

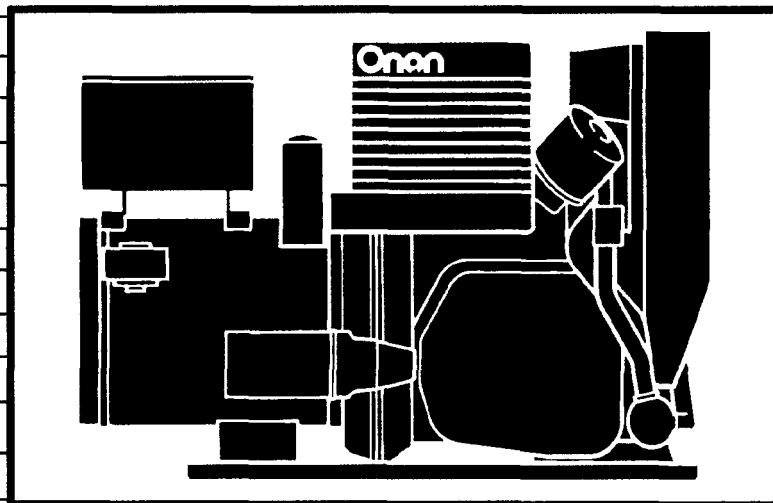
Onan

MARINE

Operator's Manual

MDKC, MDKD

Diesel Series



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

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California

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Section 1. Introduction

ABOUT THIS MANUAL

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

HOW TO OBTAIN SERVICE

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

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

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

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

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

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

⚠WARNING

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

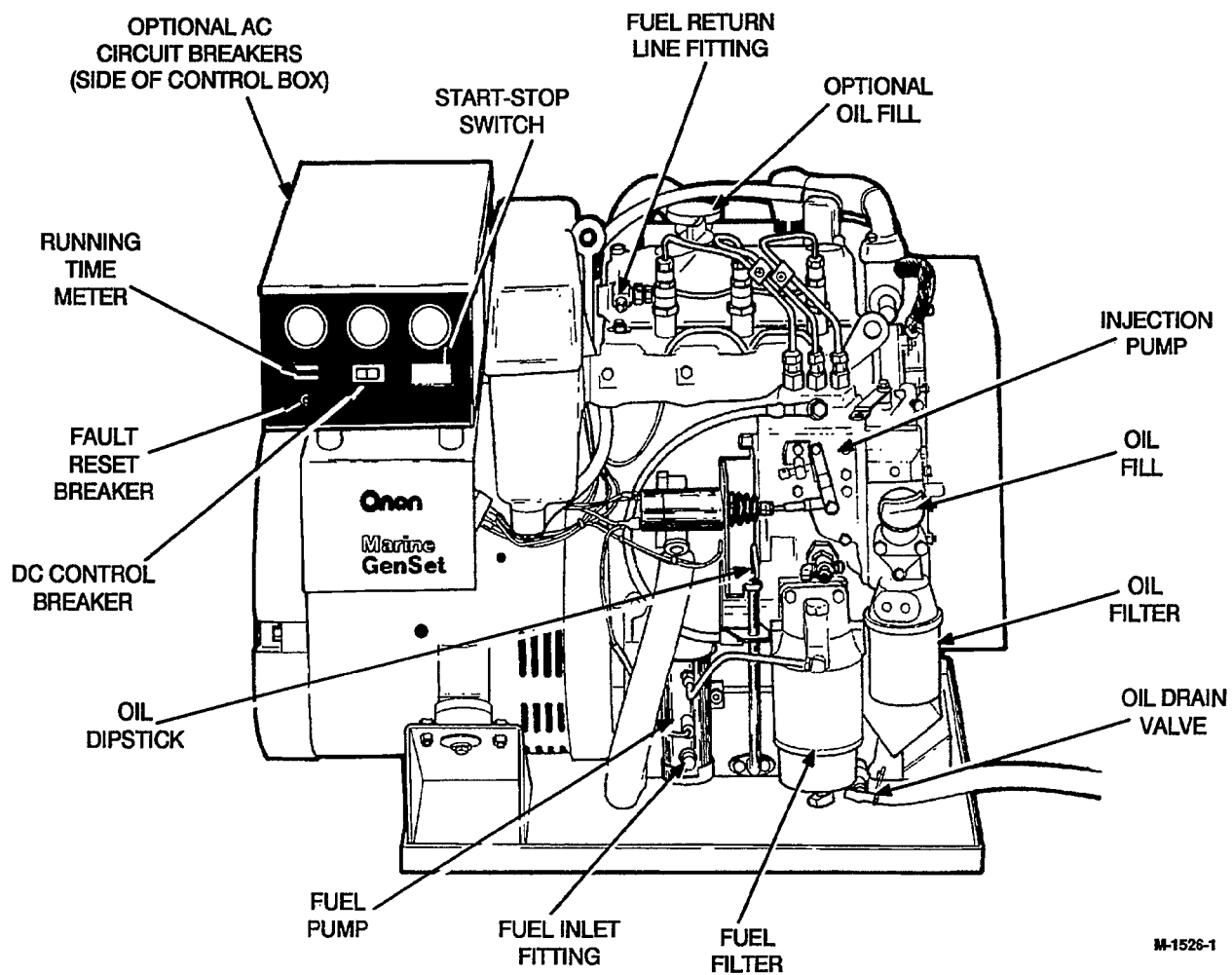


FIGURE 1-1. MDKC/MDKD GENERATOR SET COMPONENTS

Section 2. Specifications

GENERATOR DETAILS

Type Onan, Revolving Field, 4-Pole, Brushless

Standby Ratings:

60 Hz General Marine Rating, 8.0 MDKD-A, B, J, 1-phase ..	8.0 kW, 8.0 kVA at 1.0 PF
8.0 MDKD-L, 3-phase	8.0 kW, 10.0 kVA at 0.8 PF
4.0 MDKC-A, B, J, 1-phase ..	4.0 kW, 4.0 kVA at 1.0 PF
4.0 MDKC-L, 3-phase	4.0 kW, 5.0 kVA at 0.8 PF
50 Hz General Marine Rating, 6.5 MDKD-P, 1-phase	6.5 kW, 6.5 kVA at 1.0 PF
6.5 MDKD-Z, 3-phase	6.5 kW, 8.1 kVA at 0.8 PF
3.5 MDKC-P, 1-phase	3.5 kW, 3.5 kVA at 1.0 PF
3.5 MDKC-Z, 3-phase	3.5 kW, 4.4 kVA at 0.8 PF

AC Voltage Regulation:

Electronic Regulation	±2%
Magnetic Regulation	±5%

ENGINE DETAILS

Engine Type Diesel, 3 Cylinder, Vertical In-Line

Engine Speed (r/min) 1800/1500

Fuel No.2 Diesel

Fuel Consumption, Average @ Full Load:

3.5 MDKC	0.42 gph (1.57 L/h)
4.0 MDKC	0.50 gph (1.89 L/h)
6.5 MDKD	0.75 gph (3.12 L/h)
8.0 MDKD	0.90 gph (3.75 L/h)

Fuel Pump Lift (Self-Priming) 4 ft (1.2 m)

Total Air Per Minute Required (Cooling and Combustion):

3.5 MDKC	150 ft ³ /min (4.2 m ³ /min)
4.0 MDKC	170 ft ³ /min (4.8 m ³ /min)
6.5 MDKD	160 ft ³ /min (4.5 m ³ /min)
8.0 MDKD	180 ft ³ /min (5.1 m ³ /min)

Battery Charge Alternator Maximum Output (Regulated) 10 Amperes

Battery Voltage (Nominal) 12 Volts

Battery Recommendation Minimum Cranking Performance @ 0° F (-18° C) .. 360 Ampere

Cooling System Capacity, Including Heat Exchanger 3 quarts (2.8 L)

Oil Capacity With Filter 4 qt. (3.8 L)

Section 3. 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 vehicle 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 genset. Read through this entire section before attempting to start the genset. It is essential for safe operation that the operator be completely familiar with the genset.

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 the 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 hot pressurized coolant can result in serious personal injury. Remove the expansion tank pressure cap slowly after the engine has cooled.*

Fuel

Make sure the fuel tanks are full and the fuel system is primed for operation (see Maintenance section).

Exhaust

Make sure the exhaust system components are tightly connected and not corroded.

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

CONTROL PANEL

The following describes the function and operation of the genset controls. All instruments and control switches are located on the face of the control panel as illustrated in Figure 3-1.

Gauges/Meters and Switches

Start-Stop Switch: Starts and stops the genset locally. When switch is released, the genset can be operated from a remote switch connected to the control panel.

Running Time Meter: Registers the total number of hours that the unit has run. Useful for determining need for periodic maintenance procedures. Time is cumulative and cannot be reset.

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

Coolant Temperature Gauge (Optional): Shows engine coolant temperature. The gauge is wired to

a sensor on the engine and has a range of 100° to 250° F (40° to 121° C).

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

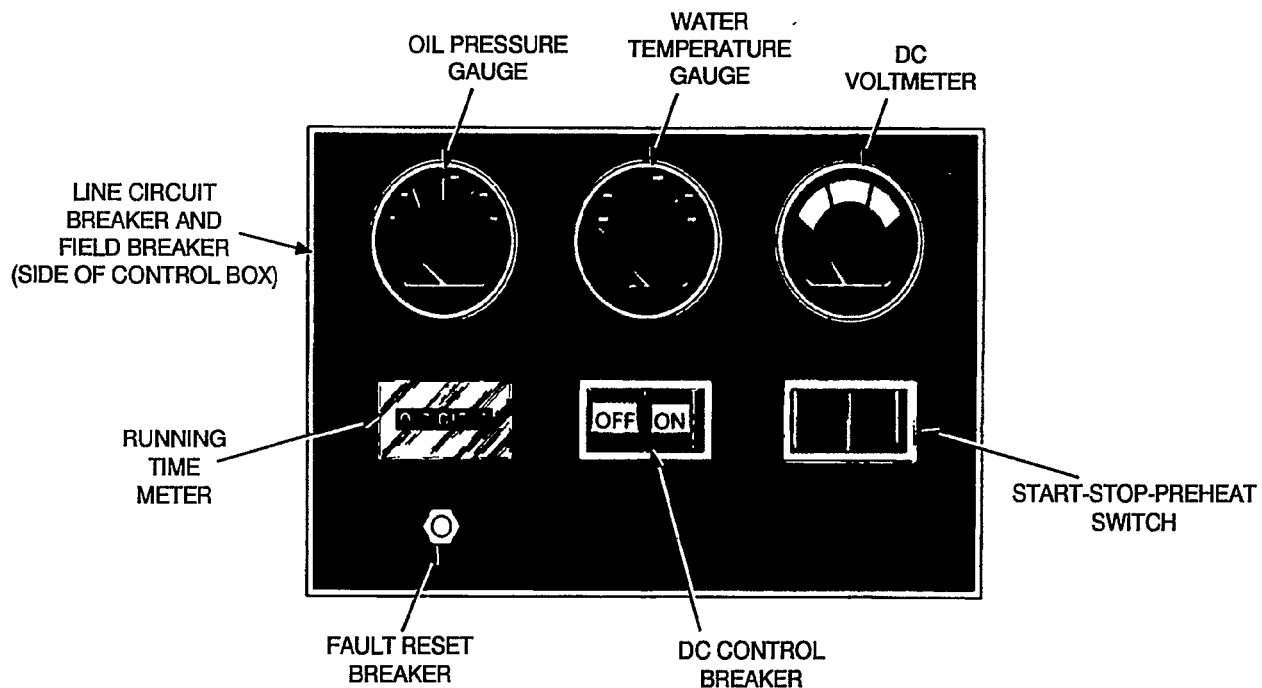
Circuit Breakers

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

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.

