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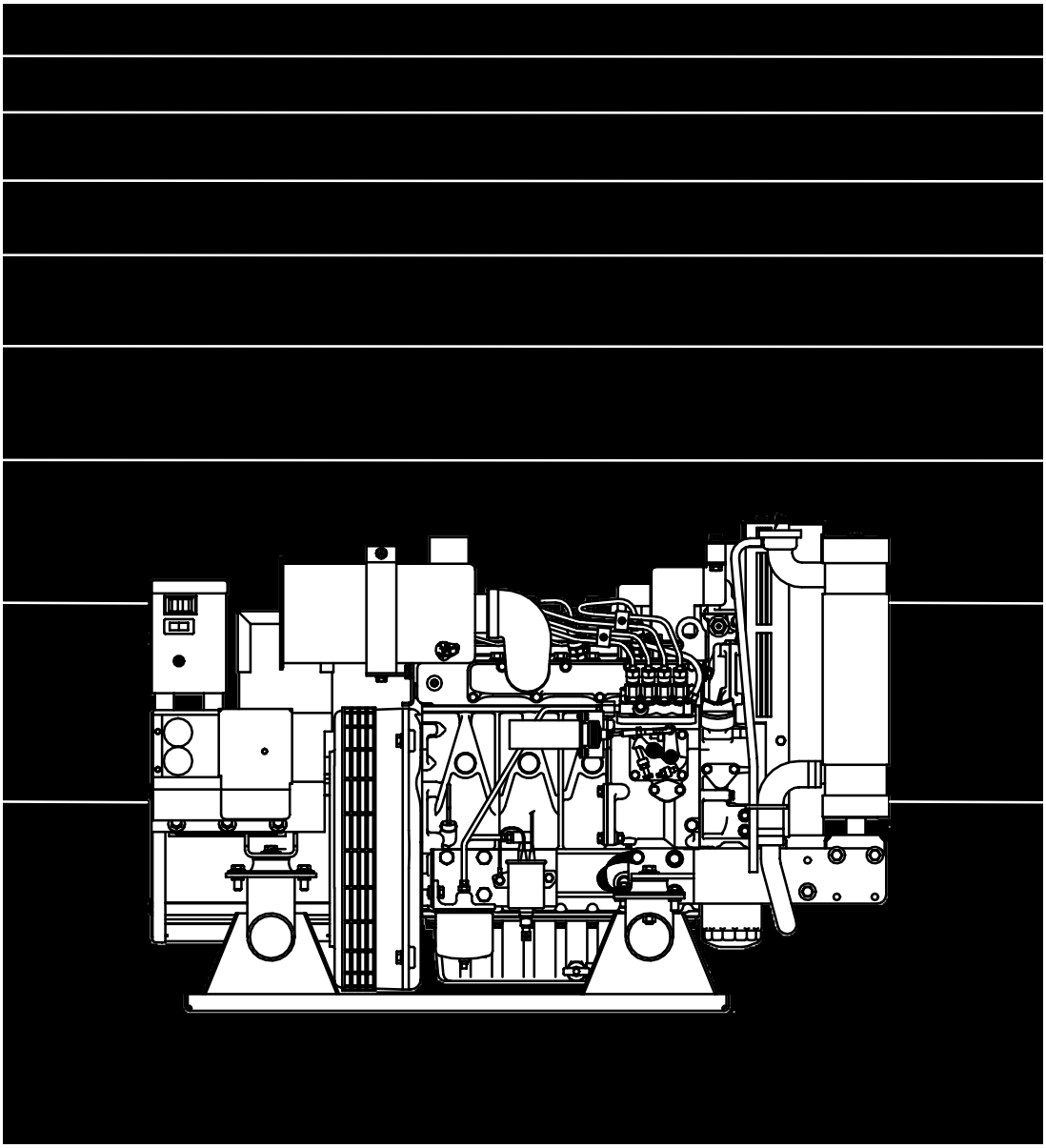
Service Manual

10.0 kW HDKAG Generator Sets



Printed in U.S.A.

981-0516
10-97

Supplement 981-1051
Date: 02-05
Insert with-
Title: HDKAG Service Manual
Number (Date): 981-0516 (10-97)

This Supplement transmits changes to Figure 4-5 to illustrate the location of the voltage adjustment pot on newer voltage regulator boards. Replace Sheet 4-5/4-6 with the attached sheet.

GENERATOR OPERATION

Refer to Figures 4-3 and 4-4, the generator schematics, while working through the following description.

1. Voltage regulator VR1 (three-phase: VR21) supplies DC to the field winding (F1 - F2 leads) through brushes and slip rings, thereby establishing a revolving 4-pole magnetic field. The battery is connected during startup to initiate field excitation. Voltage regulator VR1 supplies field current during operation. Rated output voltage is maintained as the generator load varies, by varying field current to maintain field strength proportional to the load.
2. The revolving magnetic field induces AC in the stator windings (T1 - T2 and T3 - T4) which are connected to the load.
3. Under light load, the stator windings can supply sufficient current for the field to maintain rated output voltage.
4. As the load increases, load currents increase, resulting in a proportional increase of current, which in turn supplies the field. Rated output voltage is thereby maintained as the load varies.

ELECTRONIC VOLTAGE REGULATOR

The voltage regulator controls the output of the generator so that a constant voltage is maintained under varying load conditions.

Only the basic functions of the regulator are described (Figure 4-5). Voltage from quadrature windings Q1/Q2 supply power to the voltage regulator itself. The voltage regulator in turn supplies an excitation voltage (F1/F2) that is directly proportionate to the output voltage (L1/L0) it senses. Any changes in the generator output voltage produce a corresponding change in the excitation voltage provided by the regulator.

