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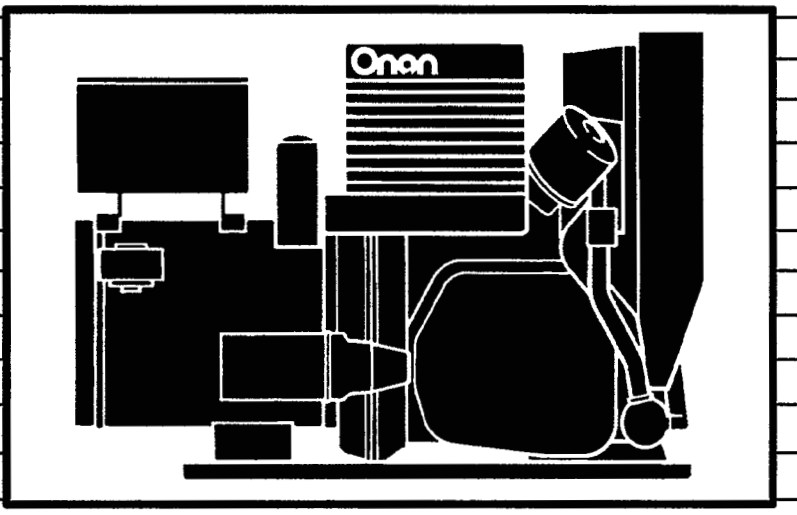
Onan MARINE

Installation Manual

MCE

Ensign Series 4500/6500



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Safety Precautions

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, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC. Fire, explosion, and personal injury can result from improper practices.

- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- 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.
- Always disconnect the battery ground (–) lead first and reconnect it 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. Equip the bilge with a power exhauster.
- 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 is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any belt guards or covers with the generator set 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, possible 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 or bilge thoroughly with the power exhauster.

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 THE GENERATOR SET TO THE PUBLIC UTILITY OR TO ANY OTHER ELECTRICAL POWER SYSTEM. Electrocution or damage to property can occur at a site remote from the boat where line or equipment repairs are being made if the set is connected to the power system. An approved transfer switch must be used if more than one power source is to be made available to service the boat.
- 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. M8

Copy and post these suggestions in potential hazard areas of the vessel.

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Section 1. Introduction

GENERAL

Each marine generator set must be installed properly if it is to operate reliably, quietly, and most important - safely. Therefore, read this entire manual before starting the installation. The manual should be used only as a guide as each installation must be considered on an individual basis. For operation and maintenance procedures, refer to the MCE Operator's Manual 927-0124 which accompanies each unit.

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
- Sea water connections
- Accessibility for operation and servicing
- Level mounting surface
- Adequate support under mounting points
- Noise levels

INSTALLATION CODES AND SAFETY RECOMMENDATIONS

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

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 Avenue
Boston, MA 02210

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

⚠WARNING

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

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Section 2. Specifications

GENERATOR

Type ..... Revolving Field, 4-Pole, Self-Excited
Standby Ratings:
  60 Hertz, 6.5 MCE ..... 6.5 kW, (6.5 kVA @ 1.0 PF)
  60 Hertz, 4.5 MCE ..... 4.5 kW, (4.5 kVA @ 1.0 PF)
  50 Hertz, 5.0 MCE ..... 5.0 kW, (5.0 kVA @ 1.0 PF)
AC Voltage Regulation ..... ±5%
Frequency Regulation .....5% (3 Hertz)

ENGINE

Engine Type .....Onan® MCE, 2-Cylinder Opposed
Engine Speed (r/min) 1800/1500
Exhaust Outlet Hose Size .....2.0 in. (50.8 mm)
Fuel.....Unleaded, 88 octane
Fuel Inlet Size.....1/4-18 NPT
Fuel Consumption, Average @ Full Load:
  60 Hertz, 6.5 MCE ..... 1.3 gph (5.0 Lph)
  60 Hertz, 4.5 MCE ..... 1.6 gph (6.1 Lph)
  50 Hertz, 5.0 MCE ..... 1.1 gph (4.2 Lph)
  Fuel Inlet Size..... 1/4-18 NPTF
  Fuel Return Outlet Size .....1/8-27 NPT
Battery Requirements:
  Minimum Cold Cranking Amps @ 0°F (-18°C)..... 360
  Voltage..... 12
Cooling System:
  Capacity, Heat Exchanger System.....10 Quarts (9.4 L)
  Heat Rejection:
    60 Hertz @ Load, Block & Exhaust Manifold ..... 800 BTU/min
    50 Hertz @ Load, Block & Exhaust Manifold ..... 650 BTU/min
Cooling Flow Rate, 60 Hertz:
    Heat Exchanger System, Thermostat Open .....2.2 gpm (8.3 L/min)
    Sea Water, Heat Exchanger System .....3.0 gpm (11.4 L/min)
    Sea Water Cooling System .....3.0 gpm (11.4 L/min)
Cooling Flow Rate, 50 Hertz:
    Heat Exchanger System, Thermostat Open .....2.2 gpm (8.3 L/min)
    Sea Water, Heat Exchanger System .....2.5 gpm (9.5 L/min)
    Sea Water Cooling System .....2.5 gpm (9.5 L/min)
Sea Water Pump Dry Lift, Maximum ..... 3 ft (0.9 m)
Total Air Required (Generator Cooling and Combustion):
  60 Hertz .....146 ft^3/min (4.1 m^3/min)
  50 Hertz ..... 120 cu. ft./min (3.4 m^3/min
Engine Oil Capacity with Filter .....3 Quarts (2.8 L)

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Section 3. Location and Mounting

LOCATION

Generator 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. However, 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 MCE 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.***

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

MOUNTING

The floor must be flat and give support directly under the genset mounting points (Figures 3-1 and 3-2). A one inch (25 mm) clearance around the unit is required to permit rocking on its mounts without restraint; and 4.2 inches (106 mm) for servicing the oil filter. Additional space must be allowed for proper ventilation for cooling and combustion, as well as service access. Also allow access for periodic maintenance such as oil fill, coolant fill, spark plug replacement, etc. The entire exhaust system must be accessible so a periodic visual and audible check for leakage can be made by the operator.

Install two hold-down clamps or two through bolts to the drip pan on both sides of the generator set. Tighten the clamps securely to the mounting base with bolts and flatwashers.

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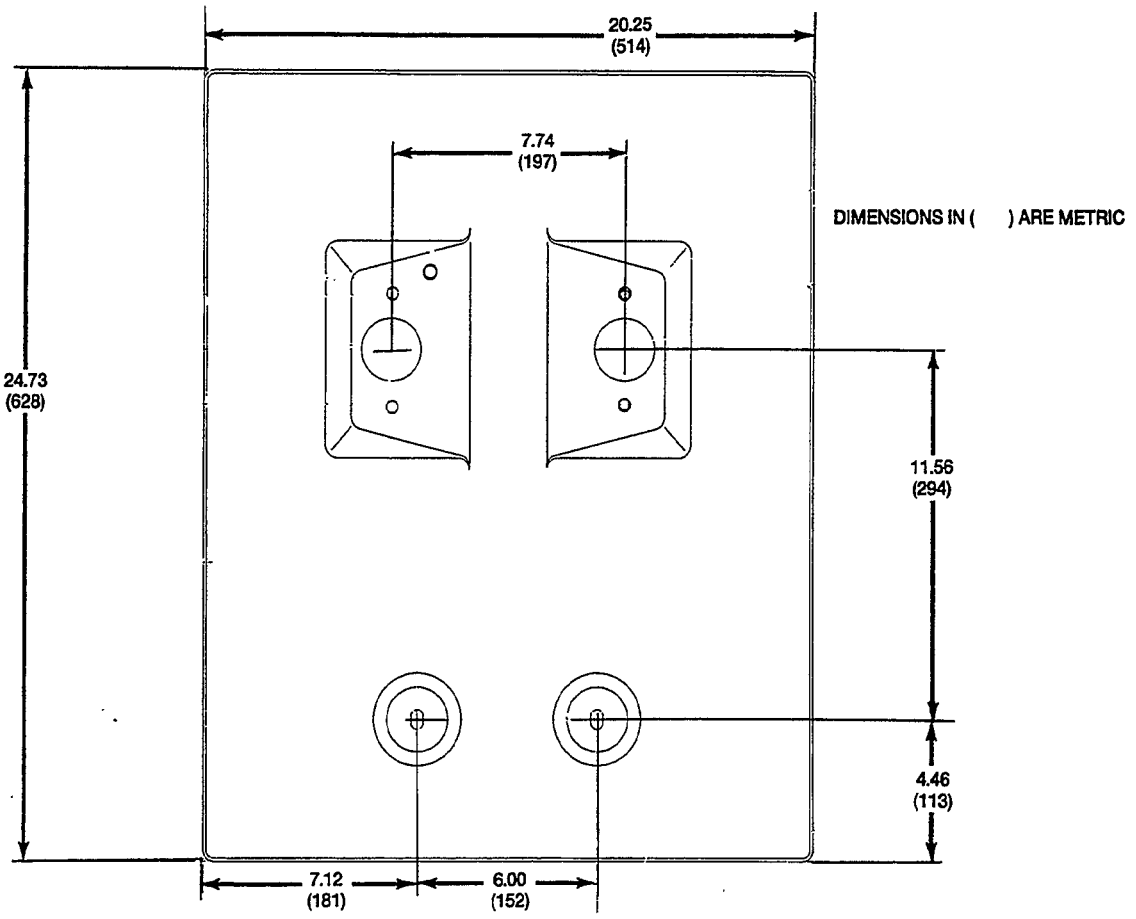

