

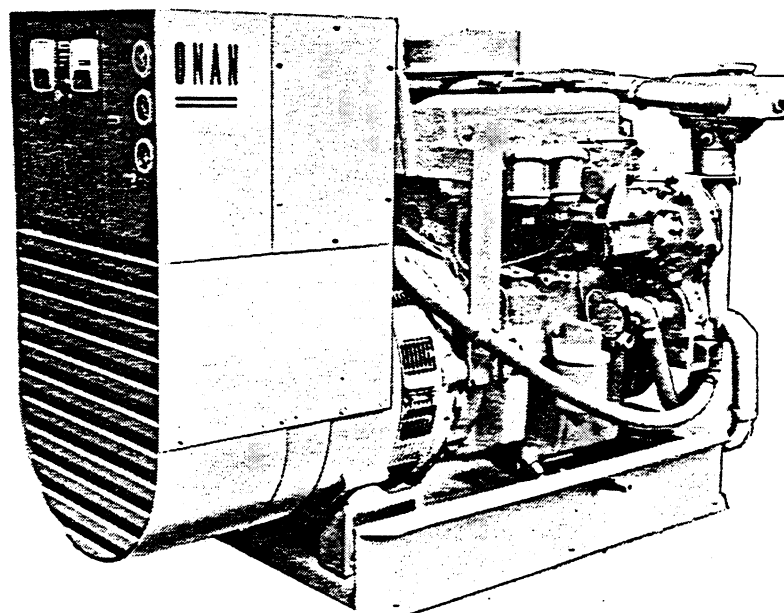
OPERATOR'S MANUAL

FOR

MDEH

SERIES

ELECTRIC GENERATING SETS



FORM NUMBER

976-0121

ISSUE DATE

9-77

(Spec H)

Printed in U.S.A.

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [-] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (-) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

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.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or 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.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocutation can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

MARINE SAFETY PRECAUTIONS

Throughout this manual you will notice Flags containing WARNINGS and CAUTIONS which alert you to conditions potentially dangerous to the operator, service personnel, or equipment if ignored!

WARNING

Onan uses this symbol throughout this manual to warn of possible personal injury.

CAUTION

This symbol refers to possible equipment damage.

Onan recommends that before you operate your marine generator set for the first time, you read the operator's manual to become thoroughly familiar with the unit. Safe and efficient operation can only be obtained if the unit is properly operated and maintained. Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards which can result in serious personal injury. Many accidents are caused by failure to follow simple, fundamental safety rules and precautions! KNOW THE EQUIPMENT, KNOW THE MANUAL AND OBSERVE ALL WARNINGS AND CAUTIONS.

General

- Keep your electric generating set and the surrounding area clean and free from obstructions. Remove any debris from set and keep the floor clean and dry.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult your local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the generating set are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- Do not wear loose clothing in the vicinity of moving parts, or jewelry while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts; cause shock or burning.
- If adjustment *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.
- Do not work on this equipment when mentally or physically fatigued.
- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Bleed the system pressure first.

Batteries

- DO NOT use salt water near lead acid batteries.

Protect Against Moving Parts

- Keep your hands away from moving parts.
- Before starting work on the generating set, disconnect batteries. This will prevent starting the set accidentally.

Cooling System

- Coolants under pressure have a boiling point higher than 212°. DON'T open a heat exchanger pressure cap while the engine is running. Always bleed off the system pressure first. Water pump and fan belts should be protected. DON'T remove guards or covers with unit running. If necessary for troubleshooting purposes, shut unit off, remove covers, then restart unit. Exercise caution while working on a unit running with protective covers removed.

Guard Against Electric Shock

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches.
- Use extreme caution when working on electrical components. High voltages cause injury or death. DON'T tamper with interlocks.

Exhaust Gases are Toxic

- Provide adequate ventilation (preferably power exhausters) to expel toxic fumes and fuel vapors from the engine compartment. Be sure exhaust system (both propulsion and generator engines) are FREE of leaks!
- Be sure the unit is well ventilated.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

Fuel System

- DO NOT fill fuel tanks while engine is running, unless tanks are outside engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME in the vicinity of the generator set or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

TABLE OF CONTENTS

TITLE	PAGE
General Safety Precautions	INSIDE FRONT COVER
Introduction	2
Specifications	3
Description	7
Installation	13
Operation	21
General Maintenance	26

WARNING

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

INTRODUCTION

FOREWORD

This manual is applicable to the MDEH Series electric generating set, consisting of an ONAN 30.0 kW, UR generator, driven by a Ford-Dorset, Diesel Engine.

The manual should be used in conjunction with the Ford engine manual, for specific engine information.

REMEMBER:

WARNING

Onan uses this symbol throughout this manual to warn of possible personal injury.

CAUTION

This symbol refers to possible equipment damage.

MODEL IDENTIFICATION

Identify your model by referring to the MODEL and SPECIFICATION NO. as shown on the Onan nameplate. Electrical characteristics are shown on the lower portion of the nameplate.

30.0	MDEH	15R	/	1	H
1	2	3		4	5

1. Indicates Kilowatt rating.
2. Factory code for SERIES identification.
3. 15 = 60 Hz Reconnectible
515 = 50 Hz Reconnectible
R—indicates remote starting feature.
4. Factory code for designating optional equipment.
5. Specification letter. (Advances when factory makes production modifications.)

When contacting a dealer or the factory regarding the set, always mention the complete Model, Spec No. and Serial No. as given on the Onan nameplate. This nameplate information is necessary to properly identify your unit among the many manufactured. Refer to the engine nameplate when requesting information from its manufacturer. The Onan nameplate is located on the right side of the generator; the Ford nameplate is on the upper left side, on flywheel housing.

Left side and right side are considered when viewed from the engine or front end of the generating set.

SPECIFICATIONS

ENGINE DETAILS

Engine Manufacturer	FORD
Engine Series	2711 E
Number of Cylinders	4
Displacement	254-cubic inches (4.16 litres)
BHP @ 1800 r/min	63 (47 kW)
Compression Ratio	16.0:1
Bore	4.22-inches (107.19 mm)
Stroke	4.52-inches (114.81 mm)
Fuel	ASTM No. 2 Diesel
Battery Voltage	12 Volt Negative Ground
Battery Group (Two 6-Volt, 135 A.H. [486 kC])	2H
Starting Method	Solenoid Shift
Governor Regulation	5% Maximum
Battery Charging Current	35-Ampere

GENERATOR DETAILS

Type	UR 15 60 Hz UR 515 50 Hz
General Marine Rating (Watts)	
60 Hertz	30 000 (37.5 kVA)
50 Hertz	25 000 (31.25 kVA)
AC Voltage Regulation	±2%
60 Hertz r/min	1800
50 Hertz r/min	1500
Output Rating	0.8 PF
AC Frequency Regulation	3 Hz Max. No Load to Full Load

CAPACITIES AND REQUIREMENTS

Cooling System (Including Heat Exchanger)	8.5 Quarts (8-litres)
Engine Oil Capacity (Filter, Lines, Crankcase)	9.5 Quarts (9.0-litres)
Exhaust Connection (inches pipe thread)	2 (Female)

AIR REQUIREMENTS (1800 r/min)

Engine Combustion	104-cfm (0.05 m ³ /s)
Total	1104-cfm (0.55 m ³ /s)
Alternator Cooling Air (1800 r/min)	1000-cfm (0.5 m ³ /s)
(1500 r/min)	833-cfm (0.4 m ³ /s)
Fuel Consumption at Rated Load ASTM No. 2 Diesel	2.6-gph (2.73 cm ³ /s)

GENERAL

Height	40.25-inches (1.02 m)
Width	28.0-inches (0.71 m)
Length	58.75-inches (1.49 m)
Approximate Weight (Mass) 1-Phase	1700-lbs (771.1 kg)
3-Phase	1575-lbs (714.4 kg)

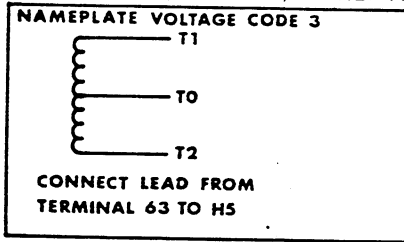
TABLE I. UR GENERATOR VOLTAGE/CURRENT OPTIONS

VOLTS	FREQ	PHASE	AMPERES	DOUBLE DELTA	SERIES DELTA	PARALLEL WYE	SERIES WYE	REF VOLTAGE WIRE (W12) TAP
110/220	50 Hz	1	142*	x				H6
115/230	50 Hz	1	136*	x				H6
120/240	60 Hz	1	156*	x				H5
110/190	50 Hz	3	95			x		H3
115/200	50 Hz	3	90			x		H4
120/208	50 Hz	3	87			x		H4
120/208	60 Hz	3	104			x		H3
110/220	50 Hz	3	82		x			H6
127/220	50 Hz	3	82			x		H5
127/220	60 Hz	3	98			x		H4
115/230	50 Hz	3	78		x			H6
120/240	60 Hz	3	90		x			H5
139/240	60 Hz	3	90			x		H5
220/380	50 Hz	3	47				x	H3
230/400	50 Hz	3	45				x	H4
240/416	50 Hz	3	43				x	H4
240/416	60 Hz	3	52				x	H3
254/440	50 Hz	3	41				x	H5
254/440	60 Hz	3	49				x	H4
277/480	60 Hz	3	45				x	H5
9X 347/600	60 Hz	3	36					H5—Not Reconnectible
3 120/240	60 Hz	1	156					H5—Not Reconnectible

30 kW 37.5 kVA 60 Hz
25 kW 31.25 kVA 50 Hz

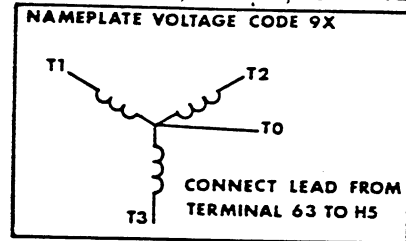
* - These current values are available only from special long stack units (B125 option). When standard 3 phase unit is connected into Double Delta configuration, maximum current is 2/3 that of value given.

