion inhibitor but does not contain a stop-leak additive.

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Use distilled or soft water whenever available. Well water often contains lime and other minerals which eventually may clog the heat exchanger core or reduce cooling efficiency.

Do not exceed a 50/50 mixutre of ethylele glycol and water. A strong mixture of ethylene glycol will alter heat transfer properties of the coolant.

Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps secure. Remove the cooling system pressure cap and loosen or remove sender or plug from the engine block (Figure 18). Slowly fill the cooling system with the recommended coolant until it starts running from the block. Install or tighten the sender or plug and continue to fill the system. Add coolant to bring level to the full mark in the recovery tank.

Start the engine and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable.

Coolant Level

Check the coolant level in the recovery tank after allowing the engine to cool and if necessary, add coolant until level is at the full mark.

⚠WARNING ***Contact with hot coolant can result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

⚠CAUTION ***High Engine Temperature Cutoff will shut down engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device thereby causing severe damage to the engine. It is therefore imperative that adequate engine coolant levels be maintained to provide operational integrity of cooling system and engine coolant overheat shutdown protection.***

Flushing and Cleaning

For efficient operation, the cooling system should be drained, flushed, and refilled once a year.

To drain the system completely, the heat exchanger drain plug and the cylinder block plug or sender must be removed. Remove the pressure cap to facilitate draining process. Check the zinc pencil on the sea water drain plug at this time as outlined in this section.

Flushing: After cleaning or before filling the system with new coolant, drain the block and heat exchanger and fill with clean water. Operate the set for 10 minutes and then drain the system completely. Refill with the recommended coolant. Flush/clean the recovery tank and add coolant to the full mark.

⚠CAUTION ***Adding cold coolant to a hot/warm engine can result in engine damage.***

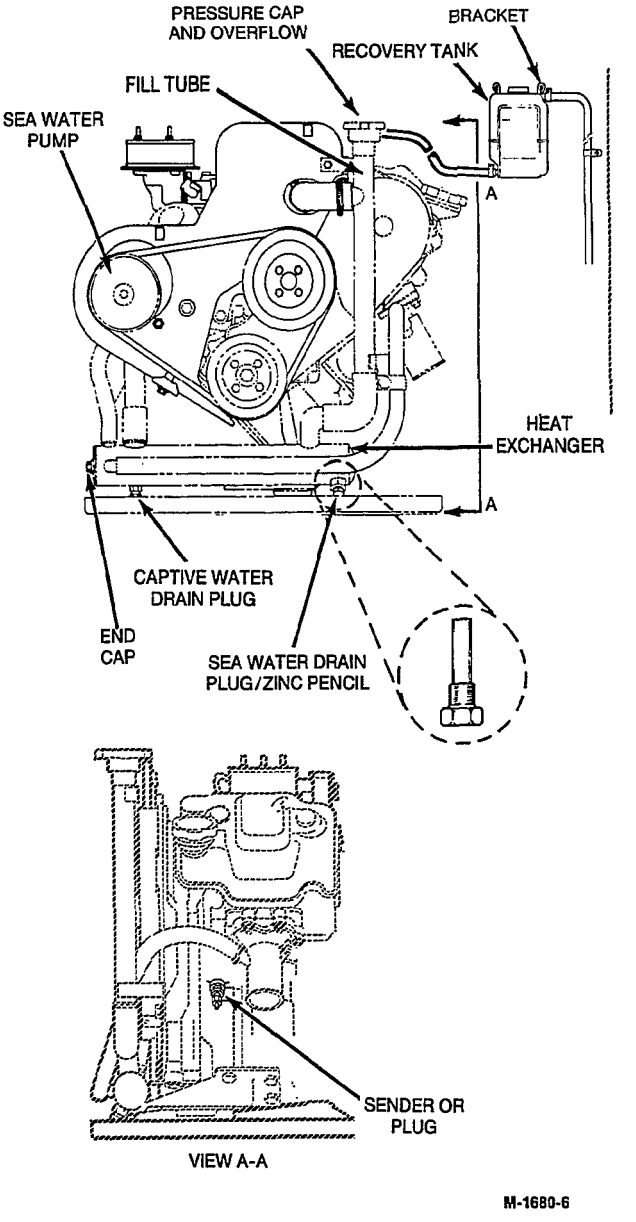

FIGURE 18. COOLING SYSTEM COMPONENTS

Zinc Pencil: The sea water side of the heat exchanger is protected from corrosion by a zinc pencil mounted on the sea water drain plug. See Figure 18. It should be inspected every two months and replaced if deteriorated to less than 1/2 inch (13 mm).

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 cap should be replaced every two years or sooner if it malfunctions. The cap is rated at 7 psi (48 kPa).

Siphon Break

A siphon break is installed on units if the exhaust injection elbow is below load water line. When properly installed, it helps prevent sea water siphoning into the engine and compartment when generator set is shut down.