FIGURE 3-1. DRIP PAN DIMENSIONS

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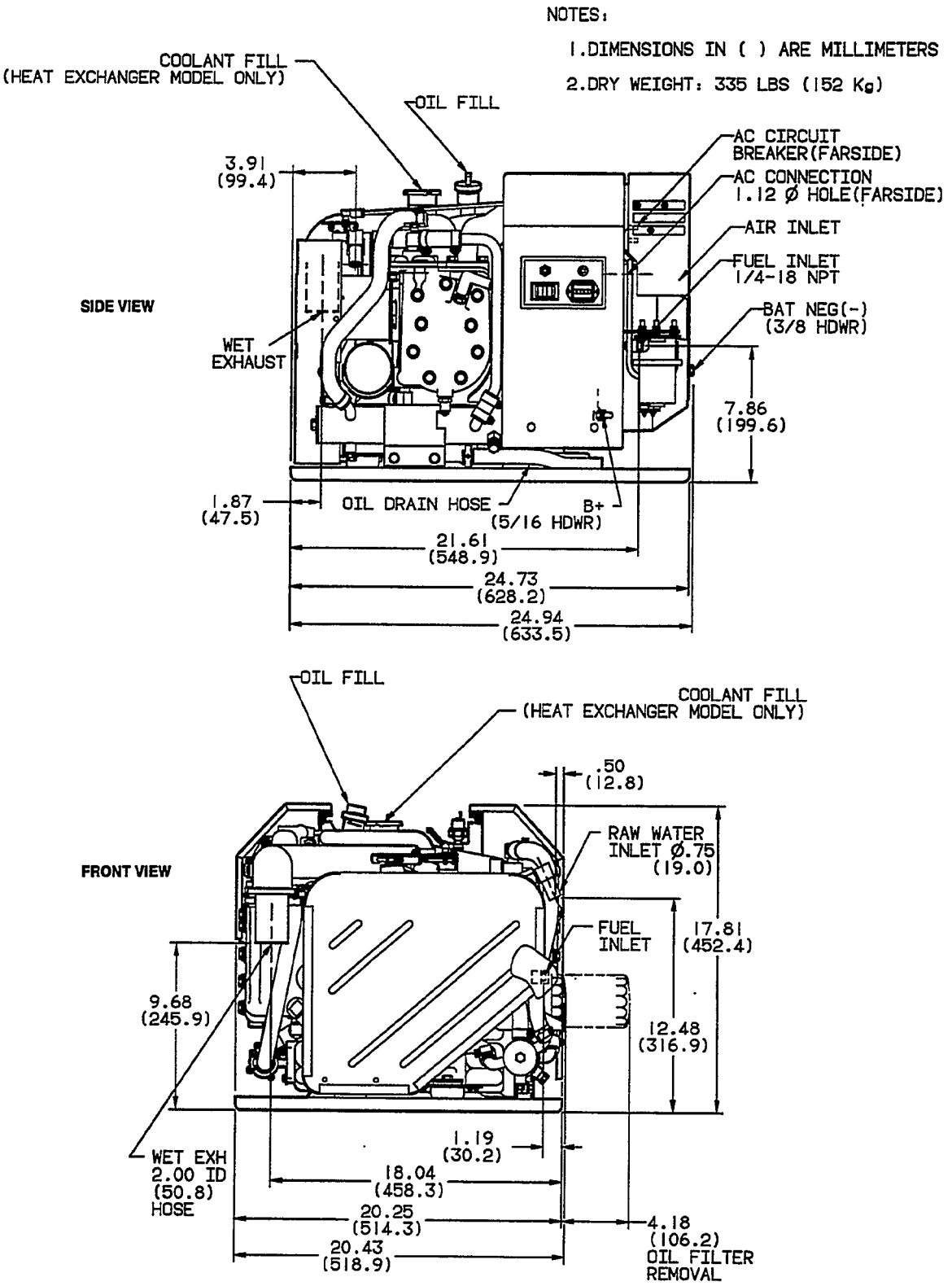

FIGURE 3-2. OUTLINE DRAWINGS

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Section 4. Ventilation

GENERAL

The installation of boat ventilation systems must meet all Coast Guard and NFPA requirements. Establishing the correct air flow quantity is particularly important with small compartments under 1000 cubic feet (28 m^3), or installations in close quarters. Ventilation systems meeting Coast Guard requirements for gasoline engines in passenger vessels (Table 4-1) will normally suffice, however special consideration must be given to compartment conditions during operation.

TABLE 4-1. PASSENGER VESSEL VENTILATION REQUIREMENTS

SIZE OF COMPARTMENT Cu. Ft. (m^3)	MINUTES REQUIRED TO EXCHANGE TOTAL AIR VOLUME
Less than 500 (14)	2
500 to 1000 (14 to 28)	3
1000 to 1500 (28 to 42)	4
1500 and Up (42 and Up)	5

REQUIREMENTS

Marine generator sets must have air ventilation for three very important reasons:

1. **To remove flammable or other harmful gases.** Coast Guard regulations require power blowers in the generator set and propulsion engine rooms be run at least four minutes prior to starting the engine and during operation. The operator must also inspect the engine room for the presence of fuel vapors prior to starting, especially when gasoline fueled equipment is used (see text under Coast Guard and NFPA Requirements).

2. **To provide engine combustion air and generator cooling air.** Coast Guard regulations require power exhausters in all installations, and one blower in each exhaust duct. Exhausters must have an air capacity 1-1/2 to 2 times the minimum generator set total air requirements. The MCE generator set requires a total operation minimum of 146 cubic feet per minute (4.2 m^3/min).

3. **To control compartment temperature during genset operation.** This will avoid overheating which can result in shutdown from vapor lock, engine and related control component damage, and power loss. As a general rule, the operating environment for a gasoline genset should not be higher than 140°F (60°C) maximum. Lower temperatures are recommended. Often an operating power blower may be required to maintain temperature when the genset is operating, especially when the boat is not moving.

The compartment must have air inlets and outlets to provide this air. Inlet ducts should have cowls or equivalent fittings of twice the area of the duct, larger if the opening is screened. Do not use recessed or flushed inlets, or louvered transom outlets.

If the gasoline fuel tank is in a separate compartment, it also must be ventilated.

COAST GUARD AND NFPA REQUIREMENTS

Both organizations require at least two inlet ducts and two outlet ducts extending to the bilge for gasoline generator set installations in a closed compartment. When not in a closed compartment, at least one duct should be installed in the fore section of the boat and another aft. The NFPA recommends a vent size of at least two square inches per foot (42.3 cm^2/m) of boat beam for total inlet area and total outet area.

Boats classified as pleasure vessels by the Coast Guard must have sufficient ventilation to eliminate accumulation of flammable gases. Boats under 65 feet (20 m) long classified as passenger vessels require ventilation be sufficient to change the compartment air within a given time interval (Table 4-1).

For passenger vessels, the Coast Guard recommends a mechanical exhausting system to meet the requirement in Table 4-1. The exhaust blower motors should be outside the compartment.

If a gasoline fuel tank is in a separate compartment, it must be ventilated to the same requirements as the engine compartment.

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Section 5. Cooling System

GENERAL

Throughout this manual, flotation water drawn into the boat for engine cooling is called sea water. Water recirculated through the engine closed system is called captive water. Thus, confusion is avoided with other generic terms describing water use.

The two types of marine cooling systems covered in this manual are *heat exchanger* and *sea water* cooling. An explanation of each system, and the advantages and disadvantages of each are covered in separate chapter headings. The heat exchanger system is ordered most often and is standard on the MCE generator set. Sea water cooling is an available option.

System Plumbing

To adequately cool the generator set under all conditions, the plumbing system must be properly planned and installed. Excess lengths of plumbing increases flow resistance and results in reduced cooling. An air leak in the sea water intake will reduce cooling, cause corrosion, and can even destroy the neoprene impeller in the sea water pump. The neoprene impeller must never be run dry, and should be primed before initial start.

The water line should have a minimum inside diameter of 0.75 inch (19 mm). For runs over 20 feet (5.2 m), increase the line one pipe size for each additional 10 feet (2.6 m) of length. Water lines can be either copper tubing or flexible hose. Be sure a length of flexible hose is used at the generator set connection to allow set movement and for noise abatement.

Unless the sea water is very clean, Onan recommends a water strainer or filter to protect the sea water cooling system. See Figure 5-1.

Onan has a hull strainer (furnished with some muffler kits) that can be used with a flush through-hull fitting. The strainer (Figure 5-1), installed with the slots parallel to the keel, helps prevent pressure or vacuum when the boat is underway. Always use a flush-type inlet with a hydrodynamic marine muffler.

⚠CAUTION ***The flush-type through-hull water inlet must have an opening at least as large as the water inlet line.***

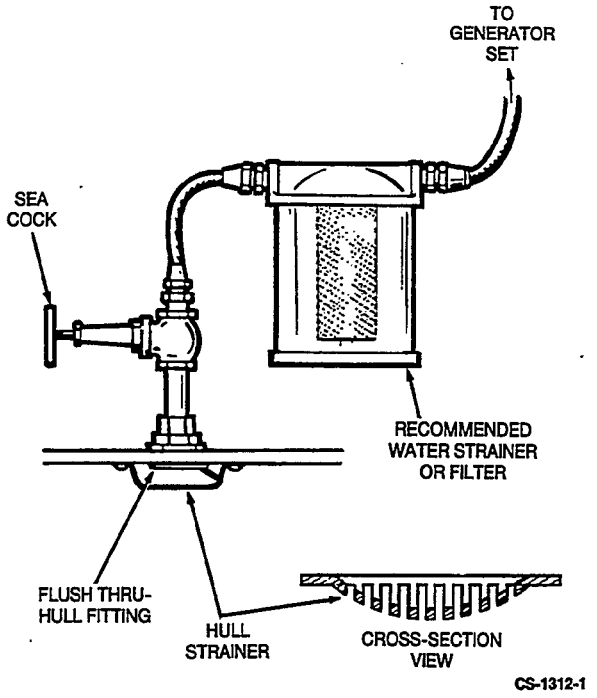

FIGURE 5-1. SEA WATER INLET

Stagger the generator set water inlet so it is not directly in line with other inlets. Not doing so can reduce the amount of sea water available to the generator set when underway and cause overheating. Never use scoop type water inlet fittings with a hydrodynamic muffler.

⚠CAUTION ***Do not use scoop type water inlet fittings with a hydrodynamic muffler. 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.***

HEAT EXCHANGER COOLING

This cooling system, standard on the genset, keeps sea water and the resulting sediment deposits (salt, silt, etc.), from the engine cooling jacket. It also provides more uniform cooling and temperature control in the engine. Sea water and captive water are kept separated, and the engine water jacket stays clean for optimum heat transfer.

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Figure 5-2 shows the flow direction of sea water and captive water. The sea water pump constantly renews the cool water bath in the heat exchanger and exhaust system. The captive water is circulated by a pump through the engine block, heat exchanger, and the exhaust manifold. The captive water temperature and flow rate are controlled by thermostats.

Each genset has a recovery tank kit to be installed in the captive cooling system. The tank (similar to automotive application) is connected to the overflow fitting below the pressure cap. It keeps the captive system filled with coolant which helps prevent corrosion and sediment. The tank should be located for easy checking of coolant level, and for serviceability. Installation instructions are furnished with the kit.

The captive cooling system should always use a 50-50 mixture of ethylene glycol and distilled water to help prevent corrosion. See the *Installation Checkout* section for filling instructions.

If a heat exchanger other than the Onan standard is installed, several precautions are required as follows:

- The heat exchanger must properly cool the generator set under all load conditions. The Onan system is designed to cool the set at full load with sea water inlet temperatures up to 100°F (38°C). Extra margin (10%) must be allowed for varying conditions of pumps, coolant and scale build up.
- Minimum captive water and sea water flow required by the generator set must be met. The heat exchanger will also have minimum and maximum flow requirements which must be met for cooling at its capacity. The generator set requirements are listed in the *Specification* section.

