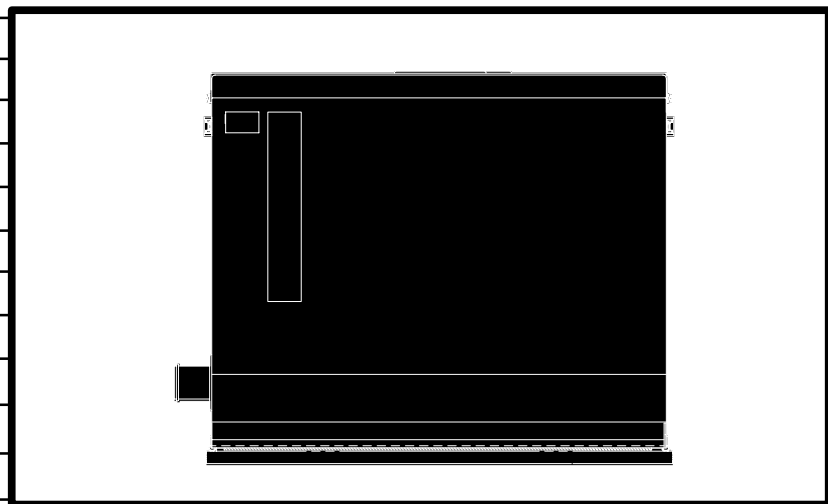
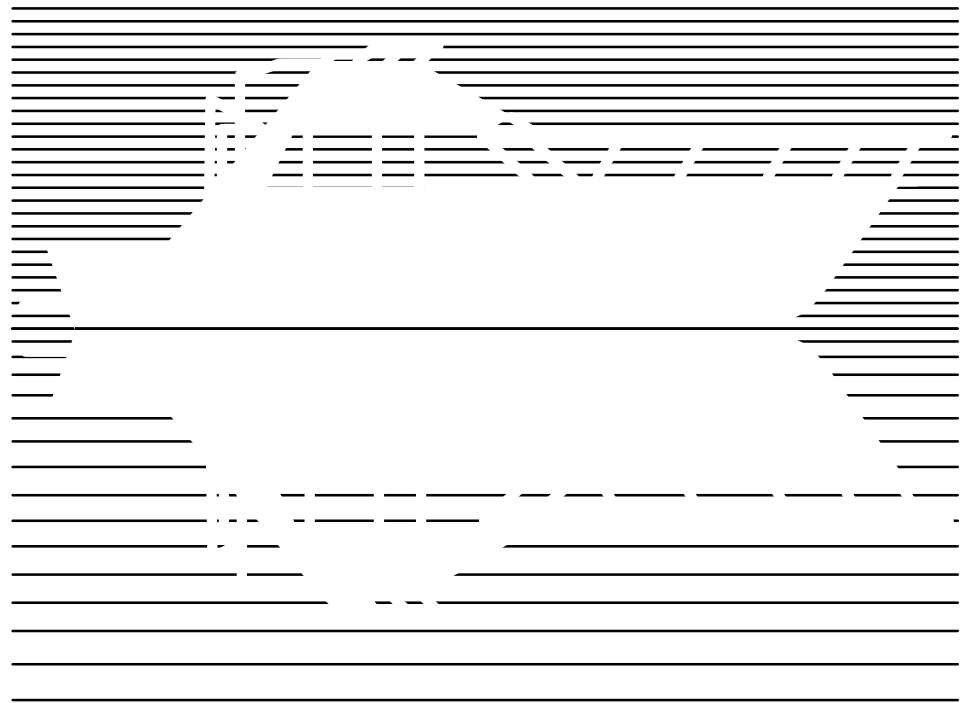


**Onan**

**MARINE**

***Operator's Manual***

**MDKUB  
MDKWB**



**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.**

# Safety Precautions

---

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# Safety Precautions

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Thoroughly read the **OPERATOR'S MANUAL** before operating the genset. Safe operation and top performance can only be attained when equipment is operated and maintained properly.

The following symbols in this manual alert you to potential hazards to operators, service personnel and equipment.

**▲ DANGER** alerts you to an immediate hazard which will result in severe personal injury or death.

**▲ WARNING** alerts you to a hazard or unsafe practice which can result in severe personal injury or death.

**▲ CAUTION** alerts you to a hazard or unsafe practice which can result in personal injury or equipment damage.

Electricity, fuel, exhaust, hot engine coolant, moving parts and batteries present hazards which can result in severe personal injury or death.

## GENERAL PRECAUTIONS

- Keep children away from the genset.
- Do not step on the genset when entering or leaving the generator room. Parts can bend or break leading to electrical shorts or to fuel, coolant or exhaust leaks.
- To prevent accidental or remote starting while working on the genset, disconnect the negative (-) battery cable at the battery.
- Let the engine cool down before removing the coolant pressure cap or opening the coolant drain. Hot coolant under pressure can spray and cause severe burns.
- Do not use evaporative starting fluids. They are highly explosive.
- Keep the genset, drip pan and compartment clean. Oily rags can catch fire. Gear stowed in the compartment can restrict cooling.

- Make sure all fasteners are secure and properly torqued.
- Do not work on the genset when mentally or physically fatigued or after having consumed alcohol or drugs.
- You must be trained and experienced to make adjustments while the genset is running—hot, moving or electrically live parts can cause severe personal injury or death.
- Used engine oil has been identified by some U. S. state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or contact used oil or its vapors.
- Ethylene glycol, used as engine antifreeze, is toxic to humans and animals. Clean up spills and dispose of used engine coolant in accordance with local environmental regulations.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10)
- Genset installation and operation must comply with all applicable local, state and federal codes and regulations.

## GENERATOR VOLTAGE IS DEADLY

- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- The genset must not be connected to shore power or to any other source of electrical power. Back-feed to shore power can cause electric shock resulting in severe personal injury or death and damage to equipment. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry, stand on a dry wooden platform or rubber insulating mat and use tools with insulated handles.

## ENGINE EXHAUST IS DEADLY

- Never sleep in the boat while the genset is running unless the boat is equipped with properly working carbon monoxide detectors.
- The exhaust system must be installed in accordance with the genset Installation Manual and be free of leaks.
- Make sure the bilge is adequately ventilated with a power exhauster.
- Inspect for exhaust leaks every startup and after every eight hours of operation.
- For more information about carbon monoxide see American Boat and Yacht Council (ABYC) publication TH-22—*Educational Information About Carbon Monoxide*.

## DIESEL FUEL IS COMBUSTIBLE

- Do not smoke or turn electrical switches ON or OFF where fuel fumes are present or in areas sharing ventilation with fuel tanks or equipment. Keep flames, sparks, pilot lights, arc-producing equipment and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.

## BATTERY GAS IS EXPLOSIVE

- Wear safety glasses while servicing batteries and do not smoke.
- To reduce arcing when disconnecting or reconnecting battery cables, always disconnect the negative (-) battery cable first and reconnect it last.

## MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not wear loose clothing or jewelry near moving parts such as PTO shafts, fans, belts and pulleys.
- Keep hands away from moving parts.
- Keep guards in place over fans, belts, pulleys, and other moving parts.

## FLAMMABLE vapor environment

Flammable vapor can cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury or death. ***Do not operate a diesel-powered genset in a flammable vapor environment created by fuel spill, leak, etc.*** The owners and operators of the genset are solely responsible for operating the genset safely.

**POST THESE SUGGESTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT**

# Introduction

## ABOUT THIS MANUAL

This manual shows how to operate and maintain the Onan® MDKUB and MDKWB generator sets. Study the manual and heed all warnings and cautions. Using the genset properly and maintaining it regularly will promote longer set life, better performance, and safer operation.

The *Operating Recommendations* section covers the break-in procedure and the effects of high altitude and variations in climate. The *Wattage Requirements* section describes the wattage capacity of the set and lists the wattage use of common appliances and tools. Familiarize yourself and others who will operate this set with this information.

*Information for California Genset Users* provides important information for California genset users.

**Onan is a registered trademark of Onan Corporation.**

## MODEL IDENTIFICATION

Have the following information ready when you call a distributor:

- Model number
- Serial number

These are found on the nameplate (Figure 1), which is located on the inner side of the generator control box.

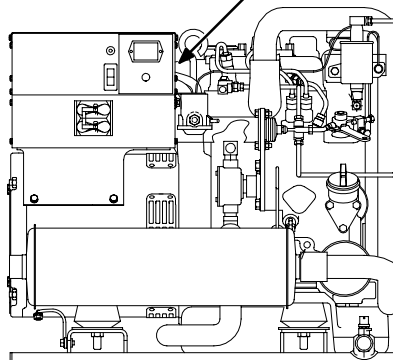
Record these numbers from your generator set in the area provided in Figure 1. Make sure that all numbers are recorded correctly.

