



**Onan**

# **Operator's Manual**

**10 GEAD**

**20 GEAE**

**25 GEAF**

**GENERATOR SETS**



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# Safety Precautions

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**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. 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.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

## 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.

## 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 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 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.

## **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.

- 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.

**KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE**

# 1. Introduction

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## ABOUT THIS MANUAL

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

## HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearest 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.***



## 2. Specifications

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MODEL	10 GEAD	20 GEAE	25 GEAF
<b>Engine</b> Onan Modified Ford, 4-cyl.	LSG-423	LSG-423	LSG-423 (Turbocharged)
<b>Generating Rating</b> Single Phase, 60 Hertz (kVa @ 0.8 PF)	10 kW (12.5 kVA)	18 kW (22.5 kVA)	25 kW (31.25 kVA)
<b>Electrical System</b> Starting Voltage Battery Charging Current	12V 65 Amp	12V 65 Amp	12V 65 Amp
<b>Capacities</b> Cooling System Oil Capacity with Filter	11.5 U.S. Qt. (11 L) 4.5 U.S. Qt. (4 L)	11.5 U.S. Qt. (11 L) 4.5 U.S. Qt. (4 L)	11.5 U.S. Qt. (11 L) 4.5 U.S. Qt. (4 L)
<b>Fuel</b> Primary Back-up	Natural Gas Propane	Natural Gas Propane	Natural Gas Propane
<b>Tune-up Specs</b> Spark Plug Gap  Timing @ 1800 RPM	0.032-0.036 inch (0.8-0.9 mm) 30° BTDC	0.032-0.036 inch (0.8-0.9 mm) 30° BTDC	0.032-0.036 inch (0.8-0.9 mm) 30° BTDC





# 3. Operation

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## GENERAL

This section covers prestart checks, starting and stopping and operating the generator set. Each operator should read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set for safe operation.

## PRESTART CHECKS

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

### Lubrication

Check the engine oil level. Keep the oil level near as possible to the dipstick high mark without overfilling.

### Coolant

Check the engine coolant level. The coolant should be between the LOW and FULL mark in the coolant recovery tank.

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

### Fuel

Open gas shutoff valve and be sure the manual changeover switch is moved to *Natural Gas* position for prime fuel source or *LPG Vapor* for secondary fuel source.

### Exhaust

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.

## CONTROL PANEL

The following describes the function and operation of the generator set control. All instruments and control switches are located on the face of the control panel as illustrated in Figures 3-1 through 3-3. The control panel is separated into a DC portion for monitoring the engine and an AC portion for monitoring the generator.

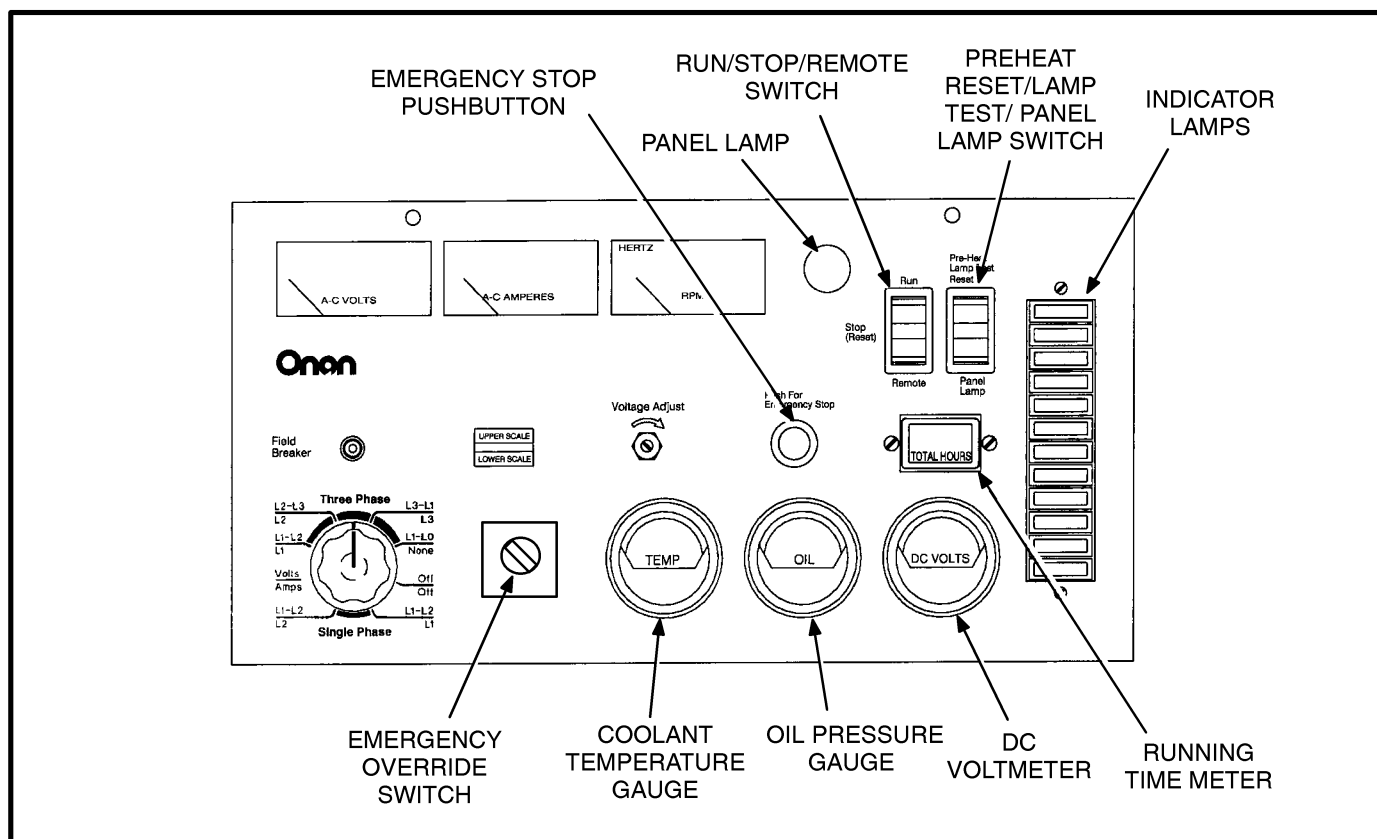


FIGURE 3-1. DC CONTROLS

## DC Controls

**Panel Lamp:** Illuminates control panel.

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

**Coolant Temperature Gauge:** Indicates temperature of circulating coolant in engine (wired to a sensor located on engine).

**DC Voltmeter:** Indicates the battery charging system voltage.

**Run/Stop/Remote Switch:** Starts and stops the set locally, or from a remote location.

**Emergency Override Switch:** A control override switch allows engine to start and run, bypassing the normal engine shutdowns and control monitor board. (Does not override Emergency Stop Switch.)