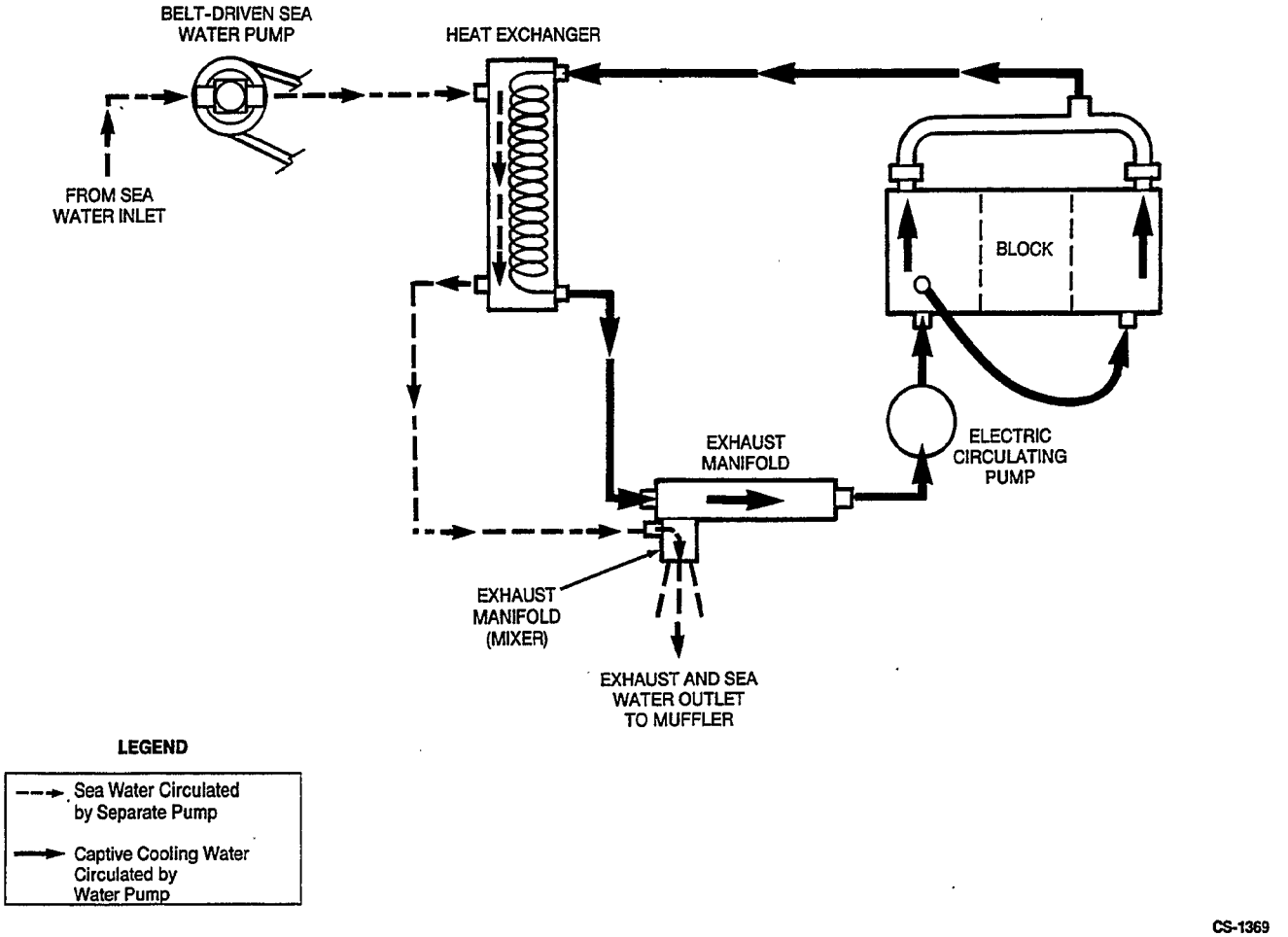

FIGURE 5-2. COOLANT FLOW, HEAT EXCHANGER COOLING SYSTEM

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SEA WATER COOLING

The sea water cooling system is shown in Figure 5-3. This system uses the belt-driven sea water pump to direct water through the engine cooling system and out the exhaust system. The electric circulating pump is not used on this system. The engine blocks have a drilled coolant bypass hole to allow some coolant flow regardless of thermostat opening. This allows for exhaust cooling and protection of the pump. The sea water and exhaust is disposed of similarly as described in Heat Exchanger Cooling with a hydrodynamic muffler (above or below water line installation).

The sea water comes into direct contact with the engine cooling jacket, and this system should be avoided for use in salt or contaminated water. Such water can cause engine block corrosion and/or plugging; therefore, heat exchanger systems are recommended.

COMBINED COOLING SYSTEMS

Onan does not recommend combining the generator set cooling system with the propulsion engine cooling system. This involves a great amount of experience and knowledge for the installer, as well as complete knowledge of characteristics of both the generator set and propulsion engines.

⚠CAUTION ***Propulsion engines use scoop-type water inlet fittings which must not be used for a generator set with a hydrodynamic muffler. When not operating, ram pressure can force water past the generator set's sea water pump and flood the exhaust system. From here it can flow back, flooding the engine cylinders and possibly the engine compartment.***

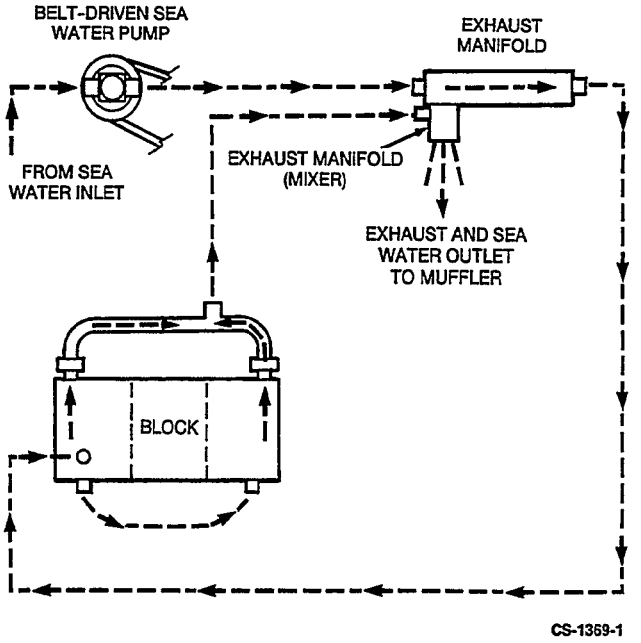

FIGURE 5-3. COOLANT FLOW, SEA WATER COOLING

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Section 6. Exhaust System

GENERAL

The installation of two water-cooled exhaust systems are covered in this section. They are below-load waterline and above-load waterline, and are covered under separate headings. 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.

- The entire exhaust system must be accessible so a periodic visual and audible check for leakage can be made by the operator.
- The exhaust system must be water cooled, and the water injected as near to the generator set as possible.
- All exhaust system sections preceding the point of water injection must be water jacketed or effectively insulated or shielded.
- The exhaust line must be installed to prevent back flow of water to the engine under any conditions; and the exhaust outlet must be above the load waterline. Water backflow into the engine will damage it.
- The generator set exhaust system *must not* be combined with the exhaust system of another engine.
- A flexible section of marine exhaust hose must be used near the engine to allow for engine movement and vibration during operation. All exhaust system hoses must be CERTIFIED for marine use.
- The exhaust system must be of sufficient size to prevent excessive back pressure. See Back Pressure data in this section.
- Install exhaust through hull fitting aft of sink, shower or other cabin drains to prevent backflow of exhaust gases into the vessel.

Material

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

⚠WARNING ***Exhaust gas contains carbon monoxide, an odorless, colorless, highly poisonous gas that presents the hazard of severe personal injury or death. Place special emphasis on the following:***

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

Use flexible hose designed and CERTIFIED for marine exhaust line use. The muffler must be at the lowest point of the entire exhaust system. The muffler top should be at least 12 inches (305 mm) below the exhaust manifold outlet. If it is higher, backflow of water toward the manifold is more likely.

Make sure the hose drains toward the muffler at a grade of 1/2 inch per lineal foot (42 mm/m). An uphill section between the exhaust manifold and muffler can cause backflow of water and is not permissible - *NO EXCEPTIONS.*

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 6-1.

The exhaust tubing (on both above and below load waterline installations) must be pitched downward to the through-hull outlet fitting at a minimum downgrade of 1/2 inch per lineal foot (42 mm/m). There must also be a 12-inch (305 mm) minimum drop from this peak to the through-hull outlet fitting as shown in Figures 6-1 and 6-2.

Allow space between the marine muffler and its mounting surface by use of spacers under the mounting flanges. This allows air circulation under the muffler and discourages condensation build-up.

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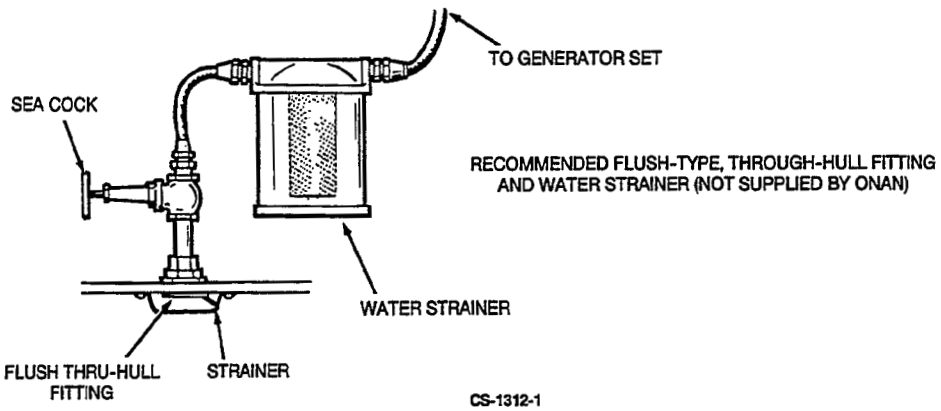
Use two clamps at each end of hose as shown in Figures 6-1 and 6-2. The clamps must be of corrosion resistant metal, a minimum of ½ inch (12.7 mm) wide. They should be spaced at least one clamp width apart, and at least one clamp width from the end of the hose. Clamps depending solely on spring tension must not be used.

Provide adequate support for hose lengths to prevent sagging, bending, and formation of water pockets. The use of automotive type pipe hangers will help stop transmission of vibration or noise to the boat hull.

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 for the MCE generator set should not exceed 3.0 inches (76 mm) of mercury (10 kPa).