## FEATURE AND COMPONENT LOCATIONS

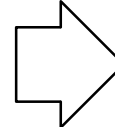
The standard control panel and the routine maintenance items are shown in Figure 2.

IMPORTANT ENGINE INFORMATION			
<b>Onan</b> ®		ONAN CORPORATION	
Model No.: 9.0MDKWB/60507D		1400 73rd Ave. NE	
S/N: A953123456		Minneapolis, MN 55432	
		Made in U.S.A.	
AC Volts:	Ph:	kW:	
Amps:	Pf:	RPM:	
Fuel:	Hz:	Bat:	12V
Insulation - NEMA Class		Ambient: 40°C	INI 3461 URC
<b>REFER TO OPERATOR'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.</b>			
<b>THIS ENGINE MEETS 1995-1998 CALIFORNIA EMISSIONS REGULATIONS FOR ULGE ENGINES.</b>			
SKB719U6D2RA		719 cc	

NAMEPLATE LOCATED ON  
INNER SIDE OF CONTROL BOX



RECORD COMPLETE  
MODEL AND SERIAL  
NUMBER HERE



MODEL NUMBER
SERIAL NUMBER

**FIGURE 1. MODEL IDENTIFICATION**

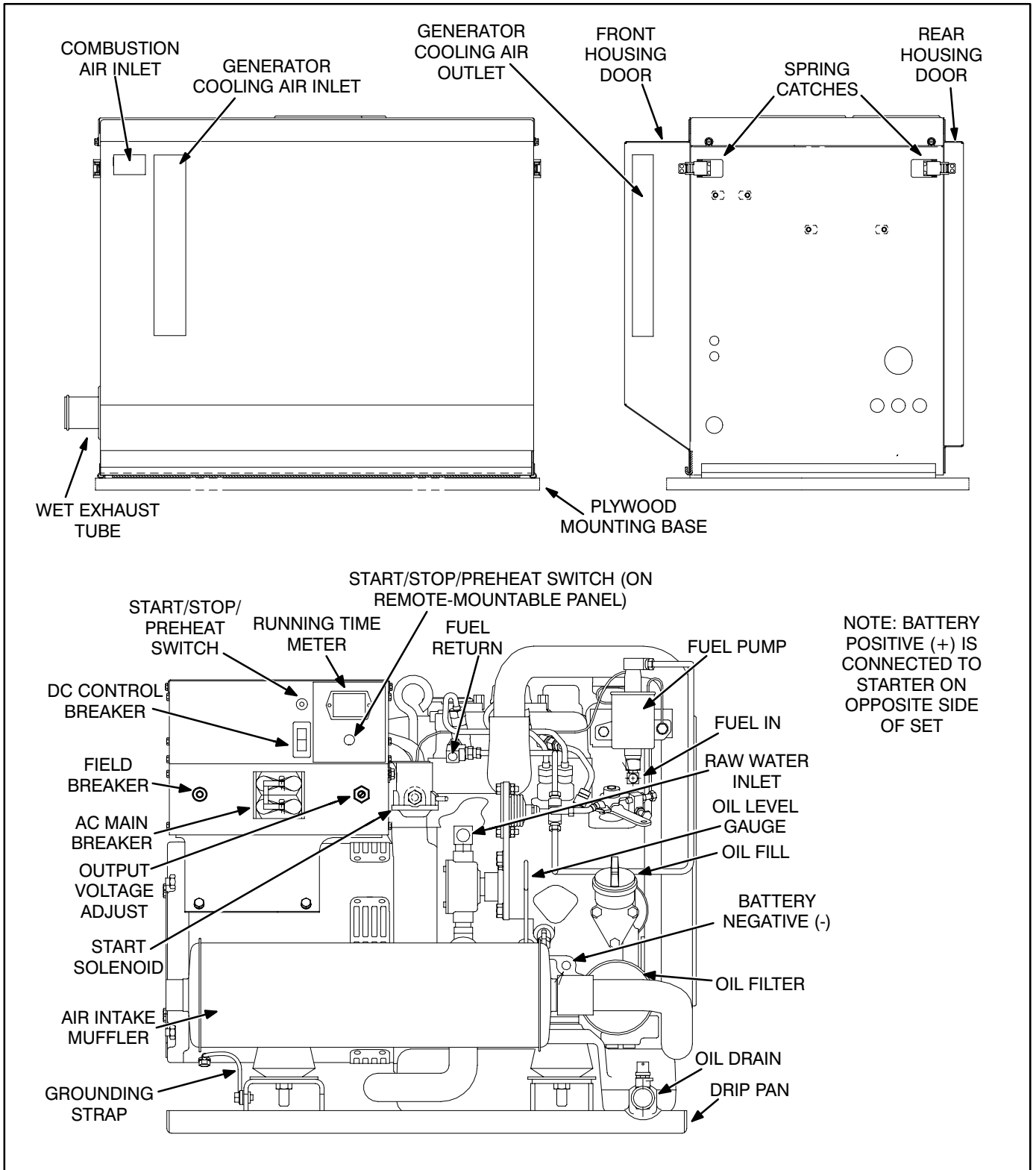


FIGURE 2. GENERATOR SET COMPONENT LOCATIONS (MDKUB SHOWN)



# Controls and Circuit Breakers

The set controls and circuit breakers are located on the front of the generator set, behind the front housing panel. See Figure 4.

The genset control panel is held on the set by two screws. This panel may be removed, unplugged and remounted anywhere on the vessel with the aid of a remote wiring harness. A blanking plate is used to cover the opening in the control box. See the Installation Manual, publication 981-0602.

## Remote (Detachable) Control Panel

**Start/Stop/Preheat Switch:** Starts and stops the generator set. Operates the engine cylinder preheaters.

**Running Time Meter:** A meter that displays the number of hours the generator set runs.

## Set-Mounted Controls and Breakers

**Start/Stop/Preheat Switch:** Starts and stops the generator set. Operates the engine cylinder preheaters.

**Voltage Adjustment Pot:** A potentiometer that is used to adjust the set output voltage (qualified technicians only).

**Field Breaker:** A breaker which trips when the generator field overloads.

**DC Control Breaker:** A 15 ampere DC breaker that protects the control box and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

**Line Circuit Breaker:** A dual circuit breaker that protects the set from a short circuit or other overload. It is mounted on the side of the AC control box.