120/240 VOLT, 1 PHASE, 60 HERTZ



+

347/600 VOLT, 3 PHASE, 60 HERTZ



THIS DIAGRAM APPLIES TO 12 LEAD GENERATORS ONLY

NAMEPLATE VOLTAGE CODE					VOLTAGE	PHASES	HERTZ	CONNECT LEAD FROM TERMINAL 63 TO:	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM (WITH CURRENT TRANSFORMERS WHEN USED)
15	120/240	1	60	H5	DOUBLE DELTA						
515	115/230	1	50	H6							
	110/220	1	50	H6							
15	120/240	3	60	H5	SERIES DELTA						
515	115/230	3	50	H6							
	110/220	3	50	H6							
15	120/208	3	60	H3	PARALLEL WYE						
	127/220	3	60	H4							
	139/240	3	60	H5							
515	110/190	3	50	H3							
	115/200	3	50	H4							
	120/208	3	50	H4	SERIES WYE						
15	240/416	3	60	H3							
	254/440	3	60	H4							
	277/480	3	60	H5							
515	220/380	3	50	H3							
	230/400	3	50	H4							
	240/416	3	50	H4							
	254/440	3	50	H5							

98C2193

FIGURE 1. GENERATOR RECONNECTIONS

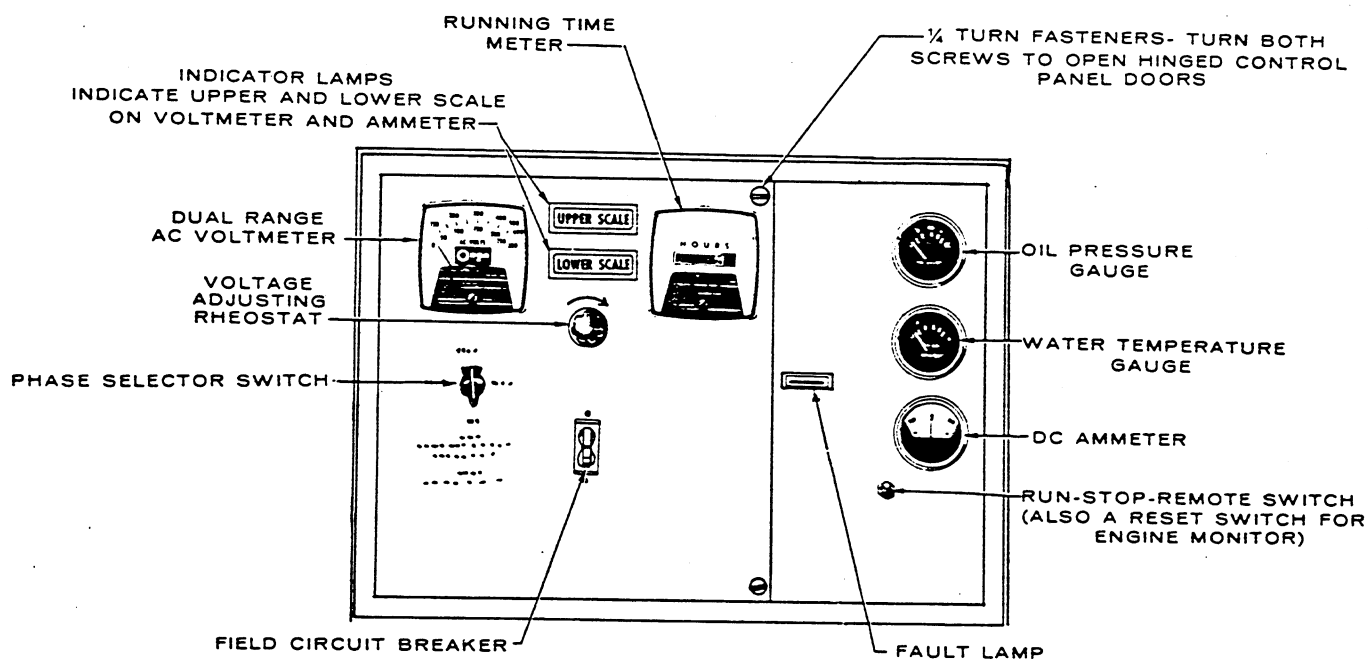


FIGURE 2. TYPICAL CONTROL PANEL (ONE FAULT LAMP)

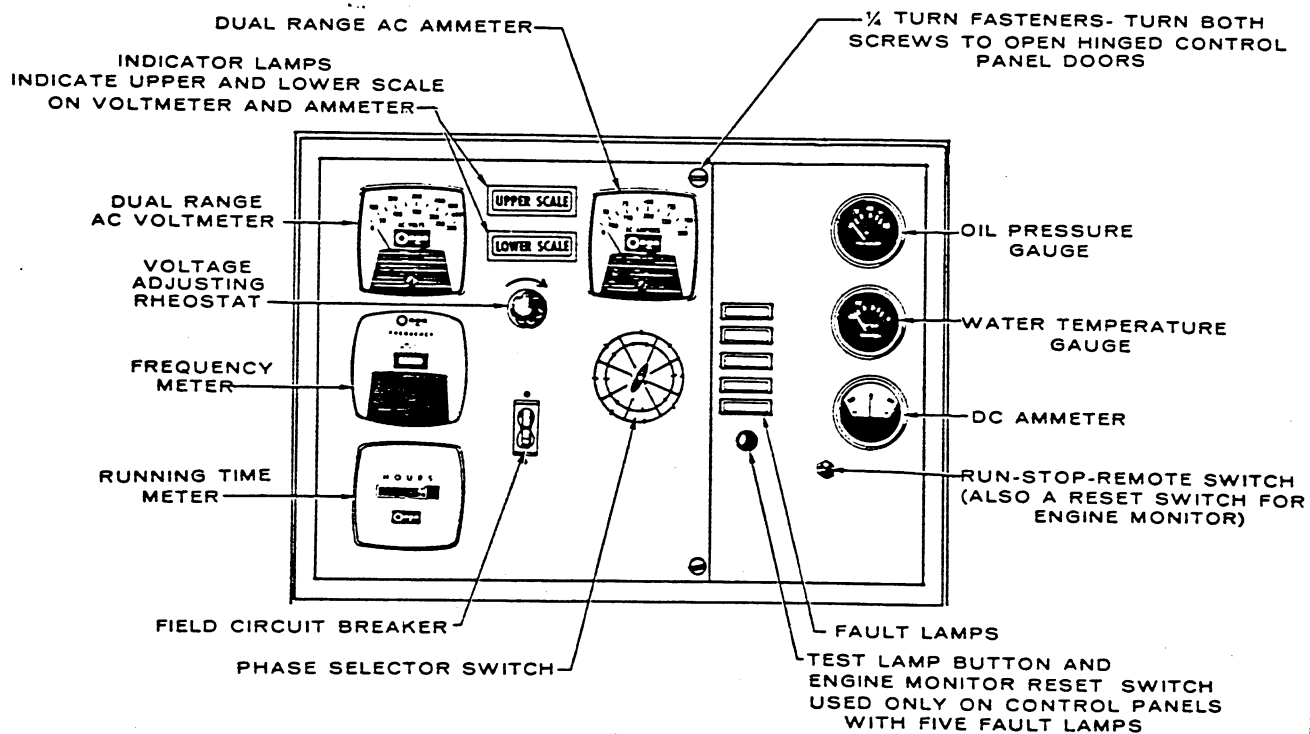


FIGURE 3. OPTIONAL CONTROL PANEL (FIVE FAULT LAMPS)

DESCRIPTION

GENERAL

An Onan MDEH Series electric generating set is a complete unit consisting of an engine driven AC generator, with standard and optional controls and accessories as ordered.

ENGINE

The engine on the MDEH is a Ford-Dorset 2711E as described in the engine manual. Basic measurements and requirements will be found under *SPECIFICATIONS*. For operation, maintenance and service information, consult the Ford-Dorset manual.

AC GENERATOR

The generator is an ONAN Type UR, 12 lead, 4-pole revolving field, reconnectable, brushless unit. The main rotor is attached directly to the engine flywheel, therefore engine speed determines generator output frequency. The 60 Hz set operates at 1800 r/min, the 50 Hz at 1500 r/min. Excitation is achieved as follows—

Residual alternating current from the stator winding is applied to the voltage regulator, where it is compared with a reference voltage, rectified and returned to the field winding of the exciter. Current then induced in the exciter rotor is rectified and fed into the generator rotor. This induces a current in generator stator which is applied to the load.

CONTROL PANEL

The following is a brief description of each of the standard controls and instruments located on the face of the panel. See Figure 2.

DC Panel

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

Water Temperature Gauge: Indicates temperature of circulating coolant in engine. (Wired to a sensor unit located on the engine.)

Battery Charge Rate DC Ammeter: Indicates battery charging current.

Run-Stop/Reset-Remote Switch: Starts and stops the unit locally or from a remote location. Resets engine monitor relay in Stop/Reset position.

Warning Light: Indicates "Fault" in engine operation.

AC Panel

AC Voltmeter: Indicates AC generator output voltage. Dual range instrument: measurement range in use shown on indicator light.

Voltage Regulator: Rheostat, provides approximately plus or minus 5% adjustment of the rated output voltage.

Exciter Circuit Breaker: Provides generator exciter and regulator protection from overheating, in the event of certain failure modes of the generator, exciter and voltage regulator.

Running Time Meter: Registers the total number of hours, to 1/10th, that the unit has run. Use it to keep a record for periodic servicing. Time is accumulative, meter cannot be reset.

Voltmeter Phase Selector Switch: Selects phases of generator output to be measured by the AC voltmeter.

OPTIONAL EQUIPMENT

DC Panel

Warning Lights: Eliminates the one "Fault" light and substitutes five indicator (see Figure 3) lights to give warning of—

- a. Overcrank
- b. Overspeed
- c. Low oil pressure
- d. High engine temperature
- e. Low engine temperature

Operation of these lights will be discussed in conjunction with engine monitor panel.

Reset Switch: Manual reset for engine monitor after shut-down (five light system engine monitor).

Lamp Test: Press to test warning lamp bulbs (when engine is running only).

AC Panel

AC Ammeter: Indicates AC generator output current. Dual range in use shown on indicator lights.

Frequency Meter: Indicates the frequency of the generator output in hertz. It can be used to check engine speed. (Each hertz equals 30 r/min.)

CONTROL PANEL INTERIOR

Discussed below is equipment which the operator may have reason to adjust or inspect for service.

Terminal Board (TB) 21: Connection of wire W12 to terminals H3, H4, H5, and H6 is made at this point, to change reference voltage when reconnecting generator for different voltages. Refer to Figure 1.

Voltage Regulator: Begin Spec G. Solid state unit, consisting of printed circuit board VR21, an SCR bridge CR21, with a commutating reactor L21 are located in the control panel as part of the voltage regulator system. AC output from generator is controlled at predetermined level regardless of load; regulation is plus or minus 2% from no load to full load, at 0.8 PF.

Engine Monitor: Printed circuit plug-in modules provide the following functions:

1. A 75 second cranking period.
2. Approximately a 12.5-second time delay for oil pressure buildup.
3. An external alarm contact to light a fault lamp and shut down the set for alarm conditions such as:
 - a. Overcrank (failed to start after cranking 75 seconds).

- b. Overspeed (engine speed reaches 2100 r/min).
- c. Low oil pressure 14 psi (96.5 kPa).
- d. High engine temperature 215° F (102° C).

On standard control panels, all four alarms are wired into one common fault lamp; on units with five fault lamps, four have shutdown alarms, the fifth (low engine temperature) lights a fault lamp only. Refer to Table 2.

Standard Cranking Module: Limits engine cranking time to 75 seconds. If engine fails to start after 75 seconds the engine monitor lights a fault lamp and opens the cranking circuit.

OPTIONAL MODULES

Cycle Cranker: Plug-in module replaces standard cranking circuit. Automatically provides a 15-second crank time and a 10-second rest time for three ON and two OFF cycles in 65 seconds. If engine fails to start, after 75 seconds the engine monitor lights a fault lamp and opens the cranking circuit. The ON and OFF cycle times are nominal and can be adjusted at potentiometers on the cranker module board.