Line Circuit Breakers (Optional): Protects generator from a short circuit or other overload. They are mounted on the control box. Replacements must meet ABYC specs for proper protection.

Field Breaker (Electronic Regulators Only): A 3 ampere breaker providing generator field protection if the voltage regulator fails.



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FIGURE 3-1. CONTROL BOX FRONT PANEL

STARTING

This section covers starting of the genset at the control panel and the remote panel (when used).

Starting at Control Panel

The following steps outline the correct procedures for starting the genset at the generator control panel. The DC Control Breaker must be in ON position.

1. Press the Stop/Preheat switch position for 10 to 30 seconds depending upon temperature as shown below in Table 1. Do not exceed 30 seconds.

⚠ CAUTION *Preheat time longer than 30 seconds may damage glow plugs.*

TABLE 1. PREHEAT TIME vs TEMPERATURE

Ambient Temperature	Preheat Time
Above 86° F (30° C)	About 10 seconds
Between 50° to 86° F (10° to 30° C)	About 15 seconds
Between 32° to 50° F (0° to 10° C)	About 20 seconds
Below 32° F (0° C)	About 30 seconds

2. Release the switch Stop/Preheat position and press Start. This activates the engine control, glow plugs and starting system. The starter will crank and after a few seconds the engine should start. The starter will automatically disconnect when the generator AC voltage builds up.
3. If the engine does not start after cranking 30 seconds, release the Start switch. Wait two minutes and then repeat Steps 1 and 2.

⚠ 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 cooling.*

4. If the engine does not start on second try, check the fuel supply and be sure the fuel system has been primed. If the genset runs out of fuel, the fuel system may need priming before

it will start. See Fuel System in the Maintenance Section.

Starting at Remote Panel

The same procedures and cautions for starting at the genset control panel apply for remote starting.

Start-up Checks

Check optional gauges on the control box after the engine has started. Observe the oil pressure gauge immediately.

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

DC Voltmeter: Normal battery voltage during operation should be 14 to 15 volts (dependent upon battery state-of-charge).

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

STOPPING

Before Stopping

Run the genset 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 the generator set runs unloaded for at least three minutes.*

To Stop: Press the Stop/Preheat switch position at the control panel, or at the remote station.

OPERATING RECOMMENDATIONS

Break-In

Drain the crankcase oil after the first 35 hours of operation on new gensets. Refer to the Maintenance Section of this manual for the recommended procedures.

No-Load Operation

Hold periods on no-load operation to a minimum and avoid if possible. No-load operation allows

combustion chamber temperatures to drop so low that the fuel does not burn completely. This results in carbon deposits which can clog injectors, cause piston rings and valves to stick and can cause cylinder glazing. If it is necessary to run the engine for long periods, connect an electrical load to the generator.

Exercise Period

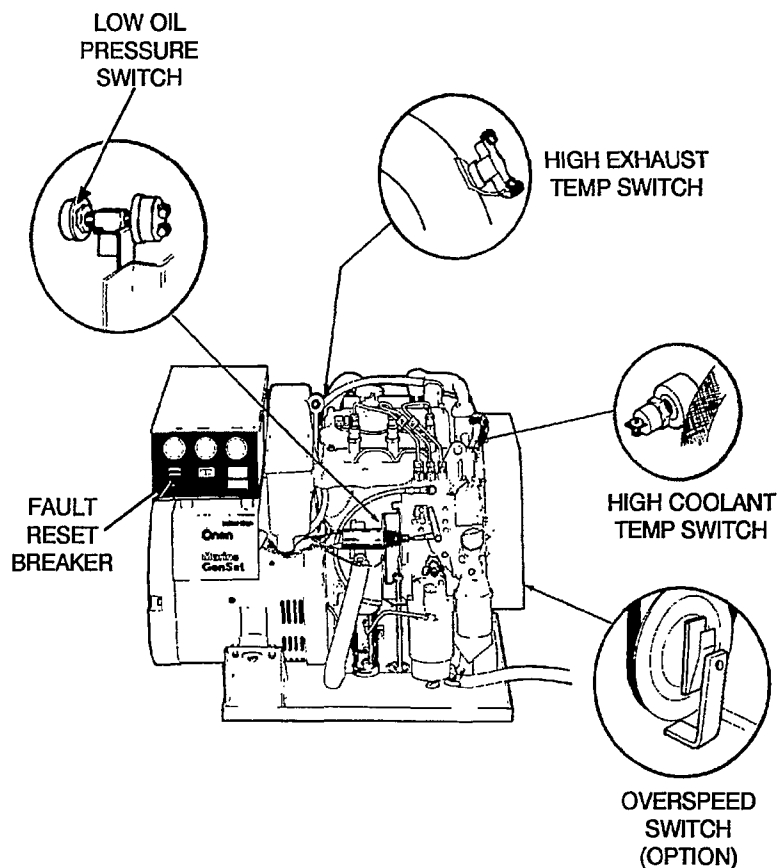
To avoid excessive engine wear, exercise the genset at least once a week for a minimum of 30 minutes. Run the genset with a load applied to allow the engine to reach normal operating temperature. Exercising will keep the engine parts lubricated, maintain fuel prime, and prevent electrical relay contacts from oxidizing. 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 and overspeed (option). If any one of these conditions occur, the fault breaker trips and stops the genset. See Figure 3-2.

