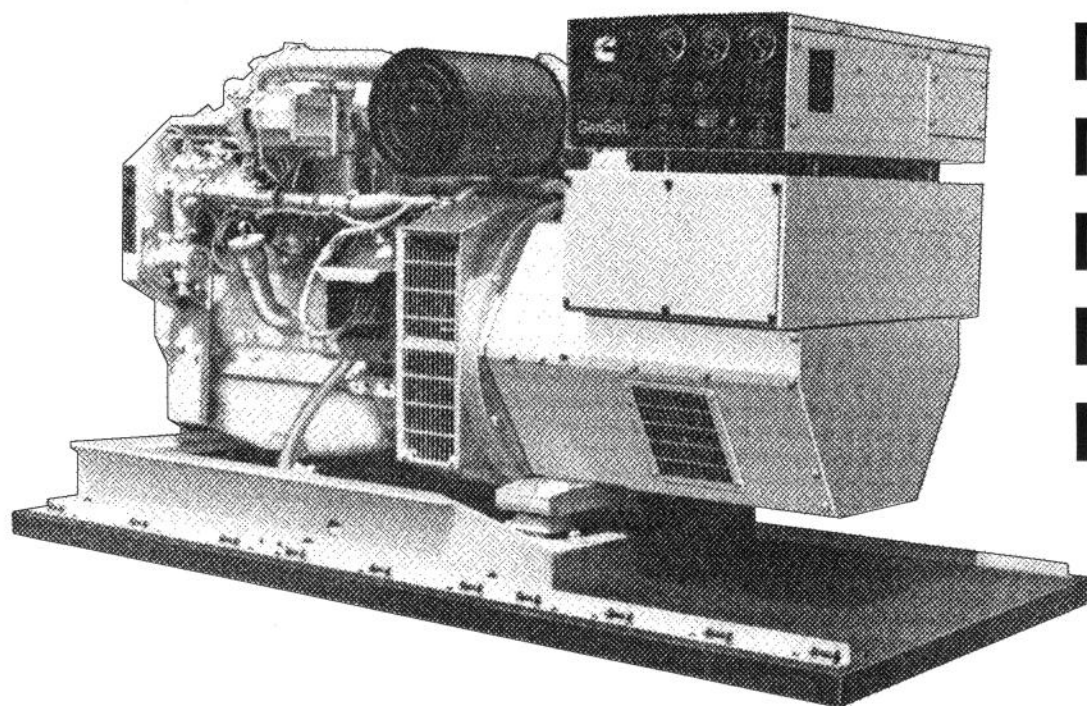




Operation and Installation Manual

Marine GenSets MDBA MDCA MDCB MDDM MDDA Mddb



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, possibly resulting in dangerous operating conditions... from leaking fuel, leaking exhaust fumes, etc.
- Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the generator set compartment 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. Electrocuting 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.



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Section 1. Introduction

ABOUT THIS MANUAL

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

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact an Onan Distributor for assistance. Onan factory trained Parts and Service representatives are ready to handle all your service needs.

When contacting an Onan Distributor, always supply the complete Model number and Serial number as shown on the Onan nameplate, see Figure 1-1. The Onan nameplate is located on the control box, see Figure 1-2.

Onan		
Model and Spec No.		
Serial No.		
Important! Always give above no.'s when ordering parts		
AC Volts	Ph	
KVA	kW	
PF	Amps	Hz
DCV	Amps	Watts
RPM	Bat.	
Time Rating		
Insulation-NEMA Class F For Electrical Equipment Only		
Amb 40° C		
Onan Corporation 1400 73rd Avenue N.E. Minneapolis Minnesota 55432 U.S.A.		

FIGURE 1-1. ONAN NAMEPLATE

⚠ WARNING

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

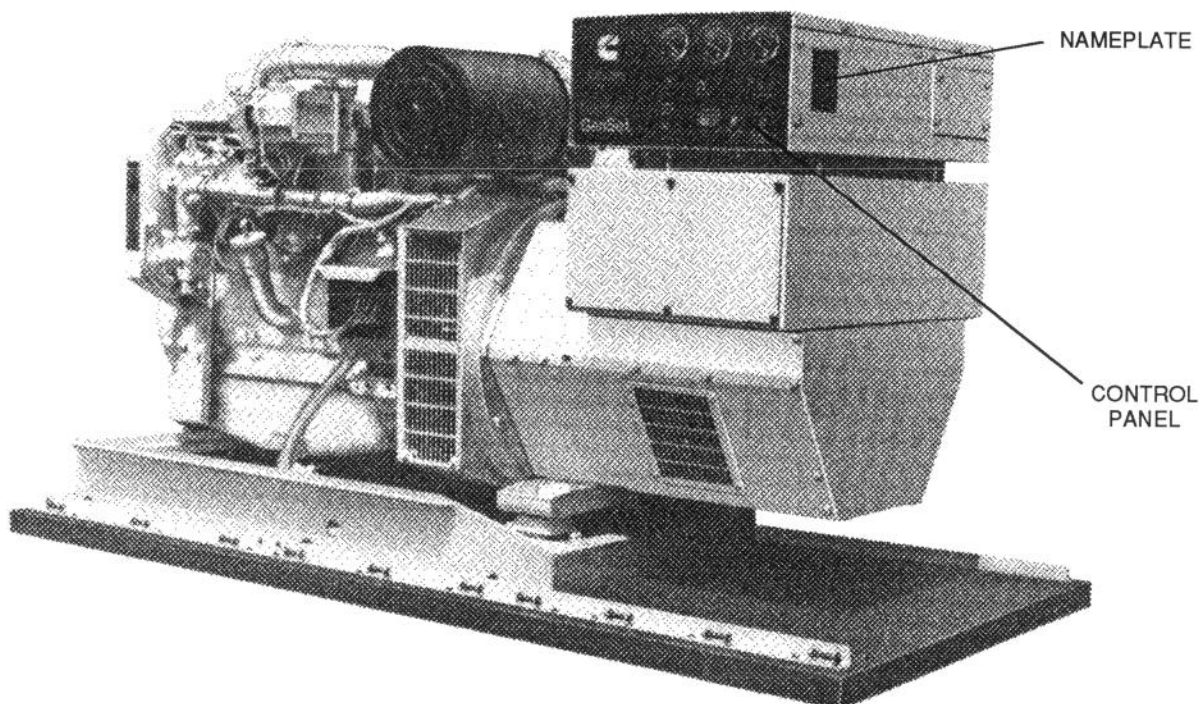


FIGURE 1-2. GENERATOR SET (Model MDCB shown)

Section 2. Operation

⚠ WARNING

EXHAUST GAS IS DEADLY!

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

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

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

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

GENERAL

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

PRE-START CHECKS

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

Lubrication

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

Coolant

The coolant level should be near the top of heat exchanger fill cap. Do not check while the coolant is hot.

⚠ WARNING

The sudden release of pressure from a heated cooling system can result in possible severe personal injury from the hot coolant. Remove the expansion tank pressure cap slowly after the engine has cooled.

Fuel

Make sure the fuel tanks are full and the fuel system primed for operation.

Sea Water Pump Priming

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

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

CONTROL PANEL

The following describes the function and operation of the generator set controls. All instruments and control switches are located on the face of the control panel as illustrated in Figure 2-1.

Gauges/Meters and Switches

Start/Stop Switch: Starts and stops the unit locally. Unit may be operated from an optional remote switch wired to the control panel.

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

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

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

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

Oil Pressure Gauge: Shows engine lubricating oil pressure. The gauge has a range of 0 to 5 bar/0 to 71 psi (ref. 0 to 500 kPa) and is connected to an engine sensor.

Low Coolant Level Shutdown (Optional): A sensor located in engine cooling system closes a switch to shut down the engine if coolant level is too low.

Circuit Breakers

Fault Reset: A manual reset breaker that shuts down the engine for low oil pressure (below 14 psi [97 kPa]), high coolant temperature (above 222° F/106° C), high exhaust temperature (above 230° F/110° C), overspeed (at or above 7 to 8 Hz over nominal Hz), or low coolant level.

Emergency Stop DC Control Breaker: A 15 ampere breaker providing protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

DC Breaker: Connects B+ to the control and trips if a short or overload occurs.

Battery Charger Failure Lamp: Illuminates upon start if battery voltage is not adequate.

Run Lamp: Illuminates when genset is running.

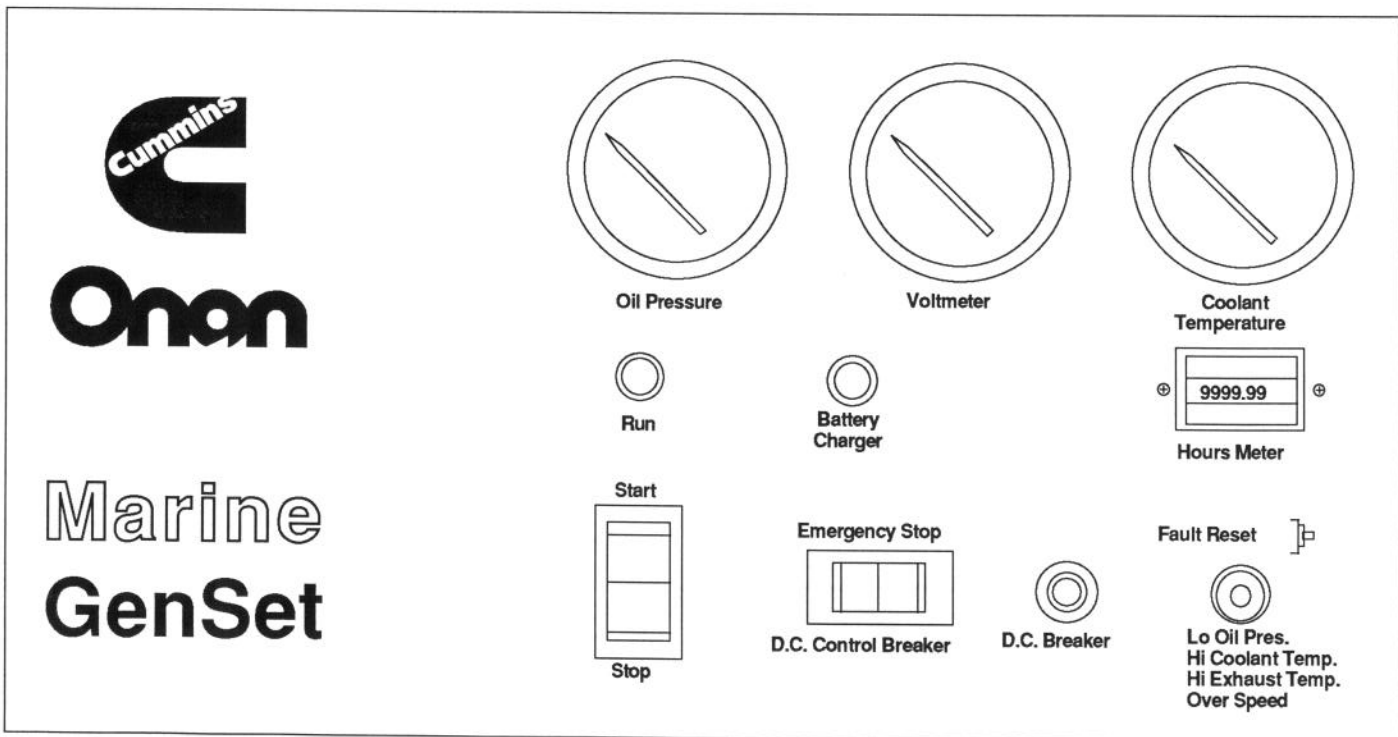


FIGURE 2-1. CONTROL PANEL

STARTING PROCEDURE

This section covers the two systems used to start the generator set and how to perform start-up checks.