On the HDKAG, the voltage regulator assembly includes a potentiometer which enables a slight degree of output voltage adjustment. The voltage regulator assembly contains no user-serviceable parts. If the assembly fails, it must be replaced.

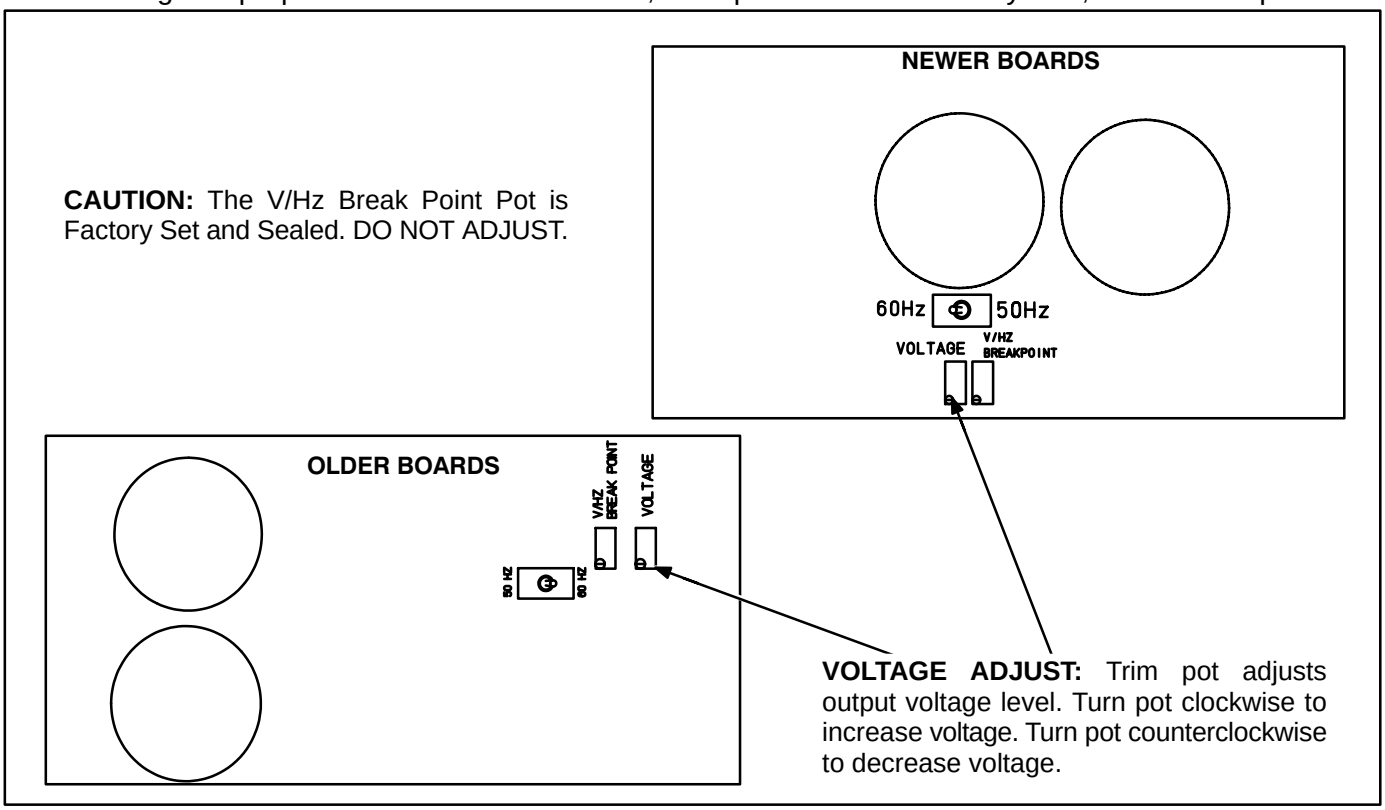


FIGURE 4-5. ADJUSTMENTS ON GENSET VOLTAGE REGULATOR BOARD

GENERATOR SERVICE

Always disconnect the battery cables (negative [-] first) from the battery to prevent accidental starting of the set while servicing the generator.

⚠WARNING ***Accidental starting of the set while working on it can cause severe injury. To prevent accidental starting, disconnect the battery cables (negative [-] first) from the battery.***

The negative (-) cable is always disconnected first, and connected last, to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while disconnecting or connecting the positive (+) cable. Arcing can ignite the explosive hydrogen gas given off by the battery, and cause severe injury.

Brush Inspection/Replacement

The generator should be inspected for brush wear and cleaning every six months.

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

1. Remove the access cover for the brush assembly.
2. Check the brushes for wear with a piece of wire marked off 1 inch (25 mm) from one end (Figure 4-6). Replace the brush and the spring if the wire goes into the brush holder 1 inch or more.
3. To replace brushes, remove the brush holder by disconnecting the two leads to the holder and removing the two mounting screws.
4. Install the new brushes and springs in the holder and keep them in place during assembly by inserting a piece of wire through the holder, as shown in Figure 4-7.
5. Install the brush holder. After tightening the mounting screws, pull out the brush retaining wire.
6. Connect the F1 lead to the inner brush terminal (nearest the rotor windings). Connect the F2 lead to the outer brush terminal (nearest the end bell).

Slip Ring Inspection/Replacement

Inspect the slip rings for grooves, pits or other damage. If dust has accumulated on any generator components, they can be cleaned with filtered low-pressure air.