Pre-Alarm: Gives advance warning for low oil pressure or high engine temperature. Requires two sensors each for engine temperature and oil pressure.

VR21
VOLTAGE REGULATOR
PRINTED CIRCUIT BOARD

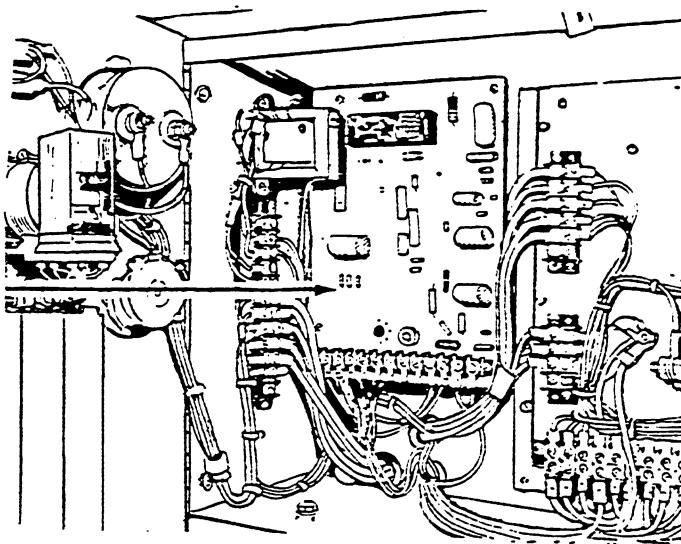


FIGURE 4. VOLTAGE REGULATOR PRINTED CIRCUIT BOARD LOCATION

TABLE 2. FAULT LAMP OPTIONS

SYSTEM	FAULT	FAULT LAMP	STOP ENGINE	EXTERNAL ALARM	PRE-ALARM
STANDARD SINGLE LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
5 LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
	Low Engine Temperature	x			
5 LIGHT PRE-ALARM	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	*	x	
	High Engine Temperature	x	*	x	x
	Low Engine Temperature	x			x

* - With additional optional sensors.

ENGINE SENSORS

Resistance units and switches in the engine temperature and oil pressure monitoring and shut-down systems are sealed units and are not repairable.

For location, refer to Figures 5 and 6. When replacing a sensor, do not substitute, use recommended items. Resistance units are matched to the gauge they supply, and cut-off switches are close-tolerance actuation parts, made for a specific application.

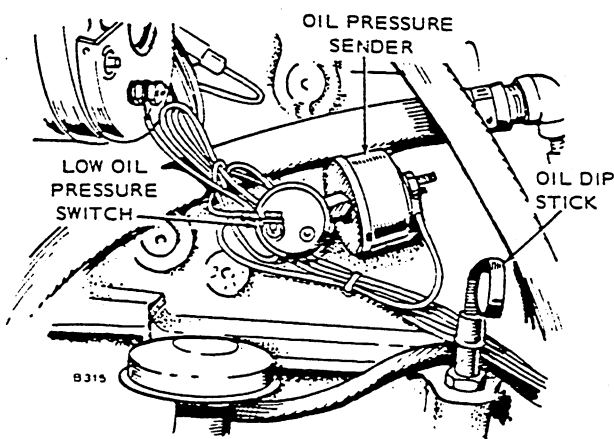


FIGURE 5. OIL PRESSURE MONITORS

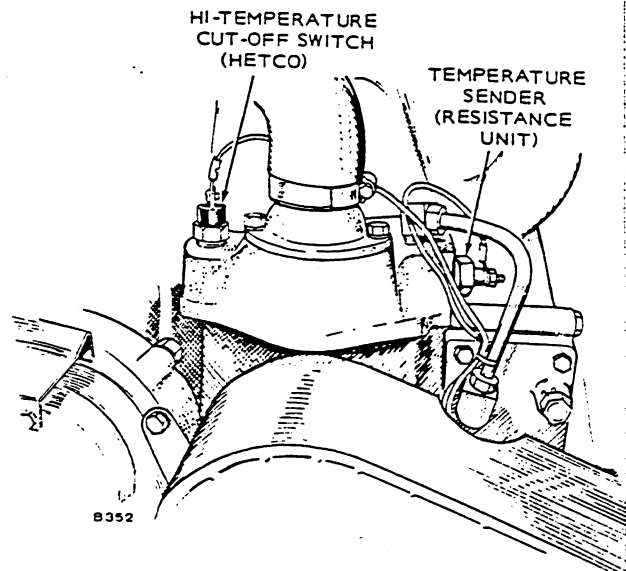


FIGURE 6. ENGINE TEMPERATURE MONITORS

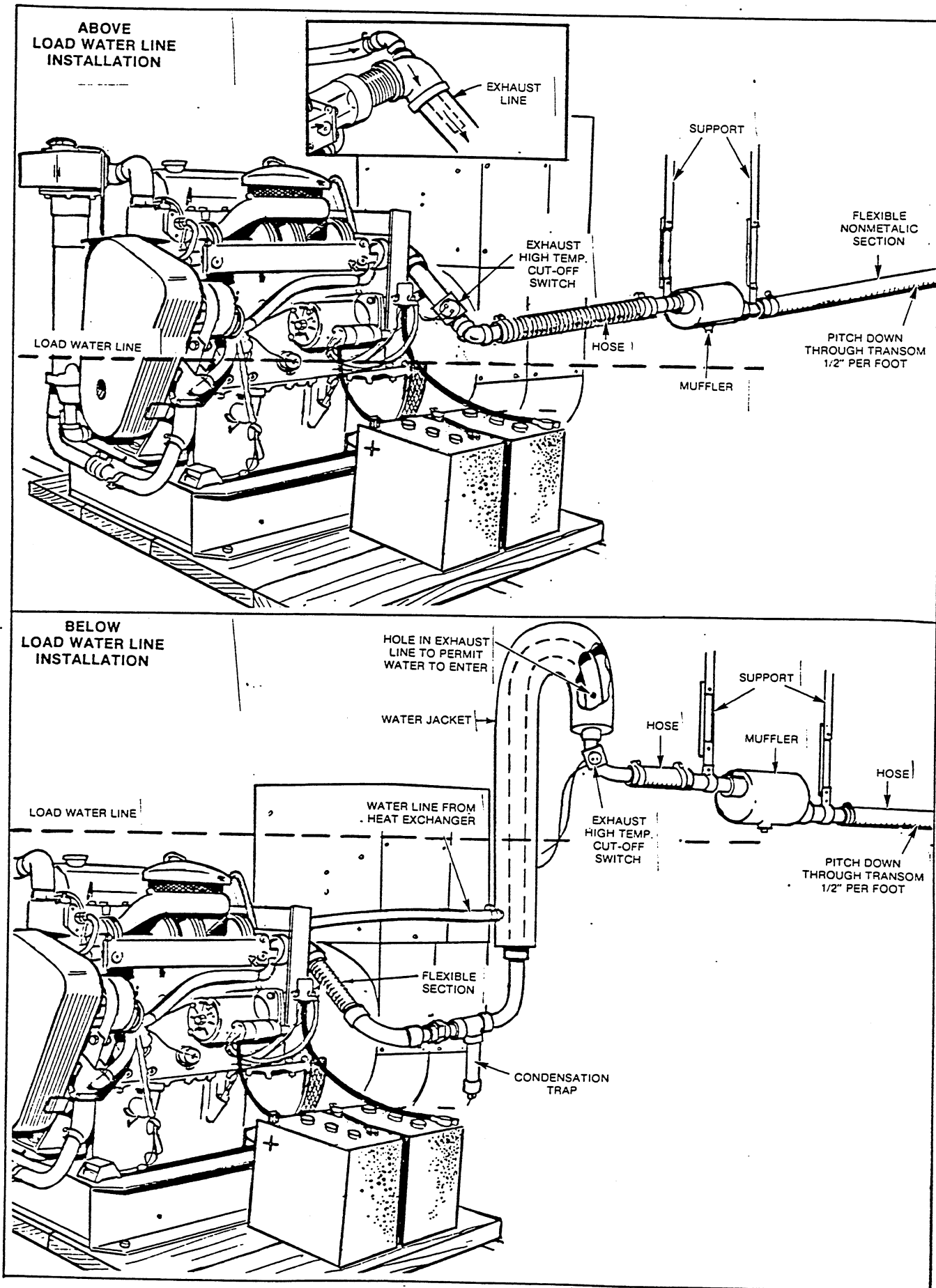


FIGURE 7. TYPICAL MDEH INSTALLATION

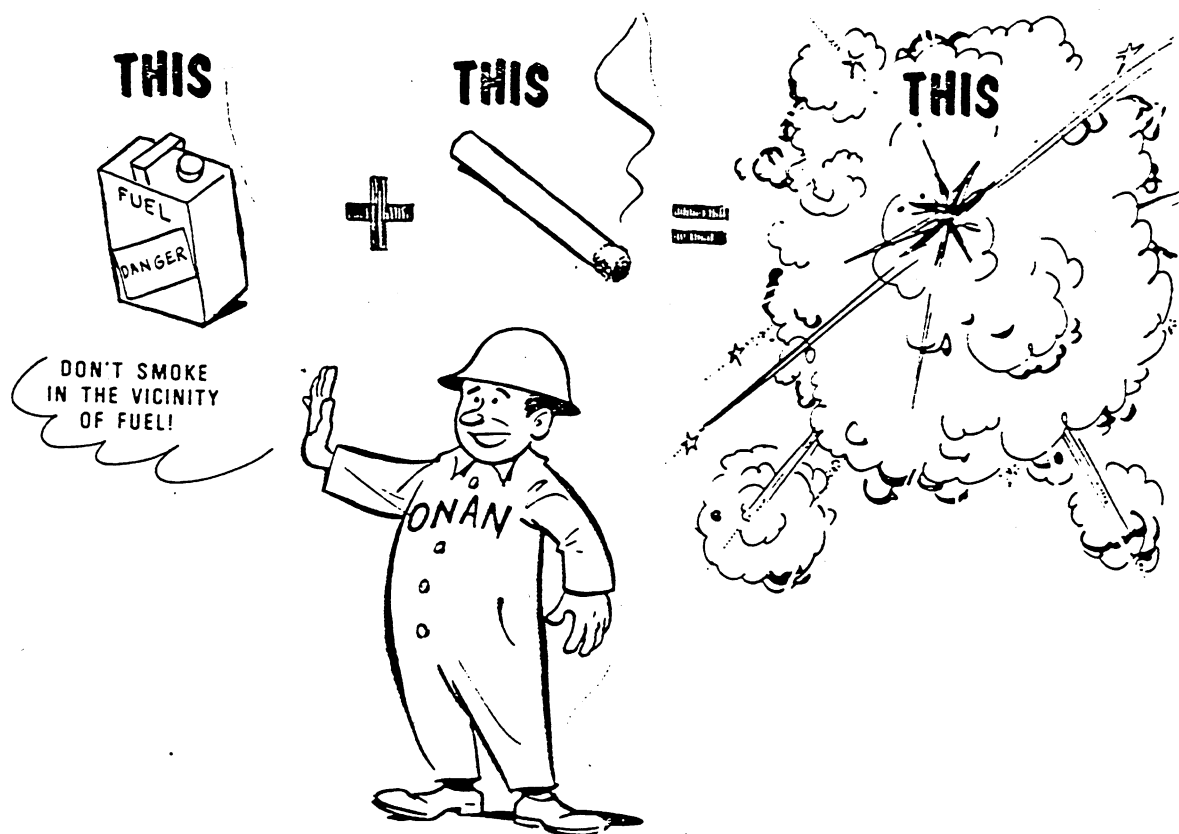
FLAMMABLE LIQUIDS

Carelessness is a deadly habit when handling electric generating sets.