The siphon break valve is very reliable. However, when used in contaminated waters or salt water for example, some corrosion may appear. The valve can be checked for free movement after unscrewing the top cover. If the valve sticks or the seat shows wear, it must be replaced (see Parts Manual).

Drive Belts

Figure 19 shows arrangement of the two V-belts used on this generator set. The longer belt is driven by the engine crankshaft pulley and turns the captive coolant pump and the sea water pump. The smaller belt is driven by a second pulley on the captive water pump and turns the flyweight governor.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first) when repairs are made to the engine, controls, or generator.***

Remove the belt guard for belt inspection or replacement. A loose or defective belt can cause the engine to overheat and cause poor speed regulation or an overspeed condition. Belts should be checked for excessive slickness, oil soak, wear, tear, cracks and overstretching. Replace if needed.

Adjustment: Proper tension is shown in Figure 19 with a specified deflection when the belts are pressed down with a pressure of 22 pounds (10 kg) at the midpoint between pulleys. Tighten adjustment capscrews when proper tension is achieved.

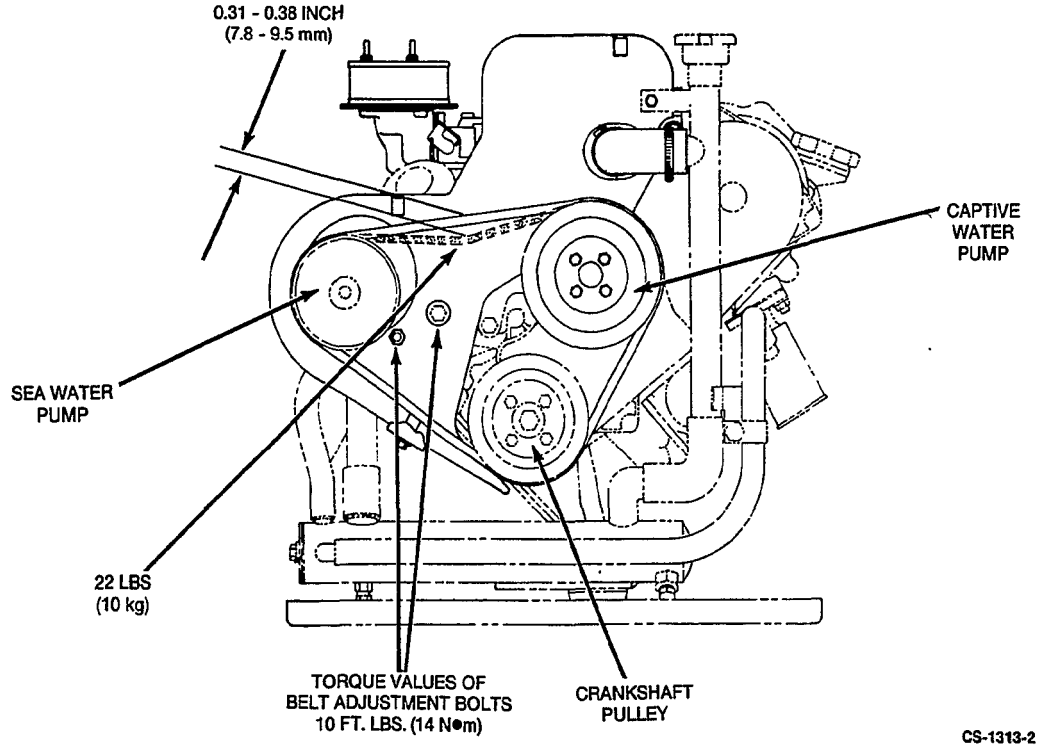

FIGURE 19. DRIVE BELT ADJUSTMENTS

FUEL SYSTEM

Use only good quality fuel obtained from a reputable supplier. The quality of the fuel used is important in obtaining dependable performance and satisfactory engine life. Fuels must be clean. Use clean, fresh, unleaded gasoline. Do not use leaded premium fuels. Using unleaded gasoline results in reduced valve and carbon cleanout maintenance.

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

⚠WARNING ***Fuel hose rupture can cause severe personal injury or death by fire or explosion. Alcohol additives in some fuel can permeate fuel hoses and cause swelling and deterioration. Check fuel hoses for deterioration and replace any suspect hose immediately.***

SPARK PLUGS

Remove and inspect/replace the spark plugs at the intervals recommended in the Periodic Maintenance Schedule. A careful examination of the plugs can often pin-point the source of an engine problem. The following covers some common spark plug conditions and the probable cause.

