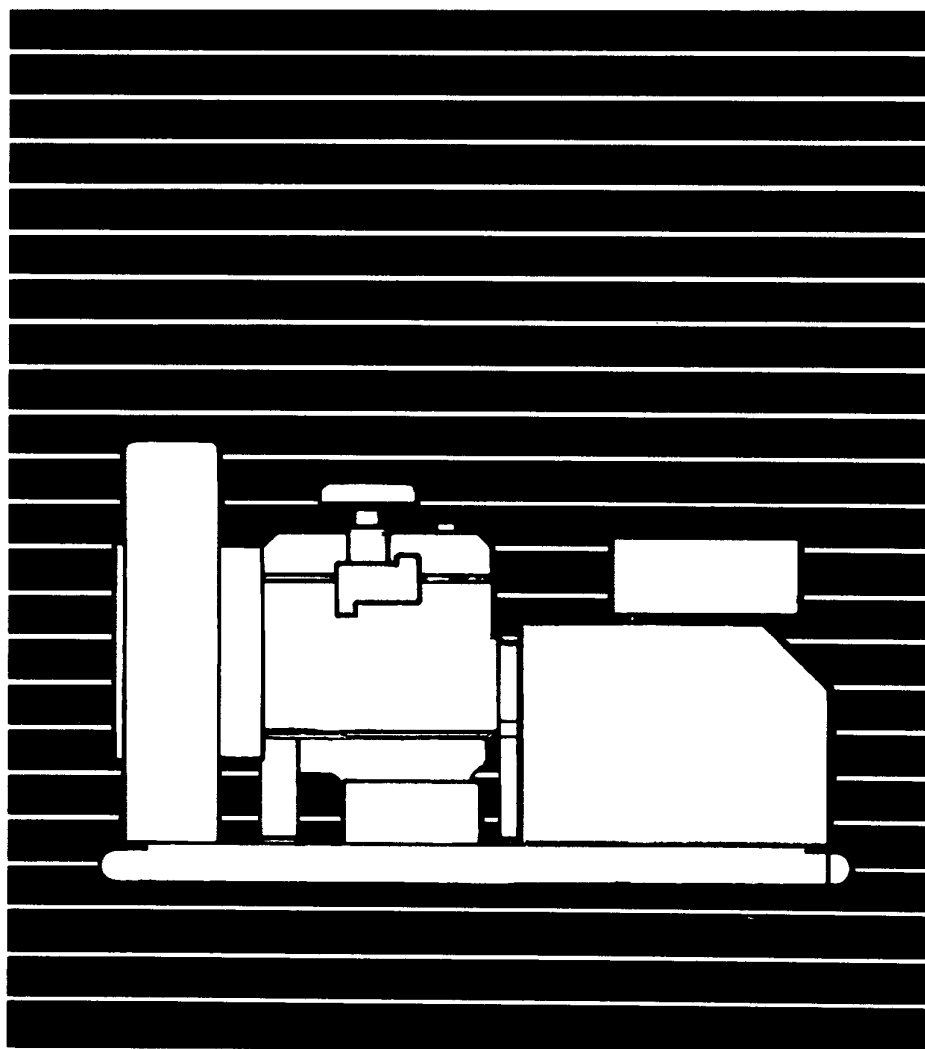




Operator's Manual

20 ES GENERATOR SET

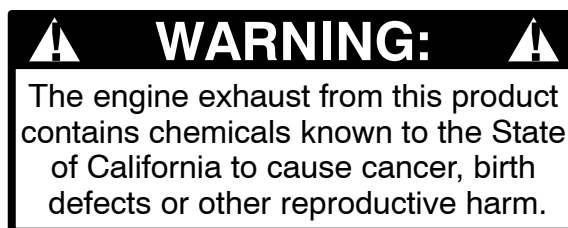


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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ 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 AND FUMES ARE FLAMMABLE

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

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.

- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc..

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

HIGH VOLTAGE GENERATOR SETS (1.9kV to 15kV)

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

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- 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.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- 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.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

This manual provides general information for operating, maintaining and adjusting the Onan® ES generator set (Figure 1-1). Study this manual carefully and comply with each of its warnings and cautions. Using the generator set (genset) properly and performing regular maintenance can result in longer unit life, better performance, and safer operation.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearest Cummins®/Onan® dealer or distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

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

GENERATORS-ELECTRIC or
ELECTRICAL PRODUCTS

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 outside North America, call Onan Corporation, 1-612-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Onan using the fax number 1-612-574-8087.

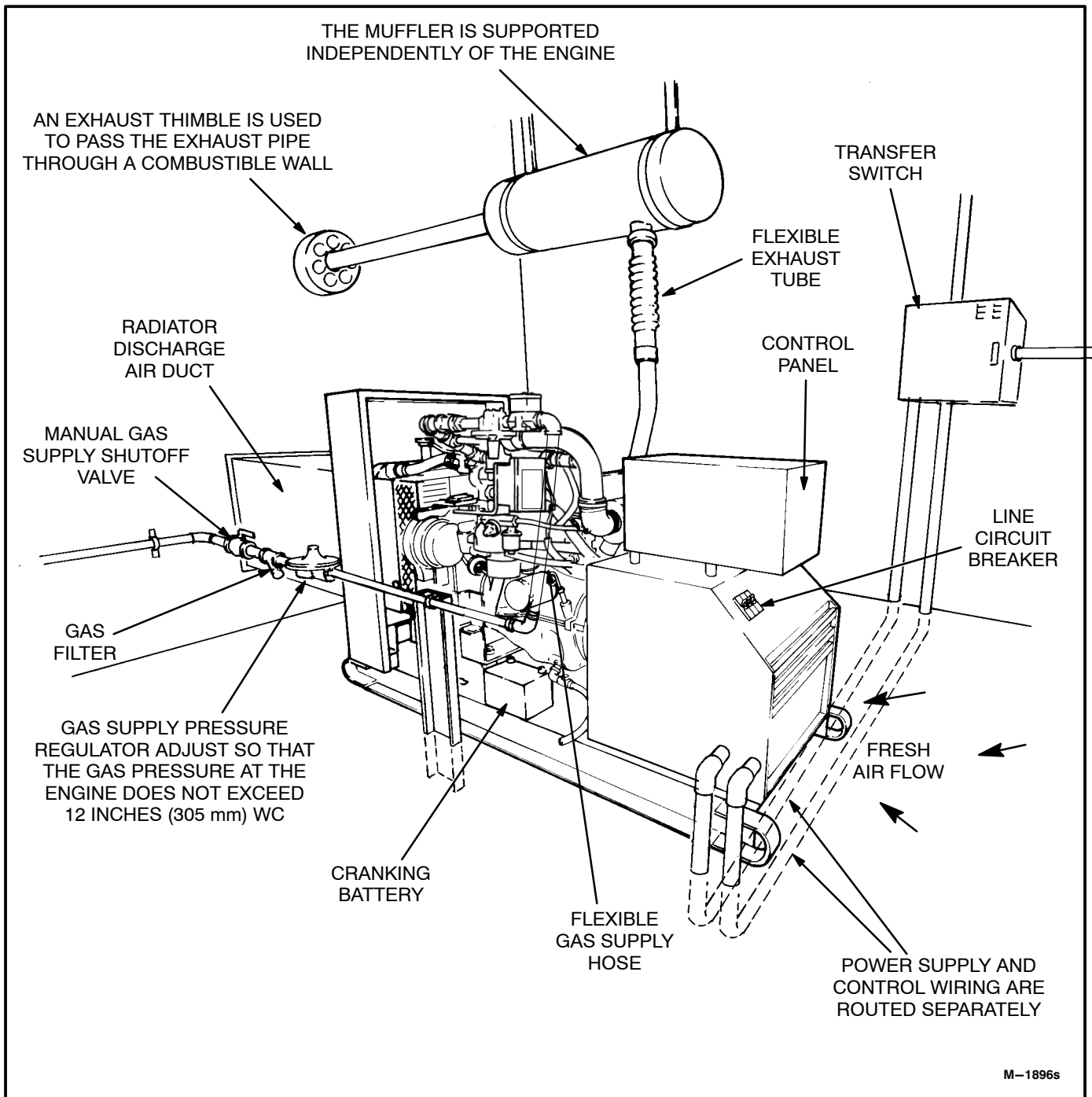
When contacting your distributor, always supply the complete Model Number and Serial Number as shown on the generator set nameplate.