Starting at Control Panel

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

1. Hold the Start/Stop switch on the control panel in the Start position. This activates the engine control and starting system. The starter will begin cranking and after a few seconds the engine should start. The starter will disconnect if switch is released, or when the generator voltage reaches about 90 volts AC.
2. If engine does not start after cranking 30 seconds, release Start switch. Wait two minutes and then repeat Step 1.

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

3. If engine does not start on second try, check the fuel supply and be sure system has been primed. See Fuel System in the Maintenance section.

Remote Starting

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

Start-Up Checks

Check all gauges on control box after the engine is started. Observe the oil pressure gauge immediately.

Oil Pressure Gauge: The oil pressure should be in the range of 3 to 3.5 bar/30 to 55 psi (207 to 380 kPa) when the engine is at operating temperature.

DC Voltmeter: Normal B+ voltages during operation should be 27 to 30 volts.

Water Temperature Gauge: The water temperature should stabilize between 165° to 195°F (74° to 91°C) depending on the load and ambient temperature.

STOPPING PROCEDURE

Before Stopping

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

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

To Stop: Hold the Start/Stop switch or the remote starting switch to the Stop position.

OPERATING RECOMMENDATIONS

Break-In

Drain and replace the crankcase oil after the first 50 hours of operation on new generator sets. Refer to the MAINTENANCE section of this manual for the recommended procedures.

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.

Exercise Period

Exercising the generator set will keep the engine parts lubricated, maintain fuel prime, and insure reliable starts. Each week, run the set with load for a minimum of 30 minutes so normal operating temperatures are reached. Top off the fuel tank after each exercise period.

TROUBLESHOOTING

DC Control

The DC control has a number of sensors that continuously monitor the engine for abnormal conditions such as low oil pressure, high coolant temperature, high exhaust temperature, optional overspeed and low coolant level fault sensors. (See Figure 2-2 for sensor locations.) If any one of these conditions occur, the control stops the engine.

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

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

After correcting any shutdown problem, be sure to depress (reset) the Fault Reset breaker.

Low Oil Pressure: Remove dipstick and check oil level. If low, add oil to bring level up to full mark. Inspect engine exterior for leaks and repair as necessary. The oil pressure switch actuates the fault circuit if pressure drops below 14 psi (97 kPa).

High Coolant Temperature: If fault occurred during operation, observe Coolant Temperature Gauge (option)

for indication of temperature over 222° F (106°C). The coolant thermostat switch closes at this temperature and actuates the fault circuit.

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

Ensure pump belt is OK and has proper tension; ensure sea water flow at exhaust outlet is about 15 ga/min (57 liter/min). Also check cooling system cleanliness (freedom from contaminants, rust, sludge build-up, etc.).

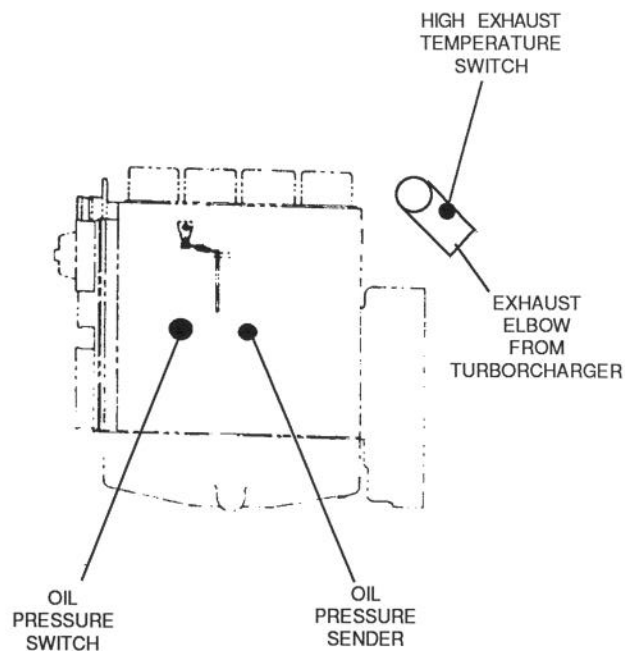
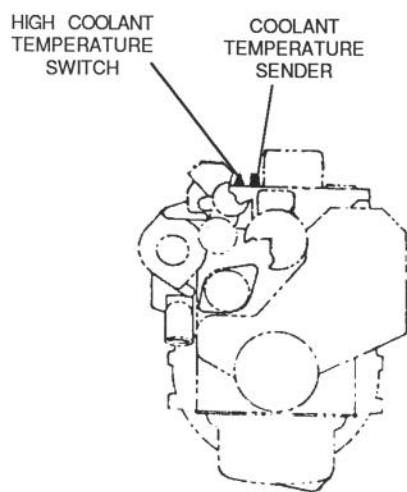
High Exhaust Temperature: The high exhaust temperature switch is mounted on the exhaust elbow and closes on temperature rise above 190°F (88°C). It will open again when temperature reaches about 165°F (74°C) and functions to protect exhaust system hoses.

⚠ WARNING

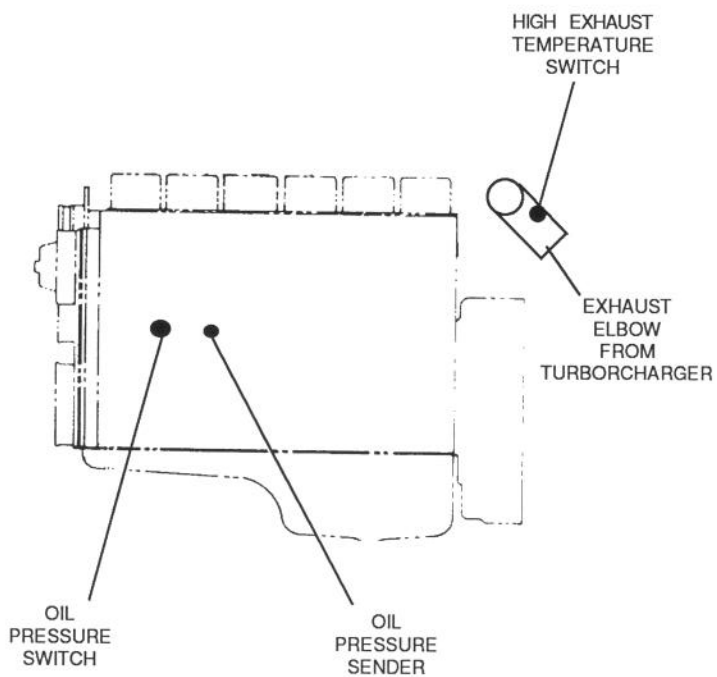
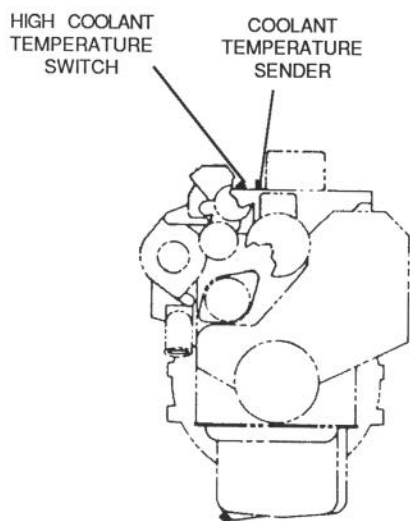
Inhalation of exhaust gas can result in severe personal injury or death. Do not disconnect or bypass the exhaust elbow switch. Excessive heat might damage exhaust hoses and cause exhaust gas leakage.

High exhaust elbow temperature is caused in insufficient or lack of sea water flow. Sea water flow at exhaust outlet should be about 15 gal/min (57 liter/min).

Low Coolant Level (Optional): This electronic sensor completes the fault circuit if coolant level falls below the sensor's location on engine. It provides an added level of engine protection.



4BT3.9 ENGINES

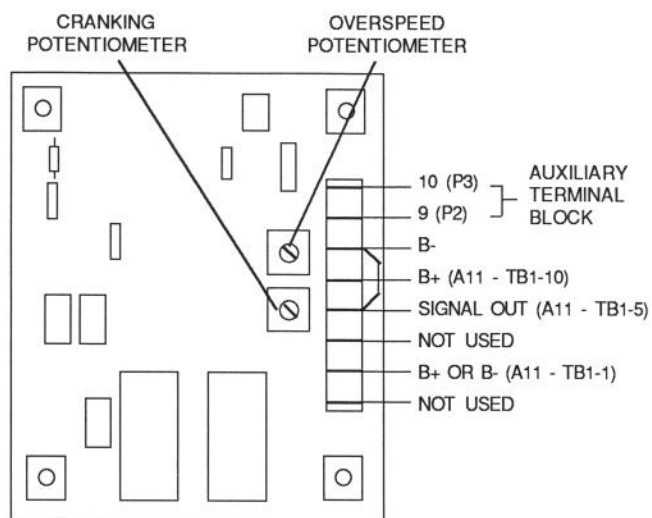


6BT5.9 ENGINES

FIGURE 2-2. FAULT SENSOR LOCATIONS

Overspeed Shutdown (Optional): Is controlled by an Overspeed (Frequency Detection) Module. This module derives a speed (Hz) signal from the PMG but is powered from the generator set battery. A small time delay, typically one second, is incorporated in the overspeed function to allow for engine overshoot. The module contains two adjustable potentiometers, Overspeed and Cranking (the cranking potentiometer is not used however).

The Overspeed potentiometer is adjustable from 1500 to 2500 RPM. Adjust the Overspeed potentiometer to achieve overspeed at approximately 1710 to 1740 RPM for 50 Hz units and 2010 to 2040 RPM for 60 Hz units. See typical wiring diagram in Figure 2-3.



ES-1859

FIGURE 2-3. OVERSPEED (FREQUENCY DETECTION) MODULE

Section 3. Installation

GENERAL

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

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

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

The instructions in this manual should be used only as a guide as each installation must be considered on an individual basis. Helpful guidance for the installer is available in the following publications:

ABYC "Safety Standards for Small Craft" from—

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

NFPA302 "Fire Protection Standard for Motor Craft" from—

NFPA
470 Atlantic Ave.
Boston, MA 02210
U.S.A

USCG 33CFR183 from—

U.S. Government Printing Office
Washington, D.C. 20404
U.S.A

Onan Technical Bulletin T-021
"Marine Electric Generating Sets"

LOCATION

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

United States Coast Guard (USCG) regulation 33CFR183 pertains to gasoline fuel systems and requires a generator set operating in a gasoline fuel environment to be "ignition protected."

This diesel generator set is not certified to operate in a gasoline fueled environment but is not required to meet the 33CFR183 regulation when used in a diesel fueled environment.

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

MOUNTING

The floor should be flat and give support directly under the entire genset mounting base, refer to appropriate Outline Drawing for mounting hole locations and overall dimensions. Use approved exhaust line, fuel line, battery cables and electrical wiring conduit.

The Onan Acoustic Enclosure is an option available for noise reduction. It is an insulated enclosure completely surrounding the generator set (Figure 3-1). Openings are provided for connection to all external lines and wires. Internal air ducts reduce airborne noise to a minimum. Contact your Onan dealer for details.