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



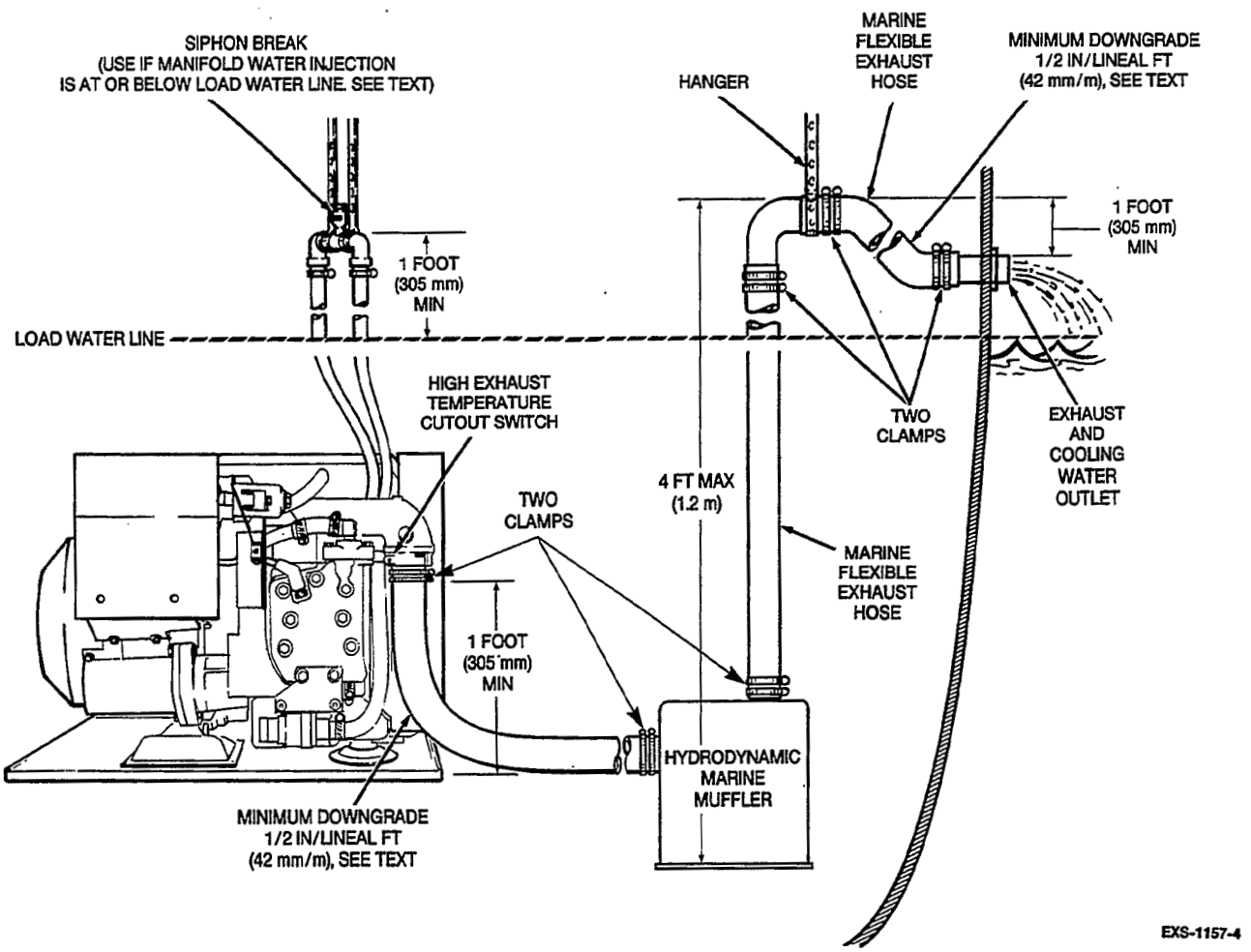


FIGURE 6-1. BELOW LOAD WATERLINE INSTALLATION

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Exhaust Cooling Water Injection

The neoprene impeller pump moves the sea water through the cooling system and into the exhaust manifold. The injected water cools the exhaust and prevents exhaust system damage from heat. A temperature operated switch on the exhaust manifold shuts the unit down if overheating occurs. The switch closes if temperature reaches 175° to 185°F (79° to 85°C) and actuates the Fault Reset breaker on the control panel. If high exhaust temperature shutdown occurs, the entire exhaust system should be checked for any signs of overheating, especially the exhaust hoses. Replace defective components immediately, and do not operate the generator set until system is repaired.

⚠WARNING ***Inhalation of exhaust gas can cause severe personal injury or death. Do not operate the generator set after a high exhaust temperature shutdown until the entire exhaust system has been checked and serviced as required.***

⚠WARNING ***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.***

BELOW LOAD WATERLINE INSTALLATION

Figure 6-1 shows details of a recommended below load waterline installation. Review and apply data from the preceding *GENERAL* section, plus the following.

Siphon Break

Install a siphon break (anti-siphon) if the sea water injection port on the exhaust manifold is at or below the load waterline. The siphon break is a vacuum operated vent valve that opens the exhaust water discharge line to the atmosphere when the engine is not operating. The open vent valve prevents sea water (flotation water) from being siphoned into the exhaust manifold and cylinders on engines installed below load waterline.

The siphon break hoses connect between the exhaust manifold water injection port and the water tube from the heat exchanger. Connect the siphon break hose ends to these connectors. Remove plug from top panel and route hoses through the hole.

Locate the siphon break in a vertical position at least 12 inches (305 mm) above the load waterline. See Figure 6-1. Remote mounting is permissible within a 5 foot (1.5 m) radius of the injection port. The vertical position and height of the valve must be maintained.

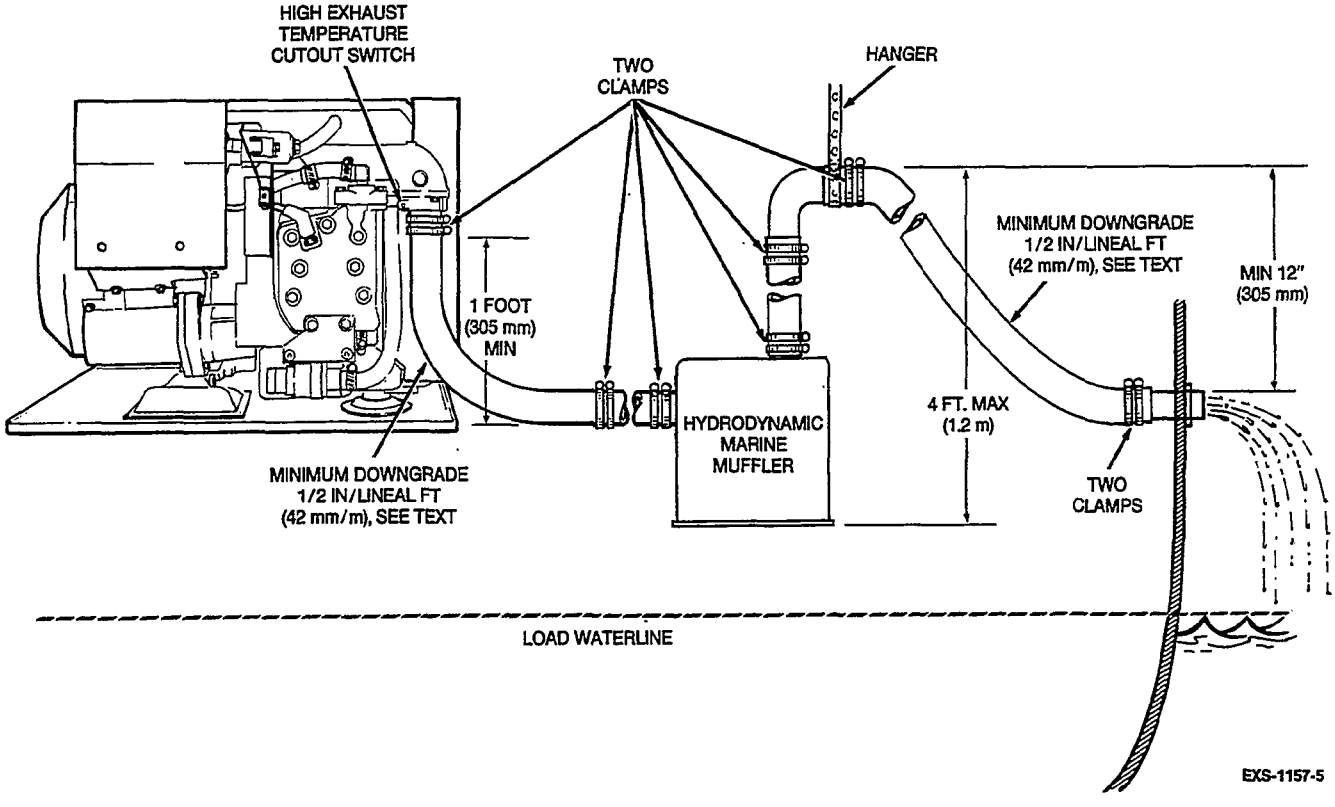

FIGURE 6-2. ABOVE LOAD WATERLINE INSTALLATION

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The siphon break must be mounted vertically with the threaded end pointed down. Use pipe strap material 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 valve will not function if the slot is closed in any way.

⚠CAUTION ***Failure to use a siphon break when the exhaust manifold injection port is at or below the load waterline will result in sea water damage to the engine and possible flooding of the boat.***

ABOVE LOAD WATERLINE INSTALLATION

Figure 6-2 shows details of a recommended above load waterline installation. A siphon break valve is not required with this installation. Review and apply data from the preceding *GENERAL* section. Be sure the minimum drop and downward pitch of exhaust runs are applied, and that all hose end connections have two clamps as shown.

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Section 7. Fuel System

GENERAL

⚠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 application.***

Make sure all fuel lines are properly supported and connections tightened securely. Use an approved pipe joint compound acceptable for use with gasoline fuel at all thread fittings.

Fuel distribution lines must have as few connections as practicable, and be protected against mechanical injury and vibration. In all fuel system installations, cleanliness is very important. Take precautions to prevent the entrance of moisture, dirt or contaminants of any kind during installation.

If possible, avoid the use of fuels composed of blends of gasoline and alcohol. Methanol notably can cause corrosion of metals and damage to plastic and rubber. Some blended fuels may have cosolvents in them to prevent damage, but the suitability of these fuels is not fully known at this time. Fuel containing alcohol can also cause external paint damage if spilled during refueling. Some states require the use of labels on pumps to indicate alcohol content. If unsure, ask the fuel station operator.

INSTALLATION

Any flexible fuel line installed between the fuel tank and the generator set must meet USCG requirement 33CFR183.558 and be stamped *"USCG TYPE A"*. There cannot be an electrical connection between the hose end fittings. A bad ground in the cranking circuit will cause a wire reinforced hose to become hot and ignite the fuel during cranking. If a metallic fuel line is run into the generator set compartment, a length of flexible hose meeting the above specifications must be installed to absorb vibration from the generator set.