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.

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M-1896s

FIGURE 1-1. TYPICAL INSTALLATION

2. Specifications

ENGINE Onan Modified Ford, 4-cylinder, LRG-423

FUEL

Fuel Natural gas, Propane, Unleaded Gasoline, or a combination of two fuels

Natural Gas Consumption at Full Load

60 Hz 301 cfh (8.5 m/h)

50 Hz 250 cfh (7.1 m/h)

Propane (Vapor) Consumption at Full Load

60 Hz 103 cfh (2.9 m/h)

50 Hz 85 cfh (2.4 m/h)

Gasoline Consumption at Full Load

60 Hz 2.7 US gph (10.2 L/h)

50 Hz 2.5 US gph (9.5 L/h)

BATTERY

Required Battery Voltage 12 VDC

Recommended Battery Rating - Cold Cranking Amps 660

OIL AND COOLANT CAPACITY

Engine Oil Capacity (Includes Filter) 4.5 U.S. quarts (4.0 L)

Engine Coolant Capacity 11.5 U.S. quarts (11.0 L)

TUNE-UP SPECS

Spark Plug Gap 0.032 to 0.036 inches (0.8 to 0.9 mm)

3. Operation

GENERAL

These sets can be started and stopped manually, or automatically by a remote control. The engine control automatically disconnects the starter when the engine starts up and shuts down the engine when a fault occurs (low oil pressure, for example). An electronic governor provides isochronous engine governing. An automatic voltage regulator regulates AC output voltage.

CONTROL BOX

The control box is mounted on vibration isolators on top of the generator output box. It can be mounted to face either side or the rear. Figure 2-1 illustrates a control panel that includes all the optional components.

The following components are standard on the control panel.

Start / Stop / Remote Switch. The switch is pushed to the **Start** position to start and run the generator set and the **Stop** position to stop the set. The **Remote** position allows a remote controller to automatically run the set.

The switch must be in the **Stop** position when the reset switch (described next) is used to restore generator set operation following a fault shutdown.

Reset / Lamp Test Switch. The switch is pushed to the **Reset** position (momentary contact) to reset the engine control to restore operation following a fault shutdown. The **Start / Stop / Remote** switch must be in the **Stop** position for reset to occur. The **Lamp Test** position (momentary contact) lights all the fault indicator lamps. Replace lamps that do not light.

Oil Pressure Gauge. The oil pressure gauge indicates engine oil pressure.

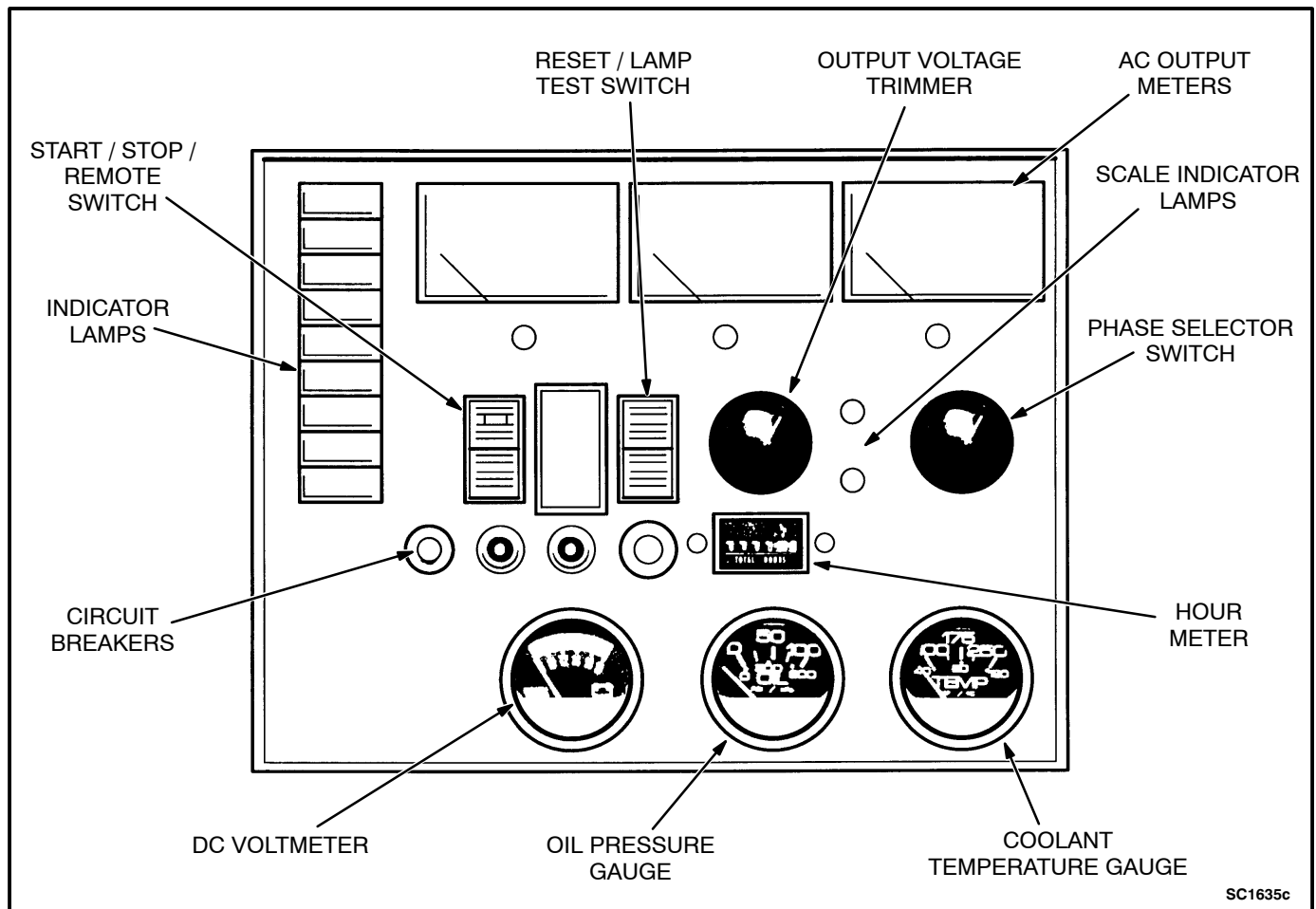


FIGURE 2-1. CONTROL PANEL

Coolant Temperature Gauge. The coolant temperature gauge indicates engine coolant temperature.