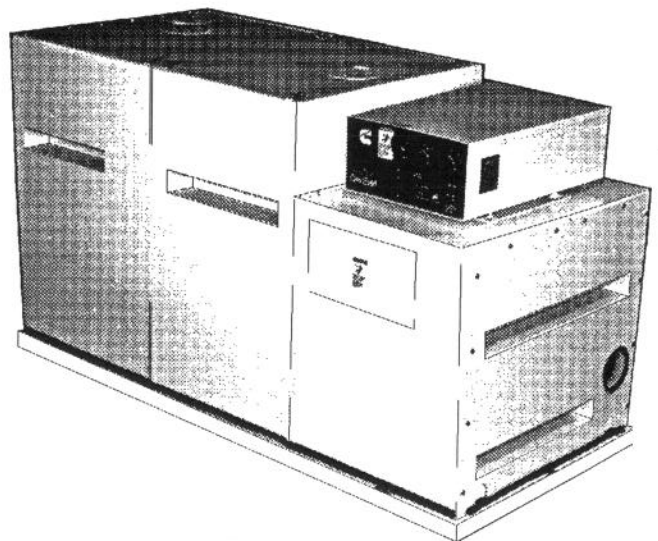


FIGURE 3-1. GENSET ACOUSTIC ENCLOSURE

SPECIFICATIONS

MDBA

GENERATOR DETAILS

Type	Newage/Onan, Revolving Field, 4-Pole, Brushless
Rating:	
60 Hertz General Marine Rating, 3-phase	37kW, 46kVA at 0.8PF
50 Hertz General Marine Rating, 3-phase	32kW, 40kVA at 0.8PF
60 Hertz Continuous Rating, 3-phase	33kW, 41kVA at 0.8PF
50 Hertz Continuous Rating, 3-phase	29kW, 36kVA at 0.8PF
AC Voltage Regulation:	
Electronic Regulation	±1.5%

ENGINE DETAILS

Engine	Cummins 4B3.9G
Engine Speed (r/min)	
60 Hertz	1800
50 Hertz	1500
Fuel	No. 2 Diesel
Fuel Inlet Size	1/4 - 18 NPFT
Fuel Return Outlet Size	0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)	5 feet (1.525m)
Average Fuel Consumption:	
60 Hertz, 37 kW, Full Load	3.0 gph (11.4 L/h)
Half Load	1.6 gph (6.1 L/h)
50 Hertz, 32 kW, Full Load	2.5 gph (9.5 L/h)
Half Load	1.3 gph (4.9 L/h)
Exhaust Outlet Hose Fitting	3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:	
Cold Cranking Amps @ 0°F (-18°C)	625
Battery Voltage, Standard System	24
Quantity Required	Two 12-Volt batteries in series
Cooling System Capacity	4.75 US gal (18.0L)
Engine Oil Capacity (Filter, Lines, Crankcase)	2.6 US gal (10.0L)
Ventilating Air Requirements:	
60 Hertz Combustion	104 cu.ft./min (2.9 m³/min.)
50 Hertz Combustion	87 cu.ft./min (2.5 m³/min.)
60 Hertz Generator Cooling	393 cu.ft./min (11.1 m³/min.)
50 Hertz Generator Cooling	282 cu.ft./min (8.0 m³/min.)
Sea Water Flow Rate	
60 Hz	18.5 gpm (70 L/m)
50 Hz	15.3 gpm (58 L/m)
Water Inlet	1.25 in. (31.8 mm) O.D. Tube

SPECIFICATIONS (Continued)

MDCA

GENERATOR DETAILS

Type	Newage/Onan Revolving Field, 4-Pole, Brushless
Rating:	
60 Hertz General Marine Ratings, 3-phase	52kW, 65kVA at 0.8PF
50 Hertz General Marine Ratings, 3-phase	44 kW, 55 kVA at 0.8 PF
60 Hertz Continuous Rating, 3-phase	47 kW, 59kVA at 0.8PF
50 Hertz Continuous Rating, 3-phase	Not Available
AC Voltage Regulation:	
Electronic Regulation	±1.5%

ENGINE DETAILS

Engine	Cummins 4BT3.9G1
Engine Speed (r/min)	
60 Hertz	1800
50 Hertz	1500
Fuel	No. 2 Diesel
Fuel Inlet Size	1/4 - 18 NPFT
Fuel Return Outlet Size	0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)	5 feet (1.525 m)
Average Fuel Consumption:	
60 Hertz, 52 kW, Full load	3.9 gph (14.8 L/h)
Half Load	2.2 gph (8.3 L/h)
50 Hertz, 44 kW, Full Load	3.3 gph (12.5 L/h)
Half Load	1.8 gph (6.8 L/h)
Exhaust Outlet Hose Fitting	3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:	
Cold Cranking Amps @ 0°F (-18°C)	625
Battery Voltage, Standard System	24
Quantity Required	Two 12-Volt batteries in series
Cooling System Capacity	5.3 US gal (20L)
Engine Oil Capacity (Filter, Lines, Crankcase)	2.6 US gal (10L)
Ventilating Air Requirements:	
60 Hertz Combustion	135 cu.ft./min (3.8 m³/min.)
50 Hertz Combustion	116 cu.ft./min (3.3 m³/min.)
60 Hertz Generator Cooling	339 cu.ft./min (9.6 m³/min.)
50 Hertz Generator Cooling	310 cu.ft./min (8.8 m³/min.)
Sea Water Flow Rate	
60 Hz	18.5 gpm (70 L/m)
50 Hz	15.3 gpm (58 L/m)
Water Inlet	1.25 in. (31.8 mm) O.D. Tube

SPECIFICATIONS (Continued)

MDCB

GENERATOR DETAILS

TypeNewage/Onan Revolving Field, 4-Pole, Brushless
Rating:
60 Hertz General Marine Rating, 3-phase60kW, 75kVA at 0.8PF
50 Hertz General Marine Rating, 3-phaseNot Available
60 Hertz Continuous Rating, 3-phase54 kW, 68 kVA at 0.8PH
50 Hertz Continuous Rating, 3-phaseNot Available
AC Voltage Regulation:
Electronic Regulation1.5%

ENGINE DETAILS

EngineCummins 4BT3.9G2
Engine Speed (r/min)
60 Hertz1800
FuelNo. 2 Diesel
Fuel Inlet Size1/4-18 NPFT
Fuel Return Outlet Size0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)5 feet (1.525 m)
Average Fuel Consumption
Full Load4.6 gph (17.4 L/h)
Half Load2.8 gph (10.6 L/h)
Exhaust Outlet Hose Fitting3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:
Cold Cranking Amps @ 0°F (-18°C)625
Battery Voltage, Standard System24
Quantity RequiredTwo 12-Volt batteries in series
Cooling System Capacity5.3 US gal (20L)
Engine Oil Capacity (Filter, Lines, Crankcase)2.6 US gal (10L)
Ventilating Air Requirements:
Combustion143 cu.ft./min (4.1 m³/min.)
Generator Cooling339 cu.ft./min (9.6 m³/min.)
Sea Water Flow
60 Hz18.5 gpm (70 L/m)
Water Inlet1.25 in. (31.8 mm) O.D. Tube

SPECIFICATIONS (Continued)

MDDM

GENERATOR DETAILS

Type	Newage/Onan Revolving Field, 4-Pole, Brushless
Rating:	
60 Hertz General Marine Rating, 3-phase	62kW, 78kVA at 0.8PF
50 Hertz General Marine Rating, 3-phase	53kW, 66kVA at 0.8PF
60 Hertz Continuous Rating, 3-phase	56kW, 70kVA at 0.8PF
50 Hertz Continuous Rating, 3-phase	48kW, 60kVA at 0.8PF
AC Voltage Regulation:	
Electronic Regulation	±1.5%

ENGINE DETAILS

Engine	Cummins 6B5.9G
Engine Speed (r/min)	
60 Hertz	1800
50 Hertz	1500
Fuel	No. 2 Diesel
Fuel Inlet Size	1/4 - 18NPFT
Fuel Return Outlet Size	0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)	5 feet (1.525m)
Average Fuel Consumption:	
60 Hertz, 62kW, Full Load	4.7 gph (17.8 L/h)
Half Load	2.8 gph (10.6 L/h)
50 Hertz, 53 kW, Full Load	4.0 gph (15.0 L/h)
Half Load	2.1 gph (8.0 L/h)
Exhaust Outlet Hose Fitting	3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:	
Cold Cranking Amps @ 0°F (-18°C)	800
Battery Voltage, Standard System	24
Quantity Required	Two 12-Volt batteries in series
Cooling System Capacity	5.3 US gal (20L)
Engine Oil Capacity (Filter, Lines, Crankcase)	3.7 US gal (14L)
Ventilating Air Requirements:	
60 Hertz Combustion	216 cu.ft./min (6.1m ³ /min.)
50 Hertz Combustion	151 cu.ft./min (4.3m ³ /min.)
60 Hertz Generator Cooling	636cu.ft./min (18.0 m ³ /min.)
50 Hertz Generator Cooling	530 cu.ft./min (15.0m ³ /min.)
Sea Water Flow Rate	
60 Hz	16.9 gpm (64 L/m)
50 Hz	13.8 gpm (52 L/m)
Water Inlet	1.25 in. (31.8 mm) O.D. Tube

SPECIFICATIONS (Continued)

MDDA

GENERATOR DETAILS

Type	Newage/Onan Revolving Field, 4-Pole, Brushless
Rating:	
60 Hertz General Marine Rating, 3-phase	85kW, 106kVA at 0.8PF
50 Hertz General Marine Rating, 3-phase	71kW, 89kVA at 0.8PF
60 Hertz Continuous Rating, 3-phase	77kW, 96kVA at 0.8PF
50 Hertz Continuous Rating, 3-phase	65kW, 81kVA at 0.8PF
AC Voltage Regulation:	
Electronic Regulation	±1.5%

ENGINE DETAILS

Engine	Cummins 6BT5.9G1
Engine Speed (r/min)	
60 Hertz	1800
50 Hertz	1500
Fuel	No. 2 Diesel
Fuel Inlet Size	1/4 - 18
Fuel Return Outlet Size	0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)	5 feet (1.525m)
Average Fuel Consumption:	
60 Hertz, 71kW, Full Load	6.4 gph (24.2 L/h)
Half Load	3.7 gph (14.0 L/h)
50 Hertz, 85 kW, Full Load	5.7 gph (21.6 L/h)
Half Load	2.5 gph (9.5 L/h)
Exhaust Outlet Hose Fitting	3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:	
Cold Cranking Amps @ 0°F (-18°C)	800
Battery Voltage, Standard System	24
Quantity Required	Two 12-Volt batteries in series
Cooling System Capacity	5.8 US gal (22L)
Engine Oil Capacity (Filter, Lines, Crankcase)	3.7 U.S. gal (14.0L)
Ventilating Air Requirements:	
60 Hertz Combustion	216 cu.ft./min (6.1m³/min.)
50 Hertz Combustion	151 cu.ft./min (4.3m³/min.)
60 Hertz Generator Cooling	636cu.ft./min (18.0 m³/min.)
50 Hertz Generator Cooling	530 cu.ft./min (15.0m³/min.)
Sea Water Flow Rate	
60 Hz	16.9 gpm (64 L/m)
50 Hz	13.8 gpm (52 L/m)
Water Inlet	1.25 in. (31.8 mm) O.D. Tube

SPECIFICATIONS (Continued)

MDDB

GENERATOR DETAILS

Type	Newage/Onan Revolving Field, 4-Pole, Brushless
Rating:	
60 Hertz General Marine Rating, 3-phase	108kW, 135kVA at 0.8PF
50 Hertz General Marine Rating, 3-phase	86kW, 108kVA at 0.8PF
60 Hertz Continuous Rating, 3-phase	98kW, 123kVA at 0.8PF
50 Hertz Continuous Rating, 3-phase	78kW, 98kVA at 0.8PF
AC Voltage Regulation:	
Electronic Regulation	±1.5%