⚠WARNING ***Ignition of fuel can cause fire and severe personal injury or death. Be sure any flexible fuel line used between the fuel tank and the generator set meets USCG requirement 33CFR183.558 and is stamped "USCG TYPE A".***

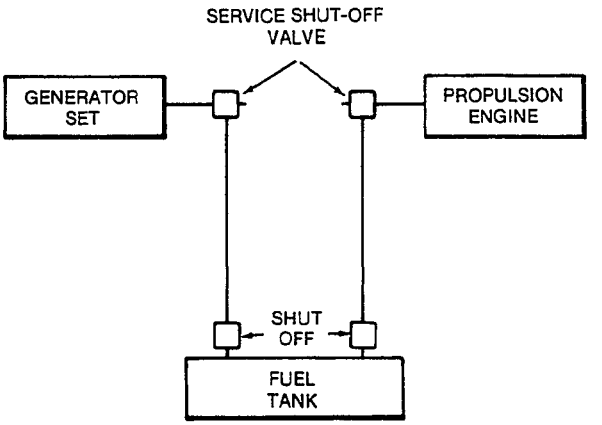

FIGURE 7-1. INSTALLATION ABOVE TANK LEVEL

⚠WARNING ***Leakage of gasoline in or around the generator set compartment presents a hazard of fire or explosion and can cause severe personal injury or death. Do not permit any flame, spark, cigarette, pilot light, arcing equipment, or other ignition source near the generator set. The ventilation system must provide a constant flow of air to safely expel all fuel vapors.***

The fuel line should be run at or above level of the tank top to a point close to the engine connection whenever possible to prevent siphoning. See Figure 7-1. The line should be supported throughout its length with clips or straps spaced at no more than 14-inch (355 mm) intervals.

A separate fuel line is recommended for the genset. If a fuel tank is shared, a fuel line tee *is not recommended.* A tee can cause erratic set operation due to fuel starvation. The generator set's fuel pump has neither the capacity nor the power to overcome the draw of the propulsion engine fuel pump.

If the fuel tank fitting is large enough, a second, shorter dip tube may be installed as shown in Figure 7-2. The required fittings can be built by a machine shop. Install an anti-siphon device at the tank fitting as shown.

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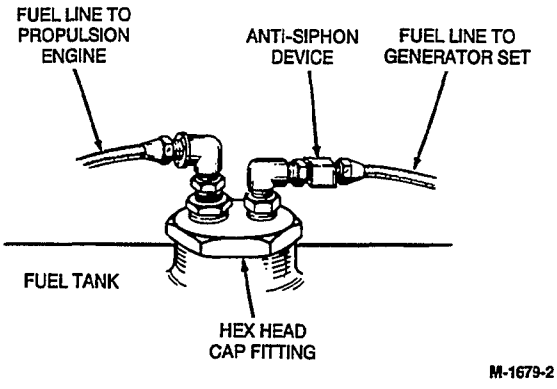

FIGURE 7-2. TWO FUEL LINES IN TANK FITTING

If the tank does not have an unused outlet, a new outlet can be installed. The metal tank must be removed to braze or weld a new outlet fitting. This procedure requires the service of a welder familiar with the essential safety measures.

⚠WARNING ***Ignition of fuel vapors can cause severe personal injury or death. Welding a fuel tank, empty or not, is extremely dangerous! Vapors can ignite causing an explosion and fire.***

Another consideration is the generator set fuel pump lift capacity. The vertical height must not exceed 4 feet (1.2 m), minus the requirement of an anti-siphon valve when used, or the generator set operation can be adversely affected.

FUEL TANKS

A valve must be installed directly at the tank connection to shut off fuel flow. This valve may be electrically or manually operated. If electrically operated, it must be energized only during engine operation, and have a manual override to comply with USCG regulations. This electric valve can be purchased from Onan and is listed in the parts manual.

The manual valve must have an arrangement for operating it outside the compartment in which the tank is located, preferable from above deck.

A USCG approved service shutoff valve must be installed at the engine end of the fuel line under conditions listed below. This valve stops fuel flow when the genset is serviced.

- When fuel tanks are located in a compartment other than the engine.
- When the engine and fuel tanks are separated more than 12 feet (3.7 m).

If the propulsion engines and generator set use different fuels, a separate fuel tank will be required. Use only an approved fuel tank designed for marine application. Be sure that the compartment is well ventilated (see *Ventilation System* section). Fuel consumption data in the *Specifications* section is useful for determining the tank size.

When installing a separate tank, locate it as close as possible to the generator set compartment. Be sure it is accessible and can be removed for inspection.

⚠CAUTION ***Fuel starvation can cause marginal operation of the generator set. Fiberglass fuel tanks can present a problem if the fuel pick-up tube is too close to the tank bottom. Fiberglass fibers can settle and form a mat with time. Make a diagonal cut on the bottom of the pick-up tube and install ½ to 2 inches (13 to 51 mm) from the tank bottom.***

Mount the fuel tank and secure into position. The NFPA recommends that flat bottom tanks be installed on slatted wooden platforms to help prevent moisture condensation. Cylindrical tanks should be set in chocks or cradles and securely fastened.

Small fuel tanks can be suspended from deck beams. Support and brace the tank to prevent any movement. Line up braces with the tank internal baffle plates. Insulate all wood or metal surfaces from the tank surface with a non-abrasive and non-absorbent material. Heavy rubber-impregnated cotton fabric or oil and acid-resistant plastics work well.

⚠WARNING ***Ignition of fuel when filling the tank can result in severe personal injury or death. All metallic fuel tanks MUST be electrically bonded to the boat common ground. Also bond the filler neck or opening to the tank if a hose is used between them. This helps prevent static spark when filling that can ignite the fuel.***

Position the tank fill and vent pipes so fuel or vapor cannot escape into the bilge. Run the vent and fill pipes from separate openings in the tank. If the fill pipe has a flexible section of fuel hose, install a separate grounding wire between the deck fuel plate and tank. Install the vent opening as far from any other hull opening as possible and with a gooseneck so water cannot enter. Install a flame arrester on the vent opening.

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FUEL LINES

The proper installation of fuel lines is very important. Give special attention to the following requirements.

- All fuel line materials must meet the requirements of both the USCG and the ABYC.
- Solid fuel lines must be seamless annealed, double-flared, and approved for marine installations.
- Run fuel lines at the top level of tank to a point as close to the engine as possible to reduce danger of fuel siphoning should the line break.
- Keep fuel lines away from hot engine or exhaust areas. This reduces chance of vapor lock.
- Any locked-in torsional stresses must be avoided in the fuel line.
- Install a flexible fuel line meeting USCG requirement 33CFR183.558, and stamped *"USCG TYPE A"* between the solid fuel line and engine to absorb vibration. The line length must be sufficient to prevent binding or stretching due to generator set movement.

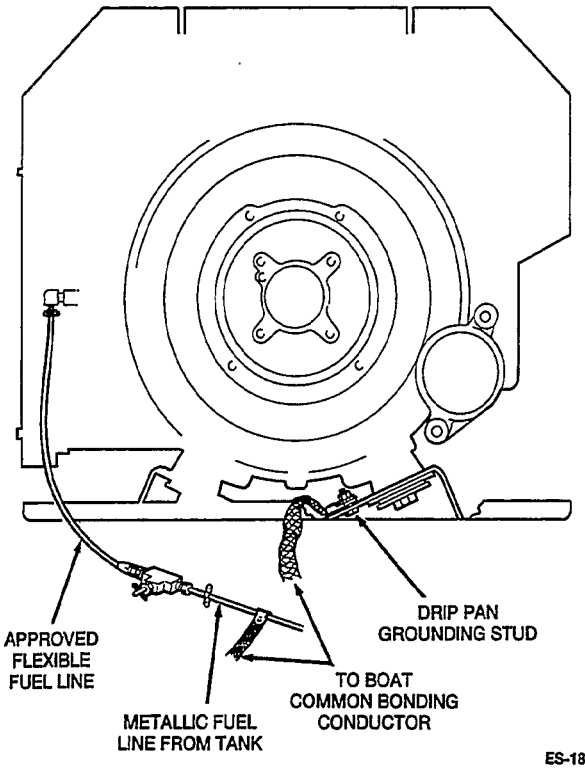

FIGURE 7-3. FUEL LINE BONDING

- Install fuel lines so they are accessible and protected from damage.
- Use non-ferrous metal straps without sharp edges to secure the fuel lines every 14 inches (355 mm).
- Electrically bond a metallic fuel line to the vessel with a suitable bonding strap. The drip pan must also be bonded to this same conductor as shown in Figure 7-3.

SIPHON PROTECTION

A carburetor float valve cannot be trusted to stop fuel flow if there is gravity feed from the fuel tank. When the tank is installed above the engine level an anti-siphon device is needed to prevent the fuel from emptying into the carburetor if the float valve doesn't close. It also prevents siphoning if the line breaks at a point below the fuel level.

Mandatory siphon protection must be provided by installing a U.S. Coast Guard approved anti-siphon device. See Figure 7-4. This device can be installed at the tank withdrawal fitting, or at a location where the line from the fuel tank will no longer remain above the fuel tank top level. The device can be either a mechanical check valve (1 ±0.5 psi [6.9 ±3.5 kPa]), or an electric valve with mechanical override. The electric valve must be connected so it operates only when the engine ignition is on.

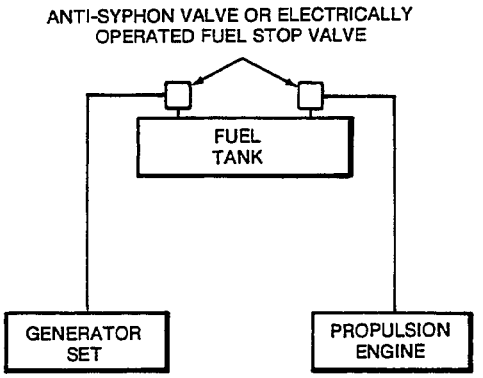

FIGURE 7-4. SIPHON PROTECTION

FUEL SYSTEM TEST

After installation, test the fuel system for tightness by pumping air into the tank to a pressure of 4 to 5 psi (28 to 35 kPa). Pressure must remain steady. If not, the leak must be found before putting the system into service.

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Section 8. Electrical System

GENERAL

All wiring must meet Coast Guard, NFPA, and all other applicable codes. Have all wiring installed by a qualified electrician. Onan wiring diagrams do not include components added by customers.