DC Voltmeter. The DC voltmeter indicates battery charging voltage during operation.

Hour Meter. The hour meter indicates the accumulated number of hours the set has run. It cannot be reset.

Field Circuit Breaker. This circuit breaker protects the generator from over excitation.

Control Circuit Breaker. This circuit breaker protects the generator control circuits.

Remote Circuit Breaker. This circuit breaker protects the remote control circuits.

Auxiliary Circuit Breaker. This circuit breaker protects the governor and fuel solenoid circuits.

Two Indicator Lamps.

- **Run (Green).** This lamp indicates that the generator set is running and that the starter has been disconnected.
- **Fault Shutdown (Red).** This lamp indicates that the engine shut down because of one of the following faults.
 - **Low Oil Pressure.** Engine oil pressure dropped to less than 14 psi (97 kPA).
 - **High Engine Temperature.** Engine coolant temperature exceeded 222° F (106° C).
 - **Overcrank.** The engine shut down because it did not start during the timed cranking period.
 - **Overspeed.** The engine shut down because of overspeed.

OPTIONAL CONTROL PANEL COMPONENTS

The following components are optional on the control panel.

AC Voltmeter. The voltmeter indicates output voltage for the phase selected.

AC Ammeter. The ammeter indicates output amperage for the phase selected.

Frequency Meter. The frequency meter indicates output frequency in Hertz (Hz). Note that engine RPM is 30 times hertz.

Scale Indicator Lamps. The scale indicator lamps indicate whether to read the upper or lower scales of the voltmeter and ammeter.

Phase Selector Switch. The selector switch is used to select the phase for voltage and amperage readings.

Output Voltage Trimmer. The output voltage trimmer can be used to adjust output voltage plus or minus five percent of nominal voltage.

Nine Indicator Lamps:

- **Run (Green).** This lamp indicates that the generator set is running and that the starter has been disconnected.
- **Pre-Low Oil Pressure Warning (Amber).** This lamp indicates that engine oil pressure is abnormally low (less than 20 psi [137 kPA]).
- **Low Oil Pressure Shutdown (Red).** This lamp indicates that the engine shut down because of excessively low engine oil pressure (less than 14 psi [97 kPA]).
- **Pre-High Engine Temperature Warning (Amber).** This lamp indicates that engine coolant temperature is abnormally high (greater than 215° F [102° C]).
- **High Engine Temperature Shutdown (Red).** This lamp indicates that the engine shut down because of excessively high engine coolant temperature (greater than 222° F [106° C]).
- **Overcrank Shutdown (Red).** This lamp indicates that the engine shut down because it did not start during the timed cranking period.
- **Overspeed Shutdown (Red).** This lamp indicates that the engine shut down because of overspeed. It is factory adjusted to shut down 60 hertz units at 2100 ±90 r/min, 50 hertz units at 1850 ±50 r/min.
- **Low Engine Temperature Warning (Amber).** This lamp indicates that engine temperature is less than 70° F (21° C) and the possibility that the engine might not start.
- **Switch-off Warning (Flashing Red).** This lamp indicates that the **Start/Stop/Remote** switch is in the **Stop** position, which prevents remote, automatic operation.

AUTOMATIC VOLTAGE REGULATOR

The generator is equipped with an automatic voltage regulator. See *Adjustments* if AC output voltage needs to be adjusted.

GOVERNOR

The engine is equipped with an electronic governor. It is not adjustable for speed.

PRESTART CHECKS

1. Check the **Fuel Supply** and open any manual fuel shutoff valves. If the generator set has a fuel selector switch, located on the governor control mounting bracket, select the fuel desired.
2. Check to make certain all **Exhaust System** components are tight and undamaged and do not terminate so exhaust might enter any enclosure. If any leaks or improper termination are detected, do not start set until repaired.
3. Always check engine **Oil** and **Coolant** levels before starting the set. See *Maintenance*.

⚠WARNING *To prevent severe scalding, always let the engine cool down before removing the coolant pressure cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.*

4. Make sure the set is disconnected from the power supply line.

STARTING

1. Press the panel switch to the **Start** position. The set should start in a matter of seconds and run up to governed speed and regulated output voltage. The engine control automatically disconnects the starter when the engine gets to about 500 RPM.

Cranking continues if the engine does not start right away. Cranking periods of 15 seconds are alternated with rest periods of 15 seconds until

the engine starts. The engine control will shut down the set in approximately 75 seconds if the engine does not start. This is indicated by the fault lamp on the control panel. See *Troubleshooting* to restore operation.

2. Watch the engine gauges and AC meters (if provided) after the engine starts. Engine oil pressure should jump to at least 10 psi in a matter of seconds. Normal oil pressure is 40 to 65 psi (275 to 448 kPA) at normal operating temperature. Normal charging voltage is 12 to 14 volts. Normal engine coolant temperature is 180° F to 195° F (83° C to 91° C) during operation. The AC meters should indicate rated voltage and frequency.
3. Let the engine warm up for five minutes. If the set appears to be operating normally, throw the switch to connect the set to the load.

REMOTE, AUTOMATIC CONTROL

Press the panel switch to the **Remote** position. This allows the transfer switch to start the generator set if a power outage occurs and stop it when the power returns.

The optional nine light control panel has a **Switch Off** indicator lamp that flashes when the control panel switch is in the **Stop** position, warning that remote, automatic operation cannot occur.

COLD STARTING WITH LOADS

Onan recommends installing standby generator sets equipped with coolant heaters in locations where the minimum ambient temperature is above 40° F (4° C). NFPA also requires that the engine coolant be maintained at a minimum of 90° F (32° C) and for most applications, accept the emergency load in 10 seconds or less. Although most properly maintained Onan generator sets will start in temperatures down to -25° F (-32° C) when equipped with coolant heaters, it might take some running time to warm the engine up before a load can be applied when ambient temperatures are below 40° F (4° C).

STOPPING

Before Stopping

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

To Stop

If the set was started at the set control panel or at a remote control panel, press the panel switch to the **Stop** position. If the set was started by an automatic transfer switch, the set will automatically stop about 15 minutes after the normal power source returns.