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.



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FIGURE 3-2. FAULT SENSOR LOCATION

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

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

High Coolant Temperature: Observe Coolant Temperature Gauge (option) for indication of temperature over 222° F (106° C). The coolant thermostat switch closes at this temperature and actuates the fault circuit.

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

Check condition of the pump belt and that it has proper tension. The sea water flow at the exhaust outlet should be about 3 gal/min (11 liter/min). Also check the 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 230° F (110° C). It will open again when temperature reaches about 190° F (88° C) and functions to protect exhaust system hoses.

⚠ WARNING *Inhalation of exhaust gas can cause serious personal injury or death. Do not disconnect or bypass the exhaust elbow switch. Excessive heat will damage the exhaust hoses and cause exhaust gas leakage. If exhaust hose is damaged, shut off the generator set immediately and do not operate until hose is repaired.*

High exhaust elbow temperature is caused by insufficient or lack of sea water flow. Sea water flow at exhaust outlet should be about 3 gal/min (11 liter/min).

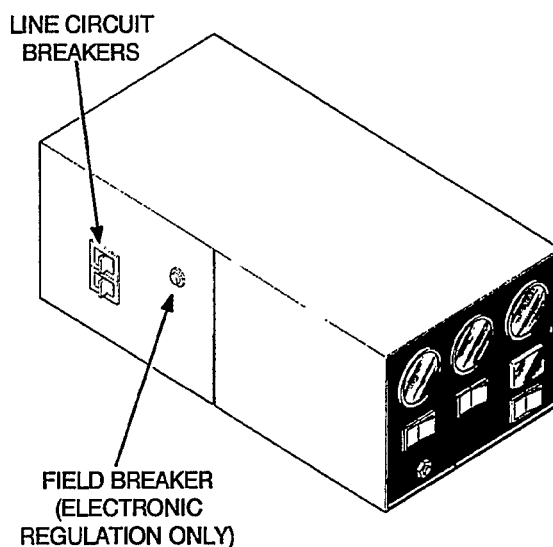
Overspeed (Option): This switch (sensor is mounted on the front of the engine crankshaft. It is factory adjusted to shut down 60 hertz units at 2200 r/min \pm 90 r/min, 50 hertz units at 1800 r/min \pm 90 r/min.

AC Control

The AC control may use two circuit breakers on the control box depending upon purchased options. See Figure 3-3. If either one trips, it results in loss of generator AC power output. They function as follows:

Field Breaker (Electronic Regulator Only): This 3-ampere breaker is located on the control side panel. It is in the regulator AC input circuit and protects the generator field if the voltage regulator fails and places abnormal demands on it. If resetting the breaker returns power only momentarily, then trips again, consult an Onan dealer or distributor for service.

Line Circuit Breakers: When supplied by Onan, these breakers are mounted on the control side panel. They are connected in series with the load.



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FIGURE 3-3. AC CONTROL BREAKERS

Section 4. Maintenance

GENERAL

Establish and adhere to a definite schedule for maintenance and service. If the genset will be subjected to extreme operation conditions, the service intervals should be reduced accordingly as indicated in Table 4-1.

Consult with an authorized Onan Dealer or Distributor if the genset will be subjected to any extreme operating conditions (high surrounding temperature, dusty air conditions, etc.), and determine a suitable schedule of maintenance. Use the run-

ning 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 the schedule to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

⚠WARNING *Accidental starting of the generator set can cause severe personal injury or death. Disconnect the starting battery (negative [-] lead first) when doing maintenance or repair to the engine, controls, or generator.*

TABLE 4-1. PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	SERVICE TIME				
	Daily or after 8 hours	Monthly or after 100 hours	6 Months or after 250 hours	Yearly or after 500 hours	P A G E
Inspect Set	x ¹				4-2
Check Oil Level	x				4-3
Check Coolant Level	x				4-4
Check Battery Specific Gravity		x			4-8
Check Anti-Freeze			x		4-4
Check Drive Belt Tension		x ⁴			4-5
Check Fuel Level	x				4-6
Clean Generator Assembly			x		4-9
Change Crankcase Oil and Filter		x ^{2,3}			4-4
Drain Water/Sediment From Fuel Filter		x			4-7
Change Fuel Filter			x		4-7
Clean Cooling System				x	4-5

- 1 - Check for oil, fuel, cooling and exhaust system leaks. Check exhaust system audibly and visually with genset running and repair any leaks immediately.
- 2 - Perform after first 35 hours of operation on new genset.
- 3 - Perform more often in extremely dusty conditions.
- 4 - Visually check belts for evidence of slippage.

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.

Engine Gauges

Check the following while the genset is operating.

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

Note: Oil pressure readings slightly lower than 35 psi may be acceptable, depending on operating conditions. Genset shutdown for low oil pressure takes place at 9 psi (163.4 kPa). Consult your Onan distributor if in doubt about oil pressure readings.

Coolant Temperature Gauge (Option): The water temperature should be in the range of 165° to 195° F (74° to 91° C) depending on the load and ambient temperature.

DC Voltmeter (Option): Normal battery voltage during operation should be 14 to 15 volts on a 12-volt system.

Exhaust System

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

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

Fuel System

With the genset operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check flexible sections for cuts, cracks and abrasions so they are not rubbing against anything that could cause breakage.

⚠ WARNING *Fuel leakage will create a fire hazard which can result in severe personal injury or death if ignited. While checking for leaks, do not smoke or allow any spark, flame, pilot light or other ignition source in the area. If any leaks are detected, have them corrected immediately.*

DC Electrical System

With the genset off, check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always disconnect the negative battery cable first, and connect it last to reduce the possibility of arcing.