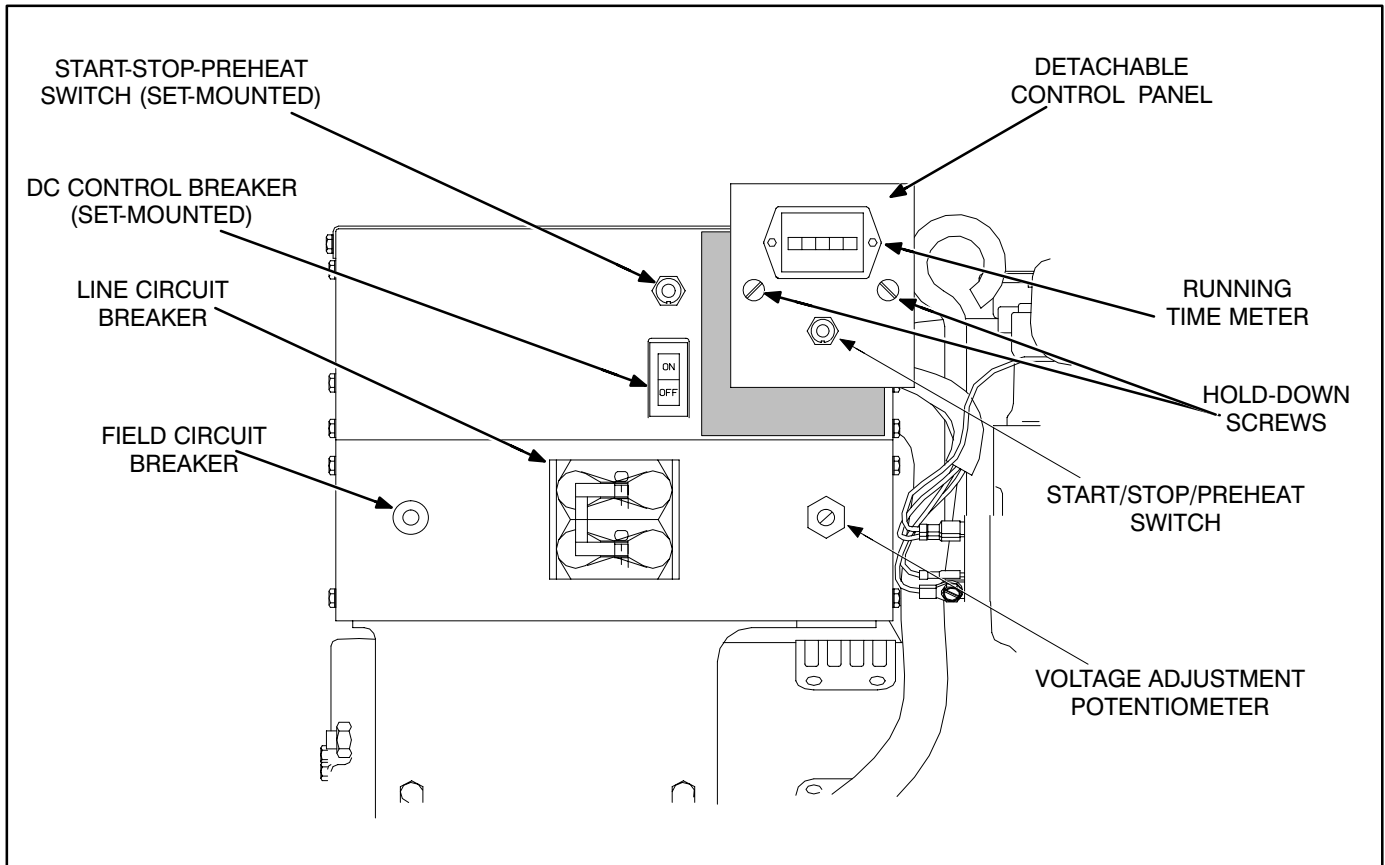


FIGURE 3. REMOTE CONTROL PANEL

## Optional Control/Meter Panel

An optional control panel includes a start/stop/pre-heat switch, running time meter, and gauges that

monitor oil pressure, coolant temperature, and DC battery voltage. The Starting and Stopping section of this manual describes these meters and what they should show during set operation.

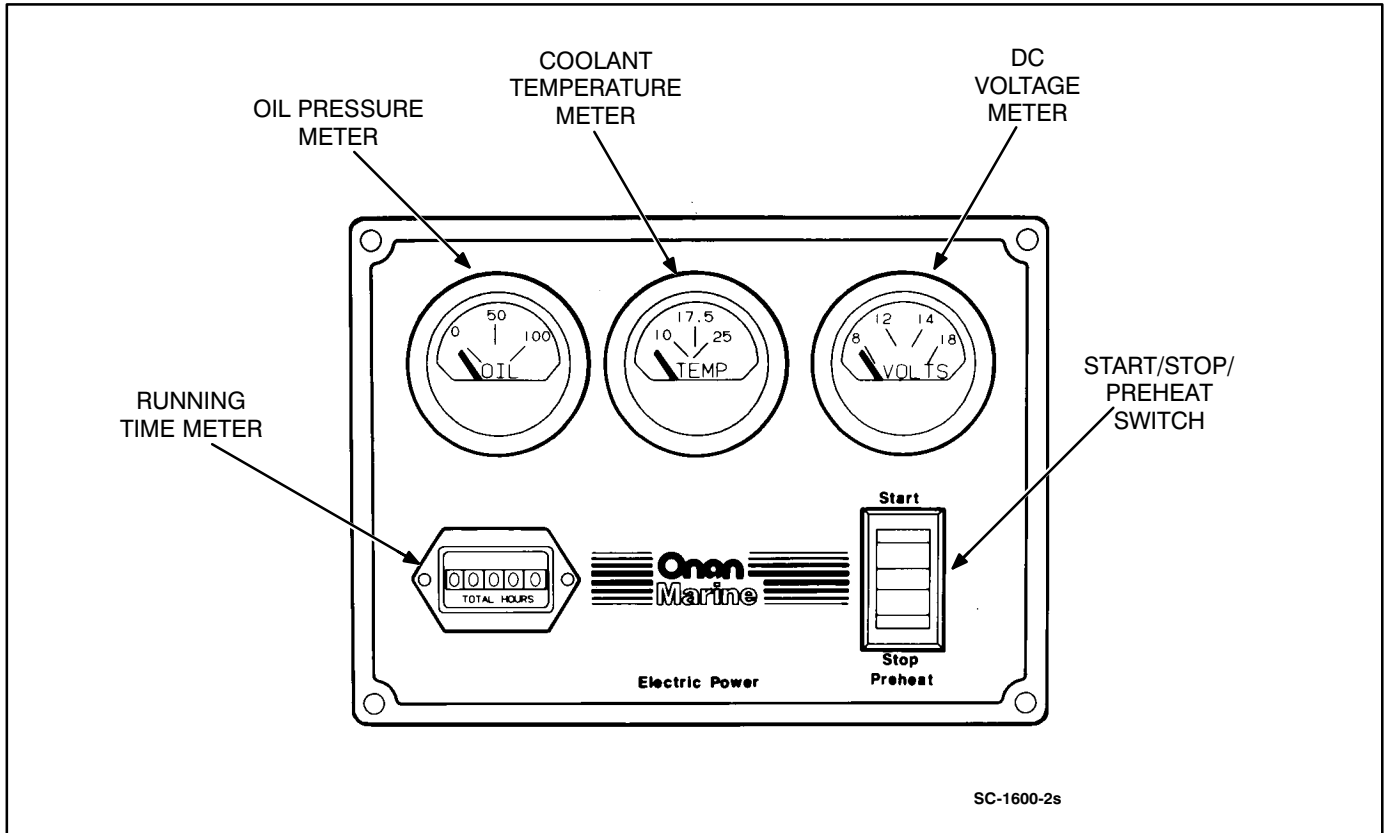


FIGURE 4. OPTIONAL CONTROL PANEL (W/METERS)

# Pre-Start Checks

## GENERAL

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 set.

## ENGINE OIL

Check the engine oil level before each start. When the generator set is new, the engine must be filled with oil before the initial start.

- MDKUB oil capacity: 3.78 liters (4 quarts)
- MDKWB oil capacity: 4.73 liters (5 quarts)

If adding oil between changes, use the same brand because different brands might not be compatible when mixed. Be careful not to overfill the crankcase because the oil will foam, resulting in engine shut-down.

### Oil Recommendations

Use premium quality motor oil. Look for the API (American Petroleum Institute) classification and use Class CD or better oil (CD, CE). Also look for the SAE (Society of Automotive Engineers) viscosity grade. Referring to Table 1, choose the viscosity grade appropriate for the ambient temperatures ex-

pected during the period of time until the next scheduled oil change.

### Checking Engine Oil Level

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

Check the engine oil level at the intervals shown in Table 2, later in this manual. The oil dipstick and fill are located on the side of the engine (see Figure 5). The dipstick is stamped with FULL and ADD to indicate the oil level in the crankcase. For an accurate reading, shut off the engine and wait 10 minutes before checking the level. This lets oil in the upper part of the engine drain into the crankcase.

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

TABLE 1. OIL VISCOSITY VS. TEMPERATURE

°F	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120						
							32															
°C	-34	-29	-23	-18	-12	-7	-1	4	10	16	21	27	32	38	43	48						
							0															
								Anticipated Ambient Temperature														

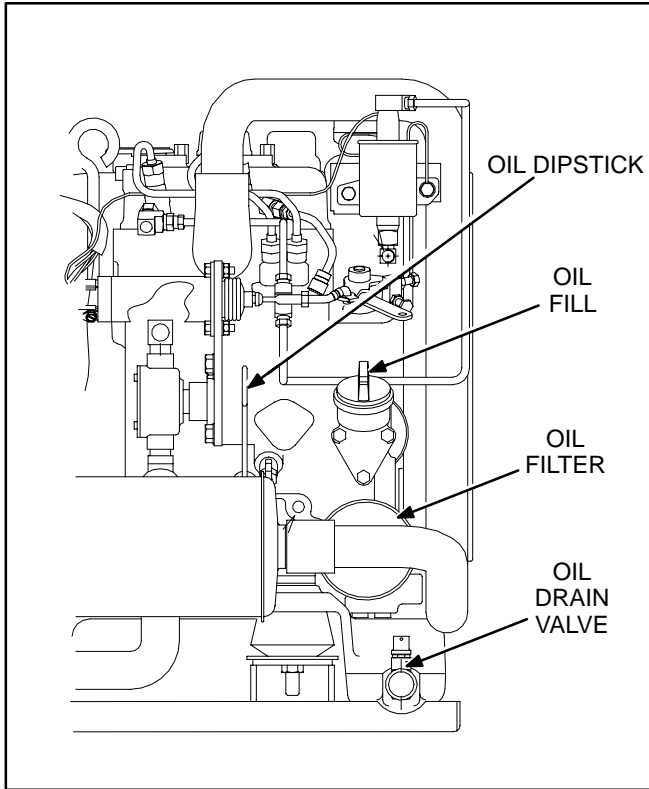


FIGURE 5. ENGINE OIL

## COOLANT

The coolant level should be near the fill mark on the coolant overflow bottle 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.*

## EXHAUST

Thoroughly inspect the exhaust system for leaks or corrosion. Have any problems repaired before operating the generator set.