1. Examine the slip rings while servicing the brushes.
2. If the rings need cleaning or service, remove the rotor from the generator and dress the rings on a lathe.

⚠CAUTION ***Dressing the slip rings on a lathe improperly may damage the generator rotor. Make certain that only an experienced technician performs this job.***

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years, because the bearing grease gradually deteriorates due to oxidation.

Replace the O-ring if it shows evidence of wear or deterioration. Renew grease if necessary (moly only).

California

Proposition 65 Warning

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

Table of Contents

Safety Precautions

Thoroughly read the OPERATOR'S MANUAL before operating the genset. Safe operation and top performance can be obtained only with proper operation and maintenance.

The following symbols in this Manual alert you to potential hazards to the operator, service person and equipment.

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

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

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

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

GENERAL PRECAUTIONS

- Keep ABC fire extinguishers handy.
- Make sure all fasteners are secure and torqued properly.
- Keep the genset and its compartment clean. Excess oil and oily rags can catch fire. Dirt and gear stowed in the compartment can restrict cooling air.
- Let the engine cool down before removing the coolant pressure cap or opening the coolant drain. Hot coolant under pressure can spray out and cause severe burns.
- Before working on the genset, disconnect the negative (**-**) battery cable at the battery to prevent starting.
- Use caution when making adjustments while the genset is running—hot, moving or electrically live parts can cause severe personal injury or death.
- Used engine oil has been identified by some state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or contact used oil or its vapors.
- Benzene and lead in some gasolines have been identified by some state and federal agencies as causing cancer or reproductive toxicity. Do not to ingest, inhale or contact gasoline or its vapors.
- Do not work on the genset when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.

GENERATOR VOLTAGE IS DEADLY!

- Generator output connections must be made by a qualified electrician in accordance with applicable codes.
- The genset must not be connected to the public utility or any other source of electrical power. Connection could lead to electrocution of utility workers, damage to equipment and fire. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry and stand on a dry wooden platform on the ground or floor.

FUEL IS FLAMMABLE AND EXPLOSIVE

- Keep flames, cigarettes, sparks, pilot lights, electrical arc-producing equipment and switches and all other sources of ignition well away from areas where fuel fumes are present and areas sharing ventilation.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.
- Use approved non-conductive flexible fuel hose for fuel connections at the genset.

ENGINE EXHAUST IS DEADLY!

- Learn the symptoms of carbon monoxide poisoning in this Manual.
- Never sleep in the vehicle while the genset is running unless the vehicle has a working carbon monoxide detector.
- The exhaust system must be installed in accordance with the genset Installation Manual.
- Do not use engine cooling air to heat the vehicle interior.
- Make sure there is ample fresh air when operating the genset in a confined area.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

BATTERY GAS IS EXPLOSIVE

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

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. ***Do not operate a diesel-powered genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine.*** The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

Mobile-3

1. Introduction

ABOUT THIS MANUAL

This manual contains troubleshooting and repair data for these components of the HDKAG generator set:

- Control
- Generator

See the Engine Service Manual for engine information.

Study this manual carefully. Heed all warnings and cautions. Proper use and maintenance can result in longer set life, better performance and safer operation.

This manual contains basic wiring diagrams and schematics for troubleshooting. Technicians should use the wiring diagram and schematic shipped with each unit. Update these diagrams and schematics when the set is modified.

PC board information is limited; in the field, it is more efficient to replace the boards than to attempt repair.

ASSISTANCE

When contacting an Onan® distributor, supply the complete model number and serial number shown on the Onan nameplate on the side of the generator control box.

TEST EQUIPMENT

- Multimeter/digital VOM
- AC voltmeter
- DC voltmeter
- Frequency meter
- Jumper leads
- Load test panel
- Megger or insulation resistance meter
- Wheatstone bridge or digital ohmmeter

⚠WARNING ***Incorrect service or replacement of parts can result in severe personal injury, death, and /or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.***

SAFETY CONSIDERATIONS

Generator sets present safety hazards that the technician must know about. Read the precautions on the inside cover of this manual. Familiarize yourself with the hazards shown in Table 1-1. When the hazards are known, approach the job with a safety-conscious attitude. Being safety-conscious is the best way to avoid injury. **Reduce the chance of an accident with the following safeguards.**

Safeguards To Avoid Hazards

- **Use Protective Clothing.** Protect your body by wearing protective clothing such as:

  - Safety shoes
  - Gloves
  - Safety glasses
  - Hard hats

  Leave rings and jewelry off. Do not wear loose clothing that might get caught on equipment.

- **Reduce Workshop Hazards.**

  - Keep guards and shields in place on machinery
  - Maintain equipment in good working order
  - Store flammable liquids in approved containers away from open flame, spark, pilot light, cigarette, or other ignition source
  - Keep the workshop clean and well-lighted
  - Provide adequate ventilation
  - Keep a fire extinguisher and safety equipment nearby
  - Be prepared to respond to an emergency

- **Develop Safe Work Habits.**

  Unsafe actions are the source of most accidents with tools and machines. Be familiar with the equipment and know how to use it safely. Use the right tool for the job, and check its condition before starting. Observe the warnings and cautions in this manual and take special precautions when working around electrical equipment. Do not work alone if possible and do not take unnecessary risks.

- **Be prepared if an accident occurs.**

Agencies such as the Red Cross and local police and fire departments offer courses in first aid, CPR, and fire control. Take advantage of this information to be ready to respond to an accident. Learn to be safety conscious and make safe practices a part of your work routine. Do not work when tired or after consuming any alcohol or drug that makes the operation of equipment unsafe.