⚠ 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.*

Mechanical

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

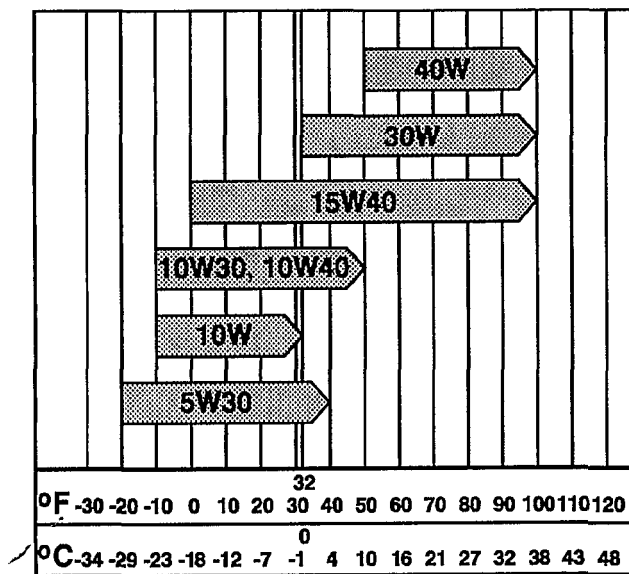
LUBRICATION SYSTEM

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

Oil Recommendations

Use oils with the American Petroleum Institute (API) classification SG/CD in viscosities per temperature as shown in Table 4 -2 below.

TABLE 4-2. OIL VISCOSITY VS TEMPERATURE



Anticipated Ambient Temperature

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

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

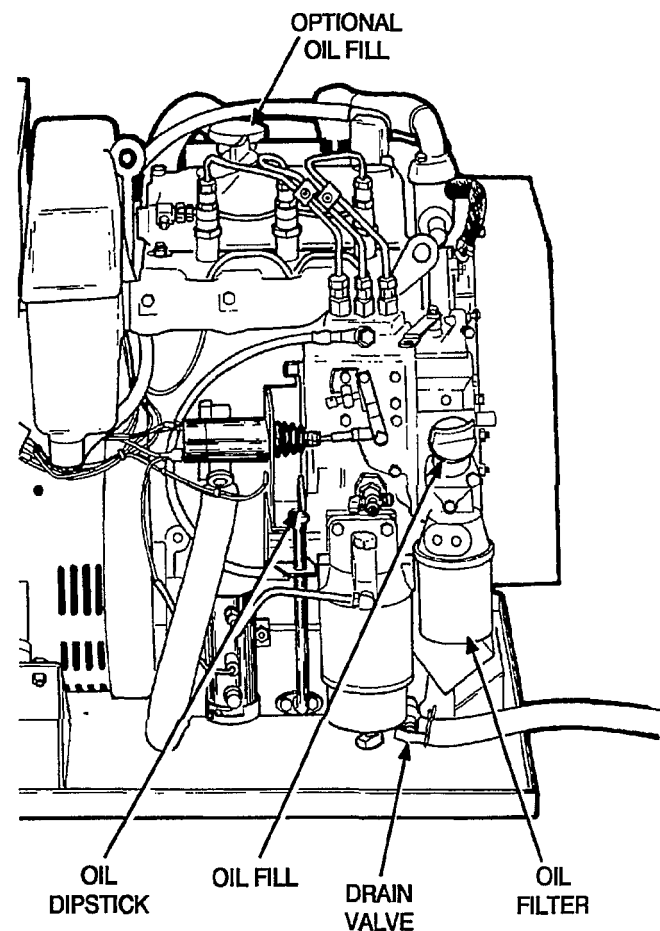
Engine Oil Level

Check the engine oil level during engine shut-down periods at the intervals specified in Table 4-1. The oil dipstick and oil fill are located on the side of the

engine (see Figure 4-1). The dipstick is stamped with FULL and ADD to indicated the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

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

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



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FIGURE 4-1. ENGINE OIL

Oil and Filter Change

Change the oil and filter at the intervals recommended in Table 4-1. Use oil that meets the API classification and appropriate SAE viscosity grade as indicated in the previous section.

Engine Oil Change: Run the engine until thoroughly warm before draining the oil. Stop engine, open drain valve (Figure 4-1) and drain oil into a container. When completely drained, close valve and refill the crankcase with new oil.

⚠ WARNING *Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.*

Oil Filter Change: Spin off the oil filter and discard it. Thoroughly clean filter mounting surface. Apply a thin film of oil to filter gasket, and spin filter on by hand until gasket just touches the mounting pad. Then turn an additional 3/4 turn. Do not over-tighten.

With oil in the crankcase, start the genset and check for leakage around the filter gasket. Tighten only as necessary to eliminate leaks.

COOLING SYSTEM

The cooling system is drained prior to shipping and must be refilled before genset 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.

Do not exceed a 50/50 mixture of ethylene glycol and water. A stronger mixture of ethylene glycol will alter heat transfer properties of the coolant. A 50/50 mixture will provide freeze protection to -34°

F (-37° C) as measured with an accurate hydrometer.

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

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.

Gensets With Coolant Recovery Tank: Fill the recovery tank with coolant mixture to the FULL mark. Operate the genset until normal operating temperature is maintained as observed on the temperature gauge (option), or about 15 minutes of operation.. Shut down the genset and let cool. Add coolant to recovery tank until coolant level stabilizes at the Full mark—this may require several operation cycles.

Gensets Without Coolant Recovery Tank: 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.

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

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

Flushing and Cleaning

For efficient operation, the cooling system should be drained, flushed, and refilled with new coolant once each year.