**⚠WARNING** *Exhaust gas presents the hazard of severe personal injury or death. Make certain that all exhaust components are operational and that there are no exhaust leaks.*

---

## FUEL CHECK

Carefully inspect the fuel system for leaks or corrosion. Have any problems repaired immediately.

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

Use the best fuel available. Fuel quality is important for dependable performance and satisfactory engine life. Regularly check the fuel filter according to the Maintenance Schedule in this manual. Replace if necessary.

**⚠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 Recommendation

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 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 which has a cloud point 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.)

### RAW WATER PUMP PRIMING

Before beginning operation (initial start-up), the raw (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 the hose from the water filter outlet. Fill the hose and pump with clean water. Replace the hose and open the sea cock. Check pump operation on start-up by observing water discharge from the exhaust outlet.

### GENERAL INSPECTION

Check the generator set for damaged or loose parts. Make sure the air inlet and outlet areas are not blocked. Investigate any abnormal operating noises. Make sure that the generator set is securely mounted.

# Starting and Stopping

## **⚠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.**

## **STARTING**

### **Starting at Set**

1. Hold the starting switch to the STOP/PREHEAT position for 10 to 30 seconds, depending on the temperature (see Table 2).

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

**TABLE 2. PREHEAT TIME vs. TEMPERATURE**

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

2. Release the switch, then move it to the START position. 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 switch. Wait two minutes, then repeat Step 1 (preheat).

**⚠CAUTION** *Excessive cranking can over-heat the starter, damaging it. Do not engage the starter longer than 30 seconds without allowing two minutes for cooling.*

4. If the engine does not start on the second try:
  - Check the fuel supply.
  - Make sure the fuel system has been primed.

With an empty tank, the fuel system may need priming before the set can start. See *Fuel System* in the *Maintenance* Section.

### **Starting at Remote Panel**

The same procedures and cautions for normal starting apply to remote starting.

---

## Starting at Remote (Meter) Panel

If the optional remote panel with meters has been installed, monitor the oil pressure, water temperature, and set DC voltage while the set is being started, and after it has run for roughly a minute. Note the following:

- **Oil Pressure Gauge:** The oil pressure should be in the range of 28 to 64 psi (294 to 543 kPa) when the engine is at operating temperature.
- **Coolant Temperature Gauge:** The coolant temperature should be in the range of 165° to 195° F (74° to 91° C) depending on the load and ambient temperature.
- **DC Voltmeter:** Normal battery voltage should be 12.5 to 15 volts. Actual voltage depends on the battery state-of-charge and condition.

## STOPPING

### Before Stopping

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

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

**To Stop:** Push the switch to STOP, and hold it there until the engine stops.

# Wattage Requirements

## AC WATTAGE CAPACITY

The AC power output from the generator will power appliances and other equipment. (The wattage requirement of appliances and electrical equipment may be referred to as “electrical load”.)

AC line circuit breakers mounted on the set protect the generator from an overloaded output, which occurs when too much load is applied at once, or if there is a short circuit in the system.

### Connecting a Load

To determine the maximum amount of electrical load that can be applied, follow these steps:

1. Determine the maximum load (wattage) supplied by the genset/vehicle circuit, by multiplying the circuit breaker size by the AC output voltage:

$$2 \times 45 \text{ (amps)} \times 120 \text{ (volts)} = 10800 \text{ watts}$$

or

$$2 \times 22.5 \text{ (amps)} \times 240 \text{ (volts)} = 10800 \text{ watts}$$

2. Check the wattage requirement of each appliance to be connected (see Table 3). The appliance nameplate should list the wattage of each item.
3. Add the wattages of all the items to be powered at the same time. Make sure that the total wattage does not exceed the limit of the circuit breaker.

#### Example:

Air Conditioner	1800 watts
Converter	500 watts
Coffee Percolator	600 watts
Television	300 watts
<u>Total</u>	<u>3200 watts</u>

4. Start the generator set and let it warm up a few minutes before applying electrical load.

Make sure that each appliance and tool is properly grounded and in good working condition before using it.

**⚠️WARNING** *Electrical shock can cause severe personal injury or death. Appliances should be in good working condition and be properly grounded to provide additional protection from electrical shock.*

**TABLE 2. APPROXIMATE POWER DRAW OF COMMON APPLIANCES**

Appliance or Tool	Approximate Running Wattage
Air Conditioner	1400-2000
Battery Charger	Up to 800
Coffee Percolator	550-750
Converter	300-500
Electric Blanket	50-200
Electric Broom	200-500
Electric Drill	250-750
Electric Frying Pan or Wok	1000-1500
Electric Iron	500-1200
Electric Stove (Per Element)	350-1000
Electric Water Heater	1000-1500
Hair Dryer	800-1500
Microwave Oven	1000-1500
Radio	50-200
Refrigerator	600-1000
Space Heater	1000-1500
Television	200-600

### Motorized Appliances

Motorized appliances consume more power during startup than they do when running at normal speed. (Some motors draw as much as three times their operating power during startup.) If you plan to use a motorized appliance, turn it on **before** starting other appliances. When the motor is running at normal speed, more appliances may be added.

### Circuit Breakers

Circuit breakers on the electrical distribution panel or on the genset will open if their current ratings are exceeded. This may be caused either by running too many appliances at once, or by a short circuit.

The genset will continue to run after a breaker trips. Turn off all appliances and other loads, then reset



---

the breaker. If it trips again, a short circuit is indicated. Turn off the set and contact a qualified technician for assistance.

If the breaker does not trip, turn on only as many appliances as the breaker size allows (see *Connecting A Load* in this section). If the breaker trips again, a defective appliance or circuit breaker is indicated.

### Connection to Utility Power

Connect the RV to utility power (power from an outside source such as a plug-in outlet) **only** through an approved device, to protect against the possibility of generator power and utility power being connected. Consult the Installation Manual (publica-

tion 981-0601) for information on isolating the generator from utility-supplied power.

**⚠WARNING** *Connecting the generator set directly to the public utility or any other power system can cause electrocution, damage to equipment, or fire. Hazardous voltages can flow from the generator set into the utility line. An approved switching device must be used to prevent interconnections.*

### DC POWER

A 10-amp belt-driven alternator on the engine supplies DC power to recharge the starting battery for the set.

# Operating Recommendations

---

## BREAK-IN PROCEDURE

Drain the crankcase oil after the first 35 hours of operation. See the *Maintenance* section of this manual for the procedure.

## NO-LOAD OPERATION

**Hold no-load operation to a minimum.** With no load, combustion chamber temperatures drop so low that fuel does not burn completely. This creates carbon deposits which clog injectors, glaze cylinders and cause piston rings and valves to stick. If it is necessary to run the engine for long periods, **connect an electrical load to the generator output.**

## EXERCISE PERIOD

Infrequent use can result in difficult starting and moisture condensation problems. This moisture is a result of the engine not being run long enough to reach normal operating temperature. In extreme cases, water may be deposited in the oil. If this happens, severe engine damage can result. To prevent this possibility, run the generator set under load at least one hour per week.

Exercising for one long period each week is better than several shorter periods of operation. Do NOT operate the set for long periods at no load.

# Maintenance Schedule

Following the maintenance schedule and using the generator set properly will result in longer genset life, better performance, and safer operation. Perform each maintenance procedure at the time period indicated or after the number of operating hours indicated, whichever comes first. Refer to the *Maintenance Procedures* section for instructions.

Consult an Onan service center if the generator set will be subjected to extremely hot or dusty conditions; a more frequent maintenance schedule may

be necessary. Use the running time meter to keep an accurate log of all service and maintenance for warranty support (see the *Maintenance Record* section).

**⚠WARNING** *Accidental starting of the generator set during maintenance can cause severe personal injury or death. Disconnect both generator set starting battery cables, before performing maintenance. Remove the negative (-) cable first to reduce the risk of arcing.*

**TABLE 2. 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 <sup>1</sup>				14
Check Oil Level	x				5
Check Coolant Level	x				6
Check Fuel Level	x				7, 19
Check Battery Specific Gravity		x			22
Check Pump Belt Tension		x <sup>4</sup>			18
Change Crankcase Oil and Filter			x <sup>2,3,5</sup>		15
Drain Water/Sediment From Fuel Filter		x			20
Change Fuel Filter			x		20, 21
Flush/Clean Cooling System				x	17
Clean Generator Assembly			x		15
Check Genset Brushes			x <sup>6</sup>		-

- 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.
- 5 - Yearly if operated less than 250 hours.
- 6 - To be performed by authorized service technician.