ENGINE DETAILS

Engine	Cummins 6BT5.9G2
Engine Speed (r/min)	
60 Hertz	1800
50 Hertz	1500
Fuel	No. 2 Diesel
Fuel Inlet Size	1/4 - 18 NPFT
Fuel Return Outlet Size	0.18 in. (4.6 mm) O.D. Tube
Fuel Pump (Lifting Capacity)	5 feet (1.525m)
Average Fuel Consumption:	
60 Hertz, 62kW, Full Load	8.0 gph (30.3L/h)
Half Load	4.5 gph (17.0 L/h)
50 Hertz, 53 kW, Full Load	6.8gph (25.7 L/h)
Half Load	3.4 gph (12.9 L/h)
Exhaust Outlet Hose Fitting	3.5 in. (88.9 mm) O.D. Tube
Battery Requirements:	
Cold Cranking Amps @ 0°F (-18°C)	800
Battery Voltage, Standard System	24
Quantity Required	Two 12-Volt batteries in series
Cooling System Capacity	5.8 US gal (22L)
Engine Oil Capacity (Filter, Lines, Crankcase)	3.7 U.S. gal (14.0L)
Ventilating Air Requirements:	
60 Hertz Combustion	266 cu.ft./min (7.5m³/min.)
50 Hertz Combustion	198 cu.ft./min (5.6m³/min.)
60 Hertz Generator Cooling	636cu.ft./min (18.0 m³/min.)
50 Hertz Generator Cooling	530 cu.ft./min (15.0m³/min.)
Sea Water Flow Rate	
60 Hz	16.9 gpm (64 L/m)
50 Hz	13.8 gpm (52 L/m)
Water Inlet	1.25 in. (31.8 mm) O.D. Tube

VENTILATION

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

EXHAUST SYSTEM

General

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

1. Except for vertical dry stack systems, exhaust systems must be water cooled, the water injected as near to the generator set as possible.
2. All exhaust system sections preceding the point of cooling water injection must be either water jacketed or effectively insulated.
3. The exhaust line must be installed so as to prevent back flow of water to the engine under any conditions, and the exhaust outlet must be above the load waterline. Water flowing back to the engine will damage it.
4. The generator set exhaust system must not be combined with the exhaust system of another engine.
5. An approved, flexible exhaust line section should be used near the engine to allow for engine movement and vibration during operation.
6. Vertical dry stack exhaust systems must have spark arresters. The exhaust system between engine manifold and spark arrester must be either water jacketed or well insulated.
7. The exhaust system must be of sufficient size to prevent excessive back pressure.
8. Install exhaust through hull fitting aft of sink, shower or other cabin drains.
9. Exhaust exit should not be below the water line in sailboat applications during any normal running angle. An exhaust system siphon break may not always overcome the pressure of incoming water when generator set is not running. If at all possible, a transom exhaust pipe location is recommended. This is especially true during tacking or heeling maneuvers.
10. The exhaust system must be gas-tight, and accessible for inspection and repair throughout its entire length.

⚠WARNING

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

Material

Use material recommended by ABYC if "Safety Standard for Small Craft," Section P1. The exhaust line should be at least as large as the engine exhaust outlet.

⚠WARNING

Inhalation of exhaust gases can result in severe personal injury or death. Prevent entrance of exhaust fumes on board with the following:

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

Use flexible hose for the water-cooled section of the exhaust line for ease of installation and flexibility. A section should be installed between the engine and muffler. (Do not connect muffler directly to exhaust manifold). Make sure the hose is designed and approved for marine exhaust line use. Provide adequate support for the hose to prevent sagging, bending, and formation of water pockets. An exhaust elbow meeting ABYC specs can be used to facilitate the installation especially within a sound shield. Use two clamps at each end of hose, see Figure 3-2. To prevent vibration transmitting to the hull, use automotive type pipe hangers.

⚠WARNING

Do not install rubber hose with sharp bends as this will reduce efficiency of exhaust system. Do not use rubber hose on dry type exhaust applications. Doing so may cause hose failure and leakage of deadly exhaust gas.

Back Pressure

Exhaust back pressure is an important criteria of an adequate exhaust system. If the installation is excessively long, back pressure should be checked. Exhaust back pressure should not exceed 3 inches (76 mm) of mercury (10 kPa).

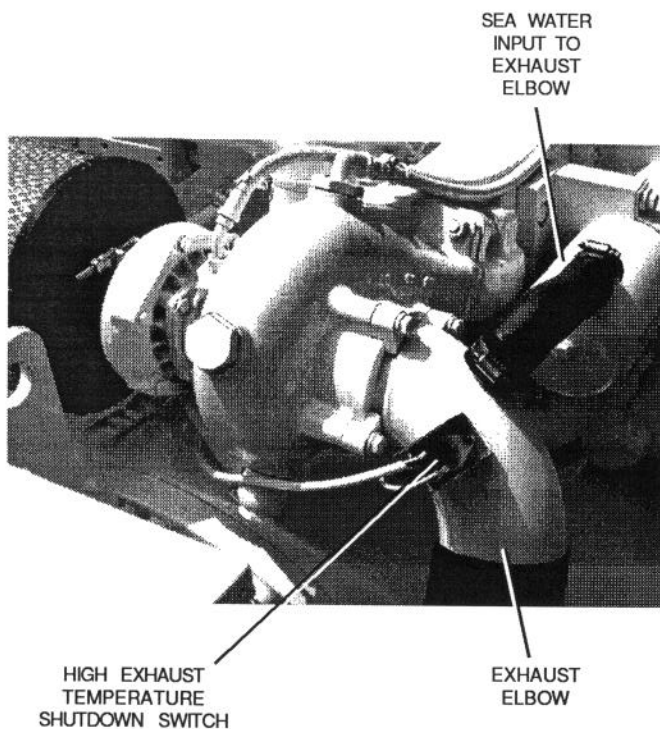


FIGURE 3-2. HIGH EXHAUST TEMPERATURE CUT-OUT SWITCH

Exhaust Cooling Water Injection

The neoprene impeller pump moves the sea water through the cooling system and into the sea water injection elbow. The injected water cools the exhaust and prevents exhaust system damage from heat. A temperature operated switch on the exhaust elbow shuts the unit down if overheating occurs. See Figure 3-2. The switch closes if temperature reaches 185° to 195°F (85° to 91° C) and actuates the Fault Reset breaker on the control panel.

⚠ CAUTION

DO NOT USE SCOOP TYPE WATER INLET FITTINGS when installing a hydrodynamic muffler. Forward facing scoops develop sufficient ram pressure to force water past the set's water pump, flooding the exhaust system where it can flow back, flooding the engine cylinders. Rear facing scoops develop vacuum which can impede cooling water flow.

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

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

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

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

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. The exhaust line must be installed to prevent backflow of water to the engine under all conditions.

There are several methods of eliminating water from the engine. All are based on separating the water injection point a few inches from the engine and installing a sharp drop in the exhaust line that water can't normally flow over. These methods are divided into two general categories; above water line installation, and below water line installation. (See Figure 3-3, and others that follow.)

Some mufflers are designed with an integral water inlet so water can be injected at the muffler, and the muffler itself serves as an additional water barrier. This type of muffler should be installed close as possible to the exhaust manifold with a seamless stainless steel flexible section between the muffler and the manifold (dry stack system only).

⚠ WARNING

Do not use the manifold as a muffler support because it puts excessive strain on the connecting exhaust line and can cause it to break causing deadly exhaust gases to leak.