The ingredients of an explosion are simple—a combustible mixture and a means of igniting it. Marine internal combustion engines operate on gasoline and diesel oil fuel. Liquid fuels alone will not burn. Air has to be mixed with the fuel so that it reaches what is called a "fume state." Only then will a liquid fuel ignite. So it is good to remember that—

IF YOU CAN SMELL FUMES, YOU HAVE HALF THE INGREDIENTS FOR AN EXPLOSION.

Remember, all that is needed is a way of igniting the fumes. Faulty engine-ignition insulation, arcing relays or brushes, welding, dropping a steel wrench on a concrete floor, and of course a cigarette.



The following example is a very real possibility: A loose connection in a fuel line, or dirt in a solenoid valve allows fuel vapors to escape.

An operator smoking a cigarette is in the vicinity of the escaping fuel. Coal at the cigarette end has a temperature of 1000° F, and rises up to 1175° F (538° C to 635° C) when air is drawn through it. That coal is hot enough to ignite a fuel vapor mixture.

Could the explosion have been prevented? The answer is obviously "yes." This accident happened because a *Planned Maintenance Program* was either non-existent, or was not being followed. Most accidents happen because some individual does not follow the simple fundamental rules of safety.

MOST ACCIDENTS CAN BE PREVENTED!

MARINE EXHAUST SYSTEM SAFETY TIPS

WARNING

Exhaust fumes are noxious. Inhalation can cause death. Don't take chances; have your marine exhaust system installed by a trained professional.

Carbon monoxide (CO) is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Because of the dangers presented by escaping carbon monoxide the design, installation and maintenance of marine exhaust systems is extremely important. Marine exhaust systems must meet or exceed the following requirements:

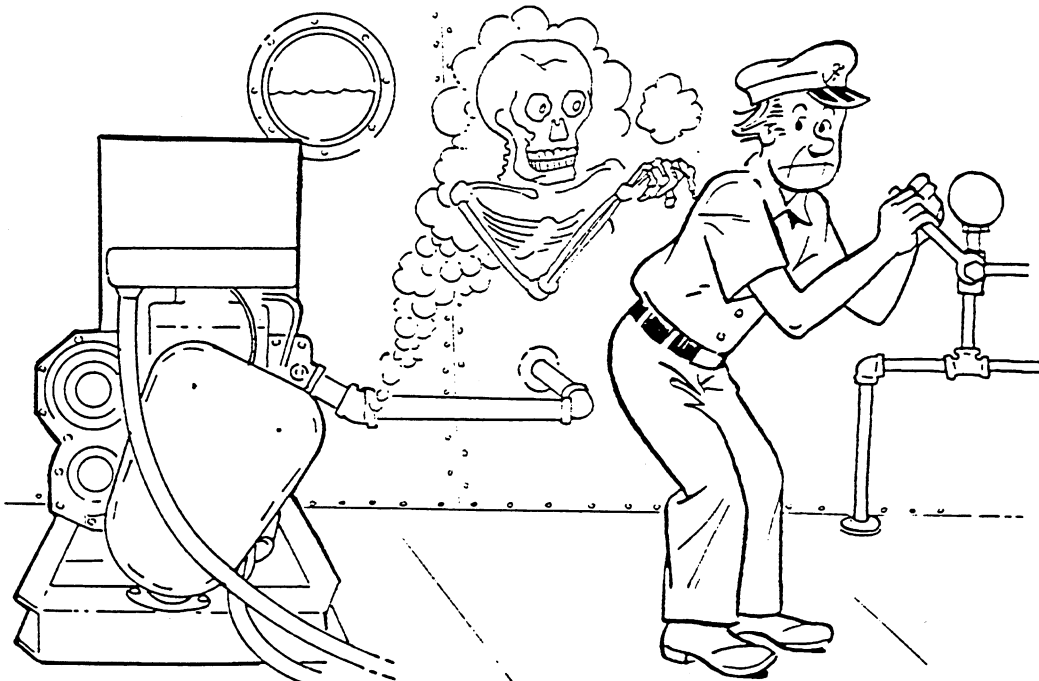
1. Except for vertical dry stack systems, exhaust systems *must* be water cooled, the water to be injected as near to the generating set as possible.
2. All exhaust system sections preceding the point of cooling water injection *must* be either water jacketed or effectively insulated.
3. The exhaust line *must* be installed to prevent back flow of water to the engine under any conditions, and the exhaust outlet *must* be above the load waterline. Water flowing back to the engine will damage it.

4. The generator set's exhaust system *must* not be combined with the exhaust system of any other engine.
5. An approved, flexible, non-metallic exhaust line section should be used near the engine to allow for engine movement and vibration during operation.
6. Vertical dry stack exhaust systems *must* have spark arrestors. The exhaust system between engine manifold and spark arrestor *must* be either water jacketed or well insulated.

WARNING

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

To prevent vibration from transmitting to hull, use automotive type tail pipe hangers. Use flexible rubber hose for the water cooled section of the exhaust line because of the ease of installation and flexibility. Be sure the rubber hose used is designed and approved for exhaust line use, such as heavy duty single braid reinforced rubber hose. Provide adequate support for rubber hose to prevent sagging, bending and formation of water pockets.



EXHAUST FUMES KILL!

INSTALLATION

GENERAL

Each installation must be considered on an individual basis. These instructions should be used only as a guide.

Requirements to examine should include—

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

LOCATION

Set location should preferably be 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.

MOUNTING

The mounting base should be flat and provide support directly under the set mounting points. The unit will rock on its mounts therefore a three-inch (75 mm) clearance is required on all sides to allow free movement.

Maximum operation angle is 18° in any direction.

Use flexible exhaust line, fuel line, battery cables and electrical wiring conduit.

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 1½- 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 SYSTEMS

Exhaust systems *must* meet these requirements:

1. Except for vertical dry stack systems, exhaust systems *must* be water cooled, the water to be injected as near to the generating 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 to prevent back flow of water to the engine under any conditions, and the exhaust outlet *must* be above the load waterline. Water flowing back to the engine will damage it.
4. The generator set's exhaust system *must* not be combined with the exhaust system of any other engine.
5. An approved, flexible, non-metallic exhaust line section should be used near the engine to allow for engine movement and vibration during operation.
6. Vertical dry stack exhaust systems *must* have spark arrestors. The exhaust system between engine manifold and spark arrestor *must* be either water jacketed or well insulated.

WARNING

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

To prevent vibration from transmitting to hull, use automotive type tail pipe hangers. Use flexible rubber hose for the water cooled section of the exhaust line because of the ease of installation and flexibility. Be sure the rubber hose used is designed and approved for exhaust line use, such as heavy duty single braid reinforced rubber hose. Provide adequate support for rubber hose to prevent sagging, bending and formation of water pockets.

MATERIAL

Either cast iron or wrought iron piping is recommended for exhaust lines. Use exhaust line at least as large as the engine (2-inch [50 mm]) exhaust outlet. The flexible section of the exhaust line should be installed between the engine and muffler (Figure 7). Do not connect the muffler directly to the exhaust manifold.

Use rubber hose only in the water-cooled sections of the exhaust system. Do not install rubber hose with sharp bends as this will reduce efficiency and may cause hose failure. Metallic flexible line is not recommended except in below water line or dry pipe installations. When using metallic flexible exhaust line, install in straight lengths only.

Maximum exhaust back pressure is 20.4-inches H₂O (5.1 kPa).

EXHAUST COOLING WATER INJECTION

Cool the exhaust with the full electric generating set cooling system water output. If a keel cooler is used (no water output) and other than dry stack is required, install a separate hull water inlet and use the engine-mounted neoprene impeller pump to provide exhaust cooling water. When installing a separate system to cool the exhaust, a device is required to indicate if the system fails. Mount a temperature operated switch on the exhaust line and connect it to operate either an alarm or a unit shut down switch if the exhaust overheats (approximately 200°F). Onan recommends high-temperature exhaust shutdown switches for all types of marine installations.

An important consideration of water injection 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. In most cases, the exhaust line cannot be installed with enough downward pitch to prevent it from tilting toward the electric generating set when the boat pitches, so a baffle of some type *must* be included in the exhaust line to prevent water from pouring into the engine.

REFERENCE DOCUMENTS

T-021 Installation of ONAN Marine Electric Generating Sets

Fire Protection Standard for Motor Craft (NFPA 302)
60 Batterymarch Street
Boston, MA 02110 (75¢)

US Coast Guard Regulations
Superintendent of Documents
US Government Printing Office
Washington D.C. 20402

American Boat & Yacht Council
Safety Standards for Small Craft
15 East 26th Street, Room 1603
New York NY 10010

COOLING

Two cooling systems in general use are (a) Heat Exchanger (Figure 8), standard on MDEH marine electric sets, and (b) Keel Cooling (Figure 9), an optional installation.

Water recirculated through a closed engine system is termed 'captive' coolant. Water drawn into the vessel for heat withdrawal is called 'raw' water.

For Heat Exchanger Cooling, two engine driven pumps are necessary for the operation of this system. Refer to Figure 8 for engine components and cooling water circuit. Raw water pump circulates water through a filter and heat exchanger, then discharges it through the exhaust line.

CAUTION

CAUTION Use neoprene impeller pump for raw water circulation. Neoprene is impervious to salt water or contaminated fresh water. It can however be damaged by heat and sand or silt.

Captive coolant pump circulates coolant through engine block and heat exchanger where it is cooled by raw water flowing through the water jacket.

CAUTION

CAUTION Use metal impeller pump for captive coolant circulation. Metal impeller is impervious to antifreeze and rust inhibitors, and will not be damaged by heat.

Fill captive coolant system with clean alkali-free water and antifreeze (if so required) with rust inhibitor to the proper level in the expansion tank.

KEEL COOLING

A marine electric set is often required to operate at heavy loads when the vessel is not moving, therefore a larger capacity keel cooler is needed than that necessary for an equal sized propulsion engine. A keel cooler manufacturer should be consulted and a system sized for the marine set capacity and application installed. The keel cooler should properly cool the set at full load when the vessel is not underway, at the maximum flotation water temperature the vessel will ever encounter. Refer to Figure 9 for typical keel cooler installation.