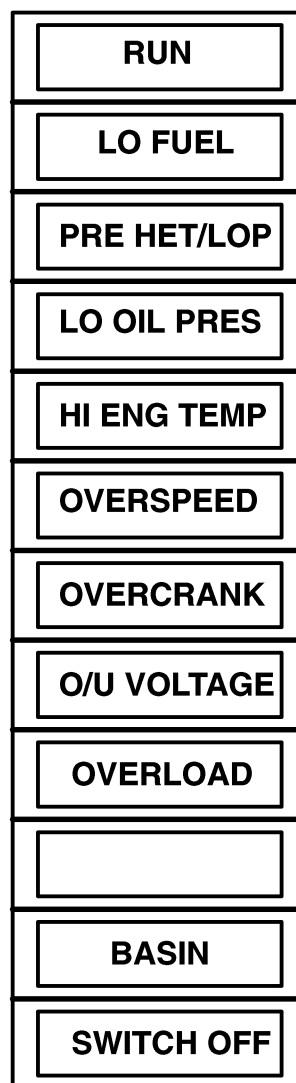
**Running Time Meter:** Registers the total number of hours the unit has run. Use it to keep a record of periodic servicing. Time is cumulative; meter cannot be reset.

**Reset/Lamp Test/Preheat/Panel Lamp Switch:** Resets the fault circuit only when the Run/Stop/Remote switch is in the Stop (Reset) position. Tests fault lamps and turns on the control panel lamp. This switch has a light which illuminates with any engine shutdown. The control must be reset to shut off the light.

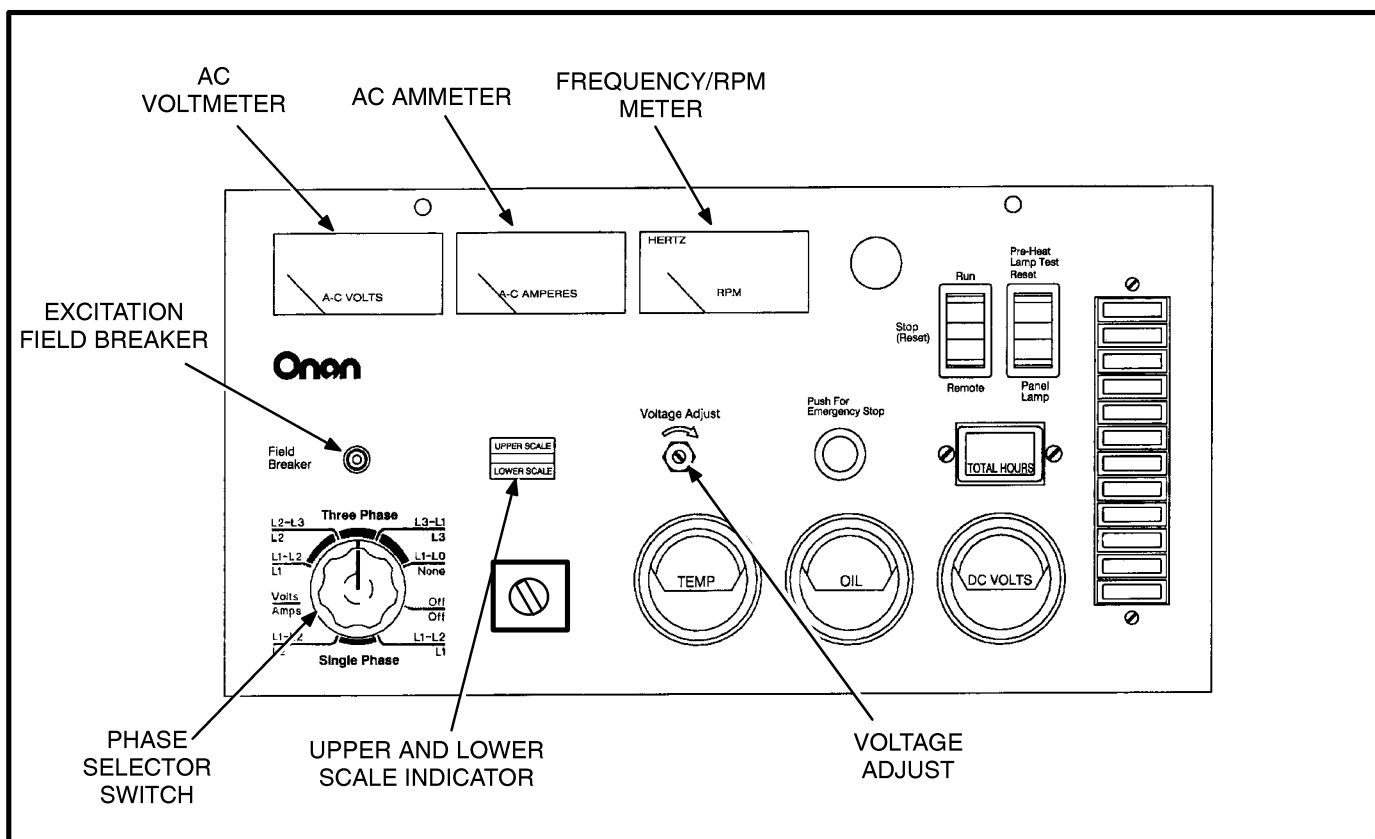
**Emergency Stop Button:** Push-in switch for emergency shutdown of the engine. To reset, pull switch out and move Run/Stop/Remote switch to Stop position. Then push switch to Reset/Lamp Test position.

**Control Indicator Lamps:** The twelve lamp control includes all the following features:

- RUN (green) lamp comes on when starter circuit opens after set starting.
- LO FUEL (yellow) indicates gas pressure is marginally low.
- PRE HET/LOP (yellow) indicates engine temperature is marginally high or oil pressure is marginally low.
- LO OIL PRES (red) indicates engine has shut down because of critically low oil pressure.
- HI ENG TEMP (red) indicates engine has shut down because of critically high engine temperature or low coolant level.
- OVERSPEED (red) indicates engine has shut down because of excessive speed.
- OVERCRANK (red) indicates engine has failed to start during the cranking period.
- O/U VOLTAGE (red) indicates engine has shut down because generator voltage is too high or too low.
- OVERLOAD (red) indicates engine has shut down because circuit breaker has tripped on major engine fault or overload.
- BASIN – Diesel Sets Only (yellow) lamp indicates internal leakage in dual wall fuel tank.
- SWITCH OFF (flashing red) indicates generator set is not in automatic operation mode. Run/Stop/Remote switch is not in Remote position.



**FIGURE 3-2. INDICATOR LAMPS**



**FIGURE 3-3. AC CONTROLS**

## AC Controls

**AC Voltmeter:** Dual range instrument indicating AC voltage. Measurement range in use shown on indicator lamp.

**AC Ammeter:** Dual range instrument indicates AC generator line current.

**Frequency/RPM Meter:** Indicates generator output frequency in hertz and engine speed in revolutions-per-minute (RPM).

**Voltage Adjusting Rheostat:** Provides approximately plus or minus five percent adjustment of the rated output voltage.