TABLE 1-1
HAZARDS AND THEIR SOURCES

- **Fire and explosions**
  - Leaking fuel
  - Hydrogen gas from charging battery
  - Oily rags improperly stored
  - Flammable liquids improperly stored
  - Any fire, flame, spark, pilot light, arc-producing equipment or other ignition sources
- **Burns**
  - Hot exhaust pipes
  - Hot engine and generator surfaces
  - Hot engine oil
  - Electrical short in DC wiring system
  - Hot engine coolant
- **Poisonous gases**
  - Carbon monoxide from faulty exhaust pipes, joints or hangers
  - Operating generator set where exhaust gases can accumulate
- **Electrical shock (AC)**
  - Improper genset load connections
  - Faulty RV wiring
  - Faulty electrical appliance
  - Faulty genset wiring
  - Working in damp conditions
  - Jewelry touching electrical components
- **Rotating Machinery**
  - Flywheel fan guard not in place
  - Jewelry or loose clothing catching in moving parts
- **Slippery Surfaces**
  - Leaking or spilled oil
- **Heavy Objects**
  - Removing generator set from RV
  - Removing heavy components

SET REMOVAL

Some service procedures require removing the generator set from the vehicle. Because of the wide variety of installations, it is not possible to specify exact removal procedures for each genset. If a satisfactory method for removing a particular set cannot be determined, contact the vehicle manufacturer or the set installer for their recommendations.

⚠WARNING ***Generator sets are heavy and they can cause severe personal injury or death if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting the generator set. Before starting set removal, place the transmission in park, set the emergency brake, and remove the negative (-) cable from the vehicle ignition system battery to avoid inadvertent movement of the vehicle.***

Disconnecting Generator Set Systems

Some installations require partial removal of the set to gain access to the battery cable, fuel line, and other connections. Read this entire section before starting set removal. The following steps are a general guideline.

⚠WARNING ***Leakage of fuel in or around the generator set compartment presents the hazard of fire or explosion that can cause severe personal injury or death. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the compartment thoroughly: park vehicles outdoors in a well ventilated area.***

1. Disconnect the generator set negative (-) battery cable at the battery terminal.
2. Disconnect the generator set positive (+) battery cable from the wire harness.
3. Disconnect the remote control plug wire from the generator set (if applicable).
4. Disconnect the generator load wires. Tag for identification when reconnecting.
5. Disconnect the exhaust system and support brackets or hangers, to allow set removal.
6. Disconnect the fuel line at the genset housing. Securely plug the end of the fuel line to prevent fuel leakage.
7. Verify that the set is adequately supported before loosening any mounting bolts or support members.

⚠WARNING ***Leakage of fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Make certain all fuel line openings are plugged. Before disconnecting the fuel line, be certain there are no ignition sources such as flame, spark, pilot light, cigarette, etc., near the generator set. Keep an ABC type fire extinguisher nearby.***

When reinstalling the set, be sure all mounting hardware, and electrical, exhaust, and fuel system components are connected exactly as they were before removal. See the appropriate installation manual during reinstallation for important safety precautions.

Check for oil and fuel leaks. Check the exhaust system audibly and visually with the generator set running. Repair leaks immediately. Replace worn, damaged, or corroded exhaust and fuel line components before leaks occur.

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2. Engine Controls

GENERAL

This section describes the generator set preheat/start/run control system. The set may be started either at the onboard DC control box or by using a remotely mounted start control.

START CONTROL AT SET

The set is started with a Start/Stop/Preheat switch on the front panel of the DC control box. Component references are found on wiring/schematic diagrams in the Wiring Diagrams section of this manual.

The DC control box does not contain meters and is designed for remote mounting within limits of the wire harness (approximately 32 inches [813 mm]). An optional remote control panel with meters is available in a kit from Onan.

Switches

Start-Stop/Preheat Switch S11: Starts and stops the unit locally. Preheat function occurs when the switch is held in the Stop position. The unit may also be operated from a remote switch wired to receptacle J3 on the rear panel.

Circuit Breakers

DC Control Breaker CB11: A 15 ampere DC breaker providing protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

Fault Breaker CB12: A manual reset breaker that shuts down the engine for low oil pressure and high coolant temperatures.

Control Components

The following describes the basic engine control components and how they function.

A11 Engine Monitor Circuit Board: A circuit board that monitors the engine control system functions. This includes starting, stopping, and fault system operation. Terminals are included for making remote connections. See Figure 2-1.

Two relays soldered into the engine monitor board are not serviceable. They function as follows:

- Power relay K12 connects battery B+ to the control meters and fuel solenoid during operation.
- Starter protection relay K15 is AC operated. When the Start switch is pressed, B+ is connected to K11 start solenoid through the K15 NC contacts until the generator output reaches about 90 volts AC. At this voltage K15 activates and disconnects the starter circuit.

K11 Start Solenoid: Located over the engine monitor circuit board (above K13 glow plug heater solenoid). It connects battery B+ to the start solenoid, K13 heater solenoid, fuel solenoid and meters during cranking.

K13 Glow Plug Heater Solenoid: Located directly above the monitor circuit board. Connects B+ to the engine glow plugs during cranking. It is energized by K11 start solenoid.

K14 Fuel Solenoid: It opens the fuel control valve when the start/stop switch is placed in the Start position.