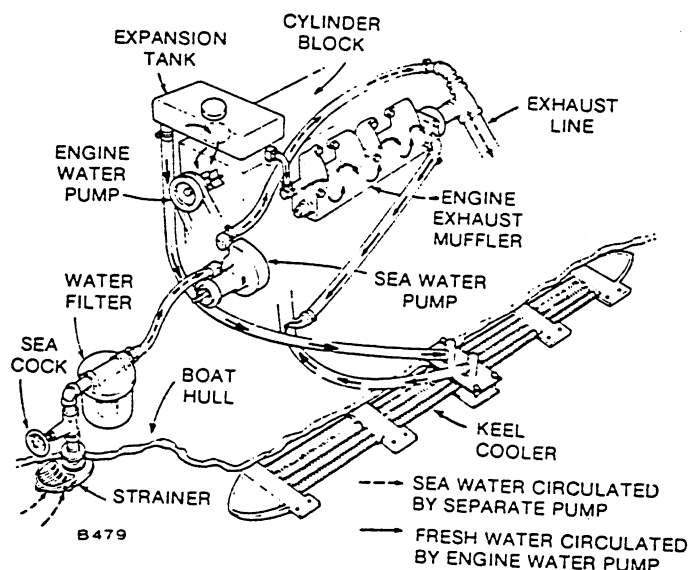


FIGURE 9. KEEL COOLING SYSTEM

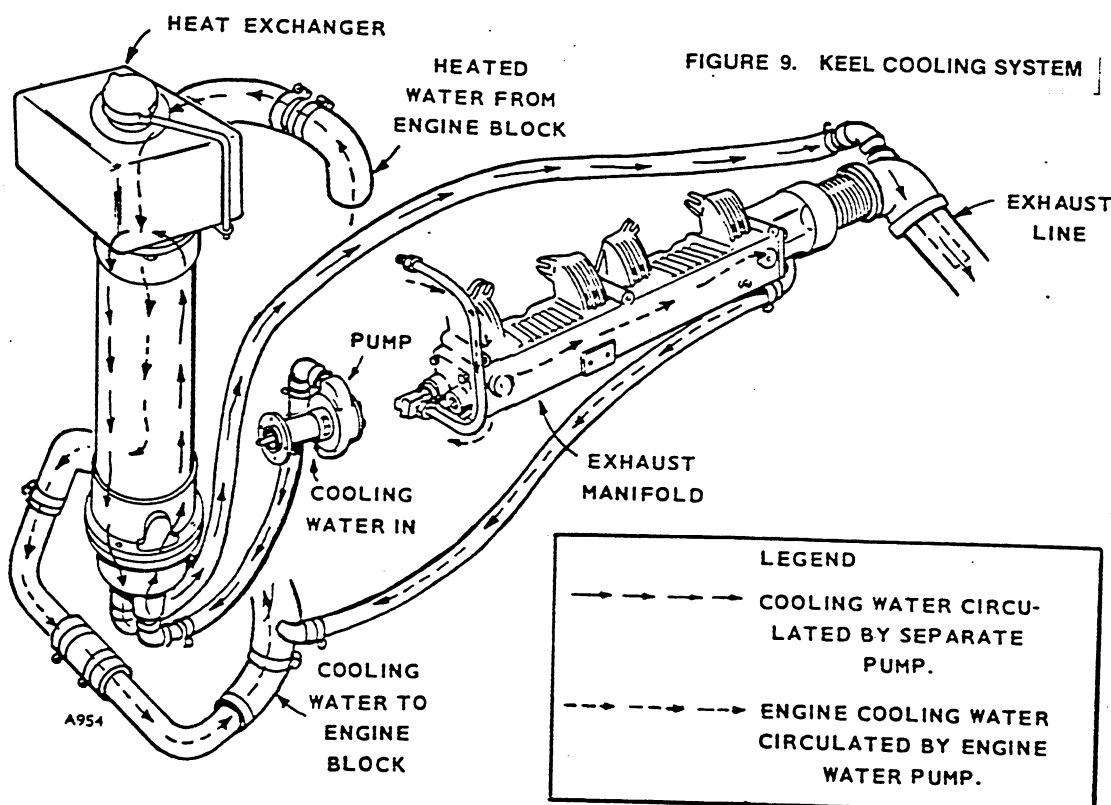


FIGURE 8. HEAT EXCHANGER COOLING

FUEL SYSTEM

Ford-Dorset engines used on MDEH marine electric sets are designed for use with ASTM No. 2 diesel fuel. They will however operate on diesel fuels within the specifications delineated in the Ford-Dorset engine manual. Lubricity factors change with fuels; do not substitute. If in doubt consult with your fuel supplier.

In all diesel engine installations, fuel system cleanliness is of utmost importance. Make every effort to prevent entrance of moisture or other contaminants. Do not use lines, fittings or tanks of galvanized material.

FUEL TANK

If the main propulsion engine is a diesel unit, it may be possible to use the fuel tanks (but not the same fuel lines) to supply the marine electric set at the same time. However, before that decision is made, the following factors must be considered—

1. **Adequate fuel capacity.** The MDEH set consumes 2.6 gallons (9.8 litres) per hour at rated load, therefore tank capacity must be capable of supplying the propulsion engine and the MDEH at the same time.

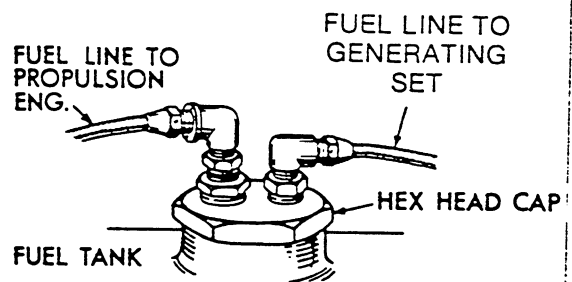
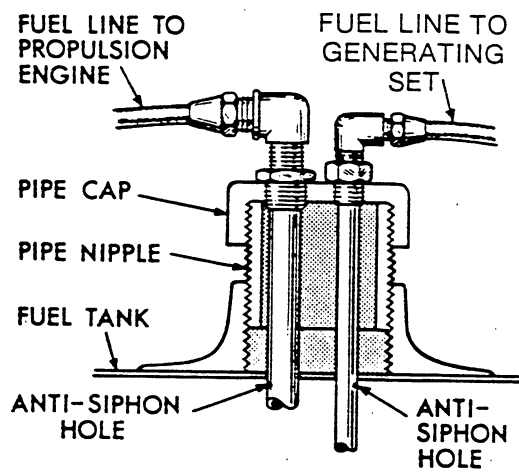
Remember also that fuel oil used to cool the injectors is returned to the tank. This fuel is warm. To assure maximum engine efficiency, fuel delivered to the injector must be cool. This means that the fuel tank volume must be adequate to cool the incoming return fuel.

2. **Distance of propulsion tanks from marine electric set.** Fuel lift and restrictions to the fuel transfer pump should not allow suction to exceed 8.5-inches Hg (28.7 kPa). If this value is exceeded, this will require installation of either an additional fuel pump or a separate tank.
3. **Modification of main tank.** Ideally, two separate lines should be run for each engine; one supply and one injector return, the return to enter the tank as far as possible from the supply line. Figure 10 shows typical methods of installing two fuel supply lines in one tank. The lines to the main propulsion engine and the generator set engine should not be connected together. The marine electric set fuel transfer pump has neither the power nor the capacity to overcome the suction of the propulsion pump, therefore erratic operation is possible.

This is true also of the return lines. Pressure from one engine could be higher than the other and force return fuel back into the lower-pressure engine injector.

Maximum back pressure to the MDEH fuel return line should not exceed 0.5 psi (3.5 kPa) with a maximum head of 5-feet (1.5 m).

Fuel inlet is to the transfer pump and is threaded for 3/8-inch pipe. Injector's return line requires a 1/8-inch low pressure hose connection. Refer to Figure 10 for fuel system.



FUEL TANK HOOKUP

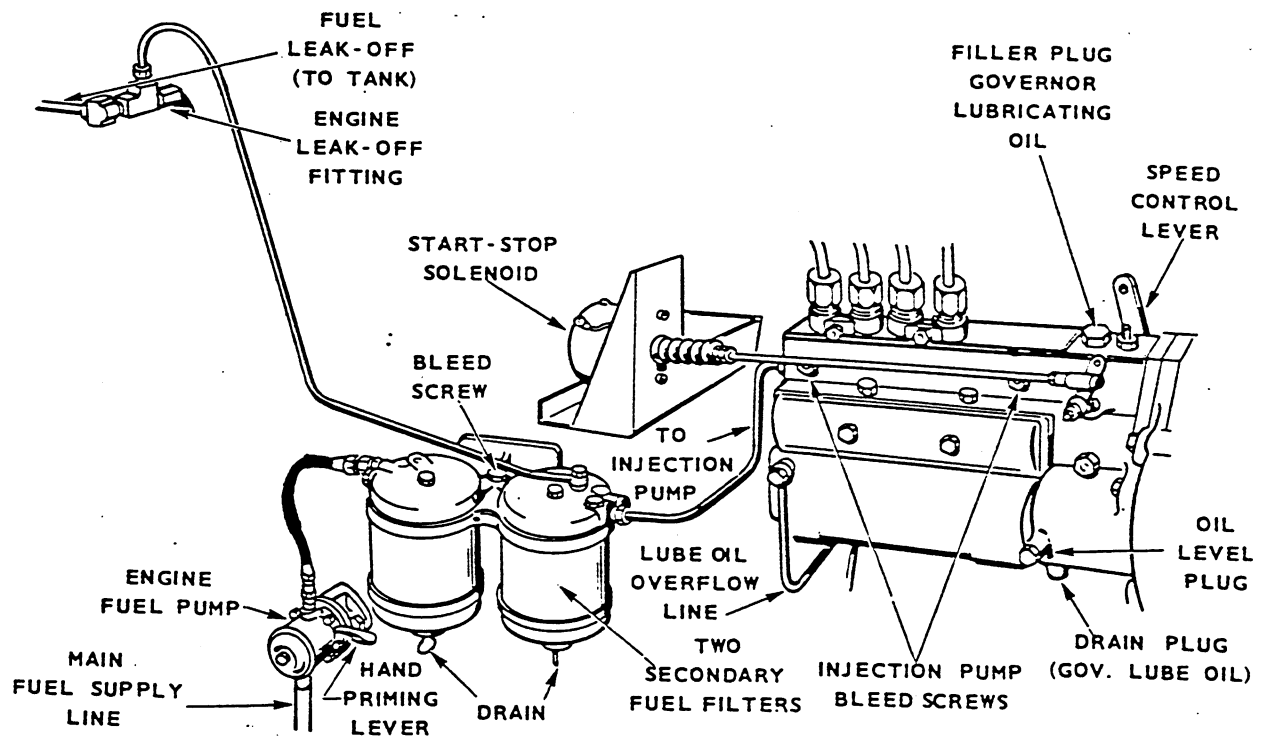


FIGURE 10. FUEL SYSTEM

BATTERY

Starting the unit requires 12-volt battery current. Use two 6-volt (see *SPECIFICATIONS*) batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second) as in Figure 11. Necessary battery cables are on unit. Service the batteries as necessary. Infrequent unit use may allow the batteries to self-discharge to the point where they cannot start the unit.