**Upper and Lower Scale Indicator Lamps:** Indicates which scale to use on the AC voltmeter and ammeter.

**Phase Selector Switch:** Selects phases of generator output to be measured by AC voltmeter and ammeter.

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

## GENERATOR AC VOLTAGE REGULATOR

The solid-state regulator controls AC output voltage from the generator at a predetermined level regardless of load. Voltage regulation is plus or minus two percent from no load to full load. Random voltage variation is plus or minus one percent for constant loads.

## ENGINE CONTROL MODULE

Electronic and relay components of the engine monitoring circuit are on a circuit board assembly. Sensor inputs are connected by the wiring harness to plug connectors on the board. The control module provides the following functions of unit protection.

- **Overcrank** - Limits engine cranking to 75 seconds. If engine fails to start, the module lights a fault lamp and opens the cranking circuit. The cycle cranking option allows three 15-second cranking cycles with two 15-second rest periods on the 12-lamp control.
- **Overspeed** - Shuts down the engine immediately if overspeed occurs and lights a fault lamp. The sensor switch is mounted in the end bell on the generator shaft. It is factory adjusted to shut down 60 hertz units at  $2100 \pm 90$  r/min, 50 hertz units at  $1850 \pm 50$  r/min.
- **Low Oil Pressure** - Shuts down the engine immediately if oil pressure drops below 14 psi (97 kPA) and lights a fault lamp. The fault is time-delayed about 10 seconds following starter disconnect and inhibited during cranking. The delay allows oil pressure to rise to normal before the electronic control module monitors this system.
- A pre-low oil pressure sensor and lamp provides an alarm that oil pressure is marginally low, 20 psi (137 kPA) or less. The cause should be found and corrected as soon as possible.
- **High Engine Temperature** - shuts down the engine immediately if coolant temperature rises above  $222^{\circ}\text{F}$  ( $106^{\circ}\text{C}$ ) and lights a fault lamp. The fault is time-delayed about 10 seconds following starter disconnect and inhibited during cranking. This delay allows coolant in a hot engine time to circulate and return the water jack-

et to normal before the electronic control module monitors this system.

A pre-high engine temperature sensor and lamp provides an alarm that engine temperature is marginally high,  $215^{\circ}\text{F}$  ( $102^{\circ}\text{C}$ ). The cause should be found and corrected as soon as possible.

- **Low Coolant Level Shutdown** – An electronic switch that provides engine shutdown and turns on the high engine temperature fault lamp if coolant level falls too low.

## STARTING

The following sections cover the three systems used to start the generator set.

### Starting at Control Panel

Move the Run-Stop-Remote switch on the DC panel to the RUN position. This will activate the engine control system and the starting system. The starter will begin cranking and after a few seconds the engine should start. The starter will disconnect when the engine reaches a speed of 450 to 570 RPM.

If the engine does not start, the starter will disengage after a specified period of time. The control will engage the starter two more cranking cycles. If the set fails to start after three full cranking cycles, the control will indicate an overcrank fault. To clear an overcrank fault, place the Run-Stop-Remote switch in the STOP position and momentarily depress the Reset switch. Wait two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt at starting, refer to the *Troubleshooting* section.

### Starting From Remote Location

When the genset is in automatic operation mode, it can be started from a remote location. A relay contact must be connected between TB2-RMT and TB2-B+ in the ATS. Closing this contact will start the set, opening it will shut down the set.

## Automatic Starting

Place the Run/Stop/Remote switch on the generator set DC panel in 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.

## 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).

## Emergency Override

A control override switch allows the engine to start and run, bypassing the normal engine shutdowns and control monitor board. (Does not override Emergency Stop Switch.) To start the set using this switch, lift the cover and turn the switch to the MOMENTARY RUN position. When the set starts, release the switch to the RUN position.

**⚠ CAUTION** *All engine monitoring and shutdown devices are bypassed when using this switch. Engine damage can result! Use only in emergencies.*

## 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, move the Run/Stop/Remote 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.

## Emergency Stop

An emergency stop button is located on the right side of control panel (Figure 3-1). Push button in for emergency stop. The lamp in the switch should light. To reset, pull switch out and move Run/Stop/Remote switch to Stop position. Then push test switch to Reset/Lamp Test position.

## 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 element, 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 Onan Distributor.

## 4. Troubleshooting

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The generator set has sensors that continuously monitor the engine for abnormal conditions, such as low oil pressure or high coolant temperature. If these conditions occur, the engine monitor activates a fault lamp, and may also stop the engine (depending on the condition). If the generator set is stopped for this reason, the operator may be able to restart the set after making adjustments or corrections. This section describes the fault condition system, and suggests troubleshooting procedures.

The twelve-light control has a single green light to indicate RUN, four amber lights and seven red fault lights. The control has a terminal connection for an audible alarm, which sounds when a fault occurs.

### SAFETY CONSIDERATIONS

High voltages are present inside the control box and ATS when the set is running. Do not open the control box or ATS while the set is running.

**⚠️WARNING** *High voltage can cause electrocution, severe personal injury or death. Keep control and output box covers in place during troubleshooting.*

When troubleshooting a set that is shut down, make certain the generator set cannot be accidentally restarted. Place the Run/Stop/Remote switch in the STOP position and remove the negative battery cable from the set starting battery.

**⚠️WARNING** *Accidental starting of the generator set during troubleshooting can cause severe personal injury or death. Disable the generator set before troubleshooting.*

When a fault lamp turns on during operation, follow the procedures listed to locate and correct the problem. For any symptom not listed, contact an authorized service center for assistance.

### Resetting the Control

The external alarm and fault lamp may be deactivated by moving the Run/Stop/Remote switch to the Stop position and pressing the Reset/Lamp Test/Preheat switch. Locate the problem and correct it before restarting the set. While pressing the Reset/Lamp Test/Preheat switch, make certain that all lamps light.

### Line Circuit Breaker

The line circuit breaker mounts in the output box on units without ATS. The circuit breakers mount inside the ATS, if equipped. If the load exceeds the generator current rating, the line circuit breaker will open, preventing the generator from being overloaded. The engine will shut down on an overload fault. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator. The heaters have a separate breaker mounted in the lower right side corner of the transfer switch.



**TABLE 4-1. TROUBLESHOOTING**

**⚠WARNING** *Many troubleshooting procedures present hazards which 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.*

SYMPTOM	CORRECTIVE ACTION
1. Green RUN lamp lights following engine startup.	1. Indicates all engine systems are normal. No corrective action required.
2. PRE HET/LOP lamp lights. Engine continues to operate.	<p>2A. Indicates engine has begun to overheat and engine temperature has risen to approximately 205°F (97°C) or coolant level is low. If generator is powering non-critical and critical loads and cannot be shut down, use the following:</p> <ul style="list-style-type: none"> <li>a. Reduce load if possible by turning off non-critical loads.</li> <li>b. Check air inlets and outlets and remove any obstructions to airflow.</li> </ul> <p>2B. Indicates engine oil pressure has dropped to 30 psi (207 kPa). If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow step 4.</p> <p><b>If engine can be stopped follow procedure in Steps 3 and 4.</b></p>
3. HI ENG TEMP lamp lights. Engine shuts down.	<p>3. Indicates engine has overheated (engine temperature has risen above 215°F/102°C) or coolant level is low. Allow engine to cool down completely before proceeding with the following checks:</p> <ul style="list-style-type: none"> <li>a. Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.</li> <li>b. Check for obstructions to cooling airflow and correct as necessary.</li> <li>c. Check for a slipping fan belt and tighten if loose.</li> <li>d. Reset control and restart after locating and correcting problem. Contact an authorized service center if none of the above.</li> </ul>
4. LO OIL PRES lamp lights. Engine shuts down. NOTE: See also step 5.	4. Indicates engine oil pressure has dropped to 25 psi (172 kPa). Check oil level, lines and filters. If oil system is OK but oil level is low, replenish. Reset control and restart. Contact an authorized service center if oil pressure is not in the range of 40 to 65 psi (275 to 448 kPa).