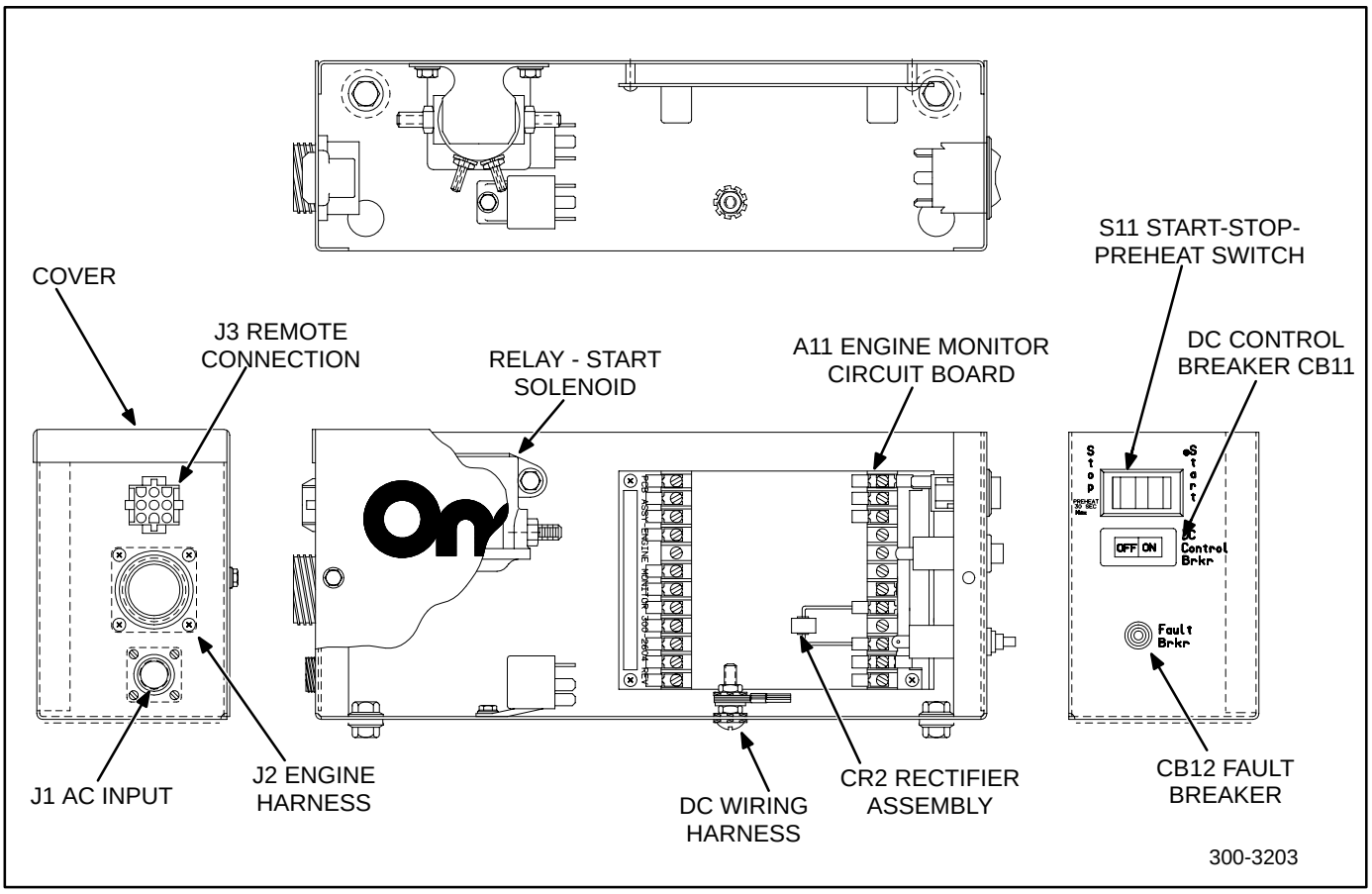


FIGURE 2-1. HDKAG GENERATOR SET DC CONTROL BOX

Engine Monitors

This section briefly describes the engine sensors (switches) and optional gauge senders. The sensors protect the engine from unfavorable operating conditions; the senders are used with the operational remote panel. These sealed units are not repairable. Do not use a substitute part if replacement is necessary, since they are close-tolerance parts made for a specific application.

The safety sensors (switches) close the fault circuit to ground if abnormal operating conditions exist, tripping the fault breaker CB12 to stop the engine. See Figure 2-2 and the schematic in Figure 2-3.

Oil Pressure Monitors

Refer to Figure 2-2 for the location of the oil pressure monitors.

Oil Pressure Sender E1: The sender resistance changes with oil pressure and results in a reading on the (optional) oil pressure meter. The meter range is 0 to 100 psi (0 to 700 kPa).

Low Oil Pressure Switch S1: This switch closes if oil pressure drops to 9 psi (62 kPa), activating the fault breaker and stopping the engine.

Control Power Latch S6: This oil pressure switch closes at 5 psi (34 kPa) and provides a latch function for the control circuits. When closed, the switch supplies a ground path for relay K12 on the engine monitor board.