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

Drain the system completely. The heat exchanger (or optional keel cooler—see manufacturer's literature) and the cylinder block drain must be opened. See Figure 4-2. Remove the pressure cap to aid the draining process.

Chemical Cleaning: Thoroughly clean the cooling system if rust and scale have collected on the engine water jacket, or in the heat exchanger. Rust and scale slow down heat absorption and can block the coolant flow. Use a good cleaning compound and follow the supplier's instructions.

Flushing: After cleaning, or before filling the system with new coolant, drain the system and fill with clean water. Operate the genset for 10 minutes, then drain the system completely. Refill with the recommended coolant.

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

Pressure Cap

Closed cooling systems make use of a pressurized cap to increase the boiling point of the coolant and allow higher operating temperatures. The pressure cap should be replaced every two years, or sooner if it malfunctions. The cap is rated at 7 psi (48 kPa).

Sea Water Drain/Zinc Pencil

The sea water side of the heat exchanger is protected from corrosion by a zinc pencil attached to the sea water plug. See Figure 4-2. The pencil should be inspected about every two months and replaced if deteriorated to less than 1/2 inch (13 mm).

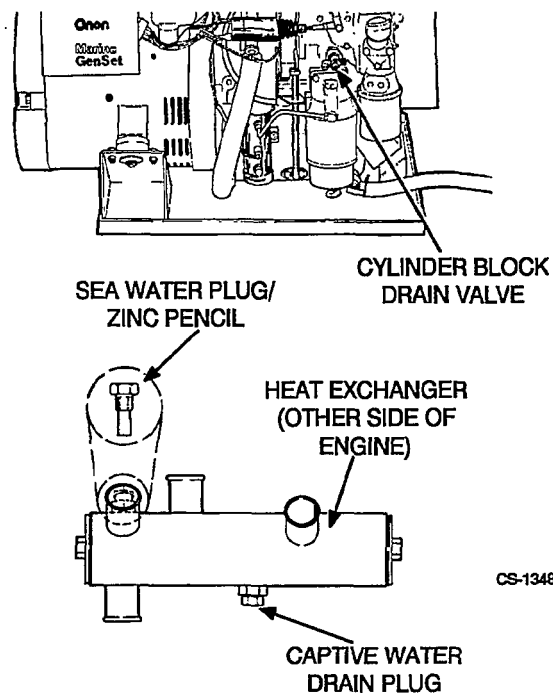


FIGURE 4 -2. LOCATION OF COOLANT DRAIN/
ZINC PENCIL

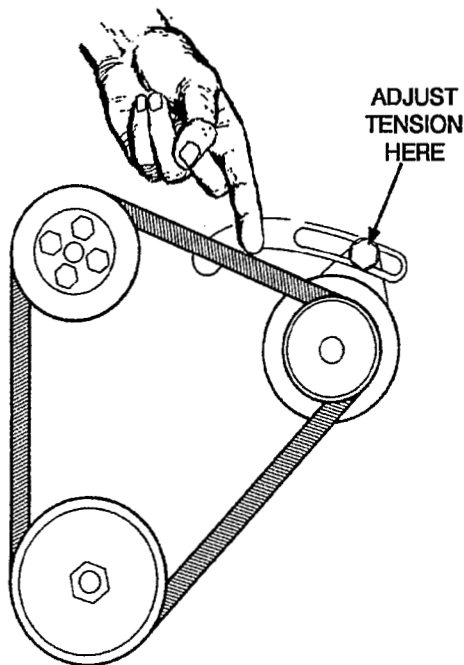
Pump Belt

Access to the belt is made by removing the belt guard from the front of the genset. Before removing the belt guard, be sure the genset is disabled by removing the battery cables—the negative (-) cable first. Do not operate the genset without the belt guard in place.

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

Belt tension is proper when a finger pressure of 22 pounds (10 kg) at middle of the belt deflects it about 0.4 inch (10 mm).

To adjust belt, loosen bolt that passes through elongated slot in alternator mounting bracket and slide alternator until proper tension is secured. See Figure 4-3.



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FIGURE 4 -3. PUMP BELT ADJUSTMENT

Siphon Break Valve

A siphon break valve is installed on gensets if the exhaust injection elbow is at or below load water line. When properly installed, it helps prevent sea water siphoning into the engine and compartment when the genset shuts down.

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

FUEL SYSTEM

Use only a good quality fuel obtained from a reputable supplier. The quality of fuel used is important in obtaining dependable performance and satisfactory engine life. Fuels must be clean, completely distilled, well refined, and non-corrosive to fuel system parts.

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

Fuel Recommendations

Use ASTM 2-D (no. 2 Diesel) or ASTM 1-D (No. 1 Diesel) fuel with a minimum cetane number of 45. Number 2 diesel fuel gives the best economy and performance under most operating conditions. Use number 1 diesel fuel when ambient temperatures are below 32° F (0° C) and during long periods of light engine load.

Use low sulfur content fuel having a cloud point of at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel 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.

⚠ CAUTION *Dirt or water in the system will cause severe damage to both the injection pump and the injection nozzles. It is extremely important the fuel be kept clean and water free.*

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the genset 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 form condensation.

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

Priming the Fuel System

The fuel system must be primed prior to initial start-up or after engine has run out of fuel.

High Pressure Fuel System: The injection pump, fuel injection lines and fuel injectors comprise the high pressure fuel system. See Figure 4-4. This part of the system is self-priming since any trapped air is forced out through the injection nozzles.

Low Pressure Fuel System: The electric fuel pump, fuel filter and injection pump inlet comprise the low pressure fuel system. To prime these components, follow the same procedure as when the fuel filter is replaced (following section).