# Maintenance Procedures

---

## INTRODUCTION

The procedures described in this section are limited to those that can be performed by the knowledgeable genset operator. If there is any doubt as to the correct performance of a procedure, consult your Onan distributor. **Certain procedures on the Maintenance Schedule (brush replacement, etc.) should only be performed by a qualified service technician.**

## GENERATOR SET INSPECTION

Inspect the generator set daily or after every eight hours of operation, whichever comes first. Check the exhaust, fuel, and DC electrical systems as described below. Also check the mechanical condition of the set.

### Engine Gauges (Remote Installation)

Check these gauges while the set is running.

**Oil Pressure Gauge:** Oil pressure should be 28 to 64 psi (294 to 543 kPa) when the engine is at operating temperature.

**Coolant Temperature Gauge:** Coolant temperature should be 165° to 195° F (74° to 91° C), depending on load and ambient temperature.

**DC Voltmeter:** Battery voltage during operation should be 12.5 to 15 volts on a 12-volt system.

### Exhaust System

With the set running, inspect the entire exhaust system including the exhaust manifold, exhaust elbow, muffler and exhaust pipe. Check raw water pump operation by observing raw water discharge from exhaust outlet: it should be about 3 gal/min. (11.4 liter/min.). Visually and audibly check for leaks at all connections, welds, gaskets, and joints. If any leaks are detected, **shut down the genset and do not operate until corrected.** Have corroded exhaust components replaced before leaks occur.

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

### Fuel System

With the set running, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check flexible sections for cuts, cracks and abrasions. See that the fuel lines do not rub against anything that could break them. Replace worn fuel line components before leaks occur.

**⚠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 battery terminals for clean and tight connections. Loose or corroded connections create resistance which can impede starting. Clean and reconnect loose battery cables. 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, 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.

## Cleaning The Set

Clean the generator set whenever dust and dirt begin to accumulate. Dust and dirt can usually be removed with a damp cloth. Steam cleaning may be needed to remove persistent dirt and grime. Do not clean the genset while the engine is running. Protect the generator, control panel, and electrical connections from cleaning solvents. Cleaning solvents can damage electrical connectors.

## OIL AND FILTER CHANGE

The engine oil was drained from the crankcase before shipment. **Before the initial start, fill the lubrication system with the recommended oil.** See the *Specifications* section for oil capacity.

Change the oil and filter at the intervals listed in Table 1. Use oil that meets the API classification and SAE viscosity grade indicated in the previous section.

### Engine Oil Change

Run the engine until thoroughly warm. Stop the engine, open the drain valve (Figure 6) and drain the oil into a container. When completely drained, close the 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.*

**⚠WARNING** *State or federal agencies have determined that prolonged contact with used engine oil can cause cancer or reproductive toxicity. When adding, changing or working with used oil, take care not to breathe, ingest or come into excessive contact with these substances. Wash hands after use. Wear protective clothing and equipment. Provide adequate ventilation.*

## Oil Filter Change

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

Add the quantity of oil listed in the Specifications section of this manual to the crankcase, start the set and check for leakage around the filter gasket. Tighten the filter only enough to eliminate leaks. Shut off the set, recheck the oil level and add additional oil if necessary.

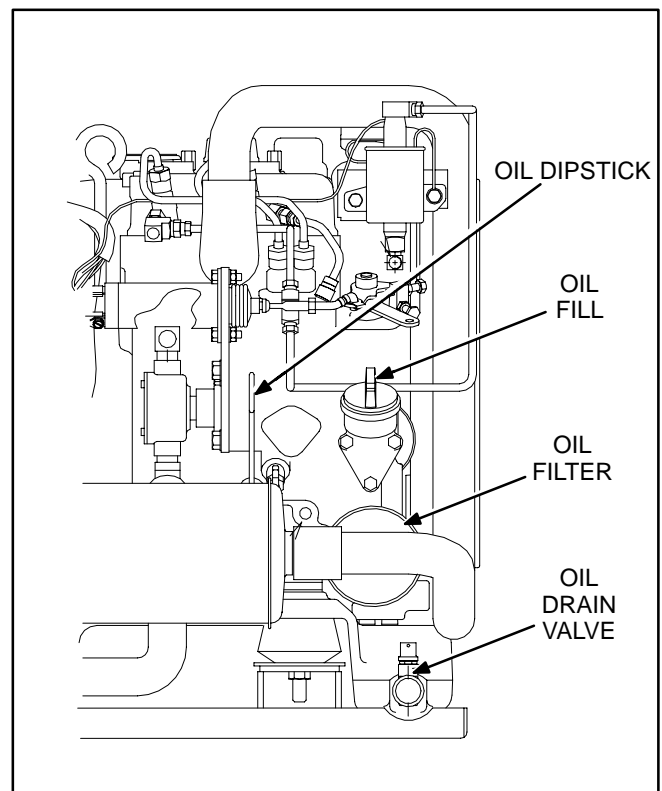


FIGURE 6. ENGINE OIL

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## COOLING SYSTEM

The cooling system is drained before the set is shipped. **It must be refilled before the genset is operated.** Cooling system capacity is listed in the *Specifications* section.

### Coolant Requirements

Engine coolant must inhibit corrosion and protect against freezing. A 50/50 mixture of ethylene glycol anti-freeze and water is recommended for normal operation and storage. Use only a reliable brand of anti-freeze that contains a rust and corrosion inhibitor. **The anti-freeze should not contain a stop-leak additive.**

Do not exceed a 50/50 mixture of ethylene glycol and water. A higher proportion of ethylene glycol will alter the heat transfer properties of the coolant. A 50/50 mixture will provide freeze protection to -34° F (-37° C).

Water used for engine coolant should be clean, low in minerals, and free of corrosive chemicals. Use distilled or soft water if available. Avoid the use of well water, which may contain minerals which can clog the heat exchanger core and reduce cooling efficiency.

### Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps are secure. Remove the cooling system

pressure cap and slowly fill the cooling system with the coolant mixture.

**⚠ CAUTION** *Exceeding the recommended fill rate can cause incomplete filling of the engine block, leading to engine damage during warm-up. Always follow the recommended fill procedure.*

Fill the recovery tank with coolant mixture to the FULL mark. Operate the genset until normal operating temperature is maintained (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.