BREAK-IN

Change engine oil after the first 50 hours of operation. See *Maintenance*.

NO-LOAD OPERATION

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

EXERCISE PERIOD

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting. Exercise the generator set at least once a week for a minimum of 30 minutes with load so the engine reaches normal operating temperatures.

Onan automatic transfer switches have an exerciser that can be preset to provide regular exercise periods. Typically the exerciser can be set for time of start, length of run, and day of week.

POWER RATING FACTORS

The generator set power rating applies to sets used in standby applications. The set will operate at the stated rating for the duration of normal utility power interruptions. The rating was established for a standard radiator cooled set running on gas fuel and operating at an altitude of 300 feet (92 m) with an ambient temperature of 81° F (27° C). For a rating relative to other applications, altitudes, cooling systems, or ambient temperatures, contact an authorized Cummins/Onan Dealer or Distributor.

4. Troubleshooting

The generator set has sensors that continuously monitor the engine for low oil pressure, high engine temperature and overspeed. If an abnormal condition occurs, the fault circuit breaker will trip, (optional fault lamp will light) and the engine shuts down. After the problem is corrected, reset the fault circuit breaker to restart the generator set.

Table 4-1 describes the operation of the fault condition system (including optional features) and lists troubleshooting procedures.

SAFETY CONSIDERATIONS

High voltages are present within the control box and generator output box when the generator is running. Do not open the control box or generator output box while the set is running.

⚠ WARNING *Contacting high voltage components can cause severe personal injury or death. Keep control and output box covers in place during troubleshooting.*

Generator set installations are normally designed for automatic starting or remote starting. When troubleshooting a set that is shut down, make certain the generator set cannot be accidentally restarted. To prevent accidental starting, always remove the negative battery cable from the set starting battery.

⚠ CAUTION *Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.*

⚠ WARNING *Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [-] first).*

Make certain battery area has been well-ventilated before servicing battery. Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur when cable is removed or re-attached, or when negative (-) battery cable is connected and a tool used to connect or disconnect positive (+) battery cable touches frame or other grounded metal part of the set. Always remove negative (-) cable first, and reconnect it last. Make certain hydrogen from battery, engine fuel, and other explosive fumes are fully dissipated. This is especially important if battery has been connected to battery charger.

When a fault condition occurs during operation, follow the procedures in Table 4-1 to locate and correct the problem. If a major problem is indicated, contact an authorized service center for assistance.

Always let the engine cool down before removing the radiator cap or heat exchanger pressure cap.

⚠ WARNING *To avoid severe scalding, always let the engine cool down before removing the coolant pressure cap and make sure the pressure has been relieved before turning the cap fully open.*

TABLE 4-1. TROUBLESHOOTING

⚠WARNING Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages ii and iii..

SYMPTOMS	CHECKS AND CORRECTIVE MEASURES
1. The green RUN lamp lights following engine startup.	1. All engine systems are operating normally.
2. The red SWITCH OFF lamp is flashing, if provided.	2. Push the control panel switch to REMOTE when placing the set in service under remote, automatic control.
3. The red LO ENG TEMP lamp is lit, if provided.	3. The engine might not start. Plug in or service the engine coolant heater, if provided. Install an engine coolant heater, if necessary.
4. The engine does not crank.	4a. If a red fault lamp is on, service the fault, and reset the engine control. b. Service the battery, terminals and cables as necessary. See <i>Maintenance</i> .
5. The engine cranks, but does not start and the fault lamp lights (OVERCRANK if provided).	5a. Check the fuel supply. b. Turn the FUEL SELECTOR SWITCH (if provided) to select the fuel that is available. c. Service the battery if the engine cranks too slowly to start, refill with engine oil of suitable viscosity and plug in or service the engine coolant heater, if provided. Install an engine coolant heater if necessary. See <i>Maintenance</i> . d. Service the carburetor, choke or ignition system as necessary. See <i>Maintenance</i> . e. Reset the engine control.
6. The amber PRE-HI TEMP lamp lights, if provided and the engine coolant temperature gauge indicates 215° F (102° C) or more while the engine is running.	6a. Shut down the set if possible. Service the cooling system as necessary. See <i>Maintenance</i> . b. If the set must not be shut down, disconnect as many non-critical loads as possible so that the engine will run cooler and service as soon as possible.
7. The engine shuts down because of high engine temperature and the fault lamp lights (HI ENG TEMP , if provided).	7a. Fill coolant, if necessary, after the engine has cooled down and fix the leaks. Observe the warning about hot coolant at the beginning of this section. b. Service the cooling system as necessary. See <i>Maintenance</i> . c. Reset the engine control.

TABLE 4-1. TROUBLESHOOTING

⚠WARNING Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages ii and iii..

SYMPTOMS	CHECKS AND CORRECTIVE MEASURES
8. The amber PRE-LO OIL PRES lamp lights, if provided and the engine oil pressure gauge indicates 20 psi or less.	8a. Shut down the set if possible. Fill oil, if necessary. b. If the set must not be shut down, disconnect as many non-critical loads as possible so that the engine will run cooler and service as soon as possible.
9. The engine shuts down because of low oil pressure and the fault lamp lights (LO OIL PRES , if provided).	9a. Fill oil, if necessary. See <i>Maintenance</i> . b. Reset the engine control.
10. The engine shuts down because of overspeed and the fault lamp lights (OVER-SPEED , if provided).	10a. Check the governor and throttle linkage. b. Reset the engine control.
11. A control panel circuit breaker has tripped.	11. Reset the circuit breaker.
12. A control panel warning lamp does not light when the panel switch is pushed to LAMP TEST .	12. Replace the defective lamp.
13. There is no output because the line circuit breaker (if provided) has tripped.	13. Determine the cause (overload or short circuit) and service as necessary. Reset the circuit breaker.

5. Maintenance

Establish a maintenance/service schedule based on the type of application, and on the severity of the environment. The Table 5-1 lists the recommended service intervals. In extreme operating conditions, reduce the service intervals accordingly. Factors that affect the maintenance schedule include the following:

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

Consult with an authorized service center if the set is subject to extreme operating conditions, and determine a suitable maintenance schedule. Perform all service at the time period indicated, or after the number of operating hours indicated, whichever comes first. Use Table 5-1 to determine the required maintenance. Refer to this section for maintenance procedures.

Keep an accurate log of maintenance to support warrant claims. See *Introduction* for contacting help when service or repair has to be performed.

Always be alert when the set is running for problems that could lead to equipment damage or to personal injury. If it is necessary to perform maintenance or

service, always disconnect the starting battery cables (negative [-] cable first) to prevent accidental starting while working on the set.

⚠ CAUTION *Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.*

⚠ WARNING *Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [-] first).*

Make certain battery area has been well-ventilated before servicing battery. Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur when cable is removed or re-attached, or when negative (-) battery cable is connected and a tool used to connect or disconnect positive (+) battery cable touches frame or other grounded metal part of the set. Always remove negative (-) cable first, and reconnect it last. Make certain hydrogen from battery, engine fuel, and other explosive fumes are fully dissipated. This is especially important if battery has been connected to battery charger.