WARNING

Do not smoke while servicing batteries. Lead acid batteries give off explosive gases while being charged.

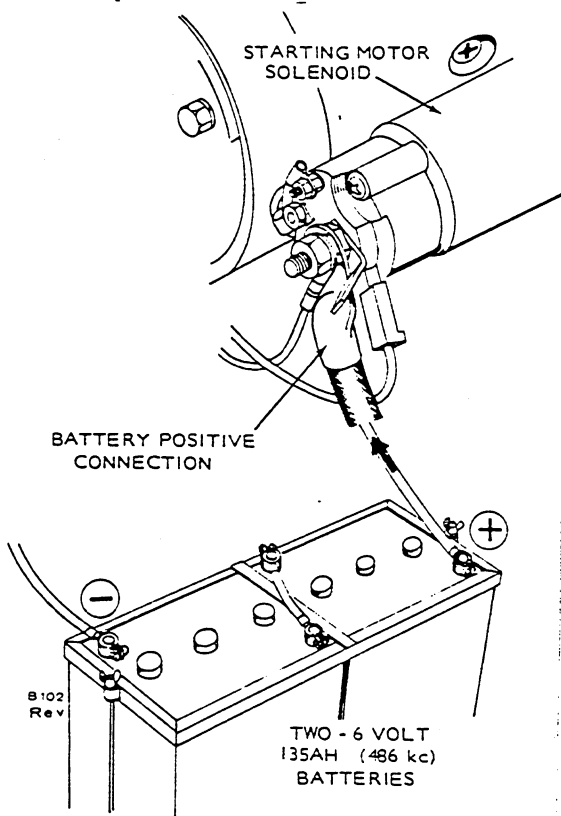


FIGURE 11. BATTERY CONNECTION

BATTERY, HOT LOCATION

Batteries will self discharge very quickly when installed where the ambient temperature is consistently above 90°F (32.2°C). To lengthen battery life, dilute the electrolyte from its normal 1.265 specific gravity reading at full charge to a 1.225 reading. The cranking power is reduced slightly when the electrolyte is so diluted, but if the temperature is above 90°F (32.2°C), this should not be noticed. The lengthened battery life will be worth the effort.

1. Fully charge the battery.
2. With the battery still on charge, draw off the electrolyte above the plates in each cell. DO NOT ATTEMPT TO POUR OFF; use a hydrometer or filler bulb and dispose of it in a safe manner. Avoid skin or clothing contact with the electrolyte.
3. Refill each cell with distilled water, to normal level.
4. Continue charging for 1 hour at a 4 to 6 hour rate.
5. Test each cell. If the specific gravity is still above 1.255, repeat steps 2, 3, and 4 until the reading is reduced to 1.225. Usually, repeating steps twice is sufficient.

REMOTE CONTROL CONNECTIONS

Provision is made for addition of remote starting. This is accomplished on a 4 place terminal block situated within the control box. Connect one or more remote switches across remote terminal and B+ terminal as shown in Figure 12. If the distance between the set and remote station is less than 1000-feet (305 m), use No. 18 AWG wire.

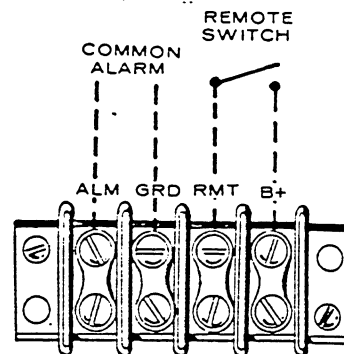


FIGURE 12. REMOTE START CONNECTION (TB12)

Control Box Connections: The factory ships these 12 lead generators with load connection wires NOT connected together in the control box. These 12 wires are labeled T1 through T12 and must be brought together before making load connections. Proceed as follows:

1. Remove either right, left or top panel from control box. See Figure 13.
2. Connect wires together as shown on panel drawing and in Figure 1 according to voltage desired.
3. Open hinged control panel doors. Connect lead from terminal 63 to correct terminal for voltage desired. These terminals are labeled H2, H3, H4, H5 and H6. See Figure 14.
4. Close front panel and secure with 1/4 turn fasteners.
5. Connect load wires to generator leads.

Preceding instructions do not apply to models designated Code 3 or 9X; this connection is made at the factory. The installer must only connect load wires.

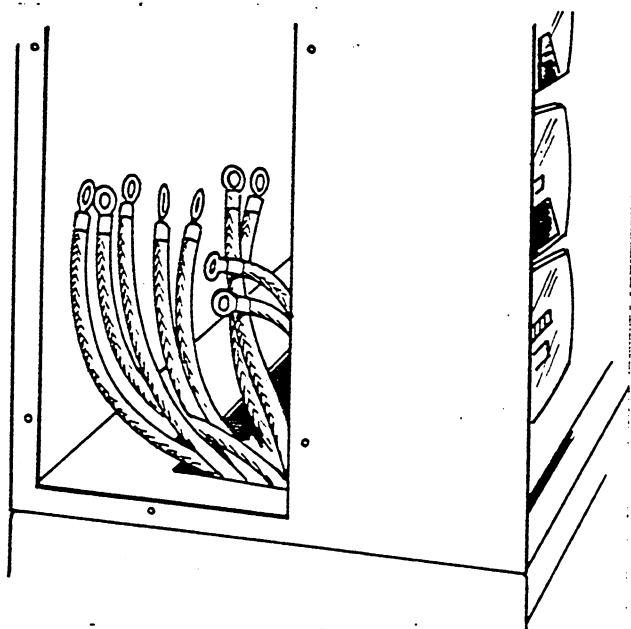


FIGURE 13. CONTROL BOX (SIDE PANEL REMOVED)

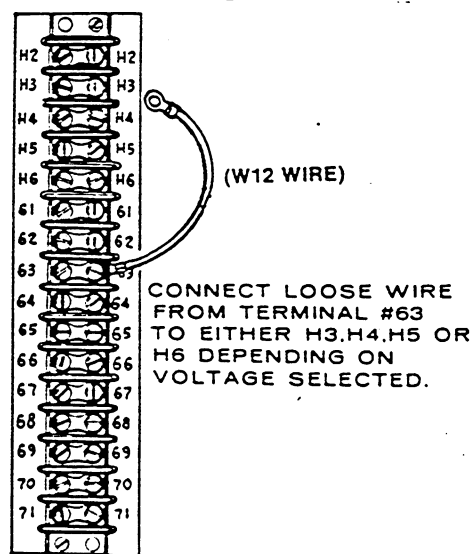


FIGURE 14. REFERENCE VOLTAGE CONNECTION (TB21)

120/240 Volt, Single Phase, 12 Lead: Terminal connection L0 can be grounded (neutral). For 120 volts, connect the hot load wires to either the L1 or L2 connection, Figure 15. Connect the neutral load wire to the grounded L0 connection. Two 120 volt circuits are thus available, with not more than 1/3 the rated capacity of the set available on either circuit. If using both circuits, be sure to balance the load between them.

For 240 volts, connect one load wire to the L1 connection and the second load wire to the L2 connection. Terminal connection L0 is not used for 240 volt service.

Only 2/3 of rated current is available from this connection.

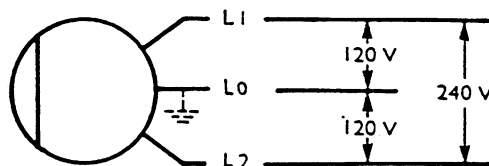


FIGURE 15. 120/240 V. 1-PHASE DOUBLE DELTA

120/240 Volt, 3 Phase, Delta Connected Set; 12 Lead:

The 3 phase Delta connected set is designed to supply 120 and 240 volt, 1 phase current and 240 volt, 3 phase current, Figure 16. For 3 phase operation, connect the three load wires to generator terminals L1, L2 and L3—one wire to each terminal. For 3 phase operation the L0 terminal is not used.

For 120/240 volt, 1 phase, 3 wire operation, terminals L1 and L2 are the "hot" terminals. The L0 terminal is the neutral, which can be grounded if required. For 120 volt service, connect the black load wire to either the L1 or L2 terminal. Connect the neutral (white) wire to the L0 terminal. Two 120 volt circuits are available. Connect between any two 3-phase terminals for 240 volt 1-phase loads.

Any combination of 1 phase and 3 phase loading can be used at the same time as long as total current does not exceed the NAMEPLATE rating of the generator. If no 3 phase output is used, usable 1 phase output is 2/3 of 3 phase kVA.

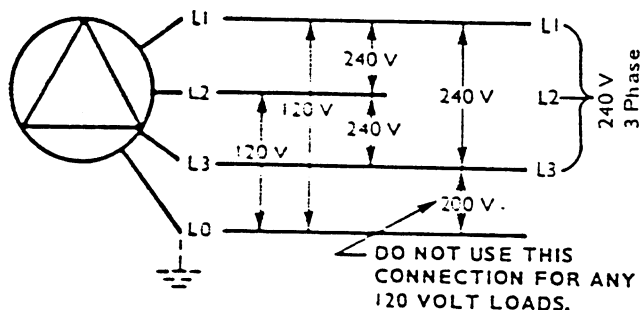


FIGURE 16. 120/240 V. 3-PHASE DELTA

3 Phase, Wye Connected Set: The 3 phase, 4 wire set produces line to neutral voltage and line to line voltage. Line to neutral voltage is the lower voltage as noted on the unit nameplate. Line to line voltage is the higher nameplate voltage.

For 3 phase loads, connect separate load wires to each of the set terminals L1, L2 and L3. Single phase output of the higher nameplate voltage is obtained between any two 3 phase terminals as shown in Figure 17.

The terminal marked L0 can be grounded. For 1 phase loads, connect the neutral (white) load wire to the L0 terminal. Connect the black load wire to any one of the other three terminals—L1, L2 or L3. Three separate 1 phase circuits are available, with not more than 1/6 the rated capacity of the set from any one circuit.

If using 1 phase and 3 phase current at the same time, use care to properly balance the 1 phase load, and not to exceed rated line current.

Figure 17 shows load connections for 120/208 voltage. Other voltages are available from either parallel wye or series wye illustration in Figure 1.

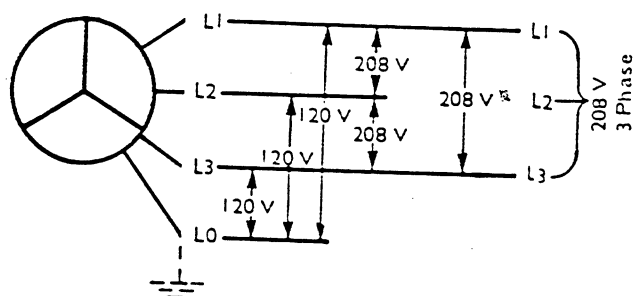


FIGURE 17. 120/208 V. 3-PHASE WYE

120/240 Volt, 1 Phase, 3 Wire Unit; (3 Units):

Terminal post T0 is the grounded (neutral) terminal. For 120 volt current, connect the "hot" load wire to either the T1 or T2 terminal. Connect the neutral load wire to the T0 terminal. Two 120 volt circuits are thus available, with not more than 1/2 the rated capacity of the set available on each circuit. Balance the load as closely as possible (Figure 18).