⚠WARNING ***Faulty electrical equipment can cause shock and severe personal injury or death. Use only approved power supply assemblies, and never remove the grounding pin from the power cord. Incorrect or no ground may cause the vessel to be electrically "hot".***

LOAD CONNECTIONS

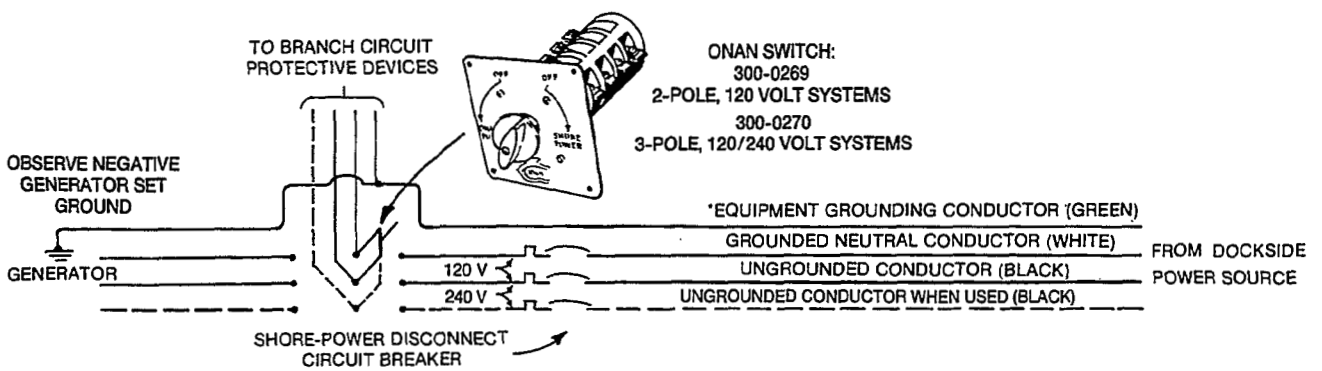
While at dock, most boats have a dockside connection for use of commercial power. These installations must have a transfer switch to isolate the generator set and the commercial power. The two power sources must never be connected together. A manual transfer switch is available from Onan for this function. See Figure 8-1.

⚠WARNING ***Ignition of explosive fumes can cause severe personal injury or death. The load transfer switch cannot be used in a gasoline fueled environment unless certified for such use. Separation by a bulkhead or deck is necessary.***

Use a section of flexible conduit at the generator set to absorb vibration. Flexible, multistrand wire must be used throughout to reduce the danger of breakage due to boat movement or vibration.

The generator set is available in either 120-volt (two-wire) or 120/240-volt (three-wire) as shown in Figures 8-2 and 8-3. The three-wire (120/240-volt) genset must have the 120-volt loads balanced across the two generator windings. Taking full load from only one winding can cause damage to the generator. A 240-volt load is connected across both windings.

The 120-volt genset will have a single-pole breaker; the 120/240-volt genset will have a two-pole breaker.



*Equipment ground is not part of generator wiring: must be customer installed if required.

FIGURE 8-1. TYPICAL MANUAL TRANSFER SWITCH CIRCUIT

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COMPONENT IDENTIFICATION

A11	PCB ASSY, ENGINE MONITOR
CB22	CIRCUIT BREAKER, LOAD
CR21	BRIDGE RECTIFIER
G21	GENERATOR, AC
T21	TRANSFORMER ASSY
TB1,2	STAND-OFF INSULATOR
RV21	SUPPRESSOR ASSY

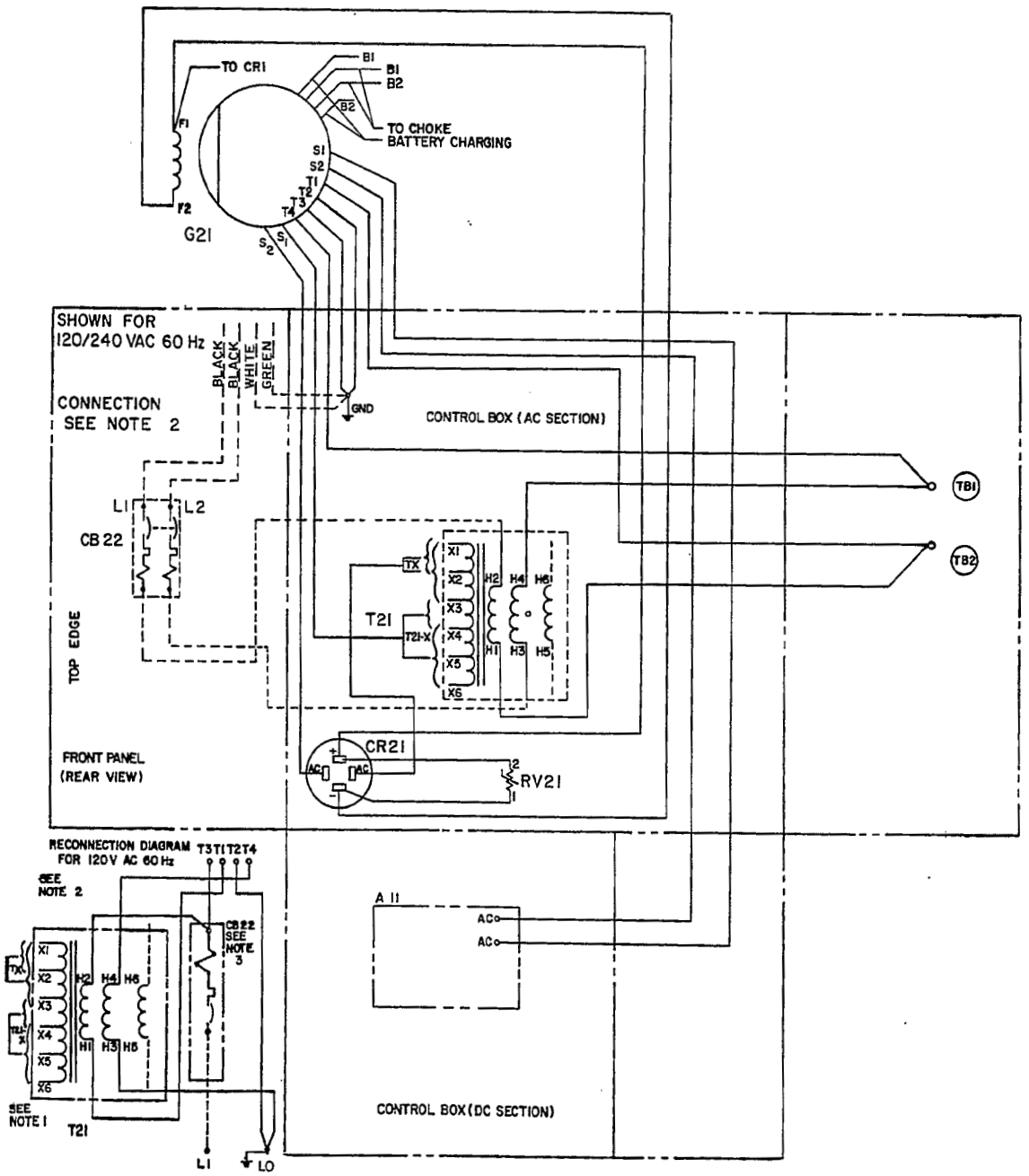

FIGURE 8-2. GENERATOR AC WIRING DIAGRAM

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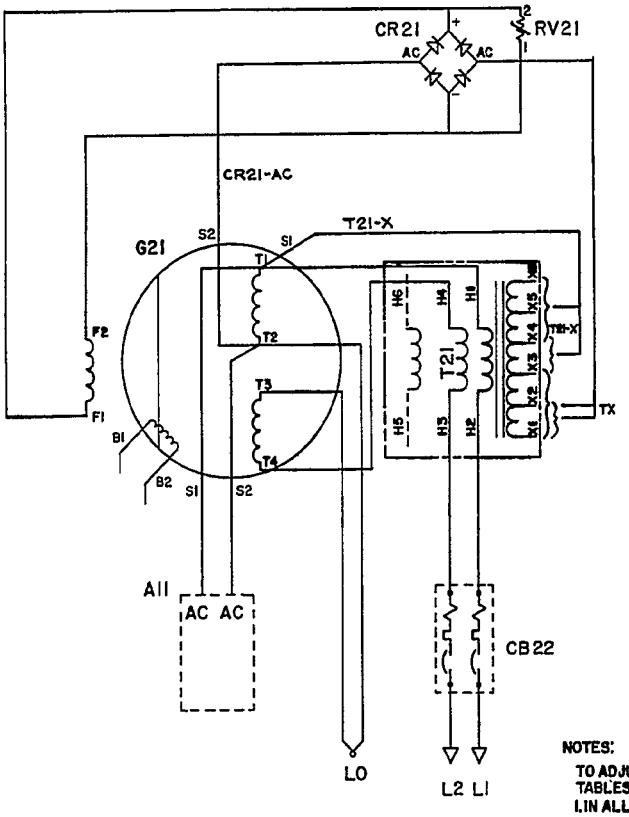
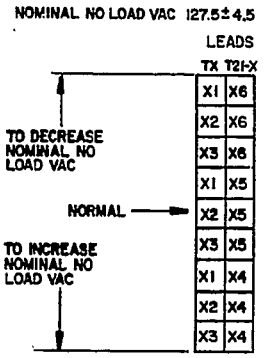
COMPONENT IDENTIFICATION

A11	PCB ASSY, ENGINE MONITOR
CB22	CIRCUIT BREAKER, LOAD
CR21	BRIDGE RECTIFIER
G21	GENERATOR, AC
T21	TRANSFORMER ASSY
TB1,2	STAND-OFF INSULATOR
RV21	SUPPRESSOR ASSY





NOTES:

TO ADJUST OUTPUT VOLTAGE, MOVE TAPS ON T21 ACCORDING TO TABLES.

1. IN ALL VOLTAGE CONNECTIONS LEAVE T1 AND T4 CONNECTED TO H1 AND H4 RESPECTIVELY.
2. FOR 60 Hz: USE TX LEAD ON TAPS X1-2 (4 TAPS) USE T1-X (FROM GEN) LEAD ON TAPS X3-4
3. IF CB22 IS NOT USED CONNECT LEADS DIRECTLY TO THE LOAD.
4. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN THE DE-ENERGIZED POSITION
5. DASHED LINES INDICATE WHEN USED

FIGURE 8-3. GENERATOR AC SCHEMATIC DIAGRAM

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REMOTE STARTING CONTROLS

Onan has control panel kits available for remote starting and stopping of the genset. The kits vary from a basic single-pole, double-throw, momentary-on switch on up to remote-gauge controls with running time meter, battery condition meter, and engine monitors. The kits come with installation instructions and wiring diagrams for connection.

The control panels are prewired and terminate with a plug connector. See Figure 8-4. Onan has prewired harness assemblies in 15, 25, and 45 foot lengths (4.6, 7.6, and 13.7 m) with plug connectors that connect to the generator set control box and the remote panel. Multiple remote stations are possible with parallel hard-wiring. The genset can be started and stopped from any station, including the set itself. Engine monitor gauges can be used on only one panel (generator set or remote).