- ***One Plug Carbon Fouled:*** Check for an open ignition cable or low compression.
- ***Black Soot Deposits:*** Check for faulty choke operation, overly rich fuel mixture, or restricted air intake.
- ***Oil Fouled:*** Check for faulty crankcase breather hose, worn rings, or worn valve guides.
- ***Burned or Overheated:*** Check for leaking intake manifold gaskets, lean fuel mixture, or incorrect ignition timing. Be sure plug has correct heat range.
- ***Chipped Insulator:*** Check for advanced timing. Bend only the side electrode when setting plug gap.
- ***Splash Fouled:*** Check for accumulated combustion chamber deposits. See Cylinder Head section.
- ***Light Tan or Grey Deposits:*** Normal plug color.

Spark plugs should be replaced at regular intervals. Replace plugs with the same type as specified in the Parts Catalog. Check and adjust plug gap to 0.043 inch (1.09 mm). See Figure 20.

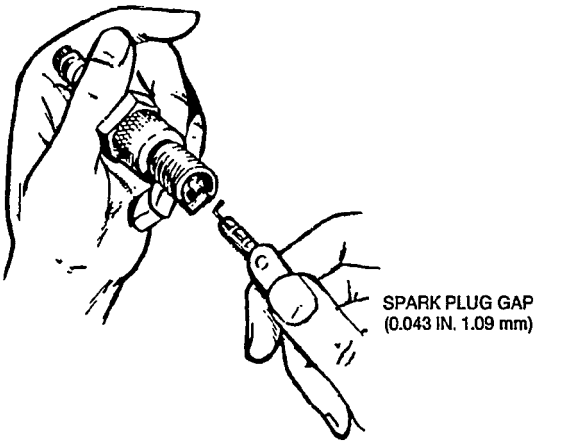

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FIGURE 20. CHECKING PLUG GAP

Installation: A 13/16-inch hexagon spark plug socket is required to remove/install plugs. After normal service life of a spark plug, a plug may be difficult to remove, especially if it had been over-torqued (see Caution). The use of penetrating oil is recommended if a plug appears to be dangerously tight. Apply steady pressure with a plug wrench until the plug loosens. Before removing the plug, blow any dirt from the port area to prevent it from getting into the combustion chamber.

Clean the plug gasket surface on the head with a clean cloth. Torque each spark plug to 18 foot pounds (25 N•m). Correct torque can be had only if the threads are clean.

⚠CAUTION ***The cylinder head is made of an aluminum alloy. Do not torque spark plugs beyond specs or remove plugs from a hot engine. Damage to the internal threads may result.***

BATTERIES

Check the condition of the starting batteries at the interval specified in the Periodic Maintenance Schedule. Always disconnect the battery before working on any part of the electrical system or the engine. Disregard the sections on Checking Specific Gravity and Checking Electrolyte Level if using a maintenance free type battery.

⚠WARNING ***Leakage of fuel in or around the generator set compartment presents a hazard of fire or explosion that can cause severe personal injury or death. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the compartment thoroughly with the bilge blowers or power exhausters.***

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. Do not smoke. Wear goggles and protective, rubber gloves and apron when servicing batteries.***

Cleaning Batteries

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive. If corrosion is present around the terminal connections, remove battery cables and wash the terminals with an ammonia solution or a solution consisting of 1/4 pound (about 100 grams) of baking soda added to 1 quart (about 1 litre) of water. See Figure 21.

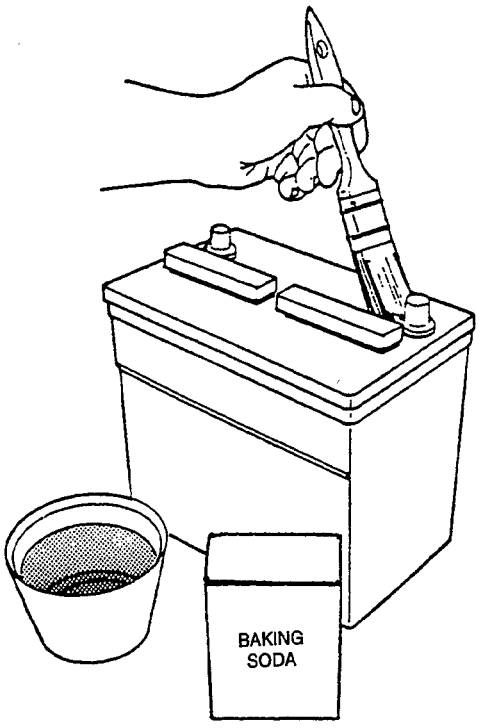

FIGURE 21. CLEANING BATTERY

Remove batteries from vessel for cleaning. Be sure the vent plugs are tight to prevent cleaning solution from entering cells.