Be sure to check fuel level in the tank, and that the shut-off valve is open.

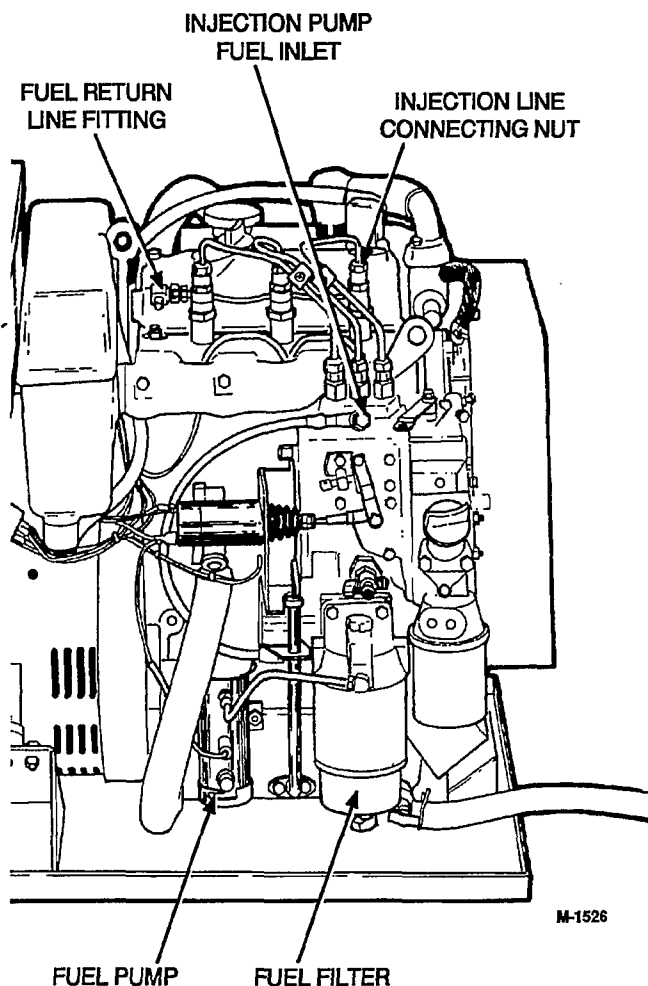


FIGURE 4-4. INJECTION PUMP FUEL SYSTEM

Fuel Filter

The filter replacement interval will vary according to the fuel quality and cleanliness. Using the wrong fuel, or dirty fuel, will shorten service life of the filter.

⚠ CAUTION *Dirt or water in the system will cause severe damage to both the injection pump and the injection nozzles. It is extremely important the fuel be kept clean and free of water.*

Draining Water/Sediment From Filter: Refer to Table 1 for the recommended time interval. Drain about 1/4 cup of fuel as follows:

1. Open the drain valve and bleed screw on the fuel filter assembly (Figure 4-5). Collect fuel in a suitable container and dispose of properly.
2. Tighten drain valve and bleed screw.
3. Bleed air from the filter housing by performing Steps 8 through 10 in the next paragraph.

Replacing Filter Element: Refer to Table 1 for the recommended filter change interval. However, if the engine shows signs of fuel starvation (reduced power or surging), change the fuel filter. Use the following procedure to replace.

1. Loosen the drain valve and bleed screws. Collect fuel in a suitable container and dispose of properly. remove the bleed plug. See Figure 4-5.
2. Remove filter element from the head with the bowl connected.
3. Clean the bowl, O-ring and O-ring gland.
4. Lubricate the O-ring with clean diesel fuel and place it in the bowl gland.
5. Spin the bowl onto the new element. **DO NOT OVER-TIGHTEN.**
6. Lubricate the element and gasket, and fill bowl and filter element with clean diesel fuel.
7. Spin the bowl and element assembly onto the head and hand tighten.
8. Disconnect the starter solenoid lead at the *Faston* terminal connector (this connector is on the starter solenoid). This allows the fuel pump operation without cranking the engine.
9. Depress the Start switch until fuel purges at the bleed screw and bleed plug opening.

10. Replace the bleed plug and close bleed screw. Reconnect the starter solenoid lead.

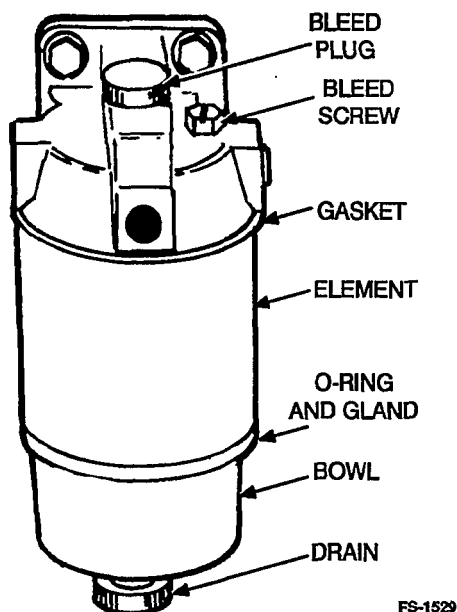


FIGURE 4-5. FUEL FILTER ASSEMBLY

BATTERY

Check the condition of the starting battery at the interval specified in Table 4-1. Always disconnect the negative (-) cable from the battery before working on any part of the genset electrical system. Disregard the sections on Checking Specific Gravity and Checking Electrolyte Level when using a maintenance-free type battery.

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

Cleaning the Battery

Keep the battery clean by wiping it with a damp cloth whenever it appears dirty. Remove the battery cables (negative (-) cable first) if corrosion is present around the terminal connections. Wash the terminals with an ammonia solution, or a solution consisting of 1/4 pound (about 100 grams) of baking soda in 1 quart (about 1 liter) of water. See Figure 4-6.