**TABLE 4-1. TROUBLESHOOTING (continued)**

**⚠WARNING** *Many troubleshooting procedures present hazards which 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.*

SYMPTOM	CORRECTIVE ACTION
<p>5. OVERCRANK lamp lights and engine stops cranking.</p> <p>or</p> <p>Engine runs, shuts down, and LO OIL PRES lamp lights.</p>	<p>5. Indicates possible fuel system problem.</p> <ul style="list-style-type: none"> <li>a. Check for empty fuel tank (LPG Vapor), fuel leaks, or plugged fuel lines and correct as required.</li> <li>b. Check for dirty fuel filter and replace if necessary (see <i>Maintenance</i> section).</li> <li>c. Check for dirty or plugged air filter and replace if necessary (see <i>Maintenance</i> section).</li> <li>d. Reset the control and restart after correcting the problem. Contact an authorized service center for service if none of the above.</li> </ul>
<p>6. Engine runs and then shuts down, OVERSPEED lamp lights.</p>	<p>6. Indicates engine has exceeded normal operating speed. Contact an authorized service center for service.</p>
<p>7. SWITCH OFF lamp flashes.</p>	<p>7. Indicates Run/Stop/Remote switch is in the Stop position which will prevent automatic starting if an automatic transfer switch is used. Move the Run/Stop/Remote switch to the Remote position for automatic starting.</p>
<p>8. LO FUEL lamp lights. Engine continues to run....or</p> <p>LO FUEL lamp lights. Engine shuts down and LO OIL PRES lamp lights.</p>	<p>8. Indicates interruption of natural gas supply. Connect to a propane fuel supply (if not already connected). Move the selector switch on the governor mounting bracket to the PROPANE position.</p>

**TABLE 4-1. TROUBLESHOOTING (continued)**

**⚠WARNING** *Many troubleshooting procedures present hazards which 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.*

<b>SYMPTOM</b>	<b>CORRECTIVE ACTION</b>
9. The OVERLOAD lamp lights. Engine shuts down.	9. The line circuit breaker is located in the ATS or generator set output box. If load exceeds generator current rating, the breaker will trip preventing the generator from being overloaded. Locate the source of overload and correct as necessary. Manually reset breaker to reconnect the load to the generator.
10. The O/U VOLTAGE lamp lights. Engine shuts down.	10. Contact an authorized service center for service.
11. Fault lamp lights but no fault exists. Engine gauges show oil pressure, engine temperature, and frequency (speed) are within normal limits.	11. The monitor board or a sensor may be at fault. Contact an authorized service center for service.
12. Engine will not crank.	12. Indicates possible fault with control or starting system. Check for the following conditions: <ul style="list-style-type: none"> <li>a. Fault lamp on. Correct fault and reset control.</li> <li>b. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.</li> <li>c. Discharged or defective battery. Recharge or replace the battery.</li> <li>d. Emergency stop button pushed in. To reset, pull switch out and move Run/Stop/Remote switch to Stop position. Then push test switch to Reset/Lamp position.</li> <li>e. Contact an authorized service center if none of the above.</li> </ul>
13. No AC output voltage.	13. Field breaker is tripped. Reset breaker. Contact an authorized service center if voltage buildup causes breaker to trip.
14. Green RUN lamp does not light following engine startup.	14. Indicates possible Start/Disconnect relay failure. Test light with LAMP TEST position on switch. Contact an authorized service center for assistance.

## 5. Maintenance

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. Table 5-1 covers the recommended service intervals for a generator set on STANDBY service. If the set will be subjected to extreme operating conditions such as high temperatures, dusty conditions, salt water atmosphere or prime power, reduce the service intervals accordingly.

Consult with an authorized service center if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter (Figure 5-1) to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use Table 5-1 to determine the maintenance required and then refer to the sections that follow for correct service procedures.