TABLE 5-1. MAINTENANCE SCHEDULE

HOURS OF OPERATION	MAINTENANCE TASK
8	<ul style="list-style-type: none"> • Inspect exhaust system; See Note 1 and 2 • Inspect generator set • Check fuel supply; See Note 1 • Check oil level • Check engine coolant level
100	<ul style="list-style-type: none"> • Check condition of battery • Change crankcase oil and oil filter (or annually); See Note 3 • Replace air filter element (standard air filter) • Check condition of fan belt.
400	<ul style="list-style-type: none"> • Replace the air cleaner element (heavy duty air filter) • Clean dust and debris from the radiator, air ducts and louvers • Clean dust from the generator assembly
800	<ul style="list-style-type: none"> • Replace the fuel filter. • Clean and adjust or replace the spark plugs; See Note 4 • Clean or replace the ignition distributor cap; See Note 4
TWO YEARS	<ul style="list-style-type: none"> • Change the engine coolant

1. Every 8 hours of operation or each time set is started, whichever comes first. If any leaks are detected, visually, audibly, or by smell, stop genset and repair immediately.
2. Drain the exhaust system condensation trap periodically.
3. Perform more often in extremely dusty conditions.
4. See the engine Maintenance and Operator's Manual

GENERATOR SET INSPECTION

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

Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler and exhaust pipe. Check for leaks at all connections, welds, gaskets and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the genset and have leaks corrected immediately.

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

Fuel System

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

⚠️WARNING *Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, pilot light, spark, arcing switch or equipment or other source of ignition near the fuel system or other area with shared ventilation.*

AC Electric System (Optional Meters)

Check the following while the genset is operating. Using the appropriate AC meter, measure load lines L1, L2 and L3 (L3 – 3 phase only).

Frequency Meter: The generator frequency should be stable and the reading should be the same as nameplate rating (50 hz/1500 rpm or 60 hz/1800 rpm).

AC Voltmeter: Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2, L2-L3 and L3-L1). Read the AC voltmeter using the upper or lower scale as indicated by the scale indicator lamp. At no load, the line-to-line voltage(s) should be the same as the set nameplate rating.

AC Ammeter: Turn the phase selector switch to each phase selection shown on the amps scale (L1, L2 and L3). Read the ammeter using the upper or lower scale as indicated by the scale indicator lamp. At no load the current ratings should be zero. With a load applied, each line current should be about the same.

Fault Lamps: Push the Reset/Lamp switch on the control panel. All indicator lamps should light. Verify that all the bulbs are on and then release the switch. Replace any bulbs that are burned out.

DC Electrical System

Check the terminals on the batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always disconnect both ends of the negative battery cable. Reconnect one end of the cable to the negative battery terminal first, then the other end to ground. This will make sure that any arcing will be away from the battery and least likely to ignite explosive battery gases.

⚠️WARNING *Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any igniter near the batteries.*

⚠️CAUTION *To prevent arcing, always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.*

⚠️WARNING *Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [-] first).*

Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (-) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (-) cable first, and reconnect it last.

LUBRICATION SYSTEM

Before the initial start, check dipstick to be sure crankcase is filled with oil. See *Specifications* section for lubricating oil capacity.

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

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

Oil Recommendations

Refer to Table 5-2 for the recommended oil viscosity grades at various ambient temperatures. Oils must conform to the American Petroleum Institute (API) classification SG, SH SH/CC or SH/CD. When selecting the oil viscosity, pick the grade that is right for the lowest temperature expected. Oil that is too thick can result in a lack of lubrication when the engine is started.

TABLE 5-2. OIL VISCOSITY

PREVAILING AMBIENT TEMPERATURE RANGE	SAE VISCOSITY GRADE
MULTI-GRADE VISCOSITY OILS	
Below 10F (-12C)	5W-20
Below 60F (15C)	5W-30
-10F to 90F (-23C to 32C)	10W-30
Above -10F (-23C)	10W-40 or 10W-50
Above 20F (-6C)	20W-40 or 20W-50
SINGLE-GRADE VISCOSITY OILS	
-10F to 60F (-23C to 16C)	10W
10F to 90F (-12C to 32C)	20W-20
Above 32F (0C)	30W
Above 50F (10C)	40W

Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance

Table. The dipstick is stamped with FULL and ADD to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the engine 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.

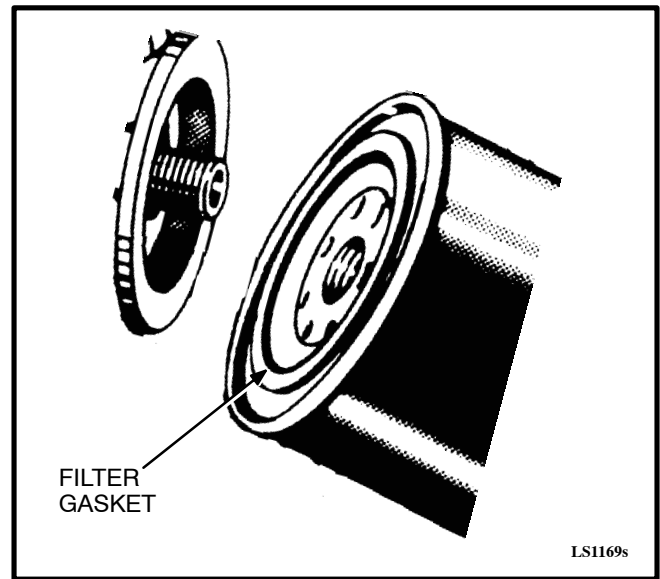


FIGURE 5-1. ENGINE OIL FILTER

Engine Oil Change

Run engine until thoroughly warm before draining oil. Stop the set, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API viscosity grade for the temperature conditions.

Oil Filter Change

Spin off oil filter and discard it. Thoroughly clean filter mounting surface. Apply a thin film of oil to filter gasket and install new element. Spin element on by hand until gasket just touches mounting pad and then turn an additional 1/2 to 3/4 turn. Do not over-tighten (Figure 5-1).

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks but do not over-tighten.

COOLANT SYSTEM

⚠ CAUTION *The coolant heater must not be operated while the cooling system is empty or damage to the heater will occur.*

Coolant Requirements

The water used for engine coolant should be clean, low in mineral content and free of any corrosive chemicals such as chloride, sulphate or acid. Generally, any water that is suitable for drinking can be treated for use as engine coolant.

Cooling systems that are subjected to freezing conditions must also be protected with a permanent type antifreeze. Use a 50/50 coolant solution (50% pure water and 50% antifreeze). Do not use an antifreeze that contains anti-leak additives. Cooling system coolant must also have corrosion inhibitors.

BATTERIES

Check the battery connections to make sure they are clean and tight. A light coating of non-conductive grease will retard terminal corrosion.