For 240 volt current, connect one load wire to terminal T1 and the second load wire to terminal T2. Terminal T0 is not used for 240 volt service.

CAUTION If using both 120 and 240 volt current at the same time, use care not to overload either circuit.

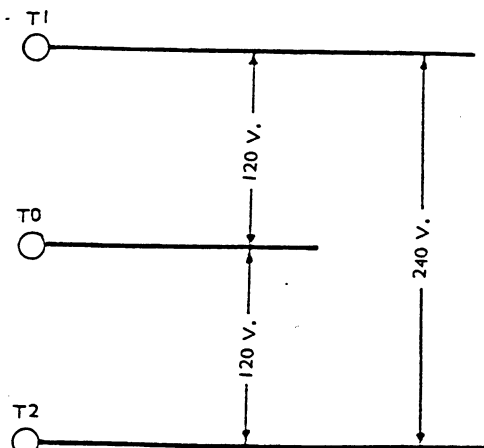


FIGURE 18. 120/240 V. 1-PHASE (CODE 3)

OPERATION

GENERAL

Onan MDEH Series electric generating sets are given a complete running test under various load conditions and are thoroughly checked before leaving the factory. Inspect your unit closely for loose or missing parts and damage which may have occurred in transit. Tighten loose parts, replace missing parts and repair any damage before putting set into operation.

PRESTART SERVICING

Lubrication System: Engine oil was drained prior to shipment. Fill engine to capacities shown. After engine has been run, check dipstick, add oil to bring level to full mark. Record total capacity for future oil changes. For most operating conditions grade CC/CD lubricating oil is recommended. Do not mix brands nor grades of lubrication oils.

Cooling System: Cooling system was drained prior to shipment. Fill cooling system before starting. Nominal capacity is 8.5-quarts (8.0 litres). Fill the system with clean soft water. Use a good rust and scale inhibitor additive. If a possibility exists of set being exposed to freezing temperatures use anti-freeze with an ethylene glycol base. During initial engine run, check the coolant level several times and replenish if necessary to compensate for air pockets which may have formed during filling. Refer to Ford-Dorset engine manual for additional information.

CAUTION

If engine is equipped with a cooling system filter, do not use antifreeze with an anti-leak formula. The stop leak element can prevent or retard the coolant flow through the filter, thereby eliminating the filtering process completely.

WARNING

Be careful when checking coolant under pressure. It is advisable to shut engine down and bleed off pressure before removing pressure cap. Severe burns could result from contact with hot coolant.

Fuel System: Refer to the Ford-Dorset engine manual for fuel oil specifications. Check with fuel supplier and ensure that fuel supplied meets the specifications. Filter or strain fuel when filling tank. Fuel supply tanks should be kept as nearly full as possible by topping up each time engine is used. Warm fuel returning from the injector pump heats the fuel in the supply tank. If the fuel level is low in cold weather, the upper portion of the tank not heated by returning fuel tends to increase condensation. In warm weather both the supply tank and fuel are warm. Cool night air lowers the temperature of the tank more rapidly than the temperature of the fuel. Again this tends to increase condensation.

Condensate mixing with the sulphur in the fuel forms a sulphurous acid which will corrode and damage the engine. KEEP FUEL CLEAN.

WARNING

DO NOT SMOKE while handling fuel. Diesel fuel is flammable.

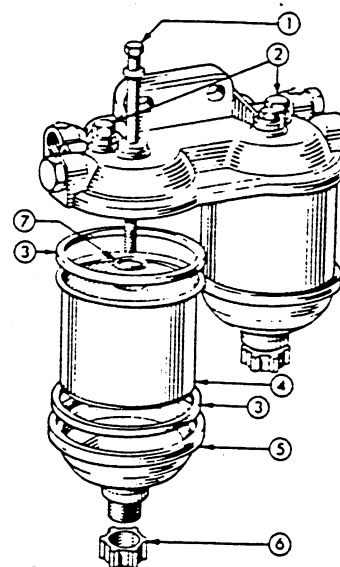
Priming Fuel System: Verify that all connections in the fuel system are secure and no leaks exist. Proceed with priming as follows:

1. Open bleed screw on the inlet side of fuel filter. See Figure 19.
2. Actuate priming lever on the side of the fuel transfer pump (Figure 10A) until fuel flows from filter bleed screw without showing air bubbles.
3. Close filter inlet bleed screw.
4. Open bleed screw on the outlet side of filter. See Figure 19.
5. Again, actuate priming lever until a bubble-free flow of fuel comes out of the bleed screw.
6. Close filter outlet bleed screw.
7. Open one or two bleed screws on fuel injection pump.
8. Repeat priming lever actuation until bubble-free fuel is emitted from bleed screws on injection pump.
9. Close bleed screw(s).
10. Torque bleed screws.

Filter — 5-7 lb-ft (6.88 to 9.5 N•m)

Pump — 3-5 lb-ft (4.1 to 6.8 N•m)

1. SECURING BOLT
2. BLEED SCREWS
3. SEAL
4. FILTER ELEMENT
5. BOWL
6. DRAIN CAP
7. SEAL



B318

FIGURE 19. FUEL FILTER

BATTERIES

Ensure that cable connections to the batteries are secure. Coat connections with petroleum based or non-conductive grease to retard formation of corrosive deposits.

Check level of electrolyte to be at split ring mark. Measure specific gravity of electrolyte: SG 1.280 at 80°F (26.7°C). If distilled water has been added or specific gravity is less than 1.280, place batteries on charge until desired reading is reached. Do not over-charge.

STARTING

When the preceding service functions have been performed, recheck to verify unit is ready to start.

1. Crankcase filled.
2. Cooling system filled—input solenoid valve open.
3. Batteries charged and connected.
4. Fuel solenoid valve open.

To start, move the "run-stop/reset-remote" switch to the "run" position. The engine should start after a few seconds of cranking. Immediately after start, observe the oil pressure gauge. Normal oil pressure is between 30 psi (207 kPa) and 55 psi (380 kPa). Check the following gauges:

1. DC Ammeter—10 to 30 amperes.
2. AC Voltmeter—AC generator output voltage.
3. Frequency Meter—AC generator output frequency.

After running 10 minutes under load the water temperature gauge should have stabilized at 180°F to 195°F (82°C to 90.6°C).

Break-In Note: Run set at 50 percent rated load for the first half-hour of initial operation after reaching operating temperature.

Non-Start: If after a few seconds of cranking engine fails to start, or starts and runs then stops and fault lamp lights, refer to appropriate troubleshooting chart, Table 3 or Table 4.

STOPPING

To reduce and stabilize the engine temperatures, run the engine at no load for three to five minutes before shutting down.

Move the run-stop/reset-remote switch to stop position to shut down the set.

EXERCISE PERIOD

Cylinder walls, piston rings and bearings on engines used infrequently, will lose their film of lubricating oil as it gradually returns to the crankcase.

This imposes severe conditions on the engine. Friction of dry piston rings upon dry cylinder walls causes scuffing and rapid wearing. These can be relieved by exercising the set at least once a week for a minimum time of 30 minutes per exercise period. Preferably, run the set under at least 50 percent load to allow the engine to reach normal operating temperature. This will keep engine parts lubricated, maintain fuel prime, prevent electrical relay contacts from oxidizing and insure easy emergency starts.

After each exercise period, top off fuel tank, check engine for leaks and unit for general condition. Locate cause of leaks (if any) and correct.

NO LOAD OPERATION

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of heater elements, etc.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to-and-from the set.
2. Keep cooling system clean.
3. Use correct SAE No. oil for temperature conditions.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow but use care to avoid overheating.
5. Refer to Ford-Dorset manual for further information.

TABLE 3.
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Engines with only one fault lamp)

SYMPTOM	CORRECTIVE ACTION
1. Engine stops cranking and fault lamp lights, after cranking approximately 75 seconds.	1. See engine service manual for troubleshooting fuel system. After correcting problem, reset engine monitor relay by placing Run-Stop/Reset-Remote switch to Stop/Reset, then back to the required running position.
2. Fault lamp lights immediately after engine starts.	2. Check for: Overspeed condition as engine starts.
3. Fault lamp lights and engine shuts down after running for a period.	3. Check the following: a. Oil level. Engine will shut down if sensor is closed. b. Check engine manual for troubleshooting oil system. c. High engine temperature. Check coolant level; check water flow, pump belts for tightness. See engine manual for troubleshooting cooling system. d. Check for faulty oil pressure sensor or faulty high engine temperature sensor.
4. Engine runs, shuts down and cranks for 75-seconds. Cranking cycle stops; fault lamp lights.	4. Check fuel supply.
5. Fault lamp lights, no fault exists.	5. To check a no-fault condition, disconnect leads from TB11 terminals 29, 30 and 31. If fault lamp lights with leads disconnected, replace engine monitor board. Reconnect leads.

TABLE 4.
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Units with five fault lamps)

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75-seconds.	1. See engine service manual for troubleshooting fuel system. After correcting fault, reset engine monitor relay by placing Run-Stop/Reset-Remote switch to Stop/Reset position, depressing Reset button, then to the required running position.
2. Engine runs, shuts down, cranks for 75-seconds, cranking cycle stops, overcrank light ON.	2. Check fuel supply.
3. Low oil pressure shutdown.	3. Check— a. Oil level. Replenish if necessary. b. Sensor. Faulty sensor will shut down engine. c. Refer to engine service manual for troubleshooting guide for oil system.
4. High engine temperature shutdown.	4. Check— a. Coolant level. Replenish if necessary. b. Check sensor; check thermostat. c. Check pump belts.
5. Overspeed shutdown.	5. Check governor and throttle linkages for freedom of movement. Check overspeed switch.
6. Overspeed light on, no shutdown.	6. Disconnect wire at TB11-29. Light on after reset; replace engine monitor board.
7. Low oil pressure light ON. No shutdown.	7. Disconnect wire at TB11-30. Light ON after relay reset. Replace engine monitor board.
8. High engine temperature light ON. No shutdown.	8. Disconnect wire at TB11-31. Light ON after relay reset. Replace engine monitor board.

STORAGE

The following instructions are applicable to the storage of a new or used engine.

1. Drain the oil from the crankcase, oil filter, injection pump housing and air cleaner. Refill these parts with a preservative oil to normal specified oil levels.
2. Disconnect fuel line from the fuel tank at the lift pump. Connect a line from a kerosene source to the lift pump.
3. Run the engine for 15 minutes at 1800 r/min (generator under at least 50% load). It may be necessary to run the engine longer to be sure the preservative oil has reached all parts of the engine, and that the fuel system, including injector nozzles, has filled completely with kerosene.
4. Remove air cleaner hose at the intake manifold. Remove intake manifold. Pour at least one ounce of preservative oil in each cylinder that has an open intake valve. Then bar the engine 1/4 revolution or less. Pour preservative oil in the rest of the cylinders as the intake valves open. Install intake manifold. Install air cleaner hose at intake manifold.
5. Bar the engine until the engine has turned over 8 to 10 times. This will coat the cylinder walls with preservative oil.