**⚠ 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 a 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.*

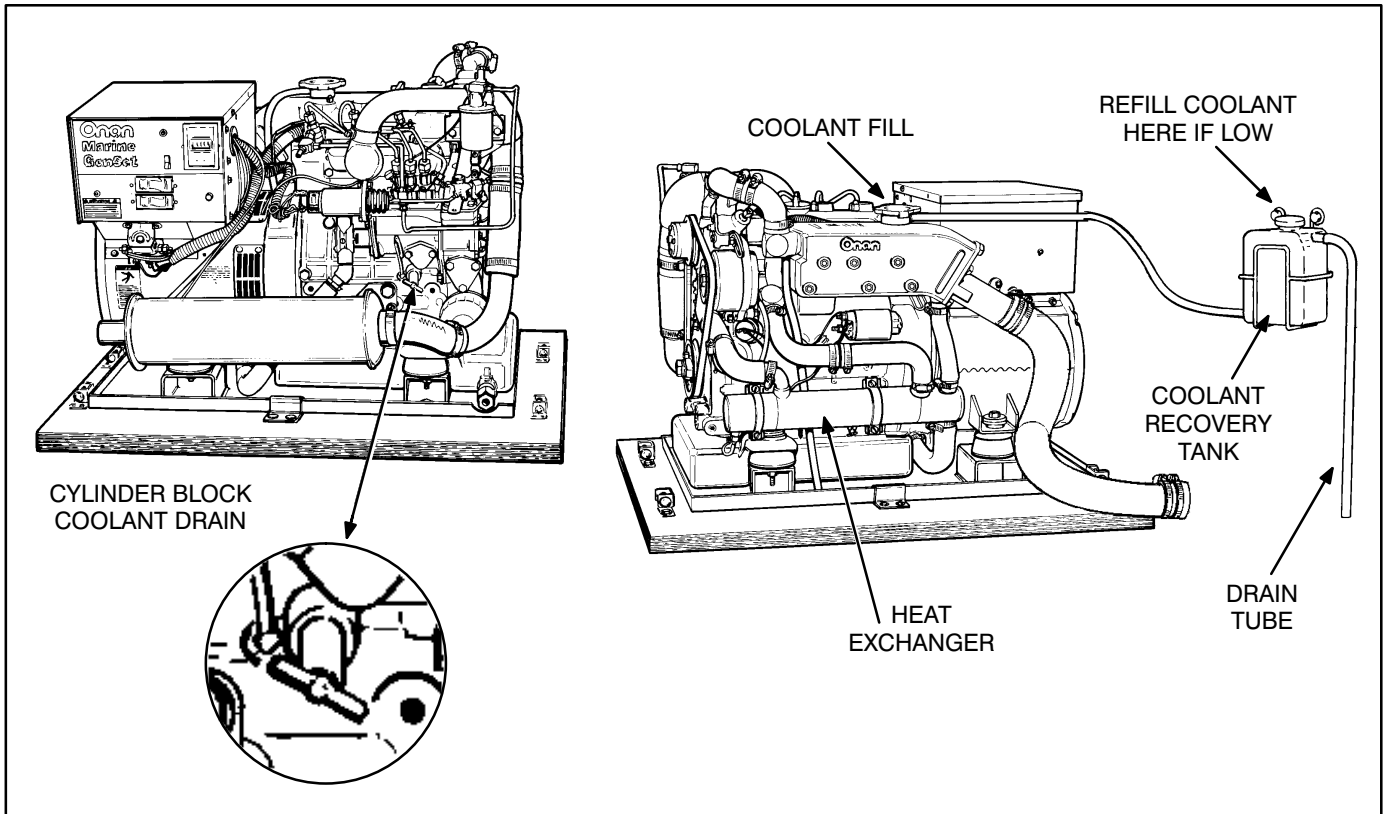


FIGURE 7. GENSET COOLING SYSTEM

## Flushing and Cleaning

Once a year, drain, flush and refill the cooling system with new coolant. To drain the system, open the heat exchanger drain and the cylinder block drain on the left side of engine. See Figure 7.

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

Drain the system completely. The heat exchanger and the cylinder block drain must be opened. See Figure 7. Remove the pressure cap to aid the draining process.

**Chemical Cleaning:** Rust and scale slow heat absorption and can block coolant flow. Clean the cooling system if rust and scale have collected on the engine water jacket or in the heat exchanger. Use a good cleaning compound and follow its instructions.

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

**⚠ CAUTION** *Never pour hot water into a cold engine or cold water into a hot engine. Doing so can crack the head or the cylinder block. Do not operate the unit without water for even a few minutes.*

## Pressure Cap

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

## Pump Belt

Access to the belt is made by removing the genset housing. 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.*

To adjust the belt, loosen the bottom pivot bolt on the alternator, then loosen the bolt that passes through the long slot in the alternator mounting bracket. Slide the alternator until the tension is right. See Figure 8.

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

**⚠ CAUTION** *Operation of the generator set with too much tension on the pump belt may cause reduced belt life. For longest belt life, do not overtighten the pump belt.*

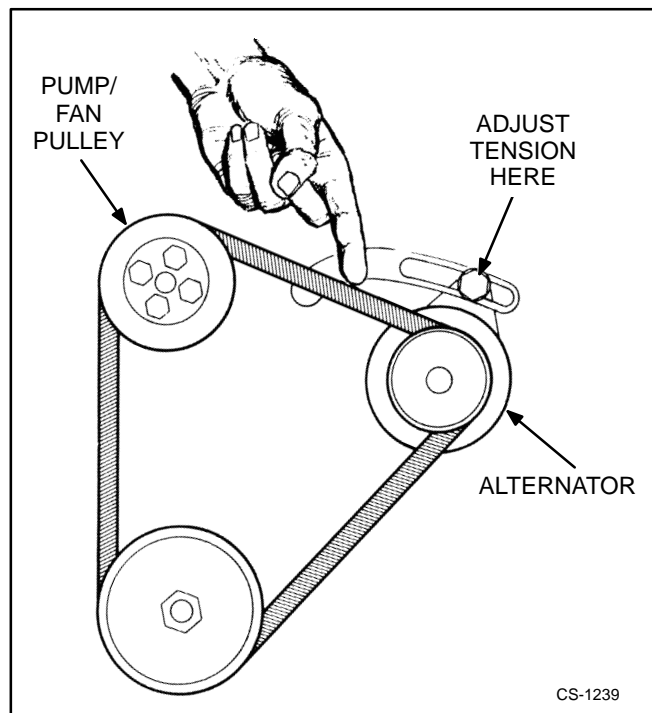


FIGURE 8. PUMP BELT ADJUSTMENT

## Siphon Break Valve

A siphon break valve should be 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). The siphon valve is not part of the generator set; however, Onan provides a siphon valve kit.



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## FUEL SYSTEM

Use the best fuel available. Fuel quality is important for dependable performance and satisfactory engine life.

**⚠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 Recommendation

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 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 which has a cloud point 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

Prevent dirt, water or other contaminants from entering the fuel system. Filter or strain the fuel as the tank is filled.

**⚠CAUTION** *Due to the precise tolerances of diesel injection systems, 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.*

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

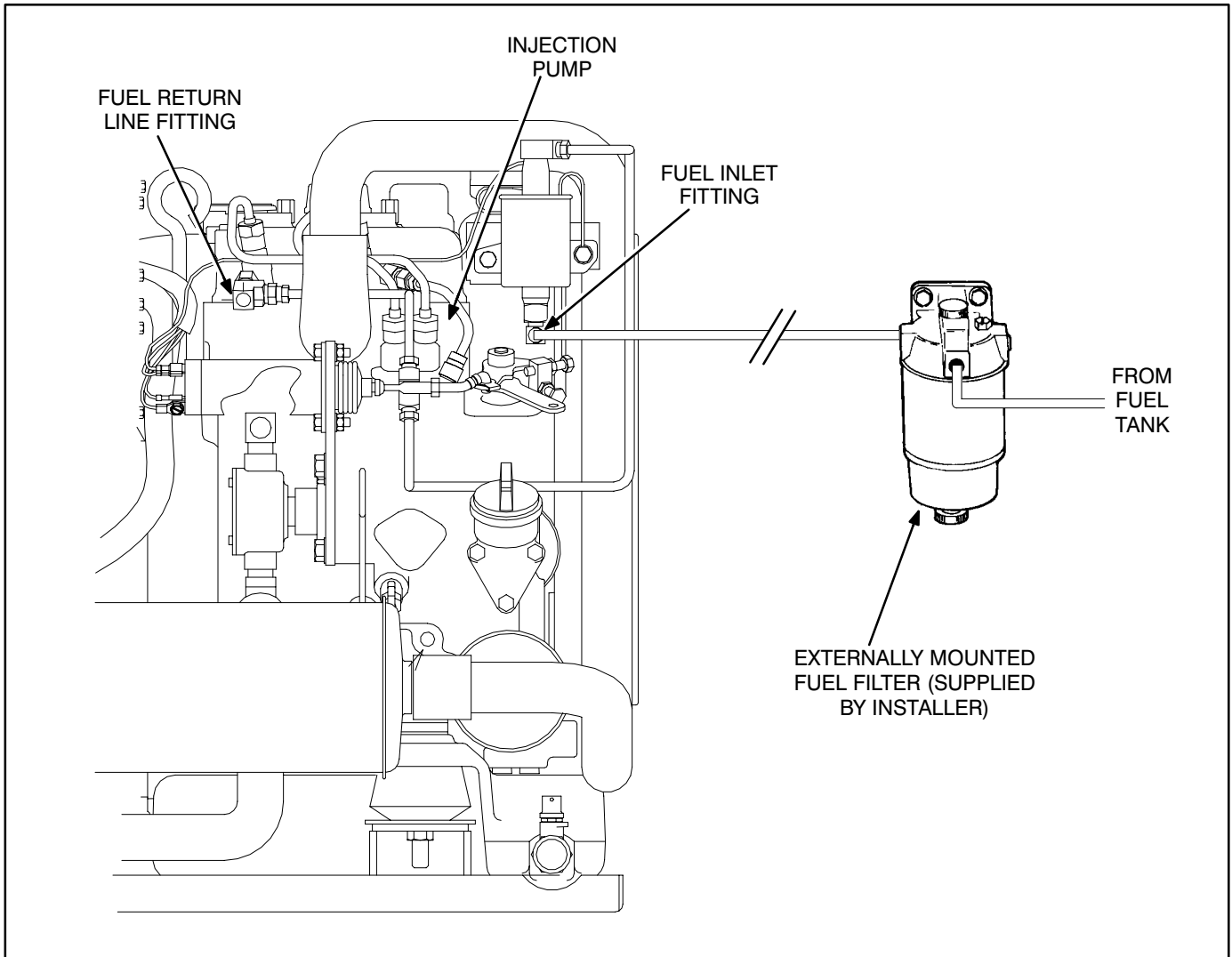
Low fuel in the tank promotes condensation. In warm weather, the fuel tank cools at night quicker than the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly, forming condensation. In cold weather, the warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel is low, condensation may form on the upper part of the tank. **To avoid condensation, fill the fuel tank every time the genset is used.**

### Priming the Fuel System

The fuel system must be primed before initial start-up or after the engine has run out of fuel. Figure 9 illustrates the fuel system.