DRIVE BELT

The alternator, water pump and fan are driven by a single belt. The belt tension is maintained by a belt tensioner and does not require adjustment.

Inspect the belt at the recommended intervals. Replace a worn or damaged belt before belt failure occurs. A defective or broken belt will cause overheating and insufficient battery charging.

AIR CLEANER

The engine air intake components should be checked at the interval indicated in Table 5-1. The frequency of cleaning or replacing air cleaner filter elements is primarily determined by the conditions in which the genset operates. The standard air cleaner contains a paper cartridge filter element which can be cleaned and reused if not damaged, or discarded and replaced.

To Service the Air Cleaner:

1. Loosen clamps and remove air cleaner housing end cap.
2. Remove the air filter element from the filter housing.
3. To clean, blow low pressure compressed air (30 psi/207 kPa) through the element from the clean side. Hold the nozzle at least 1 inch (25 mm) away to avoid damaging the element.
4. Soak the filter for at least 15 minutes in water and Donaldsons D1400 solvent to remove soot, carbon and dirt.
5. Rinse with clean water (low pressure) and allow to air dry. Do not blow dry with compressed air. Reinstall when the filter element is dry. Replace the filter after two cleanings to avoid restricting the airflow.

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

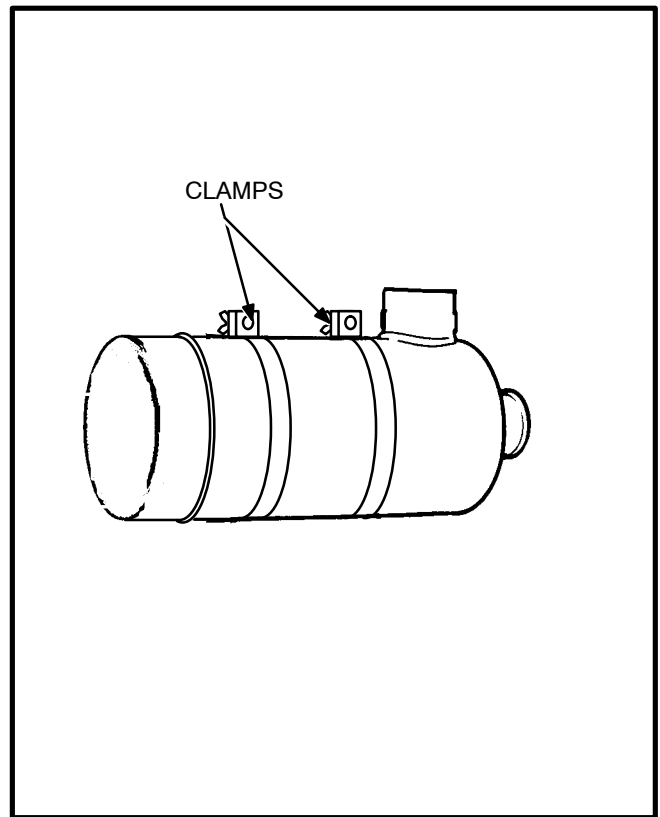


FIGURE 5-2. AIR CLEANER

IGNITION SYSTEM

The engine uses a distributorless ignition system. The ignition system consists of: an engine speed sensor, ignition module, coil assembly (containing two coils) and the high tension leads and spark plugs. The spark plugs are the only components that require periodic maintenance.

The ignition system must be completely functional or the set will run poorly and will not be able to carry a full load. Inspect the the spark plug wires and maintain the spark plugs at the recommended intervals.

High Tension Wires

Check the spark plug wires for good contact at the coil assembly and spark plugs. Terminal connections should be tight and fully seated. All spark plug covers and cable end boots should be in good condition and fit tightly. There should be no breaks or cracks in the insulation. Replace the wire if any of these conditions are noted.

CAUTION *High tension wires can be damaged if removed incorrectly from terminals. Grasp the wire by the spark plug boot to prevent damage to the conductor.*

Spark Plugs

Remove the spark plugs and inspect for damaged or cracked insulators, worn electrodes, damaged gaskets or excessive carbon deposits. Replace the spark plug if any of these conditions are noted.

- Carbon Fouled - Overly Rich Mixture
- Oil Fouled - High oil consumption
- Burned - Excessive engine temperature

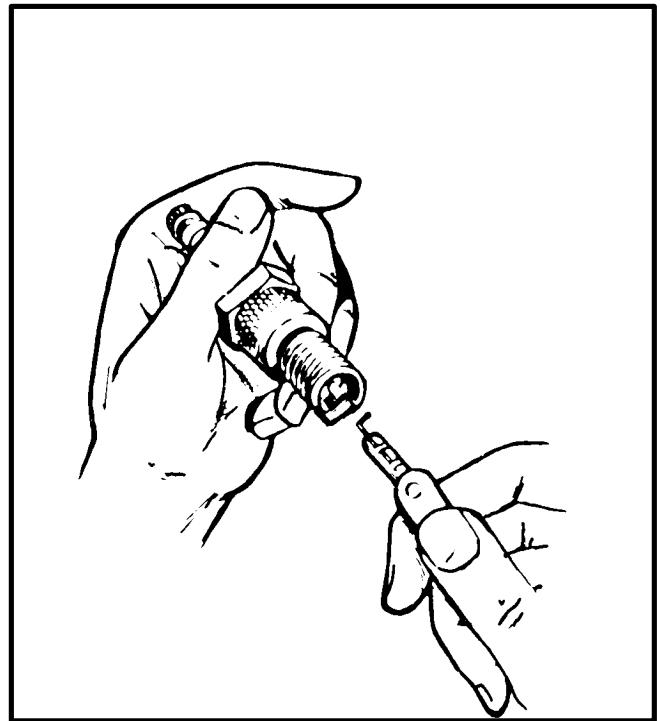


FIGURE 5-3. GAPPING SPARK PLUGS

FUEL FILTER REPLACEMENT

Refer to Table 5-1 for scheduled fuel filter replacement and Figure 5-4 for the location of the fuel filter.

Take care not to spill fuel when disconnecting the fuel line from the filter. Allow the engine to cool before disconnecting the fuel line so that it cannot ignite any fuel that may be spilled. Close any shutoff valve that may be provided in the fuel line. Remove the filter by loosening the inlet and outlet hose clamps.

⚠WARNING *Gasoline is highly flammable and can cause severe personal injury or death.*

Let the engine cool and close any fuel line shut-off valve before disconnecting the fuel line from the filter.

Do not smoke if you smell gasoline or are near fuel tanks or gasoline-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away.