If prewired harnesses are not used, number 16-gauge wire is acceptable if runs do not exceed 25 feet (7.6 m) between the remote switch and the genset. Use number 14-gauge wire for longer runs.

⚠CAUTION ***Interchanging connections other than shown on the generator set wiring diagrams can cause equipment damage.***

BATTERIES

General

Always use a battery at least as large as specified. The battery should be installed close to the generator set, preferably in a separate compartment. The compartment must be well ventilated to prevent accumulation of explosive battery gases.

Mount the battery in an acid resistant tray on a platform above the floor. It must be secured to prevent shifting. If mounted in an engine compartment, always install a non-metallic cover to prevent battery damage and arcing from accidentally dropped tools. Figure 8-5 shows a typical battery tray and cover.

Maintenance free batteries definitely should be considered for marine application. New technology of these batteries make them completely sealed and maintenance free. They usually offer higher output (CCA), better durability and vibration resistance than other equally priced batteries.

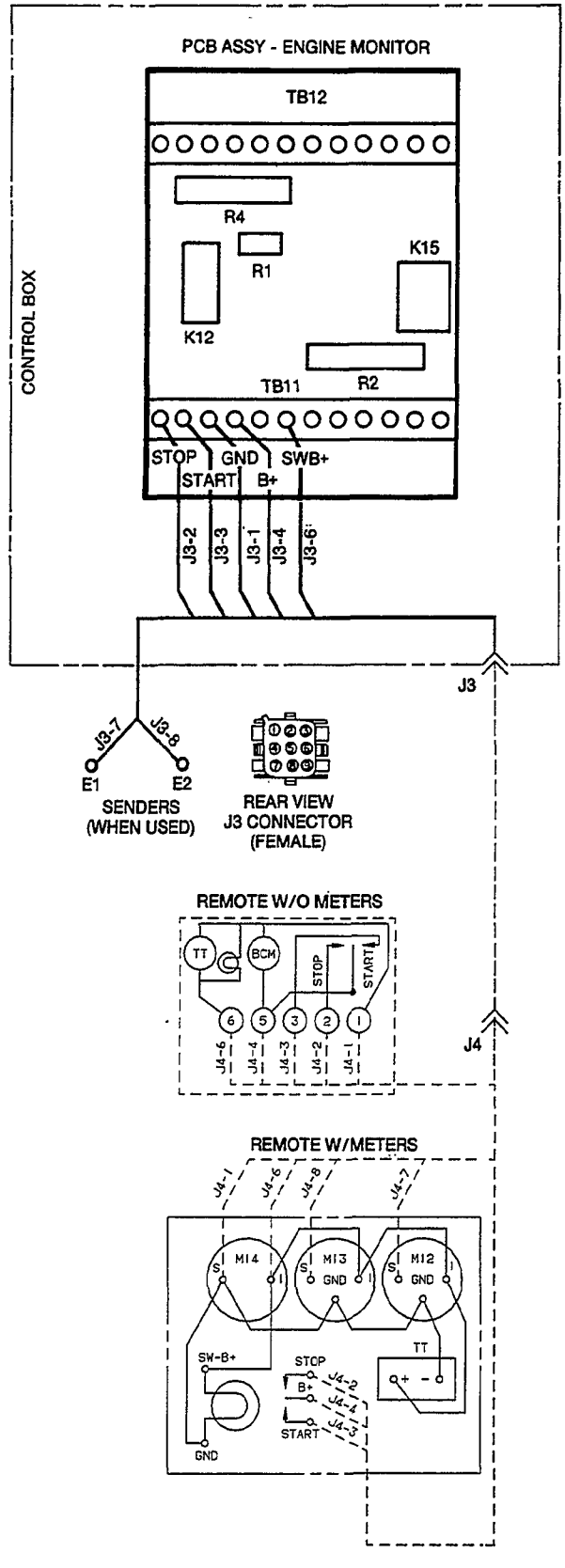

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FIGURE 8-4. REMOTE CONTROL CONNECTIONS

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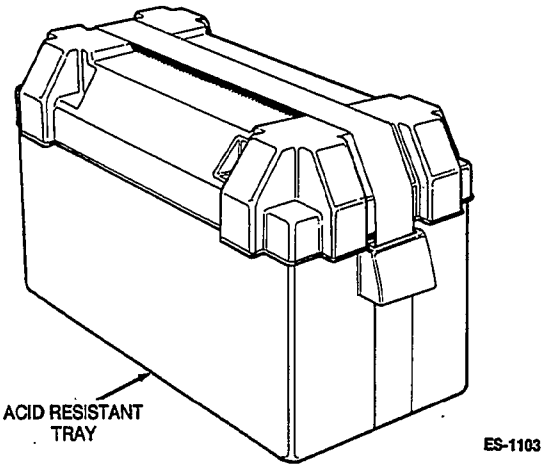

FIGURE 8-5. TYPICAL BATTERY TRAY AND COVER

⚠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.***

Connect the battery cables as shown in Figure 8-6. Use cable sizes specified in Table 8-1. Be sure the battery connections are clean and tight; then cover the battery terminals with a dielectric grease to retard corrosion.

Connect the battery negative lead to the generator set at the location shown in Figure 8-6. Failure to do so can cause arcing or resistance in the cranking circuit.

⚠WARNING ***The igntion of gasoline fuel or fumes can result in severe personal injury or death. Connect the generator set battery ground lead only at the location shown.***

TABLE 8-1. BATTERY CABLE SIZE REQUIREMENTS (Maximum Length of One Cable)

Cable Size	2	1	0	00	000	0000
Length	4 ft (1.2 m)	5 ft (1.5 m)	7 ft (2.1 m)	9 ft (2.7 m)	11 ft (3.4 m)	14 ft (4.3 m)

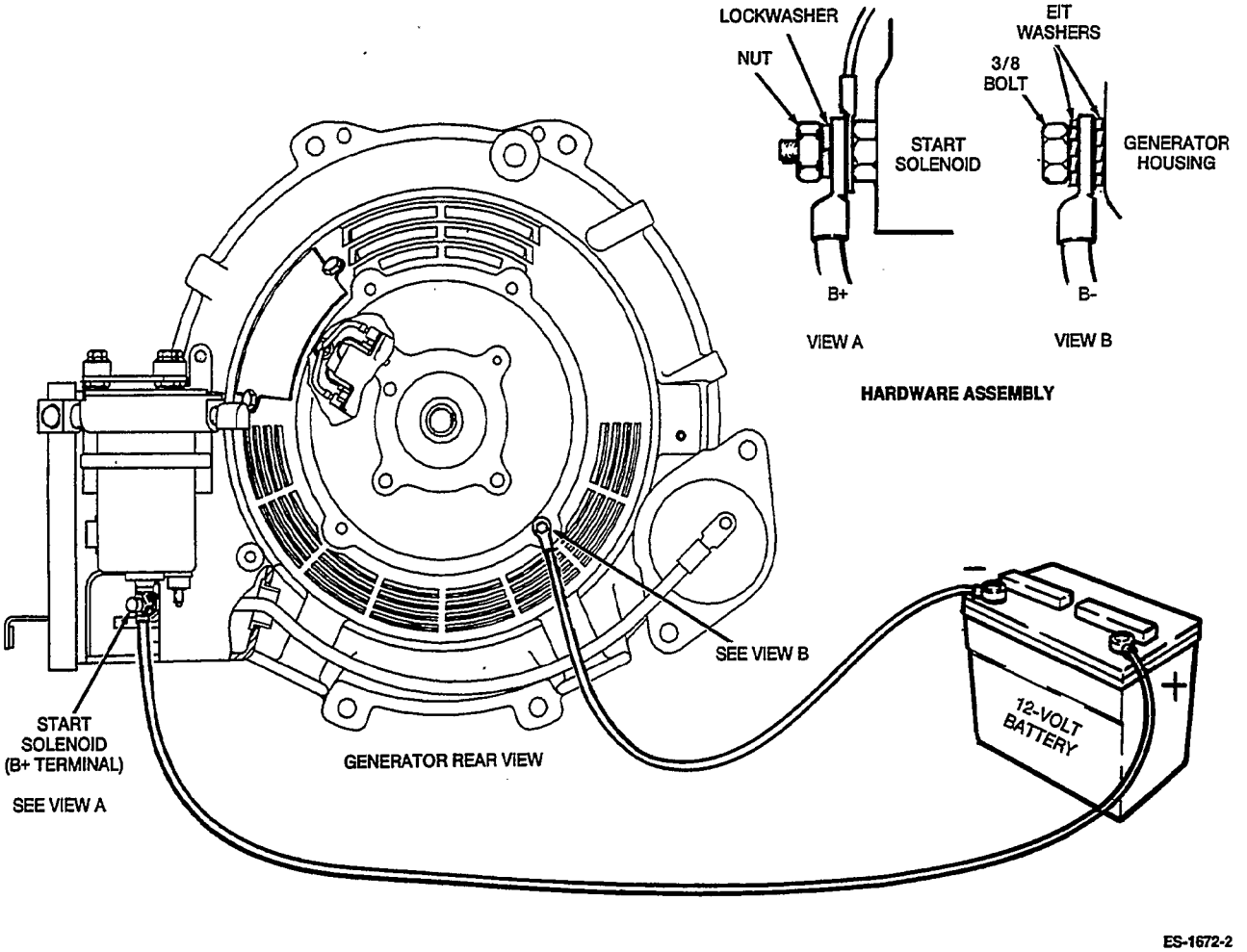

FIGURE 8-6. BATTERY CABLE CONNECTIONS

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Grounding

Onan marine generator sets require the batteries connected negative ground. Most propulsion engines and vessel electrical equipment have negative ground systems.

The generator set and propulsion engine/s must be grounded in accordance with USCG regulation 33CFR183.415. The regulation requires a common ground conductor connected between the generator set and propulsion engine cranking motor circuits. The conductor must be the same size as the largest battery cable. See Figure 8-7.

The conductor prevents accidental passage of cranking current through the fuel systems and smaller electrical conductors common to the engines. This can happen if a cranking motor ground circuit becomes resistive or opens from corrosion, vibration, bad cable, etc.

⚠WARNING ***Improper ground can cause severe personal injury or death from fire or explosion. Be sure to install a common ground conductor between all on board cranking circuits.***

Do not connect the battery negative lead to the generator set at a location other than shown in Figure 8-6.