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

Be sure to check the fuel level in the tank and that the shutoff valve is open.



**FIGURE 9. 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 that 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:

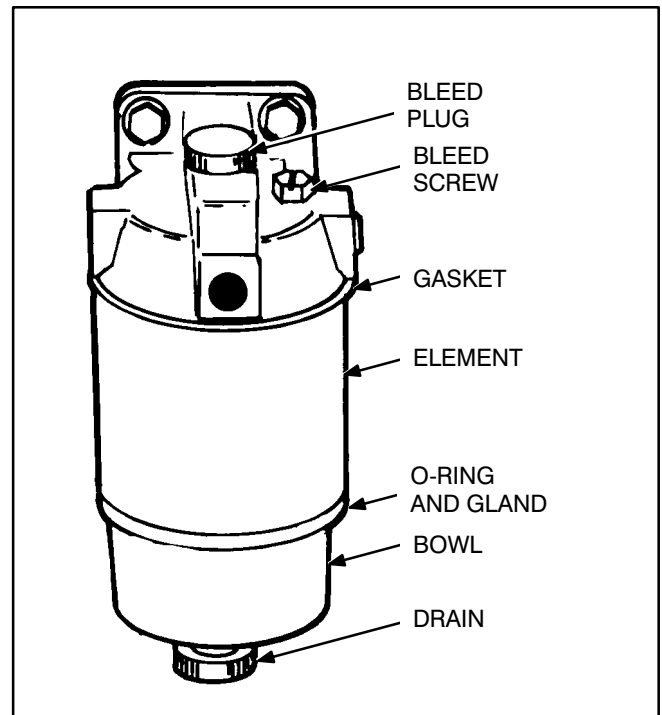
1. Open the drain valve and bleed plug on the fuel filter assembly (Figure 10). Collect fuel in a suitable container and dispose of properly.
2. Tighten drain valve.
3. Bleed air from the filter housing by performing Steps 8 through 10 in the next paragraph.

**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. Tighten the drain valve.
6. Spin the bowl onto the new element. **DO NOT OVER-TIGHTEN.**
7. Lubricate the element and gasket, and fill bowl and filter element with clean diesel fuel.
8. Spin the bowl and element assembly onto the head and hand tighten.
9. 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.
10. Depress the Start switch until fuel purges at the bleed screw and bleed plug opening.
11. Replace the bleed plug and close bleed screw. Reconnect the starter solenoid lead.



**FIGURE 10. FUEL FILTER ASSEMBLY**

## BATTERY CARE

Service the battery at the intervals shown in the maintenance schedule. Check the electrolyte level more frequently during hot weather.

**⚠WARNING** *Batteries present the hazard of explosion that can result in severe personal injury. Do not smoke or allow any fire, flame, spark, pilot light, arc-producing equipment or other ignition sources around the battery area. Do not disconnect battery cables while the generator set is cranking or running because explosive battery gases could be ignited.*

**⚠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.*

1. Keep the battery case clean and dry.
2. Make certain that the battery cable connections are clean and tight. Use a terminal puller tool to remove the battery cables.

Remove corrosion from the battery 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. 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.

3. Identify the cable as positive (+) or negative (-) before making the battery connections. Always connect the negative (-) cable last, to reduce the risk of arcing.
4. Maintain the electrolyte level by adding distilled water. Fill each cell to the split-level marker in the battery. The water component of the electrolyte evaporates, but the sulfuric acid component remains. For this reason, add water, not electrolyte to the battery.
5. Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell (Figure 11). Charge the battery if the specific gravity measures less than 1.215. Do not overcharge the battery. Stop charging the battery

when the electrolyte specific gravity reaches 1.260, at approximately 80° F (27° C).

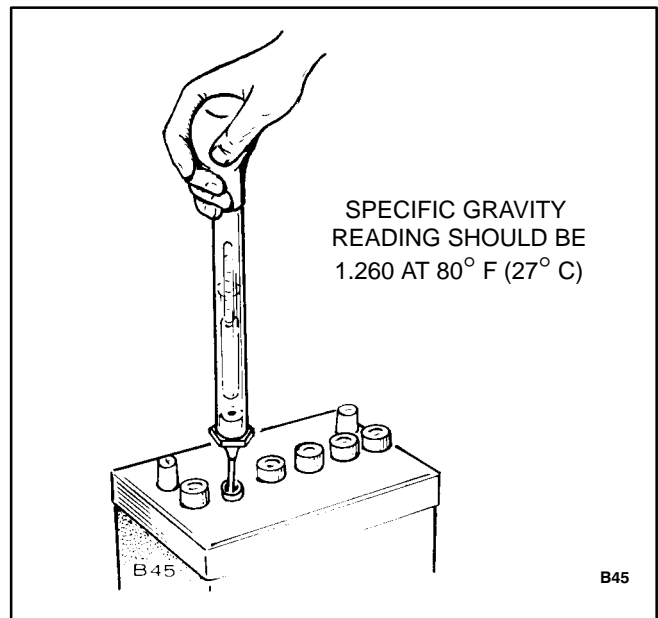


FIGURE 11. BATTERY CHECK

## AC GENERATOR

### Generator Brushes

The generator should be inspected for brush wear and cleaning as required per the Periodic Maintenance Schedule. This procedure should be performed by an authorized Onan service technician.

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

### Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years, because the bearing grease gradually deteriorates due to oxidation. See the Service Manual (publication 981-0512) for the bearing replacement procedure. If the generator requires major repair or service, contact an authorized Onan dealer or distributor.

# Generator Set Storage

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## OUT-OF-SERVICE PROTECTION

The lubricating qualities of No. 2 diesel fuel should protect the cylinders of a diesel engine at least 30 days when the set is not being run. For storage longer than 30 days, proceed as follows:

1. Exercise the genset (see *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 oil viscosity.
4. Check the coolant level. Add more coolant if low. If freezing temperatures are possible, test 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 raw 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. Lightly coat parts that may rust with 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 sea cock.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check the battery. Measure the electrolyte specific gravity with a hydrometer (1.260 @ 80° F [27° C]) and verify the proper level. If the specific gravity is low, charge the battery until the value is correct. If the level is low, add distilled water and charge until the specific gravity reading is correct. **DO NOT OVERCHARGE.**

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

4. Prime the fuel system.
5. Connect the starting battery, negative (-) cable last.
6. Remove all loads before starting the genset.
7. After starting, run the generator set at no load for roughly 30 seconds. Then apply a load of at least 50 percent rated capacity.
8. Check all gauges for normal readings. Genset is ready for operation.

# Troubleshooting

## DC CONTROL

The DC control has a number of sensors that continuously monitor the engine for low oil pressure, high coolant temperature and high exhaust tem-

perature. If any of these conditions occur, the control stops the engine. See Figure 13.

If a major problem is indicated, contact an Onan dealer or distributor for help or service.