**⚠ 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.*

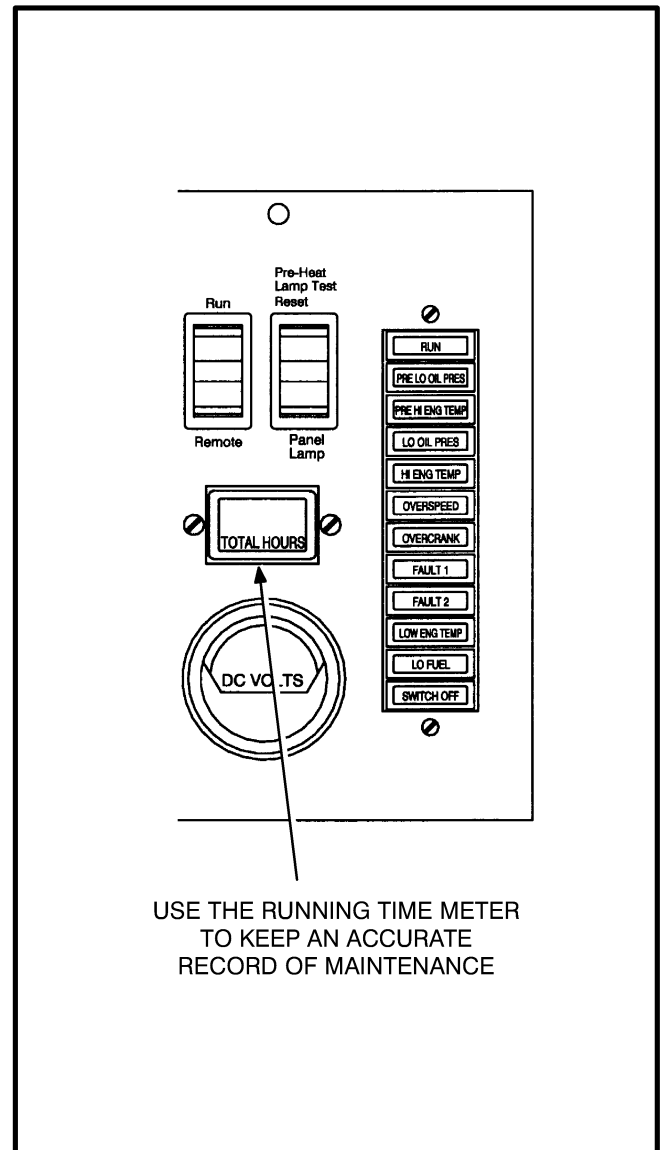


FIGURE 5-1. RUNNING TIME METER

**TABLE 5-1. MAINTENANCE SCHEDULE**

MAINTENANCE CHECKS	SERVICE TIME (OPERATING HOURS)			
	3 MONTHS or after 90 HOURS	6 MONTHS or after 90 HOURS	9 MONTHS or after 90 HOURS	YEARLY
Inspect Set	X <sup>1</sup>	X <sup>1</sup>	X <sup>1</sup>	X <sup>1</sup>
Check Oil Level	X	X	X	X
Check Coolant Level	X	X	X	X
Check Coolant Heater	X	X	X	X
Check Air Cleaner	X	X	X	X
Check or Replace Spark Plugs				X
Check Anti-freeze				X
Check Drive Belt Tension				X <sup>2</sup>
Change Crankcase Oil and Filter				X <sup>5</sup>
Clean Crankcase Breather				X
Change Air Cleaner Element				X
Check Radiator Hoses for Wear & Cracks				X <sup>3</sup>
Check Fuel Lines and Fittings for Leaks				X
Clean Cooling System	X <sup>4</sup>	X <sup>4</sup>	X <sup>4</sup>	X <sup>4</sup>
Adjust Valve Clearances				X <sup>6</sup>

1. Check for oil, fuel, cooling and exhaust system leaks. Also, perform exercise of equipment to confirm proper operation.
2. Visually check belts for evidence of wear or slippage.
3. Replace hoses and clamps when worn or cracked.
4. Ensure enclosure air inlet and exit grills and louvers are free of vegetation, debris and chaff.
5. Change oil and filter annually or every 200 hours.
6. Contact your authorized service center.

## 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 provide 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 deadlly 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

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

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

### 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.

### 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.

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

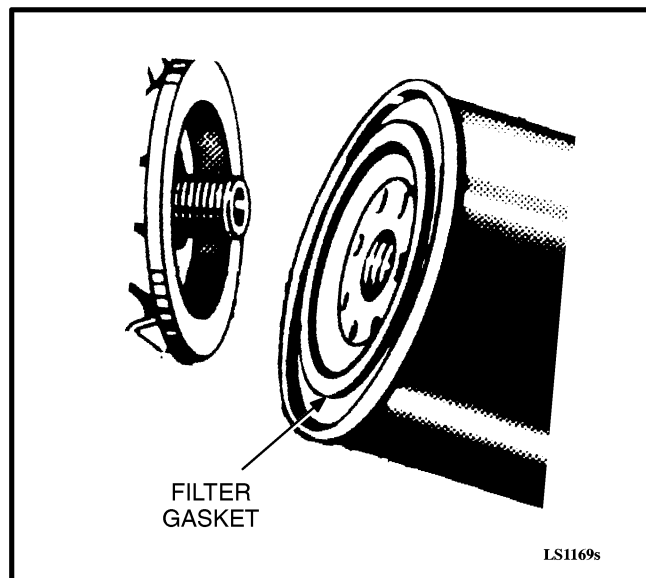
## Oil Filter Change

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 5-2).

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 overtighten.

## BATTERIES

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



**FIGURE 5-2. ENGINE OIL FILTER**



## COOLANT SYSTEM

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

### Coolant Recovery Tank

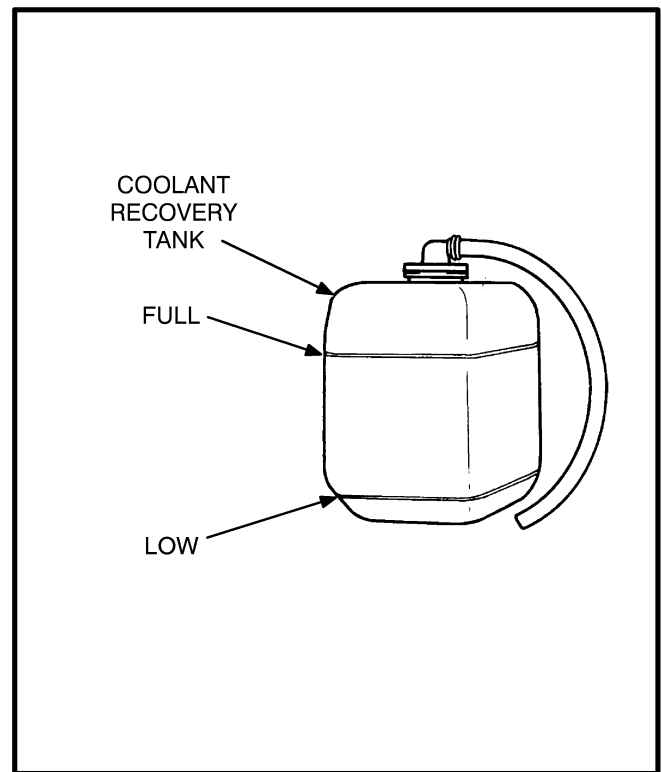
Check the coolant level during shutdown periods at the interval specified in Table 5-1. Use a 50/50 coolant solution (50% pure water and 50% antifreeze).

Always keep level in the coolant recovery tank between **LOW** and **FULL**. See Figure 5-3.

### 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.



**FIGURE 5-3. COOLANT RECOVERY TANK**

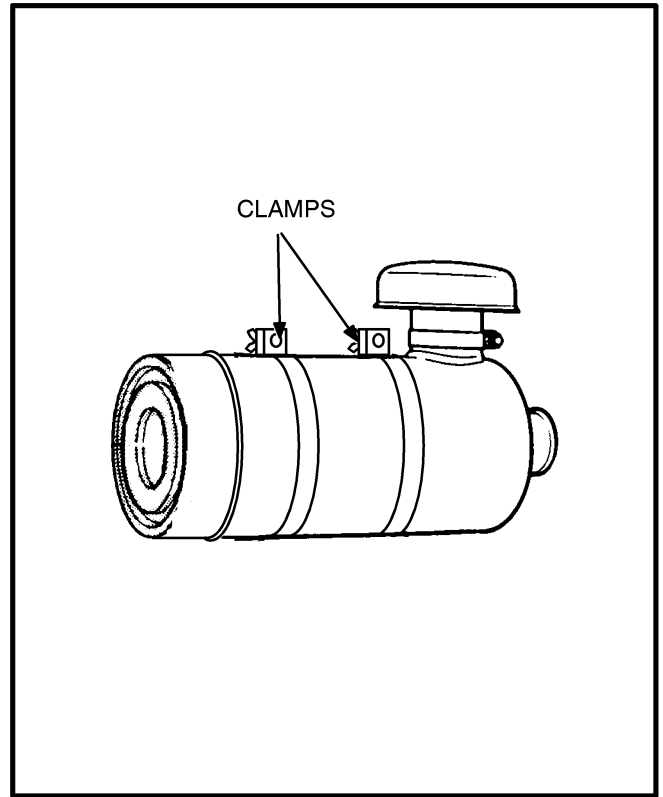
## AIR CLEANER

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 air filter element after cleaning it twice, 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 5-4. AIR CLEANER**

## IGNITION SYSTEM

The ignition system consists of the distributor, ignition coil, high tension wires, spark plugs and electronic control module. Maintenance consists of periodic inspections to detect possible problems and replacement of worn or deteriorated parts. The ignition system must be completely functional or the set may run poorly or be unable to carry full load. Perform the following inspections at recommended intervals.