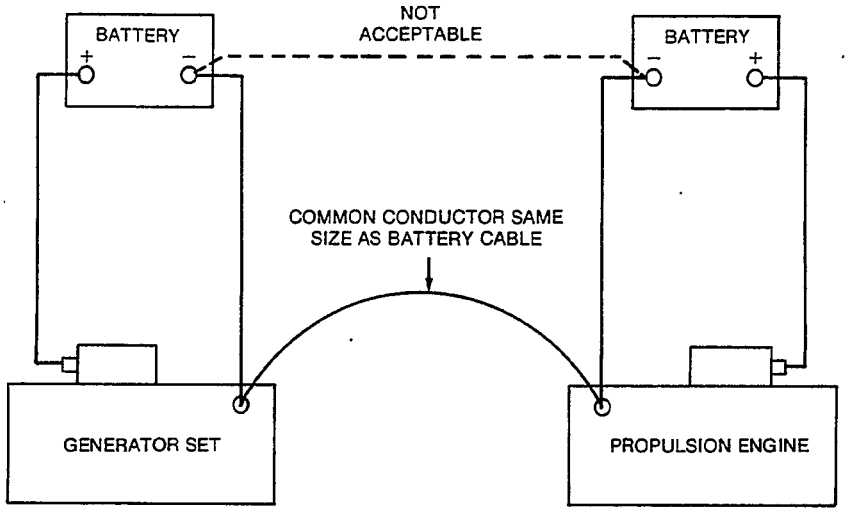

FIGURE 8-7. COMMON GROUND CONDUCTOR

Bonding

The generator set must be bonded to the vessel common bonding conductor with a bonding strap as shown in Figure 8-8. If a metallic fuel line is installed between the fuel tank and the generator set shutoff valve, it too must be bonded to the same vessel common conductor.

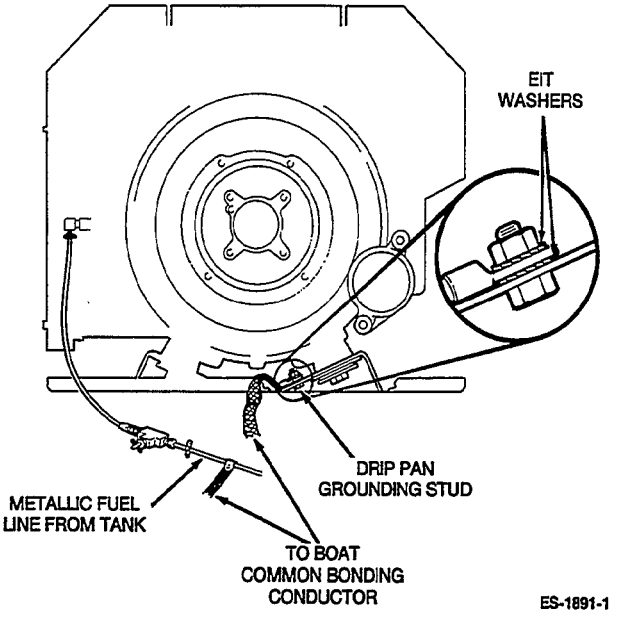

FIGURE 8-8. BONDING CONNECTIONS

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Section 9. Final Installation Checks

INSTALLATION CHECKS

Before trying to start the generator set, determine that the installation is complete by answering affirmatively the following questions:

- Is the exhaust system secure and all connections tight?
- Is a flexible section of exhaust hose used between the genset and muffler?
- Is all exhaust hose certified for marine exhaust application, and adequately supported and protected?
- Is the exhaust outlet terminated away from windows, vents or other openings that might allow exhaust gases to enter the vessel, or be pulled into the vessel when in motion?
- Does the fuel system have a flexible section at the generator set to allow for movement of the genset when the vessel pitches?
- Are the AC generator and load wires securely and correctly connected to the circuit breaker?
- Are the battery cables connected correctly and securely at the generator set and battery?
- Has crankcase oil and coolant been added to the engine, and are they at correct levels? See the *Maintenance* section of the Operator's Manual.

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

INITIAL STARTING AND CHECKS

Refer to the *Operator's Manual* before trying to start the generator set. Make sure the fuel shutoff valve and sea water cock are open. Operating the sea water pump without water will ruin the neoprene impeller.

⚠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 the source and correct prior to generator set operation.***

1. Start the genset by holding the Start/Stop switch in the Start position. The genset should start within a few seconds. If not, check fuel supply and shutoff valve/s.
2. Check the hull exhaust outlet for water flow and the genset operation. Monitor the remote control panel gauges (if equipped) for normal range of readings. Refer to *Operator's Manual* for proper values.
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 genset immediately and repair.

⚠WARNING ***Exhaust gas is deadly. For this reason, shut down the generator set immediately if an exhaust leak or exhaust component needs repair. Do not run the generator set until the exhaust system is repaired.***

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

Output frequency is determined by engine speed and normally does not require adjustment. Verify that frequency is correct before making any voltage adjustments. Call an authorized Onan distributor or dealer for assistance if needed.

If the voltage is not within specs, it can be adjusted for the generator connection used as shown in the Figure 8-3 table. Before making any adjustments, disable the genset by removing the negative (-) cable at the battery.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Disconnect the negative (-) battery cable before adjusting the regulator transformer taps.***

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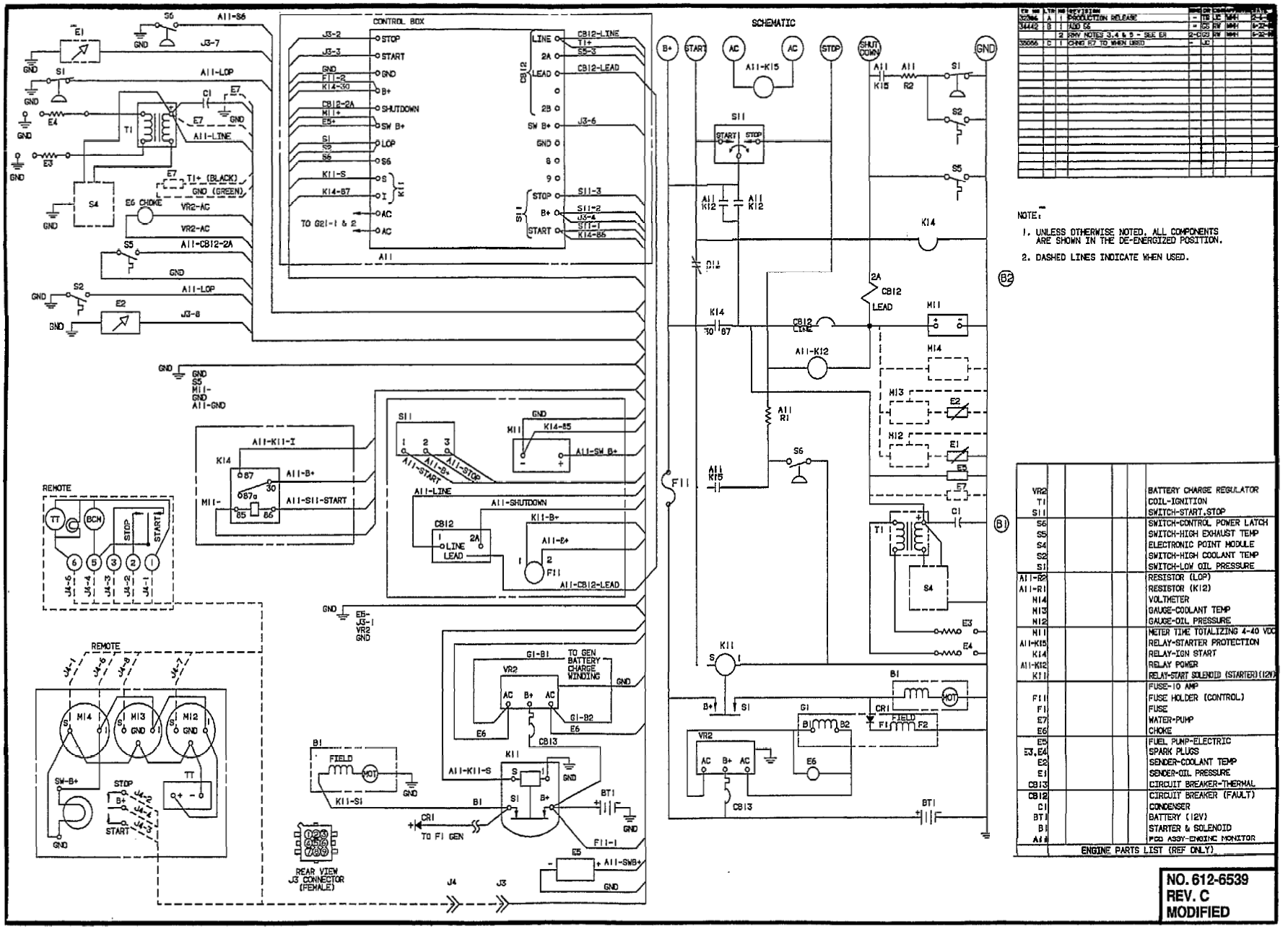
Section 10. DC Wiring Diagram

This section contains DC wiring diagram number 612–6539 for the MCE generator set. Use this diagram in conjunction with the wiring information in Section 8 of this manual to make the electrical connections necessary to operate the set.


CONTROL BOX
SCHEMATIC
REMOTE
REAR VIEW J3 CONNECTOR (FEMALE)
NOTE:
1. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN THE DE-ENERGIZED POSITION.
2. DASHED LINES INDICATE WHEN USED.
VR2 BATTERY CHARGE REGULATOR
T1 COIL-IGNITION
S11 SWITCH-START,STOP
S6 SWITCH-CONTROL POWER LATCH
S5 SWITCH-HIGH EXHAUST TEMP
S4 ELECTRONIC POINT MODULE
S2 SWITCH-HIGH COOLANT TEMP
S1 SWITCH-LOW OIL PRESSURE
A11-R2 RESISTOR (LOP)
A11-R1 RESISTOR (K12)
M14 VOLTMETER
M13 GAUGE-COOLANT TEMP
M12 GAUGE-OIL PRESSURE
M11 METER TIME TOTALIZING 4-40 VDC
A11-K15 RELAY-STARTER PROTECTION
K14 RELAY-IGN START
A11-K12 RELAY POWER
K11 RELAY-START SOLENOID (STARTER)(12V)
F11 FUSE-10 AMP
F1 FUSE HOLDER (CONTROL)
E7 FUSE
E6 WATER-PUMP
E5 CHOKE
E3,E4 FUEL PUMP-ELECTRIC
E2 SPARK PLUGS
E1 SENDER-COOLANT TEMP
CB13 SENDER-OIL PRESSURE
CB12 CIRCUIT BREAKER-THERMAL
C1 CIRCUIT BREAKER (FAULT)
BT1 CONDENSER
B1 BATTERY (12V)
A11 STARTER & SOLENOID
PCD ASSY-ENGINE MONITOR
ENGINE PARTS LIST (REF ONLY)
NO. 612-6539
REV. C
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