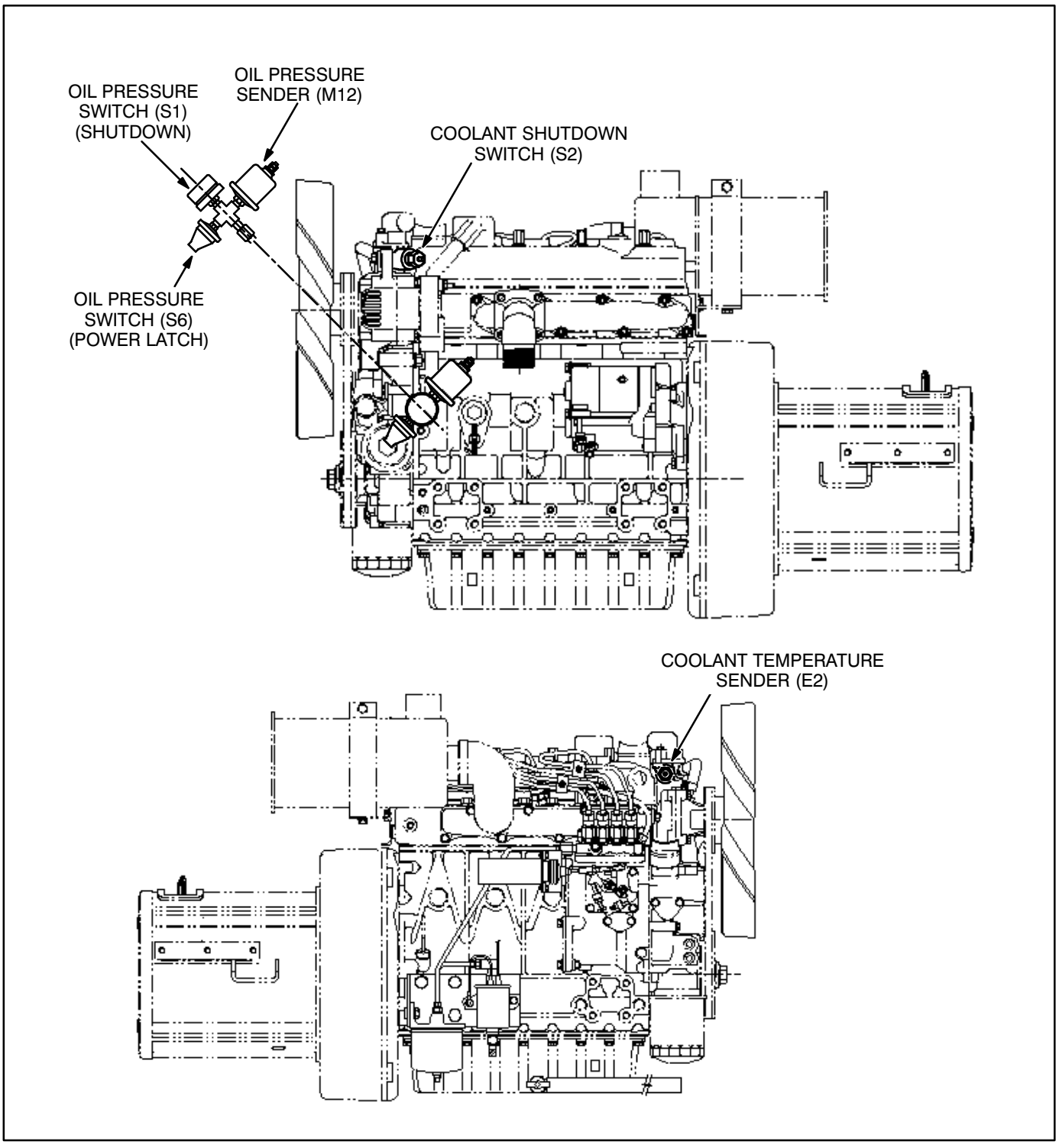


FIGURE 2-2. HDKAG FAULT SENSOR LOCATIONS

Engine Temperature Monitors

Refer to Figure 2-2 for the location of the engine temperature sensors.

Coolant Temperature Sender E2: The resistance of the sender unit changes with the engine coolant temperature and causes a reading on the coolant temperature meter (optional). The meter range is 100° to 250° F (40° to 121° C).

High Coolant Temperature Switch S2: This switch closes if the coolant temperature rises to 250° F (121° C), activating the fault breaker CB12 and stopping the engine.

Control Operation

To understand control operation, refer to the following text and the schematic diagram (Figure 2-3).

Starting Sequence: When start/stop switch S11 is held in the *Stop* (preheat) position, battery B+ is connected to the coil of heater relay K13. The relay contacts close and connect B+ to heaters HR1 - HR4.

After the preheat time interval, the operator holds S11 in the *Start* position. This connects B+ to K14 fuel solenoid relay and through A11-K15 NC (normally closed) contacts to K11 start solenoid relay. These relays actuate K1 fuel solenoid, B1 solenoid/starter motor and heaters HR1 - HR4 (via K13 NC contacts).

A11-K12 power relay is actuated after a short delay, when the control power latch switch S6 closes. S6 is closed when oil pressure rises to 5 psi (34 kPa), assuring engine lubrication before the set reaches full operating speed. Normally open (NO) contacts on A11-K12 close, supplying B+ to the other components on the engine monitor board.

Start-Disconnect Sequence: As the generator gains speed and output voltage, A11-K15 starter protection relay energizes at about 90 VAC. A11-K15 NC contact opens and de-energizes start solenoid relay K11. K11 then disconnects B+ from the starter solenoid (to stop the cranking motor) and from the glow plug heaters. If the generator fails to develop voltage, the engine will attempt to start but will stop as soon as the Start switch is released.