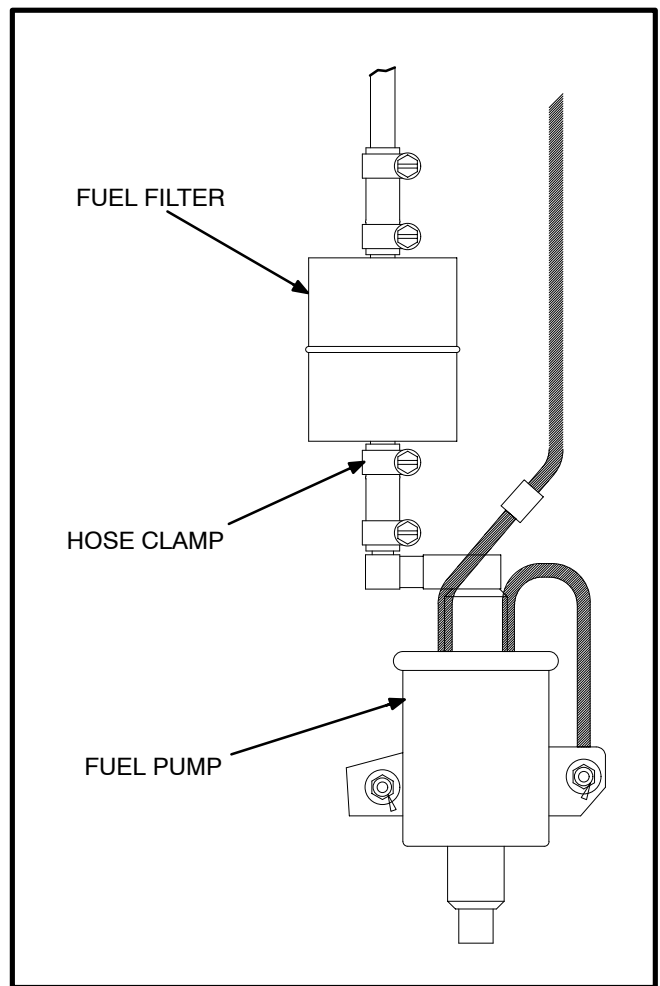


FIGURE 5-4. FUEL FILTER

6. Adjustments

OUTPUT VOLTAGE ADJUSTMENT

Output voltage can be adjusted plus or minus five percent of nominal voltage by the adjustment knob on the control panel (Figure 3-1). Call your distributor if the required voltage cannot be obtained by this adjustment.

FUEL SYSTEM ADJUSTMENTS

The engine is equipped with a carburetor to run on unleaded gasoline and/or a gas mixer to run on natural gas or propane or both.

Gasoline Fuel System

A gasoline carburetor is provided for gasoline fuel systems. The idle mixture and choke are adjustable on the gasoline carburetor.

Idle Mixture Adjustment: If the adjustment has been disturbed or the engine performs poorly under light load, make the following adjustments.

1. Shut off the engine and turn the idle adjustment screw in gently until it bottoms and then turn it out 2-1/2 turns so that the engine will run.

CAUTION *The adjustment screw and seat are easily damaged. Do not force the adjustment screw.*

2. Start the engine and let the set warm up under a partial load (at least 1/4 rated load) and then disconnect all loads.

3. Turn the idle adjustment screw out (counter-clockwise) approximately one half turn and jounce the throttle. If the engine begins to hunt, turn the adjustment screw in slowly until engine speed becomes stable. If one half turn does not cause instability, turn the adjustment screw out one half turn more and repeat the procedure.

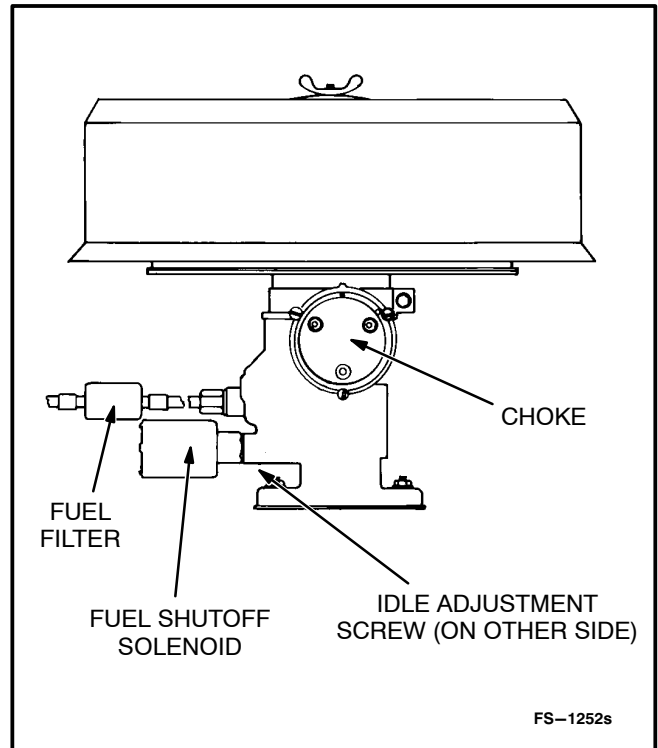


FIGURE 6-1. GASOLINE CARBURETOR

Choke Adjustment: The gasoline carburetor is equipped with an automatic choke for easier cold weather starting. The choke has a bi-metal coil that progressively closes the choke plate as ambient temperature drops, in preparation for the next start. It also has an electric heating element that heats the bi-metal coil to fully open the choke soon after the engine starts.

The choke housing cover can be rotated to adjust the choke. The perimeter of the cover is graduated with evenly spaced lines cast in it. One of the lines has an asterisk (*). For normal adjustments, the asterisk (*) should line up with the line cast in the edge of the housing.

1. For better starting in cold weather, loosen the three cover screws and rotate the cover clockwise so that the asterisk (*) is one or two lines past the line on the housing and re-tighten the cover screws.
2. For better starting in warm weather, loosen the three cover screws and rotate the cover counterclockwise so that the asterisk (*) is one or two lines past the line on the housing and re-tighten the cover screws.

Gaseous and Combination Fuel Systems

An engine equipped for gasoline and natural gas or propane has a regular gasoline carburetor with a gas mixer mounted on the horn of the carburetor. The carburetor throttle serves both fuels. Each fuel has a separate shutoff solenoid valve. The position of the fuel selector switch located on the governor control mounting bracket, determines which solenoid valve will open for operation.

An engine equipped for natural gas and propane has a gas mixer that serves both fuels. Each fuel has a separate shutoff solenoid valve. If the generator set is equipped with a fuel selector switch, the position of the switch determines which solenoid valve will open for operation. If not equipped with a fuel selector switch, fuel changeover occurs automatically. (While the engine is running, a gas pressure switch causes the natural gas solenoid valve to close and the propane solenoid valve to open when natural gas pressure is lost, without stopping the engine. When natural gas pressure is restored, the natural gas solenoid valve opens and the propane solenoid valve closes.)