### Distributor Cap

Remove the distributor cap and inspect the inside for cracks, burn marks, deterioration of the carbon button or eroded terminals. Replace the cap if any of these conditions are noted.

### Rotor

While the distributor cap is removed, inspect the rotor for cracks, excessive burning of the tip, deterioration of the center spring terminal. Replace the rotor if any of these conditions are noted.

### 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.

If the spark plugs show any of the following conditions, the engine may require additional service. Contact your authorized service distributor for help.

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

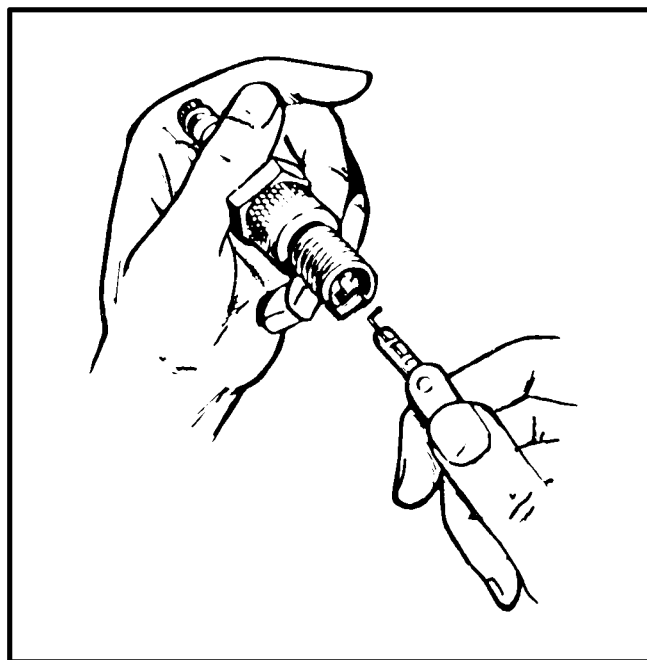


FIGURE 5-5. GAPPING SPARK PLUGS

## High Tension Wires

Check the spark plug wires and coil wire for good contact at the coil, distributor cap 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.

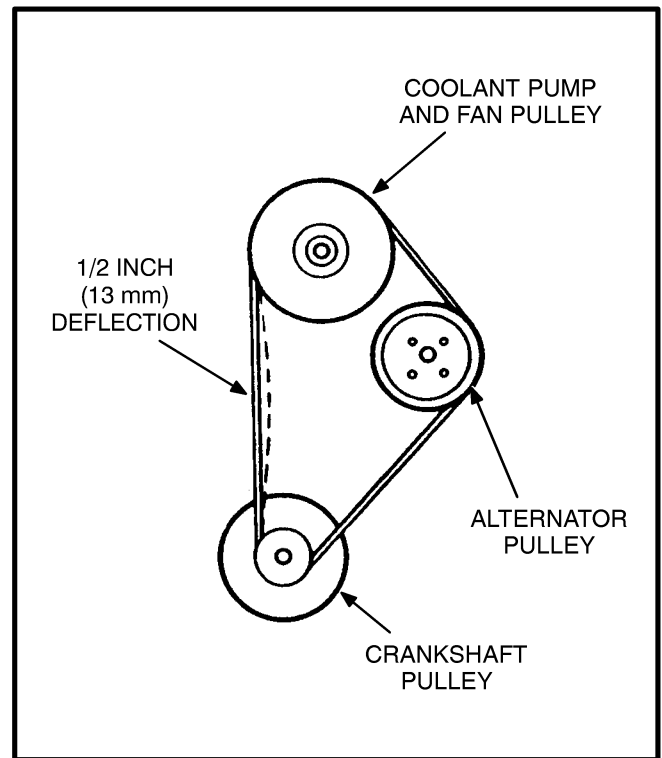
**⚠ CAUTION** *High tension wires can be damaged if removed incorrectly from terminals. Grasp wire by spark plug boot to prevent damage to conductor.*

## Ignition Coil

Clean the top of the ignition coil and check for cracks, carbon tracks or corrosion in the high tension terminal hole. Replace the coil if any of these conditions are noted.

### FAN BELT

An improperly adjusted fan belt can cause engine overheating and insufficient battery charging. Push on the fan belt in the middle and check that it deflects no more than 0.5 in. (13 mm) under a load of 15 lbs. (67 N). If belt is loose, loosen the two bolts on the battery charging alternator and adjust until proper tension is obtained. Retighten alternator bolts after adjustment.



**FIGURE 5-6. FAN BELT ADJUSTMENT**



## 6. Adjustments

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### OUTPUT VOLTAGE ADJUSTMENT

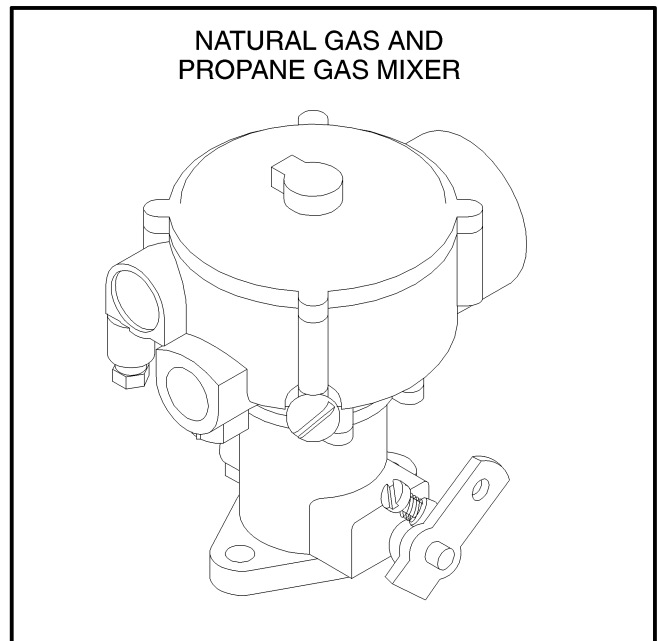
Output voltage can be adjusted plus or minus five percent of nominal voltage by the adjustment knob on the control panel (Figure 3-3). Call your distributor if the required voltage cannot be obtained by this adjustment.

### FUEL SYSTEM ADJUSTMENTS

The engine is equipped with a carburetor to run on natural gas or propane or both.