The two K15 NO (normally open) contacts close and function as follows:

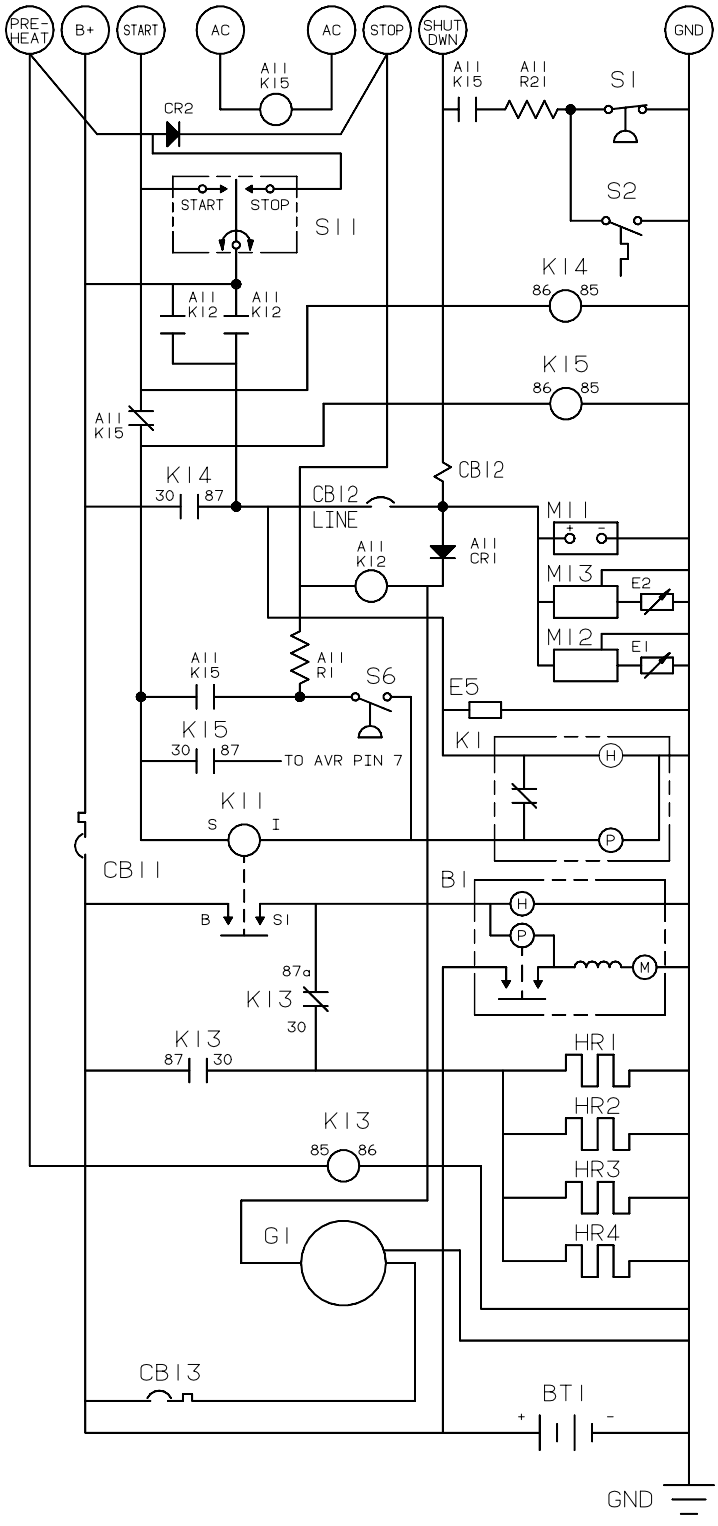
- Closes circuit for S1 and S2 (low oil pressure and high coolant temperature switches respectively)
- Provides another ground path for K12 coil (through K11 coil) similar to S6.

Battery Charge Circuit: Alternator G1, powered by a belt from the engine, supplies B+ voltage to recharge the generator set starting battery through circuit breaker CB13.

Stopping Sequence: Placing S11 in the Stop position puts B+ (through diode CR2) on the ground side of the A11-K12 power relay. This causes K12 to de-energize and disconnect B+ from CB12 and K1 fuel solenoid. De-energizing K1 shuts off the fuel flow to stop the engine.

Fault Shutdown: Fault breaker CB12 opens to stop the engine any time a fault sensor closes the circuit to ground. The fault sensors as shown in Figure 2-2 are:

- S1 low oil pressure
- S2 high coolant temperature



ENGINE PARTS

B1	Starter and solenoid
BT1	Battery (12V)
E1	Sender (oil pressure)
E2	Sender (coolant temperature)
HR1-4	Heater - glow plug
E5	Fuel pump - electric
K1	Fuel solenoid
S1	Switch - low oil pressure
S2	Switch - high coolant temperature
S6	Switch - control power latch
G1	Alternator

CONTROL BOX PARTS

A11	PCB assy - engine monitor
CB11, 13	Circuit breaker (control)
CB12	Circuit breaker (fault)
K11	Relay - start solenoid (starter) (12 V)
A11-K12	Relay - power
K13	Relay - heater
K14	Relay - fuel solenoid
A11 - K15	Relay - starter protection
K15	Relay
A11 - R1	Resistor (K12)
A11 - R2	Resistor (LOP timing)
S11	Switch - start/stop/preheat
J3 - J4	Connector - remote

FIGURE 2-3. DC CONTROL SCHEMATIC DIAGRAM

Remote Control Operation (Optional): The generator set may be operated from a remote switch connected to the control receptacle J3. Installation instructions are furnished with the kit available from Onan. See Figure 2-4.