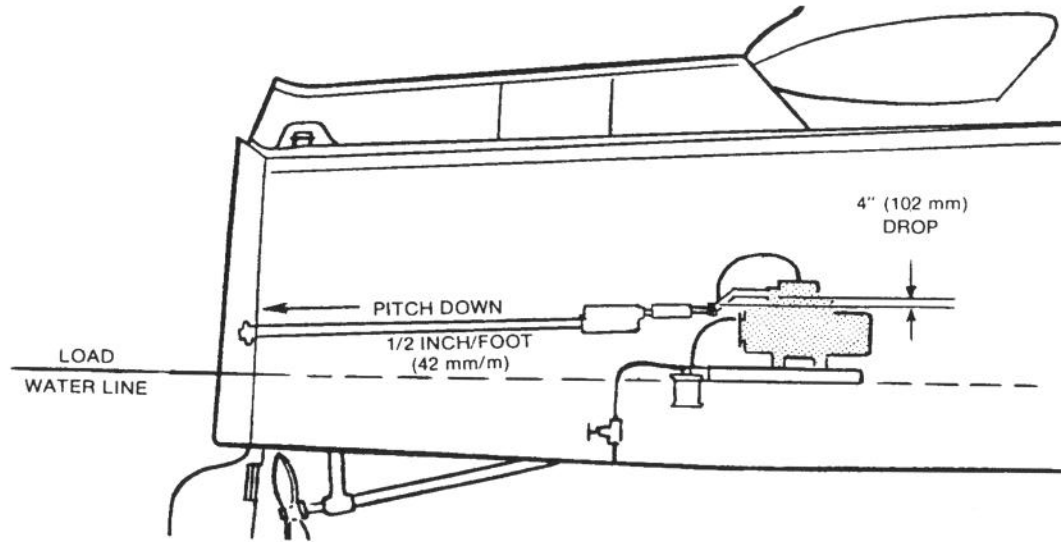


FIGURE 3-3. EXHAUST LINE INSTALLATION

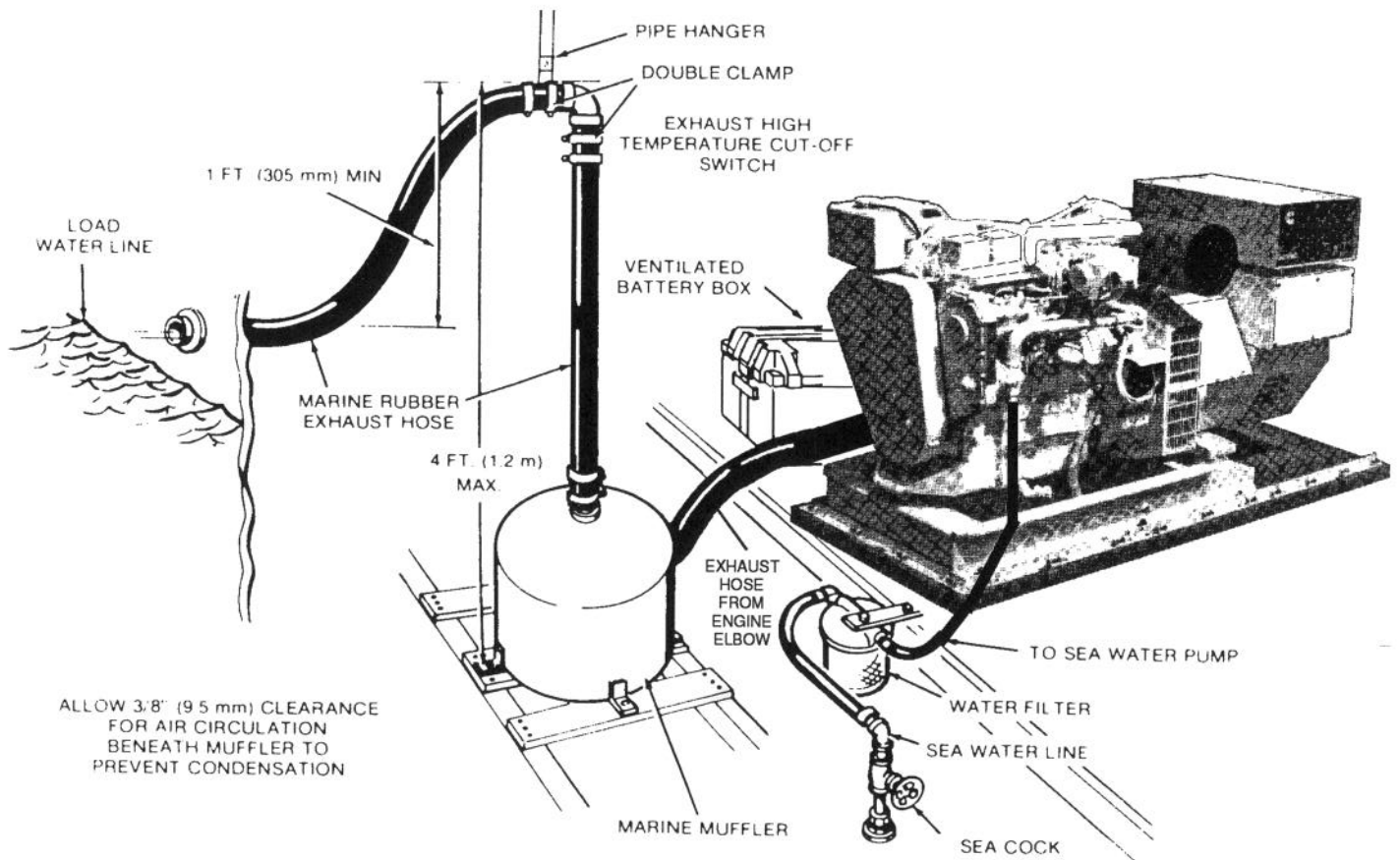


FIGURE 3-4. TYPICAL BELOW WATER LINE INSTALLATION WITH LIFT-TYPE MUFFLER

COOLING SYSTEM

Throughout this manual, flotation water drawn into the boat for engine cooling will be called *sea water*. Water recirculated through a closed system will be called *captive water*.

The electric generator set uses heat exchanger cooling. The heat exchanger is an integral part of the engine cooling water circuit.

This closed cooling system pumps captive water through the engine water jackets, exhaust manifold and heat exchanger. In the heat exchanger, the hot captive water is piped through a bath of cool sea water.

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

A sea water pump is used to constantly renew the water bath in the heat exchanger and discharge the heated sea water into the exhaust line. The maximum lift of the pump is 10 feet (3 m).

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

⚠CAUTION

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

FUEL SYSTEM

In all diesel engine installations, fuel system cleanliness is of utmost importance. Make every effort to prevent entrance of moisture or other contaminants.

Carefully clean all separate diesel fuel system components before installation and putting the unit into operation.

⚠CAUTION

Dirt or water in the fuel system is the major cause of diesel engine failure. A tiny piece of dirt or a few drops of water in the injection system can stop the unit.

The inlet on the fuel pump is threaded for 1/4 inch pipe connector. The return line is 0.18 O.D. pipe. Ensure that the fuel line is properly installed. Fuel return stoppage can stop the engine or result in intermittent operation. Refer to outlines for location of fuel system components.

Always use approved flexible hose (non-wire reinforced) between engine and the fuel supply and return lines.

If the main propulsion engine uses diesel fuel, it may be possible to use the same existing fuel tanks to supply the marine generator set. However, before that decision is made, the following factors must be considered.

1. Adequate fuel capacity. Fuel consumption varies with load, engine speed and model. Check carefully (see *Specifications* section) the usage of both the propulsion and generator set engines to determine tank capacity.
2. Distance of tanks from generator set. Fuel lift and restrictions to the fuel pump should not allow suction to exceed 2.5 psi (17 kPa) at the pump inlet. The pump maximum lift is 5 feet (1.525 m). If these values are exceeded, it will require installation of either an additional fuel pump or a separate tank.

Maximum back pressure at the fuel return line connector on the injector pump should not exceed 5.0 psi (34 kPa) at rated speed and power. This pressure is a function of fuel flow rate, tank height, line size and length.

The lines to the main propulsion engine and the generator set engine should not be connected together. The generator set transfer pump has neither the power nor capacity to overcome the suction of the propulsion engine pump, and could cause erratic operation.

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. Return lines should enter that tank as far as possible from the supply lines.

⚠CAUTION

Never use galvanized or copper fuel lines, fittings or fuel tanks with diesel fuel systems. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The molecular structure of the copper or galvanized lines or tanks reacts with the acid and contaminates the fuel.

⚠WARNING

Fuel leaks create fire and explosion hazards which can result in severe personal injury or death. Always use approved flexible tubing between engine and the fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.

ELECTRICAL CONNECTIONS

General

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

⚠ WARNING *Accidental starting of the generator set during installation creates a hazard of serious personal injury or death. Do not connect the starting batteries until instructed to later in this section.*

Generator Voltage Connections

The generator output voltage and maximum current rating are specified on the generator set data tag. Line-to-neutral voltage is always the lower voltage shown on the data tag and line-to-line voltage is the higher rating.

These generators can be configured for the voltages shown in Reconnection Diagram (see Figure 3-6). Most of these generators must be reconnected by the installer to give the voltage required for the installation. Before shipping, the factory tests the generator set output by connecting the generator to produce a particular test voltage. The generators may be connected at the factory to produce a specified voltage per customer order. The installer must always check the stator lead terminal block connections and perform any necessary reconnect to obtain the voltage desired.

Refer to Reconnection Diagram (see Figure 3-6) when reviewing the voltage connection information; and use the electrical schematic supplied with your generator set when actually performing load connections.

⚠ CAUTION *Reconnecting factory connected generator sets to lower voltages may reduce set ratings, and also render line circuit breakers too small. Consult with your distributor before performing reconnection for different voltage.*

Line Circuit Breakers

Line breakers must be installed to protect the generator from short circuit or other overloads.

Load Connections

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

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

Connecting the Load: All loads are connected to the generator by bolting the load wires to the appropriate terminals on the generator terminal block (see Figure 3-6). The terminals are stamped U, V, W, and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2, and L3; and N with L0 respectively.)

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

Load Balancing

When connecting loads to the generator set, balance the loads so the current flow from each line terminal (L1, L2, and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value and no line current exceeds the nameplate rating of the generator. Check the current flow from each line after connections by observing the control panel ammeter.

Dockside Power Connection

Most boats incorporate a dockside connection so the boat can be plugged directly into a commercial source while at dock. If this is done, include a switch to transfer the load between the generator set and dock power (Figure 3-5). The switch must never permit the generator and power line source to be connected together, nor permit arc-over between them.

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

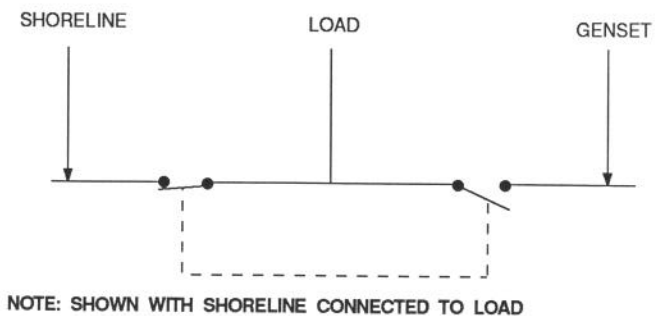
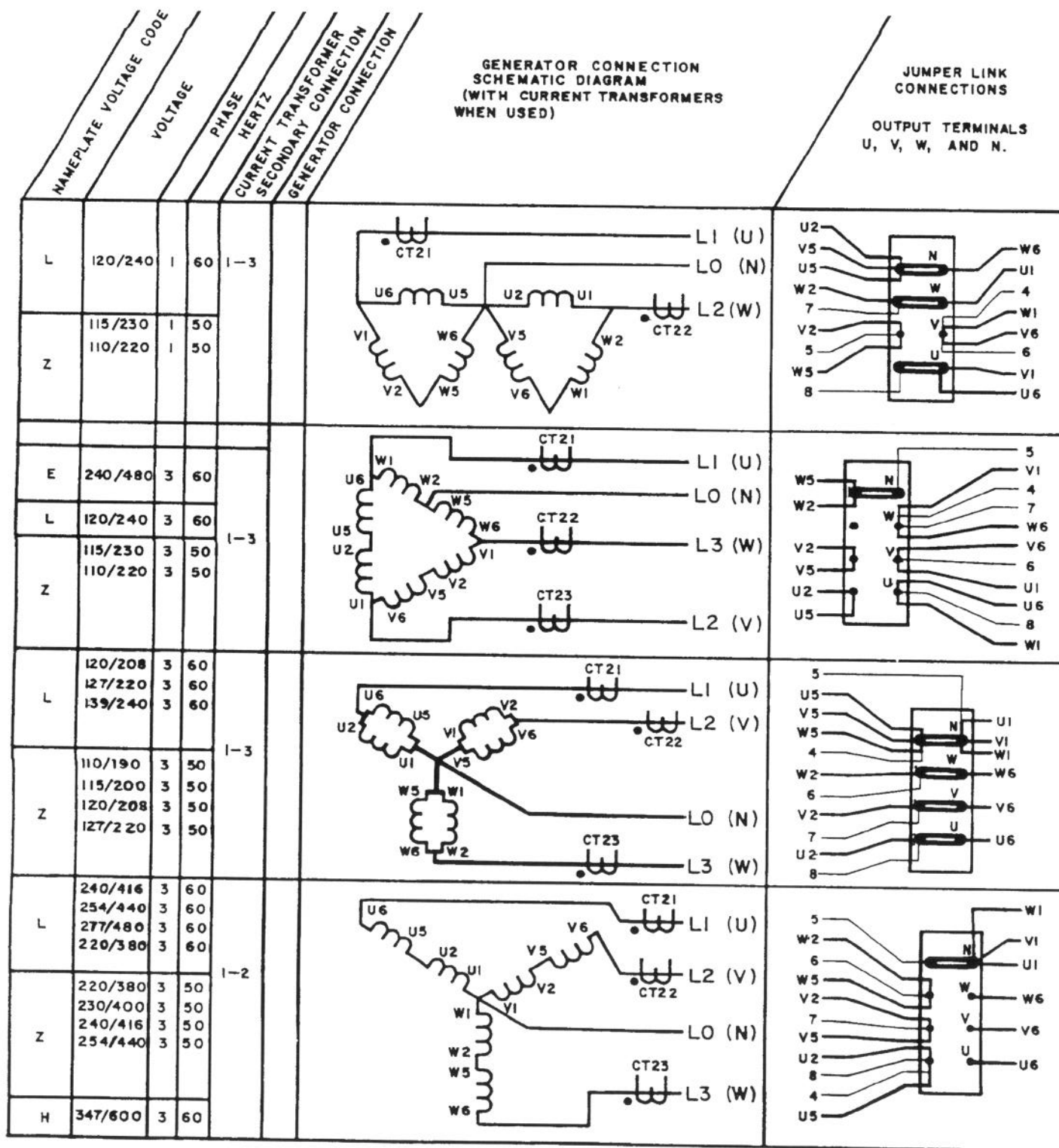


FIGURE 3-5. LOAD TRANSFER SWITCH



Ref. 98-5106

FIGURE 3-6. GENERATOR VOLTAGE CONNECTIONS (RECONNECTION DIAGRAM)

Remote Control Connections

Provision is made for connecting remote start/stop control stations to the generator set. Onan has available two remote control kits complete with instructions for making the installation. The basic switching function is shown in Figure 3-7 with connections to the Engine Monitor board terminal block in the control box. The switch is a single-pole, double-throw momentary on, center-off type.