CAUTION

The engine can start on the preservative oil. DO NOT allow the engine to start. If the engine does start on the preservative oil the storage process will have to be repeated.

6. Disconnect battery and follow standard battery storage procedure. Apply a film of non conductive grease to battery cable lugs.
7. Remove injection pump side cover plate and spray exposed parts with preservative oil, particularly the springs. Install injection pump side cover plate.
8. Drain the oil from the crankcase.
9. Drain engine of coolant.
10. Plug exhaust.
11. Tag engine—"DO NOT RUN—NO OIL IN CRANKCASE. INJECTION PUMP, ETC.—NO WATER IN RADIATOR."
12. Degrease exterior of the engine.
13. Seal all openings on the engine and accessories with a suitable tape or equivalent. Tape all electrical contact areas.
14. Dry all surfaces of the engine, accessories and electrical wiring; spray the unit with an insulation fluid compound.

RETURNING A UNIT TO SERVICE

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Refer to *PRESTART SERVICING* procedure. Perform all items.
3. Clean and check battery. Measure specific gravity (1.260 at 77°F [25°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

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

4. Connect batteries.
5. Verify that no loads are connected to generator.
6. Start engine.
7. After start, apply load to at least 50 percent of rated capacity.
8. Check all gauges to be reading correctly. Unit is ready for service.

DUST AND DIRT

1. Keep set clean. Keep cooling system free of dirt, etc.
2. Service air cleaners frequently.
3. Store oil and fuel in dust-tight containers.
4. See engine operation and maintenance manual.

GENERAL MAINTENANCE

GENERAL

Follow a definite schedule of inspection and servicing, based on operating hours (Table 5). Keep an accurate logbook of maintenance, servicing, and operating time. Use the running time meter to keep a record of operation and servicing. Service periods outlined are recommended for normal service and operating conditions. For continuous duty, extreme temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly. Refer to Ford-Dorset engine manual for details of engine service and maintenance procedures.

WARNING

Before performing any maintenance work on the engine, generator, control panel, automatic transfer switch or associated wiring, disconnect batteries. Failure to do so could result in damage to the unit or serious personal injury in the event of inadvertent starting.

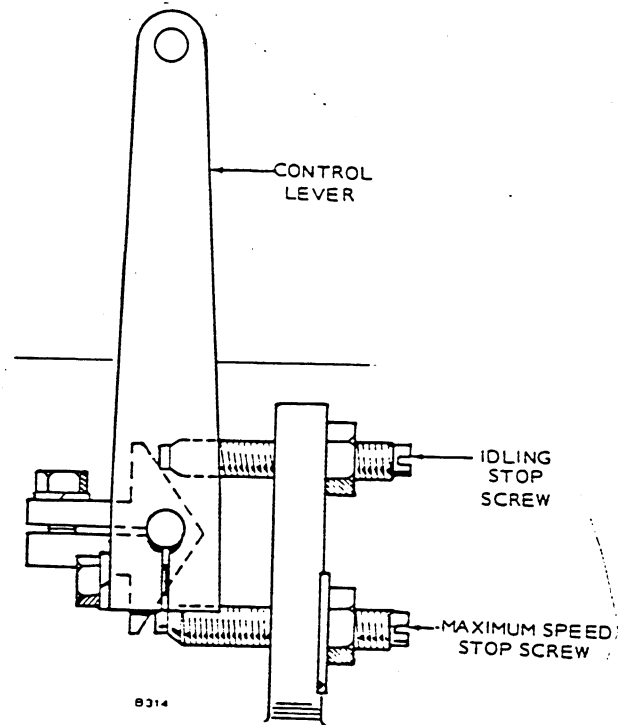


FIGURE 20. GOVERNOR SPEED ADJUSTMENT

ENGINE SPEED

Generator frequency is in direct ratio to engine speed which is controlled by the governor. The governor controlling the MDEH set is integral with the injector pump. High and low speed limit stops are set at the ONAN testing facility and normally do not require further adjustment.

If however the unit is removed for repair or the set is used frequently, adjustment may be necessary due to wear of internal components.

To adjust governor, proceed as follows:

1. Loosen lock nuts on idle stop screw and maximum speed stop screw. Refer to Figure 20.
2. Start engine; apply full load.

If governor setting is considerably out of adjustment, adjust low speed stop screw until frequency meter indicates approximately 63 Hz before applying load.

3. Back off maximum speed stop screw (screwdriver slot).
4. Turn idle speed stop screw clockwise until frequency meter indicates 60 Hz. (Counterclockwise reduces rpm.)
5. Turn maximum speed stop until it bottoms on governor control lever.
6. Secure lock nuts.

START-STOP SOLENOID (Failure to Shut Down)

In case the set does not shut down when moving Run-Stop/Reset-Remote switch to *Stop* position, the stop solenoid linkage may be out of adjustment. See Figure 21. Adjust as follows:

1. Remove the joint that attaches the stop solenoid rod to injection pump arm.
2. With engine running, move lever arm on the injection pump back slowly towards radiator just until engine stops.
3. Hold lever in this same position and adjust linkage accordingly.
4. Snap rod joint back on injection pump arm.

AC GENERATOR

Brushless (Begin Spec C): There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections to coincide with engine oil changes, will ensure good performance.

Generator Bearing: Inspect the bearing every 1000 hours with unit running. Apply light smear of Molykote grease if unit appears dry.

Voltage Adjustment: Check generator voltage. It may be necessary to make a slight readjustment of the voltage rheostat to obtain preferred voltage at average load.

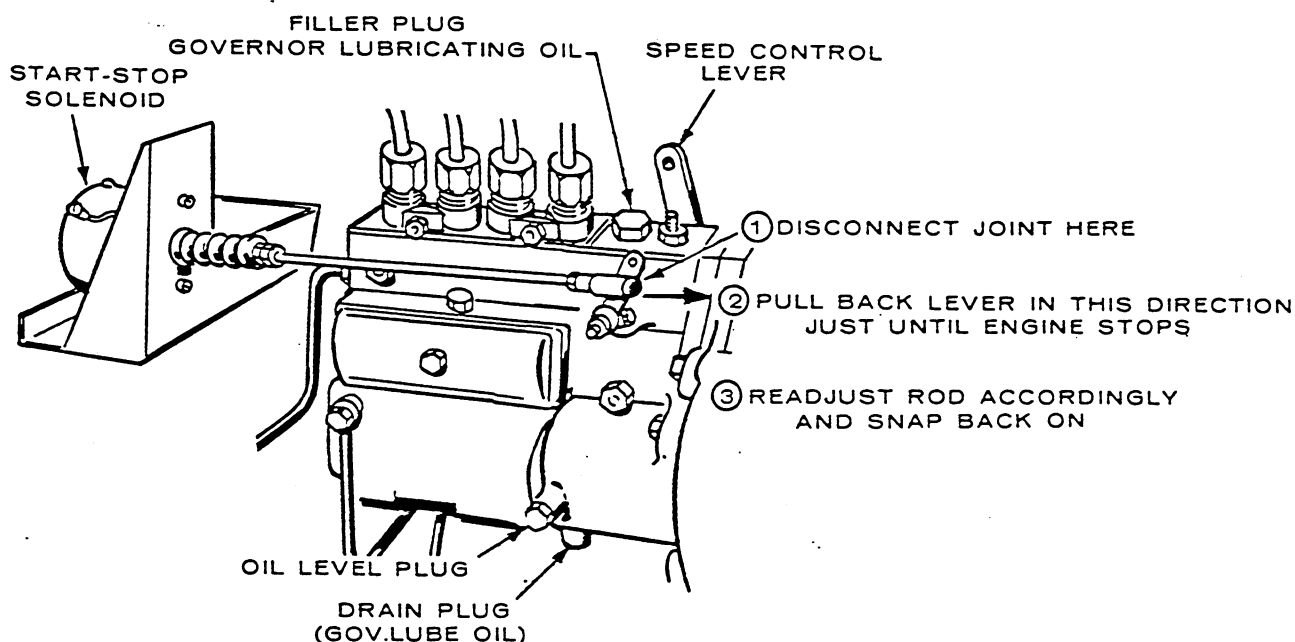


FIGURE 21. STOP-SOLENOID LINKAGE ADJUSTMENT

INSPECTION AND CLEANING

When inspecting the rotating rectifier assembly, make sure diodes are free of dust, dirt and grease. Excessive foreign matter on these diodes and heat sinks will cause overheating resultant failure. Blow out the assembly periodically, with filtered, low pressure air (max. 30 psi [207 kPa]). Check to see that diodes and leadwires are properly torqued. Diodes should be torqued to 15 in. lb. (1.7 N·m) or finger tight plus a quarter turn. Blow dust out of control panel.

BATTERIES

Check condition of the starting batteries at least every two weeks. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep electrolyte at the proper level above the plates by adding distilled water. Check specific gravity, recharge if below 1.265.

CONNECTIONS (Fuel, Exhaust, etc.)

Operator should periodically make a complete visual inspection of the set while running at rated load. Repair where necessary. Some things to check are as follows:

1. Check all fuel and oil lines for possible leakage.
2. Inspect exhaust lines and mufflers for possible leakage and cracks.
3. Periodically or daily, drain moisture from condensation traps.

4. Inspect water lines and connections for leaks and security.
5. Inspect electrical wires and connections for security and fray damage.

If generator requires major repair or servicing, contact an authorized Onan dealer or distributor.

TABLE 5. OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	10	50	200	400
Inspect Complete Set	x			
Check Engine Oil Level	x			
Check Coolant Level	x			
Check Fuel	x1			
CHECK EXHAUST SYSTEM FOR LEAKS	x1			
Check Governor Oil Level		x		
Check Air Cleaner (Clean if Required)		x2		
Check Electrolyte Level of Battery		x		
Stop-Solenoid Linkage		x2		
Adjust Belt Tension			x3	
Change Governor Oil			x	
Change Engine Oil & Filter			x2	
Clean Fuel Lift Pump			x	
Clean Sediment Bowl & Filter			x	
Check Starter			x5	
Clean & Inspect Battery Charging (DC) Alternator			x	
Check AC Generator			x	
Replace Fuel Filter Element				x2
Replace Air Cleaner Element				x2
Remove & Service Injectors				x4
Adjust Valve Clearances				x
Examine Water Filter Element				x
Inspect all Hardware and Fasteners		x6		

x1 - After every run.

x2 - Perform more often in extremely dusty conditions.

x3 - Adjust to 1/2-inch (12.5 mm) depression between pulleys. Refer to Ford engine manual.

x4 - Check for proper spray pattern, etc. Refer to the Ford manual.

x5 - Check brushes.

x6 - Or every three months.

WARNING

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