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

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

Checking Specific Gravity

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

⚠WARNING ***Battery electrolyte can cause severe eye damage and burns to the skin. Wear goggles, rubber gloves and a protective apron when working with batteries.***

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

Checking Electrolyte Level

Check the level of the electrolyte (acid and water solution) in the batteries at least every 50 hours of operation. Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks or for a bad cell. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

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

AC GENERATOR

The generator should be inspected to check brush wear and for cleaning as required per the Periodic Maintenance Schedule. Be sure to disconnect the negative battery terminal to prevent starting of the generator s before proceeding.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first) before inspecting the generator.***

Remove the end bell cover and inspect the brushes and brush holder for burn marks or other damage. If the brushes appear to be in good condition, use a piece of wire (modified with paint as shown in Figure 22) to check for brush wear.

Insert the wire through the hole above each brush. Make sure the wire is resting on the brush and not on part of the spring. If the painted part of the wire is not visible, the brush is excessively worn and must be replaced. Refer service to the nearest Onan Authorized Service Center.

Inspect the slip rings for grooves, pits or other damage. They can be refinished as necessary by the service technician. If dust has accumulated on any generator components, they can be cleaned with filtered, low pressure air.

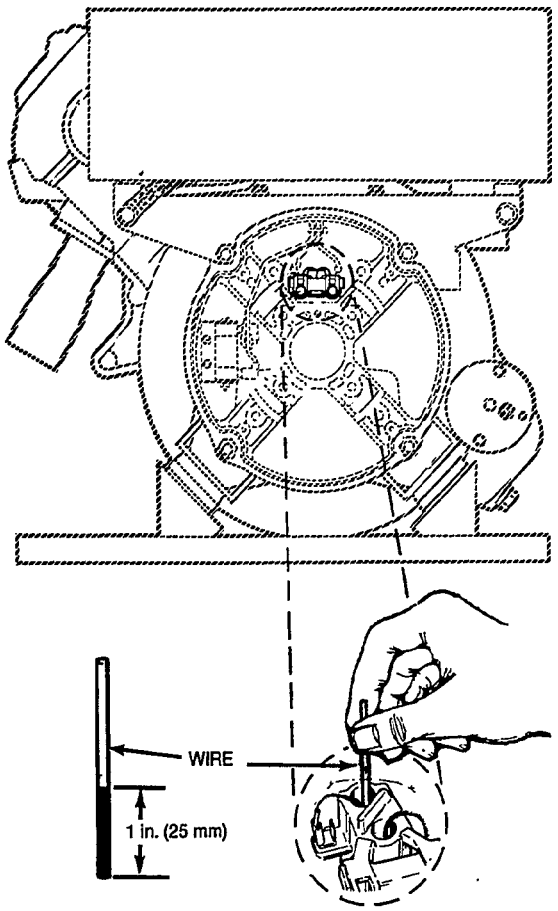

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FIGURE 22. CHECKING BRUSH WEAR

OUT-OF-SERVICE PROTECTION

If the generator set will be out of service for more than 30 days, protect it by using the following procedures.

1. Start and run the generator set with load until it is thoroughly warm. Stop the set.
2. Drain the oil from the crankcase while the engine is still warm. Replace the oil filter and refill crankcase with new oil (add extra oil for the filter).
3. Turn off the fuel supply valve. Start the engine and let the generator set run until it stops from lack of fuel.
4. Remove the spark plugs and pour about one ounce (30 ml) of rust inhibitor oil (or SAE 50 oil) into each cylinder plug opening. Crank engine over several revolutions, then install the spark plugs.
5. Check the ethylene glycol mixture in the captive cooling system to be sure it has sufficient freeze and corrosion protection.
6. Protect the sea water cooling system from freezing or corrosion as follows:
   A. Shut off the sea water cock.
   B. Remove inlet hose at the sea cock (or filter) and insert hose end in a bucket containing at least two gallons (7.6 litres) of 50-50 antifreeze/water mix.
   C. Crank engine until coolant mixture discharges from the outboard exhaust fitting.
   D. Re-install inlet hose removed in Step B.
7. Plug the exhaust outlet to prevent entrance of moisture, insects, dirt, etc.
8. Disconnect the starting battery and follow standard battery storage procedure.

⚠CAUTION ***Freezing temperatures can cause severe damage to the battery when in storage. Maintain electrolyte level and use a trickle charger to maintain specific gravity.***

9. Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of rust inhibitor oil or grease.

Returning Unit to Service

Refer to preceding paragraphs in this Maintenance section for specific service procedures.

1. Remove plug from exhaust outlet and open seacock.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check batteries. For batteries that are not maintenance free, measure specific gravity (1.260 at 80°F [27°C] 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.

⚠WARNING ***Battery electrolyte can cause severe eye damage and burns to the skin. Wear goggles, rubber gloves and a protective apron when working with batteries.***

4. Connect starting battery (ground terminal last).
5. Remove all loads before starting the engine.
6. After start, apply load to at least 50 percent of rated capacity.
7. Check all gauges for normal readings. Set is ready for service.

⚠ WARNING: ⚠

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

Onan

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