Additional control stations may be added if desired. Use minimum 16 AWG multi-strand wire between the remote station and the generator set and follow all code requirements.

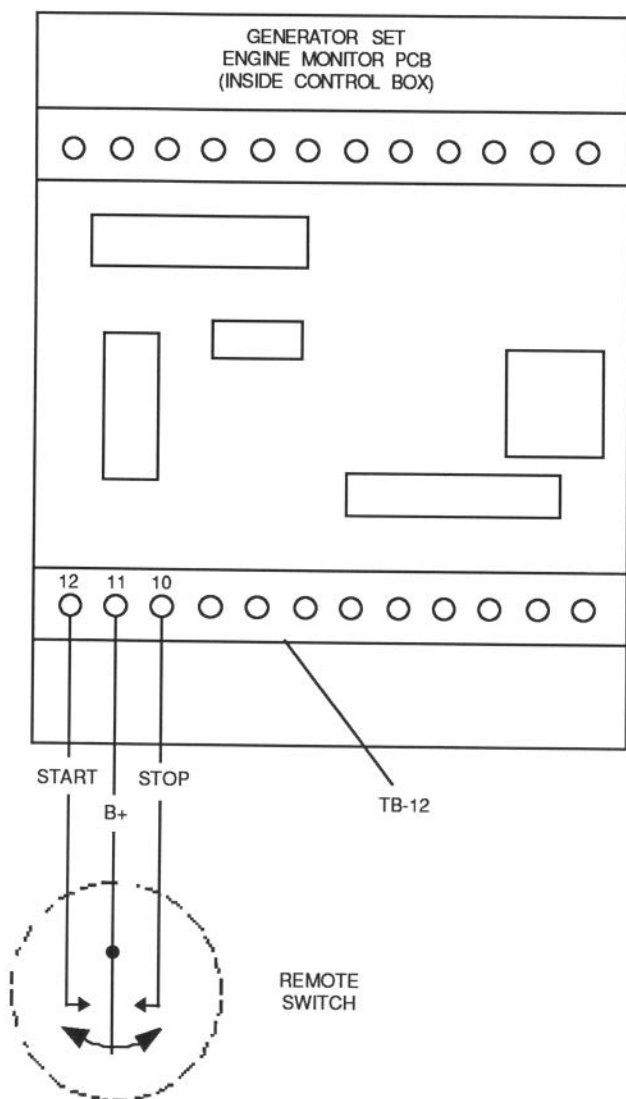


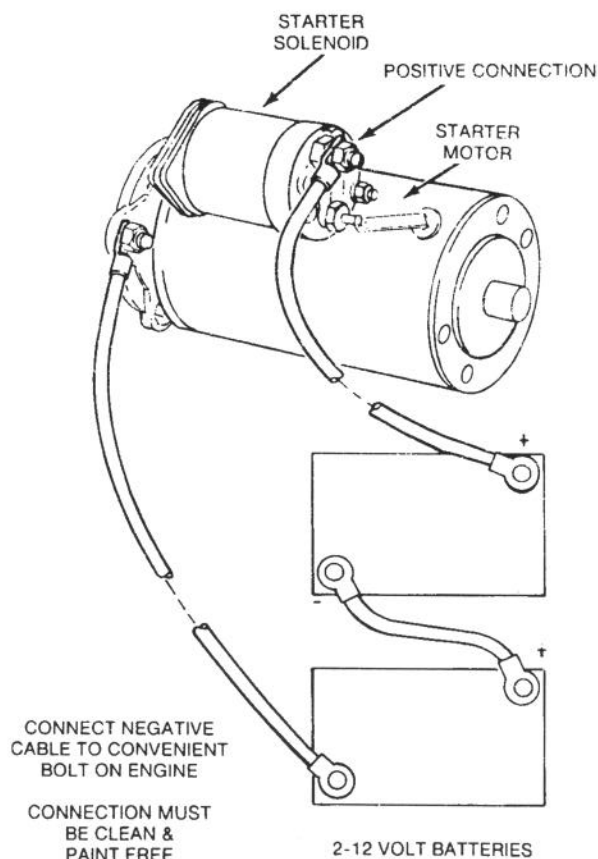
FIGURE 3-7. REMOTE CONTROL CONNECTION (BASIC FUNCTION)

Battery Connections

Starting the unit requires 24-volt battery current. Use two 12-volt (see *Specifications*) batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second) as shown in Figure 3-8. Normal installation battery cables are included. Increase the cable size if batteries are located remotely from generator set. 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

Ignition of explosive battery gases can cause severe personal injury. Do no smoke while servicing batteries.



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FIGURE 3-8. BATTERY CONNECTIONS

PRESTART PREPARATIONS

Before attempting the initial starting of the generator set, be sure it is serviced and ready for operation. Fill the coolant, lubrication and fuel systems and prime the lubrication and fuel systems.

Coolant

Engine coolant is drained prior to shipment. Before starting, fill the coolant system with the recommended coolant per the *Maintenance* section, Coolant instructions.

Lubrication

Engine lubrication is drained prior to shipment. Before starting, fill and prime the lubrication system with oil as follows:

1. Remove oil inlet line from turbocharger housing (Figure 3-9), fill bearing housing with clean engine lubricating oil; replace line, secure.

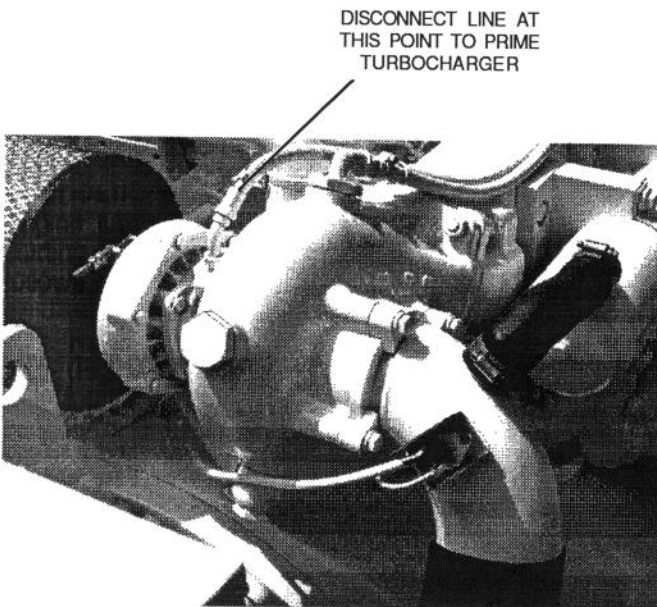


FIGURE 3-9. PRIMING TURBOCHARGER

2. Fill crankcase to "L" (low) mark on dipstick (Figure 3-10).
3. Disconnect wire from fuel solenoid valve, and crank engine for approximately 20 seconds to prime engine.
4. Reconnect wire to fuel Shut-off valve.
5. Complete oil fill to "H" (high) mark on dipstick.

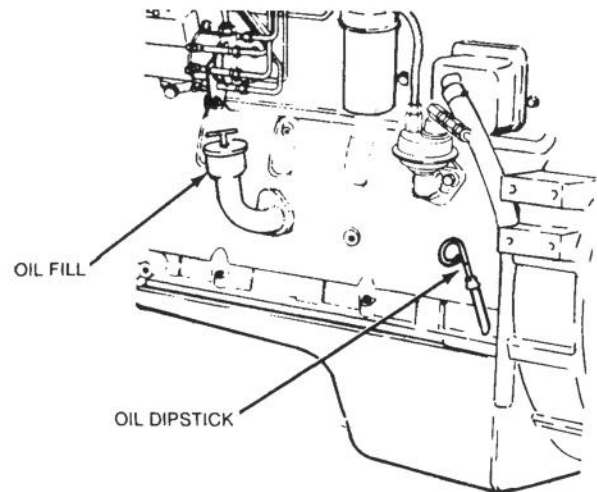


FIGURE 3-10. OIL FILL AND DIPSTICK LOCATIONS

Fuel System

⚠CAUTION

Premature failure of engine fuel pump and other engine components may occur if fuel system is not equipped with a fuel/water separator. Be sure that a fuel/water separator is installed between fuel supply and generator set.

Engine fuel may not be primed at the fuel filters after shipment. To verify and reprime the fuel system perform the following procedure:

1. Remove fuel filter (Figure 3-11) and fill with clean fuel.
2. Put a light coat of fuel on the sealing gasket.
3. Install and tighten by hand until the gasket just touches the filter head.
4. Tighten the filter an additional one-half to three-fourths of a turn.
5. Bleed the Fuel System. Refer to Cummins Engine Manual.

⚠WARNING

Fuels can ignite causing severe personal injury or death. Do not allow any spark, flame, cigarette, pilot light, etc. when working with fuel system.

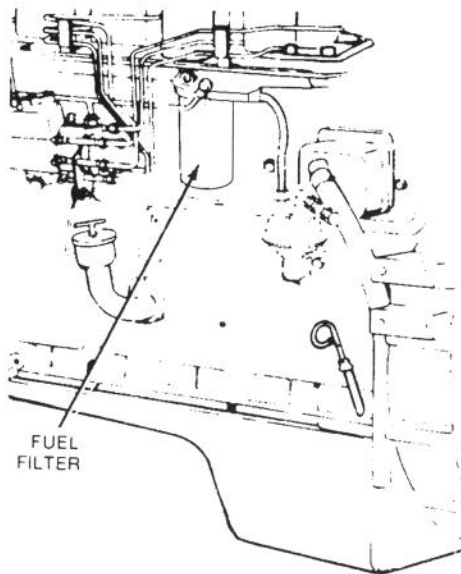


FIGURE 3-11. FUEL FILTER

Ventilation

Verify all air vents and ducts are open and free of any obstructions. Verify dampers, if used, operate properly.

Exhaust System

Check the exhaust system for proper installation. Verify there is at least 12 inches (305 mm) clearance between exhaust pipes and any combustible materials.

Electrical System

Verify all electrical connections are secure and all wiring is complete. Replace and secure any access panels that may have been removed during installation.

Battery Connections: Use two 12-volt batteries for a normal installation. Connect positive battery cable before connecting negative battery cable to prevent arcing.

Service the battery as necessary. If an automatic transfer switch is not used or is installed without a built-in charge circuit, connect a special float charger to the battery.

Load Connections: Check that load cables from generator set are properly connected to either a transfer switch or circuit breaker panel.

Mechanical Check

Check the generator set for loose or damaged components and repair or replace as required.

PREPARING GENERATOR SET FOR OPERATION

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

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

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

Connect Starting Batteries

Starting battery requirements are 24 volts (see Specifications section). Figure 3-12 shows the standard 24-volt installation. Battery cables are optional accessories and not supplied with the generator set.

Infrequent unit use may allow batteries to self-discharge to where they cannot start the generator set. This condi-

tion will require a special float charger powered by shore-line power when the boat is docked.

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

INITIAL STARTING AND CHECKS

Before starting set, prime the sea water pump as outlined in the *Operation* section.