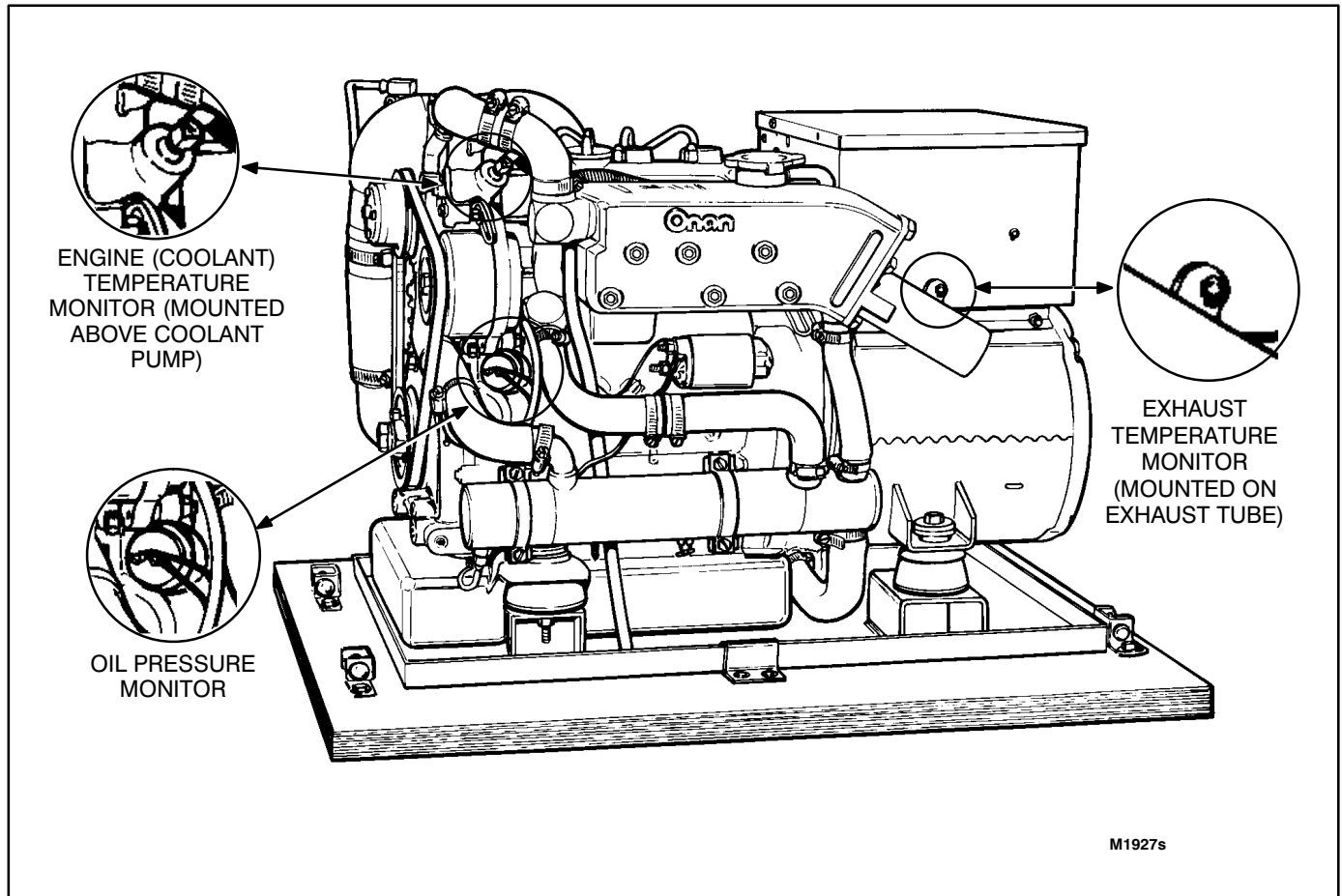


FIGURE 13. LOCATION OF ENGINE MONITORS

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## 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).

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

## High Coolant Temperature

If fault occurred during operation, check the set for indication of coolant temperature over 222° F (106° C). The coolant thermostat switch closes at this temperature and actuates the fault circuit.

Check the coolant level in the exhaust manifold after allowing the engine to cool down. Ensure pump belt is OK and has proper tension. The raw water flow at the exhaust outlet should be about 3 gal./min. (11.4 liter/min.). Also check cooling system cleanliness (freedom from contaminants, rust, sludge buildup, etc.).

**⚠WARNING** *Contact with hot coolant can result in SEVERE burns. Allow cooling system to cool before releasing pressure and removing radiator cap or release of hot coolant can result.*

## 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 closes to shut down the set if raw water flow is lost. It opens again when the temperature reaches about 190° F (88° C).

**⚠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.*

## AC CONTROL

The AC control consists of the line circuit breakers and the generator field breaker. The line circuit breakers are connected between the generator output and the load. Breakers are required to protect the generator from shorts or overload. They are mounted on the side of the AC control box on the set. Line circuit breakers are customer supplied on the set, and their location may vary.

The generator field breaker protects the generator rotor from overload damage.

# How to Obtain Service

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## LOCATING SERVICE ASSISTANCE

When your generator set needs parts or service, contact the nearest authorized dealer or distributor. Onan Parts and Service representatives are factory-trained to handle all of your service needs. Locate the nearest authorized distributor as follows:

1. Check the North American Sales and Service Directory (F-118) supplied with your Onan gen-set. This directory lists authorized distributors who will assist you in locating the nearest authorized dealer.

-or-

2. Consult the Yellow Pages. Typically, our distributors are listed under:

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

-or-

3. 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.

If you need additional assistance, please call Onan Corporation, 1-612-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday.

## SCHEDULING SERVICE

1. Before calling for service, have the following information available:

*The complete Onan product model number and serial number (see Model Identification on page 1)*

*Date of purchase*

*Nature of the problem*

2. Contact the authorized dealer or distributor nearest you to explain the problem and make an appointment.
3. If you have difficulty in arranging for service or resolving a problem, please contact the dealer coordinator or service manager at the nearest Cummins/Onan distributor for assistance.

### **▲WARNING**

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



# Specifications

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## DIMENSIONS AND WEIGHT

MDKUB:	Weight (with housing) . . . . .	172.4 kg (380 pounds)
	Height . . . . .	595.8 mm (23.46 inches)
	Length . . . . .	709.7 mm (27.94 inches)
	Width . . . . .	545.4 mm (21.47 inches)
MDKWB:	Weight . . . . .	204.1 kg (450 pounds)
	Height . . . . .	595.8 mm (23.46 inches)
	Length . . . . .	816.7 mm (32.15 inches)
	Width . . . . .	545.4 mm (21.47 inches)

## GENERATOR

Type: . . . . .	2-pole revolving field, 4-wire reconnectible
Standby ratings: . . . . .	See Genset Nameplate
Frequency regulation, no load-rated load: . . . . .	5 percent
Voltage regulation, no load-rated load: . . . . .	±2 percent

## ENGINE

Engine type:	MDKUB . . . . .	Kubota Z482B, diesel, 2 cylinder, vertical in-line
	MDKWB . . . . .	Kubota D722B, diesel, 3 cylinder, vertical in-line
Bore and stroke: . . . . .		67 x 68 mm (2.64 x 2.68 inches)
Total displacement:	MDKUB . . . . .	479 cc (29.23 cubic inches)
	MDKWB . . . . .	719 cc (43.89 cubic inches)
Combustion chamber: . . . . .		Spherical type
Engine speed:	60 Hz sets: . . . . .	3600 rpm
	50 Hz sets: . . . . .	3000 rpm
Fuel: . . . . .		No. 2 diesel
Oil capacity with filter:	MDKUB . . . . .	3.78 liters (4 quarts)
	MDKWB . . . . .	4.73 liters (5 quarts)
Fuel consumption (No. 2 diesel fuel) liters/hour (gallons/hour) average @ half load:		
	MDKUB @ 60 Hz . . . . .	1.75 (0.46)
	MDKUB @ 50 Hz . . . . .	1.4 (0.37)
	MDKWB @ 60 Hz . . . . .	2.5 (0.65)
	MDKWB @ 50 Hz . . . . .	2.0 (0.52)
Fuel consumption, (No. 2 diesel fuel) liters/hour (gallons/hour) average @ full load:		
	MDKUB @ 60 Hz . . . . .	2.65 (0.7)
	MDKUB @ 50 Hz . . . . .	2.1 (0.55)
	MDKWB @ 60 Hz . . . . .	3.7 (0.98)
	MDKWB @ 50 Hz . . . . .	3.0 (0.79)
Fuel pump lift (self-priming) . . . . .		1.2 meters (48 inches)
Fuel inlet . . . . .		1/8-27, NPT, Female
Fuel return . . . . .		1/8-27, NPT, Female
Total air per minute required (cooling and combustion): . . . . .		4.25 m <sup>3</sup> /min. (150 ft <sup>3</sup> /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
Coolant capacity:	MDKUB . . . . .	2 liters (2.1 qt.)
	MDKWB . . . . .	3.5 liters (3.7 qt.)



# Information for California Genset Users

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These gensets meet the requirements of California's Exhaust Emissions Standards for 1995 and later for Utility and Lawn and Garden Equipment Engines.

As a California user of these gensets, please be aware that unauthorized modifications or replacement of fuel, exhaust, air intake, or speed control system components that affect engine emissions are prohibited. Unauthorized modification, removal or replacement of the genset label is prohibited.

You should carefully review Operator (Owner), Installation and other manuals and information you receive with your genset. If you are unsure that the installation, use, maintenance or service of your genset is authorized, you should seek assistance from an authorized dealer.

California genset users may use Table 4 as an aid in locating information related to the California Air Resources Board requirements for emissions control.

**TABLE 4. EMISSIONS CONTROL INFORMATION**

Genset Warranty Information	The California emissions control warranty statement is located in the same packet of information as this manual when the genset is shipped from the factory.
Engine Fuel Requirements	The engine is certified to operate on diesel fuel. See FUEL RECOMMENDATIONS in <i>Pre-Start Checks</i> .
Engine Lubricating Oil Requirements	See ENGINE OIL RECOMMENDATIONS in <i>Pre-Start Checks</i> .
Engine Adjustments	High Idle Speed. This is a service procedure requiring trained personnel and proper tools. See the Service Manual.
Engine Emission Control System	The engine emission control system consists of engine design and precision manufacture. <b>(IFI)</b>



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