#### Gaseous and Combination Fuel Systems

An engine equipped for natural gas and propane has a gas mixer that serves both fuels. Each fuel has a separate shutoff solenoid valve. The unit is equipped with a fuel selector switch; the position of the switch determines which solenoid valve will open for operation. The switch is located on the governor control mounting bracket.

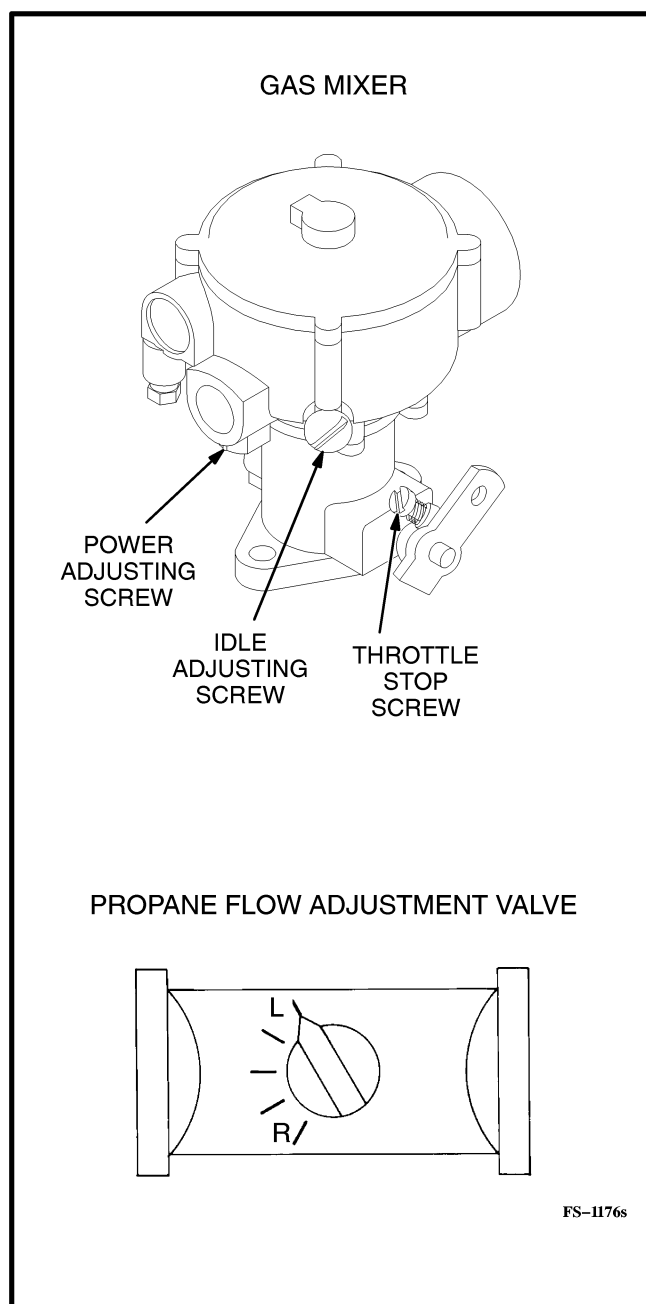


**FIGURE 6-1. TYPICAL COMBINATION FUEL SYSTEM GAS MIXER**

**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.

Turbocharged models have a gas mixer mounted inline with the air filter outlet hose and a separate throttle body with throttle stop screw mounted on the intake manifold.

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.
3. Disconnect all loads, shut down the set, connect a tachometer and disconnect 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 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.
2. 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 control panel switch (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 6-2. TYPICAL GASEOUS FUEL ADJUSTMENTS**

## ELECTRIC GOVERNOR

The governor is factory set and should not require readjustment unless parts are replaced.

If necessary, adjust the linkage according to Figure 6-4 and check the wiring of the controller according to Figure 6-3. Then adjust the governor controller as follows.

### Electric Governor Adjustments

1. Set the switches as follows, see Figure 6-3:

#### SW1

**ADJ1/ADJ2** - Down position (**ADJ1**)

**50HZ/60HZ** - Up position (**50HZ**) or down (**60HZ**).

**4CYL/6CYL** - Up position (**4CYL**) or down (**6CYL**).

#### SW2 (Rotary Switch)

**GAIN** - Position 4.

#### SW3

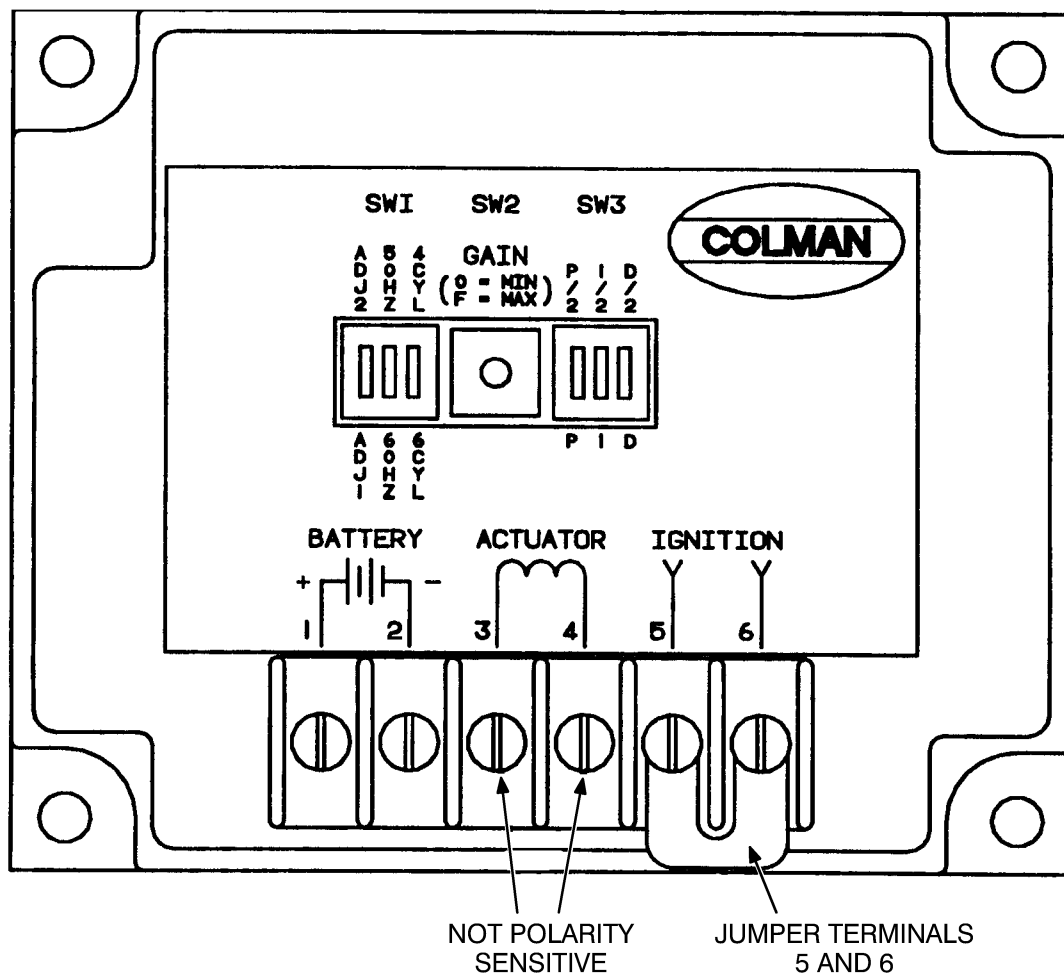
All positions down.