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

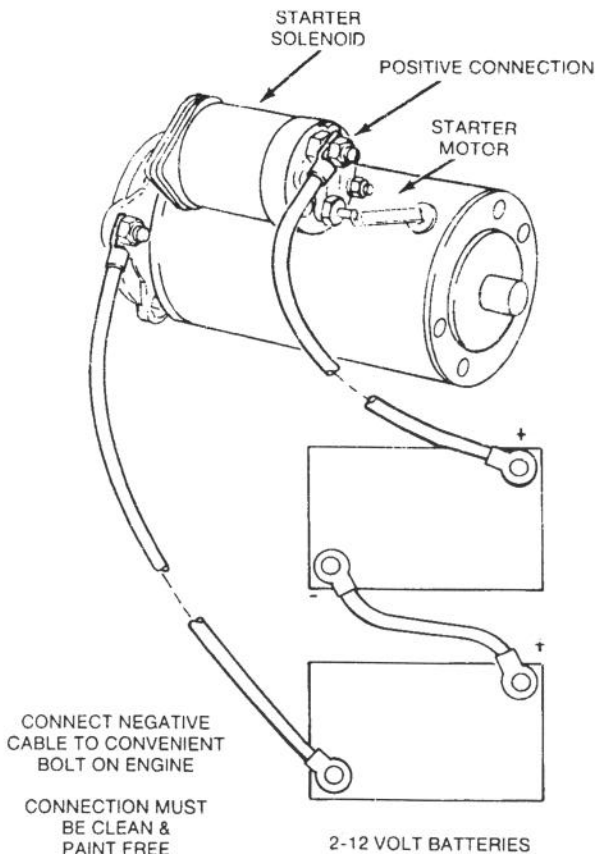
1. Start the generator set by holding the Start/Stop switch on the engine control panel to the Start position. The starter should crank and the engine should start within a few seconds. Release Start button.
2. Monitor the engine control panel and note the oil pressure, coolant temperature, and battery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

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

4. Check the generator set for fuel, oil or coolant leaks. If any are found, shut down the generator set and repair leak before making any more checks.
5. Check generator output voltage and frequency. Connect an accurate AC voltmeter and frequency meter across two line terminals. The voltage can be adjusted if not within specs. Refer to the *Adjustments* section.

WARNING *High voltages are present within the control cabinet which can cause severe personal injury or death. Proceed with care!*

Output frequency is determined by engine speed and normally does not require adjustment. If assistance is needed, refer to the *Adjustments* section.



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FIGURE 3-12. BATTERY CONNECTIONS

Section 4. Maintenance

PERIODIC MAINTENANCE

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. The table below covers the recommended service intervals for a generator set on STANDBY service. If the set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with an authorized distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use Table 4-1 to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

⚠WARNING

Accidental starting of the set can cause severe personal injury or death. Disconnect the battery cables (ground cable first) when repairs are made to the engine, controls, or generator.

TABLE 4-1. MAINTENANCE SCHEDULE

MAINTENANCE CHECKS	SERVICE TIME				
	Daily or after 8 hours	Weekly or after 50 hours	Monthly or after 100 hours	3 Months or after 250 hours	6 Months or after 500 hours
Inspect Generator Set	x ¹				
Check Coolant Heater	x				
Check Oil Level	x				
Check Coolant Level	x				
Check/Drain Fuel/Water Separator	x				
Check Air Cleaner (clean if required)		x ²			
Check Battery Charging System		x			
Drain Water/Sediment from Fuel Tanks		x ³			
Check Antifreeze and DCA Concentration			x		
Check Drive Belt Tension			x ⁴		
Check Fuel Level			x		
Drain Exhaust Condensation Trap			x		
Check Battery Level/Specific Gravity			x		
Check Generator Air Outlet			x		
Clean Generator Assembly				x	
Change Crankcase Oil and Filter				x ²	
Check Heat Exchanger Plugs (if equipped)				x	
Check Governor Adjustment				x	
Change Air Cleaner Element					x ²
Change Fuel Filters					x
Clean Cooling System					x
Adjust Valve Lash	After 1000 hours ⁵				

¹ - Check for oil, fuel, cooling, and exhaust leaks. Check exhaust system audibly and visually with the generator set running. Repair any leaks immediately.

² - Perform more often in extremely dusty conditions.

³ - Drain 1 cup or more of fuel to remove water and sediment.

⁴ - Visually check belts for evidence of slippage.

⁵ - Contact an authorized service center for service.

GENERATOR SET INSPECTION

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

Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly, including the exhaust manifold, turbocharger, muffler, and exhaust pipe. Check sea water pump operation by observing sea water discharge from exhaust outlet (See Specifications for flow). Check for leaks at all connections, welds, gaskets, and joints. If any leaks are detected, shut down the generator set and have leaks corrected immediately.

▲WARNING *Inhalation of exhaust gases can result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors or other inlets to building.*

Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, have them corrected immediately.

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

DC Electrical System

Check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always disconnect both ends of the negative battery cable. Reconnect one end of the cable to the negative battery terminal and the other end to ground. Following this sequence will help to reduce arcing at the battery.

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

▲WARNING *Accidental starting of the generator set can cause severe personal injury or death. Place the control switch in STOP position and disconnect the battery cable before inspecting generator set.*

Mechanical

With the generator set stopped, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately. With the set running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate anything that indicates possible mechanical problems.

LUBRICATION SYSTEM

The engine lubrication system must be primed and filled with oil of the recommended classification and viscosity. Refer to the SPECIFICATIONS section for the lubricating oil capacity.

Oil API Classification

The lubricating oil recommended for turbocharged diesel engines is API (American Petroleum Institute) Class CC/CD with a maximum sulphated ash content of 1.85 percent. Oils in this class satisfy the engine manufacturer's recommendations for satisfactory operation under most conditions. A book entitled "Lubricating Oils Data Book" is available from EMA (Engine Manufacturers Association) that lists the commercially available oils by brand name and the corresponding API classification. Once an oil is selected, do not mix it with oils of another classification or brand.

Oil Viscosity

The viscosity of an oil is a measure of its resistance to flow at certain specified temperatures. Oils that can meet both low 0°F or -18° C) and high (212°F or 100°C) temperature flow requirements are labeled as multigrade or multiviscosity oils. Multigrade oils that meet the API classification requirements are recommended for use in the engine by the engine manufacturer. The use of a multigrade oil will improve oil control, improve engine cranking in cold weather, maintain adequate lubrication, and can also contribute to improved fuel economy.

Table 4-2 shows the oil viscosity grades that are recommended for various ambient temperatures. Use only the viscosity grades shown in the table. Cummins does not recommend the use of a single grade oil.

TABLE 4-2

AMBIENT TEMPERATURE	SAE VISCOSITY GRADE
-13° F (-25° C) and below	See following section
-13° to 95° F (-25° to 25° C)	10W-30
14° F (-10° C) and above	15W-40
32° F (0° C) and above	20W-40

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

Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance Table. The dipstick is stamped with high and low marks to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 15 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase. The dipstick and oil fill are located on the same side of the engine as shown in Figure 4-1.

▲WARNING Crankcase pressure can blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.

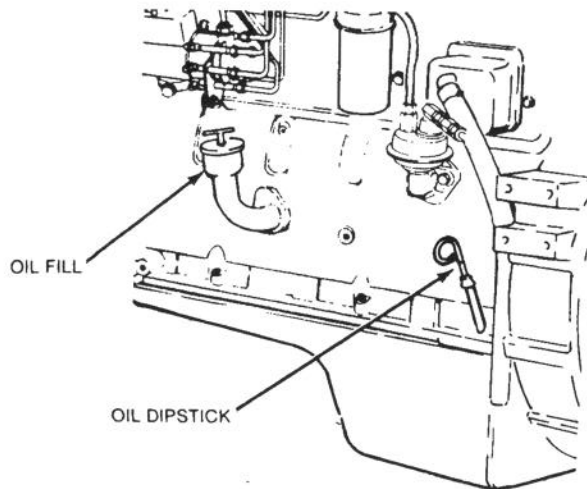


FIGURE 4-1. OIL FILL AND DIPSTICK LOCATIONS

Keep the oil level as near as possible to the high mark on the dipstick. Remove the oil fill cap (see Figure 4-2) and add oil of the same API viscosity and brand when necessary.

▲CAUTION Do not operate the engine with the oil level below the low mark or above the high mark. Overfilling can cause foaming or aeration of the oil while operation below the low mark may cause loss of oil pressure.

OIL AND FILTER CHANGE

Change the oil and filter at the intervals recommended in the maintenance table. Use oil that meets the engine manufacturer's API Classification and viscosity requirements.

Engine Oil Change

1. Bring the engine up to operating temperature and then shut it off.

2. Open the drain valve and collect the engine oil in a pan. When the crankcase is drained close the drain valve.
3. Fill the crankcase to the full mark on the dipstick. Allow for oil filters when drained or if changed.
4. Start the engine and check for oil leaks.
5. Shut off the engine and wait 15 minutes before checking the oil level. Add oil if required.

▲WARNING Crankcase pressure can blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating/

Oil Filter Change

Replace the oil filter every time the oil is changed. Six-cylinder models use a longer oil filter than the four-cylinder. The oil filter location is shown in Figure 4-2.

1. Clean around the filter head.
2. Using a filter wrench, remove the oil filter
3. Fill the filter with clean oil as recommended in Table 4-2.
4. Apply a light film of lubricating oil to the gasket sealing surface before installing the filter.
5. Install the filter until hand tight then turn an additional 1/2 turn.
6. Start engine to verify that filter is tight and does not leak.

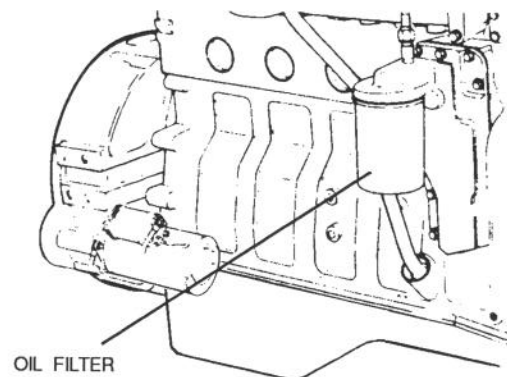


FIGURE 4-2. OIL FILTER LOCATION

COOLING SYSTEM

The cooling system is drained prior to shipping and must be refilled before generator set is operated. The cooling system capacity is listed in the Specifications section.

Coolant Requirements

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

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

▲WARNING *Contact with hot coolant can result in serious burns. Allow cooling system to cool before releasing pressure and removing radiator cap.*

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

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

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

Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps secure. Remove the cooling system pressure cap and slowly fill the cooling system with the recommended coolant.

Before the engine is started, remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable. Allow 1-1/2 inch (38 mm) for expansion in the heat exchanger. Excess will be expelled through the overflow hose.

Coolant Level

Check the coolant level during shutdown periods at the intervals specified in the Maintenance Table. Remove the pressure cap after allowing the engine to cool and if necessary, add coolant until level is near the top of the heat exchanger.

Flushing and Cleaning

The cooling System must be clean and free of rust and scale if it is to perform properly. Use only coolant that meets the engine manufacturer's requirements.

FUEL SYSTEM

The engine has been primarily designed to operate on No. 2 diesel fuels since such fuels have a higher energy content and are generally lower in cost. The engine will also operate satisfactorily on No. 1 fuel or other similar fuels if they meet certain specifications. Consult the engine manufacturer for the specific requirements if using a non-standard fuel.

Fuel Handling Precautions

Take appropriate precautions to prevent the entrance of dirt, water, or other contaminants into the fuel system. Filter or strain the fuel as the tank is filled.

▲WARNING *Ignition of fuel can cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, pilot light, or other igniter near the fuel system.*

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the daytime. At night, cool air tends to lower the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and tend to form condensation.

Condensation (water) can cause clogging of fuel filters as well as freezing problems. In addition, water mixing with the sulphur in the fuel forms acid which can corrode and damage engine parts.