Remove the battery from vessel for cleaning. Be sure the vent plugs are tight to prevent cleaning solution from entering the cells. After cleaning, flush the outside of the battery and the surrounding areas with clean water.

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

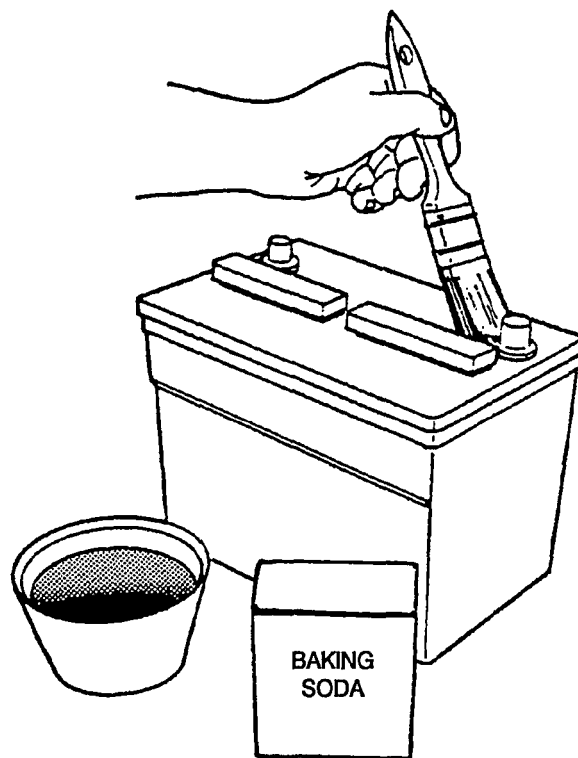


FIGURE 4-6. CLEANING BATTERY

Checking Specific Gravity

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

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

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every five degrees the electrolyte temperature is above 80° F (27° C), or subtracting four

gravity points for every five degrees below 80° F (27° C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

Checking Electrolyte Level

Check the level of the electrolyte (acid and water solution) in the battery at least every 50 hours of operation. Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leads or for a bad cell.

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

Keep the battery case clean and dry. An accumulation of moisture will lead to battery discharge and failure.

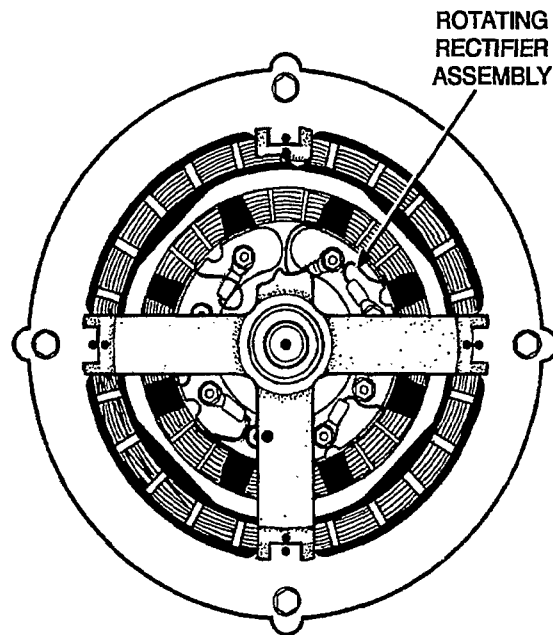
AC GENERATOR

There are no brushes, brush springs or collector rings on the generator, therefore it requires very little maintenance. Periodic inspections, to coincide with engine oil changes, will help provide good performance.

⚠ WARNING *Accidental starting of the generator set can cause severe personal injury or death. Move the Operation Selector switch to STOP and disconnect the starting battery (negative [-] lead first) before inspecting the rotating rectifier assembly.*

Remove the generator end bell cover and inspect the rotating rectifier assembly to make sure the diodes are free of dust, dirt and grease (see Figure 4-7). Excessive foreign matter on these diodes and heat sinks will cause diode overheating and failure. Blow out the assembly periodically with filtered, low-pressure air.

⚠ CAUTION *Excessive foreign matter on diodes and heat sinks will cause overheating and possible failure.*



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FIGURE 4-7. GENERATOR END VIEW

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years. Deterioration of the bearing grease due to oxidation makes this replacement necessary. If the generator requires major repair or service, contact an authorized Onan dealer or distributor.

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 not in service. To protect an engine that will be out of service for more than 30 days, proceed as follows:

1. Exercise the genset, as described in the Operation section, until the engine is at operating temperature.
2. Shut down the genset and disconnect the battery cables (negative [-] cable first). Store the battery in a cool, dry place and connect to a trickle charger once 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 crankcase oil while still warm. Replace oil filter. Refill crankcase and attach a tag indicating viscosity of the oil used.
4. Check the coolant level and add more coolant if low. If freezing temperatures are possible, test strength of the coolant mixture.

The sea water cooling 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 hose in a bucket of anti-freeze mixture and run engine until mixture is observed coming out of 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 the entire genset. Coat parts susceptible to rust with a light coating of grease or oil.

Returning the Genset to Service

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

1. Remove plug from the exhaust outlet, and open the seacock.
2. Clean and check the battery. Measure the electrolyte specific gravity with a hydrometer (1.260 @ 80° F [27° C]) and verify proper level. If the specific gravity is low, charge the battery until correct value is obtained. If level is low, add distilled water and charge until the specific gravity reading is correct.

⚠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. Prime the fuel system.
4. Connect the starting battery, the negative (-) cable last.
5. Remove all loads before starting the genset.
6. After starting, apply load of at least 50 percent rated capacity.
7. Check all gauges for normal readings. Genset is ready for operation.



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