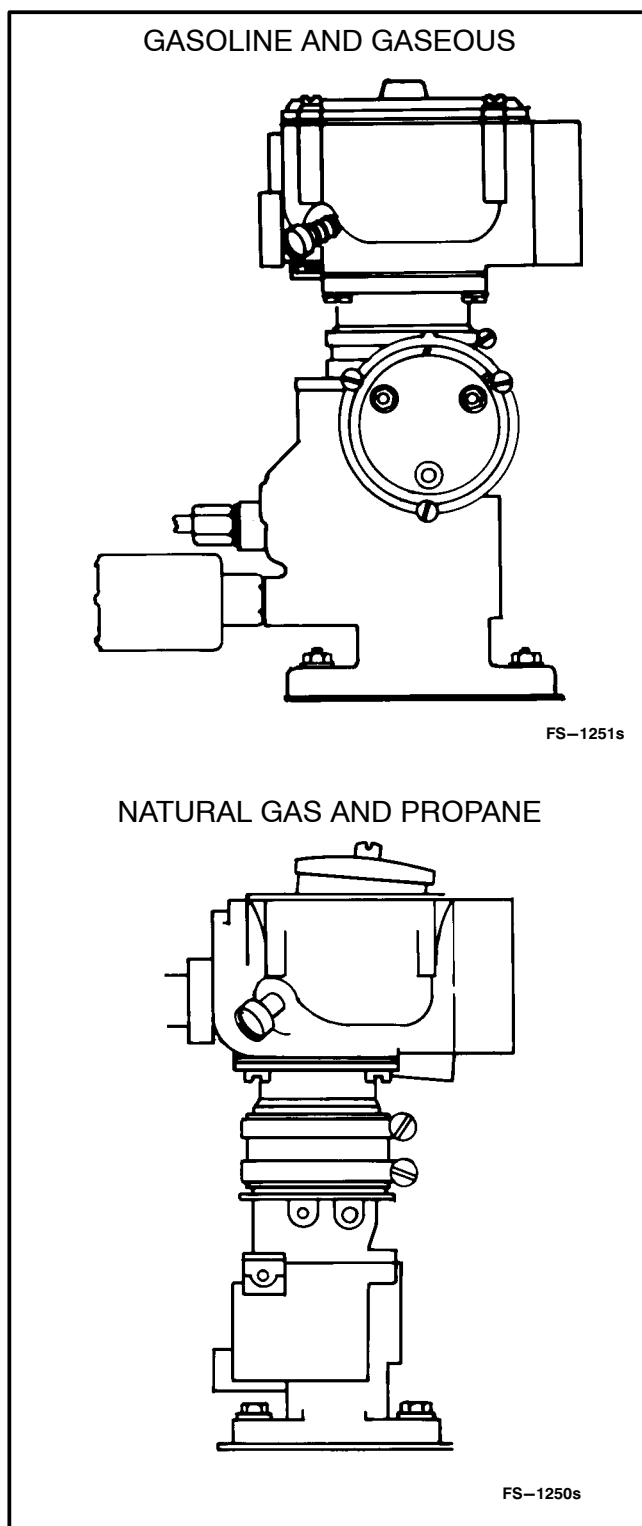


FIGURE 6-2. COMBINATION FUEL SYSTEMS

Gaseous Fuel Adjustments: Gas mixers have power and idle adjustment screws. Engines equipped for natural gas and propane also have a propane flow adjustment valve. If necessary, make the following adjustments.

1. Start the engine and let the set warm up under a partial load (at least 1/4 rated load). If the engine is equipped for natural gas and propane, start with natural gas.
2. Disconnect all loads, shut down the set, connect a tachometer and disconnect the the governor linkage at the carburetor. Start the engine and close the throttle by hand so that the engine does not overspeed. While holding the throttle closed, adjust the throttle idle position stop screw (the one next to the throttle lever) to obtain an engine speed of 900 RPM. Then turn the idle adjusting screw counterclockwise until engine speed becomes unstable. Turn the screw clockwise just enough to regain stability and reconnect the governor linkage.
3. Next, connect full rated load and turn the power adjusting screw clockwise until the engine begins to lose speed and then slowly back out the screw (counterclockwise) until the engine carries the full load smoothly.
4. If the set is equipped for natural gas and propane, switch to propane by means of the fuel selector switch, located on the governor control mounting bracket (if provided) or by closing the manual shutoff valve in the natural gas supply line.
5. Reconnect full rated load and turn the propane flow adjustment valve clockwise until the engine begins to lose speed and then slowly turn it back counterclockwise until the engine carries full load smoothly.

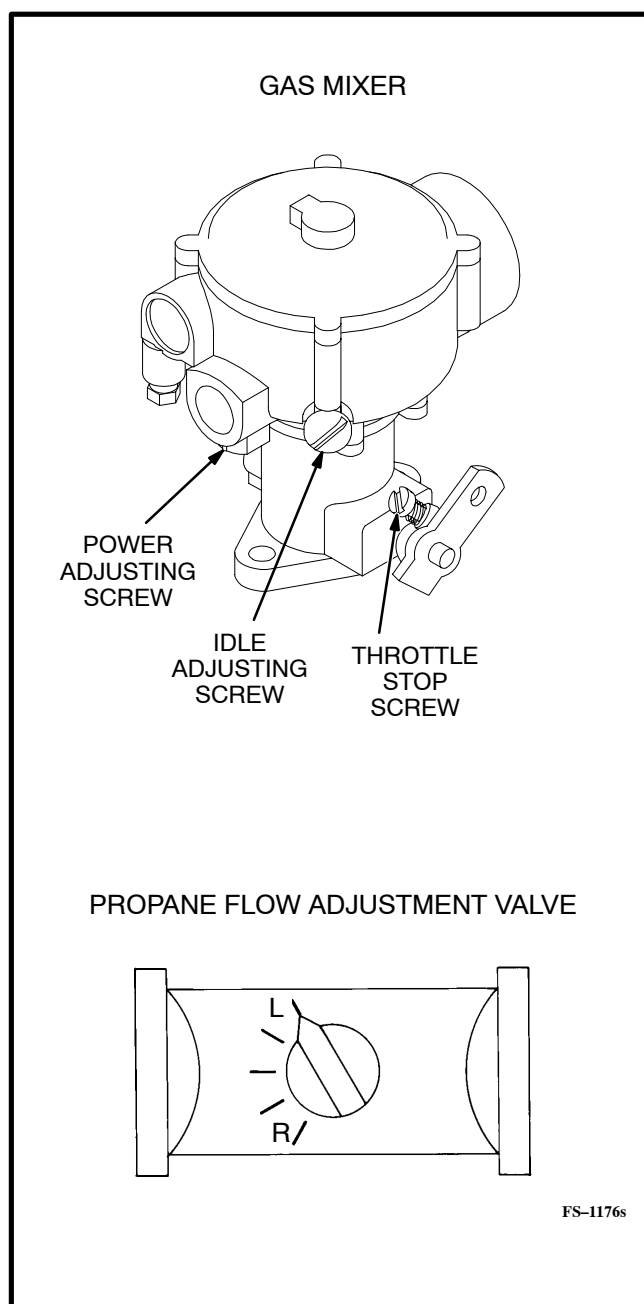


FIGURE 6-3. TYPICAL GASEOUS FUEL ADJUSTMENTS

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