▲CAUTION *Premature failure of engine fuel pump and other engine components may occur if fuel system is not equipped with a fuel/water separator. Be sure that a fuel/water separator is installed between fuel supply and generator set.*

Fuel Filters

The filter (see Figure 4-3) is a spin-off throw-away unit. Fill the new filter with diesel fuel and put a light coat of fuel on the sealing gasket. Install and tighten by hand until the gasket just touches the filter head. Tighten an additional one-half to three-fourths of a turn. The fuel system will need bleeding if:

- The fuel filter are not filled prior to installation.
- The injection pump is replaced.
- High pressure fuel lines are replaced.

Refer to Cummins Engine Manual.

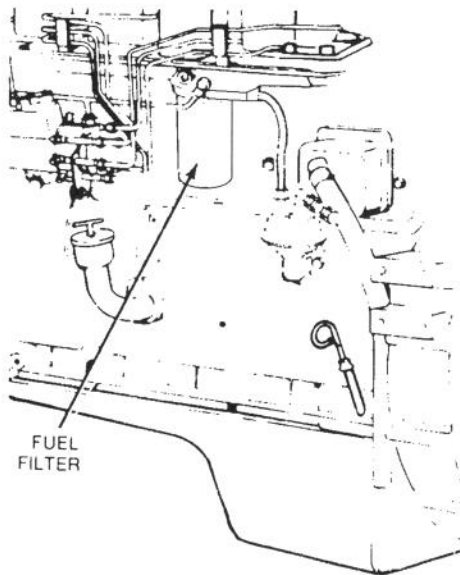


FIGURE 4-3. FUEL FILTER

AIR CLEANER

The filter element should be replaced yearly, or sooner if the generator set is exposed to dusty conditions.

Inspect all components of the air filtering system including all ducts and hoses. Verify that all connections and clamps are tight and inspect each component for cracks, dents, or other damage. Repair or service as required.

⚠CAUTION

Filters should be handled with care to prevent damage. If the filter does become damaged, install recommended replacement part.

BATTERIES

Check the condition of the starting batteries (see Figure 4-4) at the interval specified in the Maintenance Table. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity using a hydrometer and recharge if below 1.260.

⚠WARNING

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

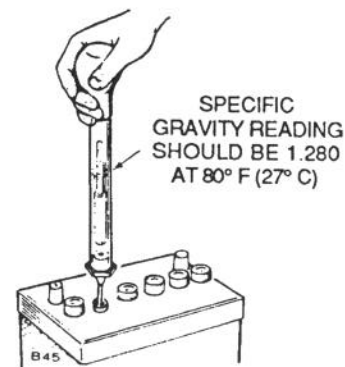


FIGURE 4-4. CHECKING BATTERY

OUT-OF-SERVICE PROTECTION

The inherent lubricating qualities of No. 2 diesel fuel should protect the cylinders of a diesel engine for at least 30 days when the unit is not in service. To protect an engine that will be out of service for more than 30 days, proceed as follows:

1. Exercise the generator set as described in the *Operation* section until the engine is up to operating temperature.
2. Shut down engine and disconnect the batteries. Store batteries in a cool dry place and connect to a charger every 30 days to maintain full charge.

⚠WARNING

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

3. Drain the oil base while still warm. Replace oil filter. Refill crankcase and attach a tag indicating viscosity of oil used.
4. Check the coolant level and add more coolant if the level is low. If freezing temperatures are possible, test strength of coolant mixture.

The sea water system must be drained of water, or protected with a 50-50 anti-freeze mixture as follows:

- A. Close sea cock and remove the sea water inlet hose at filter.
 - B. Place end of hose in a bucket of anti-freeze mixture and run engine until mixture is observed coming out the the exhaust outlet.
 - C. Replace inlet hose and tighten clamp.
5. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
 6. Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of grease or oil.

Returning a Unit to Service

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

1. Remove plug from exhaust outlet and open sea-cock.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check batteries. Measure specific gravity (1.260 at 80°F[27°C]) and verify level to be at split ring. If specific gravity low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

⚠WARNING

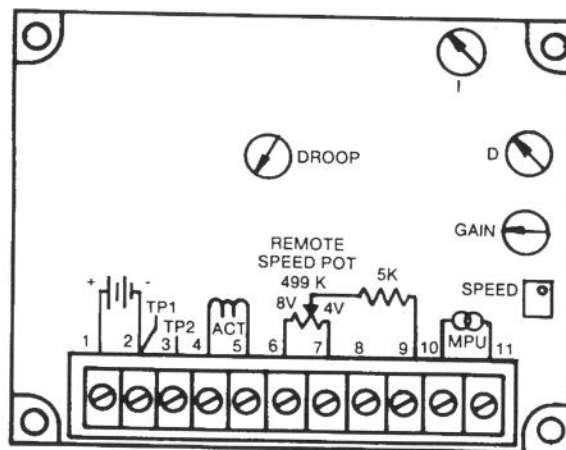
Battery electrolyte can cause severe eye damage and burns to the skin. Wear goggles, rubber gloves and protective apron when working with batteries.

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

Section 5. Adjustments

ELECTRIC GOVERNOR CONTROLLER ADJUSTMENTS

1. Hold the Start/Stop Switch on the control panel in the Start position. After the generator set starts, release the start switch. Operate the generator at no load.
2. Refer to Figure 5-1 and adjust the governor control as follows:
3. Confirm the DROOP potentiometer adjust is set at "0" (zero) position. If not, turn pointer fully counterclockwise to "0".
4. Set speed by adjusting the SPEED potentiometer. Turn clockwise to increase and counterclockwise to decrease. Set to 50 or 60 Hz.
5. Adjust the GAIN potentiometer by turning it clockwise until the engine starts to hunt. (It may be necessary to push the linkage off speed to get the engine to hunt). Turn GAIN potentiometer counterclockwise until the engine speed is one again stable (i.e., no audible hunting).
6. Adjust the "D" potentiometer the same as step 5 GAIN.
7. Adjust the "I" potentiometer by pulling back the fuel injection pump lever to its minimum position and maintain in position until the engine speed slows. Release the lever and observe the frequency meter for overshoot above rated speed. Turn the "I" potentiometer counterclockwise a slight amount to decrease overshoot. A slight amount of overshoot is acceptable.
8. Apply 1/4 load and adjust the GAIN potentiometer again per step 5.
9. From no load, apply full load to be certain that generator set will carry it. If generator set will NOT accept full load, stop generator set and lengthen the governor actuator linkage (stud and rod ends) by half turns and repeat full load operation until the generator set will accept full load. Check generator set operation at varying load levels for stability.
10. Hold the Start/Stop Switch in the Stop position. The generator should come to a complete stop within 15 seconds. If not, then stop the generator by removing one end of the linkage and repeat the calibration procedure. If the generator set stops correctly, leave generator set off for 30 seconds to allow the turbo-charger to coast down.
11. Restart the generator set and check for overshoot of engine speed.
12. Tighten all jam nuts and set screws. Replace all seals removed during these procedures.



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FIGURE 5-1. ELECTRIC GOVERNOR CONTROLLER

AUTOMATIC VOLTAGE REGULATOR (AVR) ADJUSTMENTS

1. Connect a suitable voltmeter (0-300 VAC) across line and neutral of the generator.
2. Depress the Start/Stop switch on the control panel to the Start position. After the generator starts, release the start switch. Operate the generator at no load.
3. Carefully adjust the VOLTS control (clockwise to increase output voltage; counterclockwise to decrease) until rated voltage is reached. Refer to Figure 5-2 for location of VOLTS control. Do NOT make any other

adjustment. If proper voltage adjustment is not possible, refer to an authorized Onan representative.

4. Depress the Start/Stop Switch to the Stop position. The generator should come to a complete stop within 15 seconds.
5. Remove voltmeter from unit and replace any access covers.

⚠ WARNING

Contact with electrically "hot" equipment can result in severe personal injury or death. Make sure the generator set comes to a complete stop before removing voltmeter.

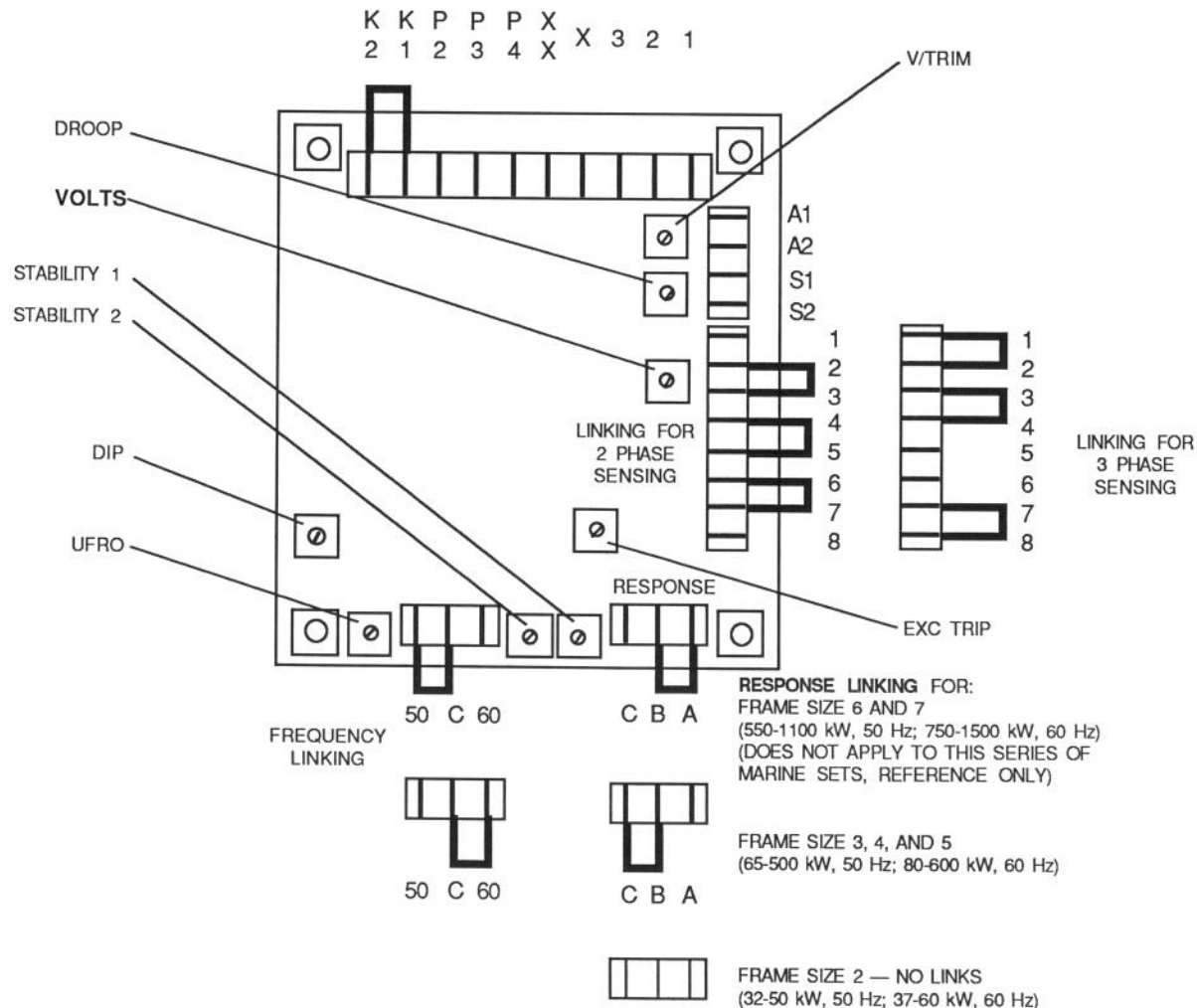


FIGURE 5-2. VOLTAGE REGULATOR WIRING DIAGRAM



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