2. Prior to adjusting governor control, make sure that governor control terminals 5 and 6 are jumpered.
3. Start the set. While monitoring the Frequency/RPM meter, hold the throttle linkage so that engine will not overspeed, should the governor control be out of adjustment.

If the engine overspeeds, shut down the set. Turn the **GAIN** switch to the next higher position and restart the set.

4. Warm up the set under at least 1/4 load until it is up to normal operating temperature and then disconnect the load.
5. If the engine has a consistent hunt at approximately 1 to 2 Hz, adjust the **GAIN** rotary switch until engine is stable and responsive to governor control (clockwise increases gain, counter-clockwise decreases gain).
6. Manually actuate governor linkage several times to ensure correct gain adjustment. Unit should respond quickly but should not hunt, use maximum possible gain setting.
7. If the engine has an audibly fast hunt, set **SW3** position **3** to the up position. If no change is seen or heard, return switch to down position.
8. If the engine has an inconsistent slow hunt that is barely audible, set **SW3** position **2** to the up position to reduce integral gain. If no change is seen or heard, return switch to down position.
9. If the engine has a very slow hunt at approximately 0.5 Hz, set **SW1** position **1** up to add friction compensation to the controller. If no effect is seen or heard, return switch to down position and check for linkage binding and repair as necessary.
10. Check for stability (no audible hunting) under a range of loads from no-load to full-load.
11. If engine has significant undershoot on load acceptance, turn **GAIN** rotary switch clockwise. Repeat Steps 6 and 10 to achieve overall stability between no-load and full-load conditions.
12. If engine has significant overshoot on load acceptance after the initial drop in engine speed, move **SW3** position **2** to the down position if it was moved to the up position in Step 8. Return switch to the up position if no change is seen or heard.
13. Shut down engine. Restart engine to make sure that unit does not overspeed.
14. Shut down engine.
15. Engine is now ready for service.





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FIGURE 6-3. GOVERNOR CONTROLLER TERMINALS AND ADJUSTING SWITCHES

## Linkage Adjustments

Figure 6-4 illustrates the arrangement of the electric governor components and how to adjust the linkage of the electric governor. The following should be checked if components are loose or require adjustment.

1. Each component is threaded at least three to four turns onto the mating component and the lock nuts are set.
2. The assembled governor linkage is threaded three or four turns onto the actuator shaft.
3. The ball joint of the governor linkage is snapped onto the ball stud of the throttle lever.
4. Loosen the throttle lever screw.
5. Rotate the throttle linkage to the full speed stop and extend the actuator shaft to its end of travel.
5. Tighten the throttle lever screw.

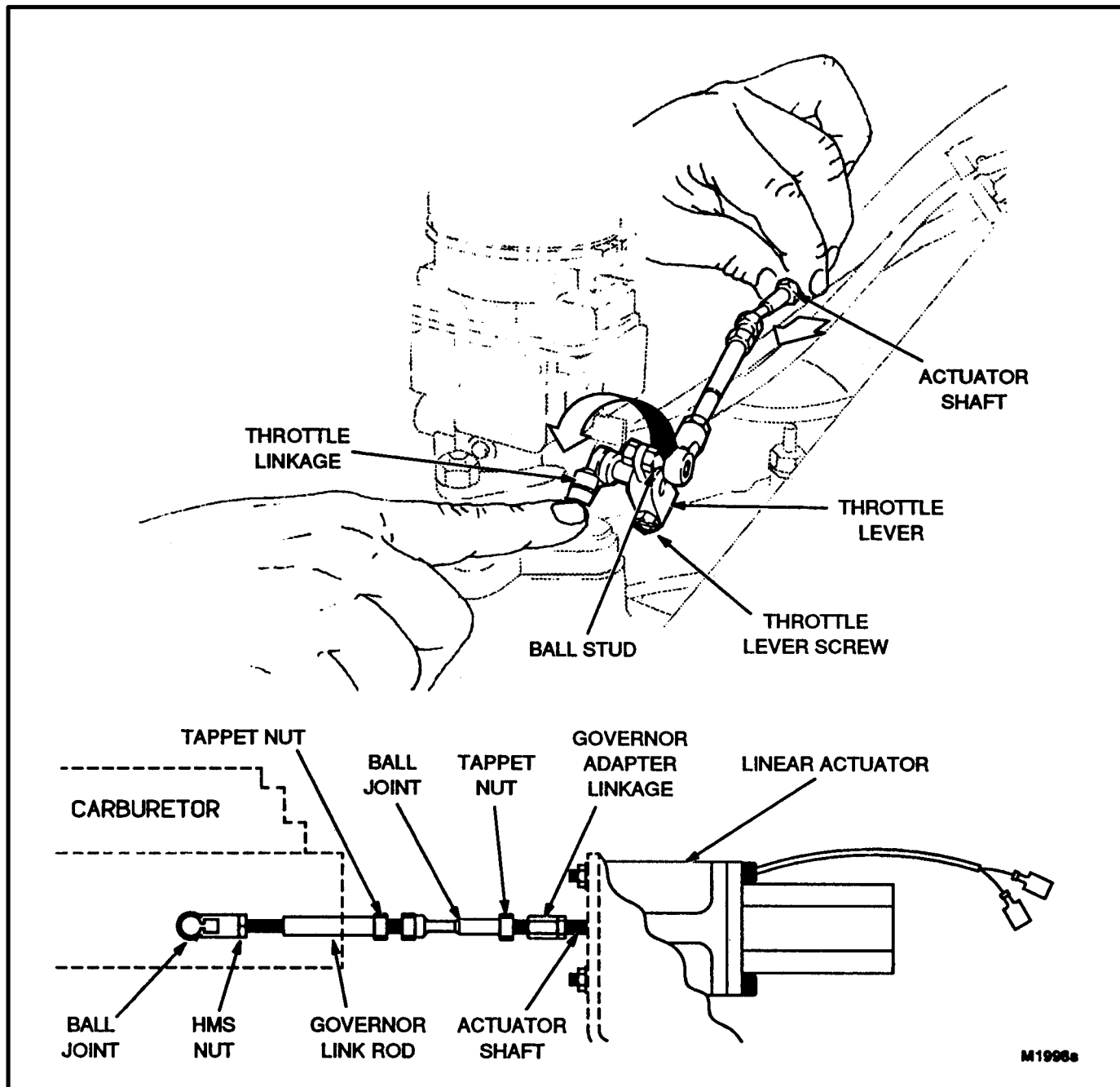


FIGURE 6-4. ELECTRIC GOVERNOR LINKAGE





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