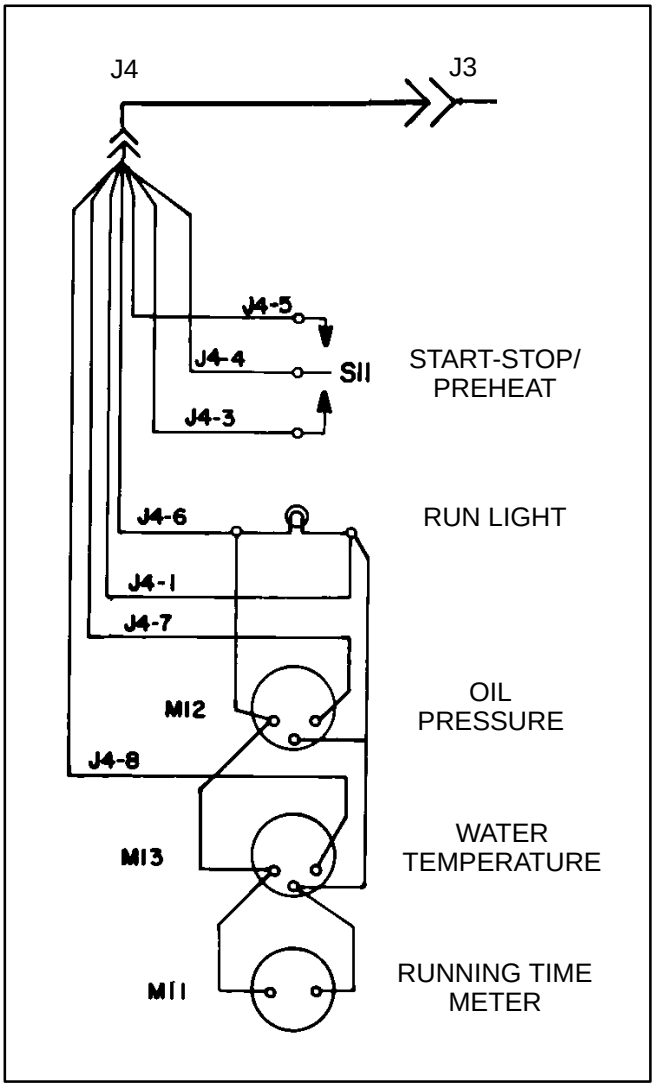


FIGURE 2-4. REMOTE CONTROL WIRING DIAGRAM

CONTROL TROUBLESHOOTING

The information in this section is divided into three flow charts. Determine the problem and then refer to the appropriate flow chart (A, B, or C) for the troubleshooting procedures.

A. Engine does not crank.
B. Engine cranks but does not start.
C. Engine starts but stops after running several seconds.

Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down on troubleshooting time.

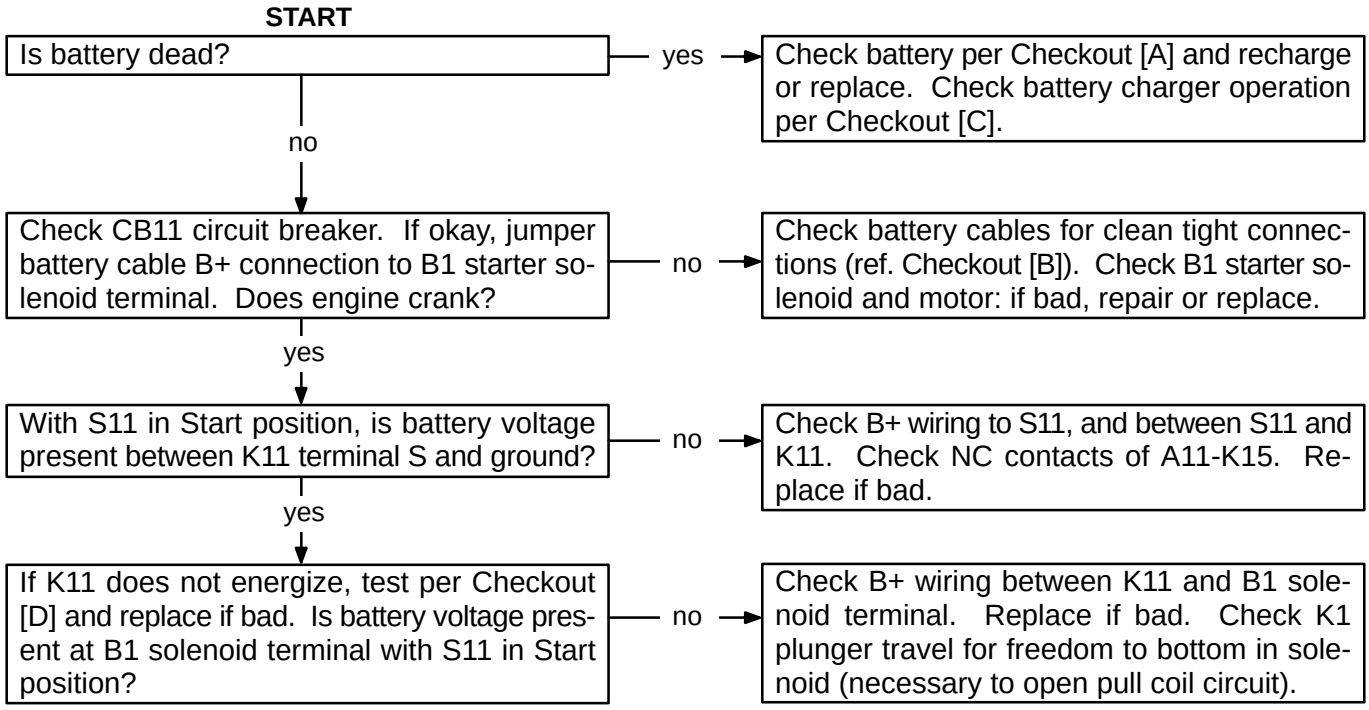
- Check all modifications, repairs, and replacements performed since last satisfactory operation of set. A loose wire connection overlooked when installing a replacement part could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced adjustments or test procedures. Refer to Figures 2-1 through 2-4 for locating control components, leads, terminals and other check points.

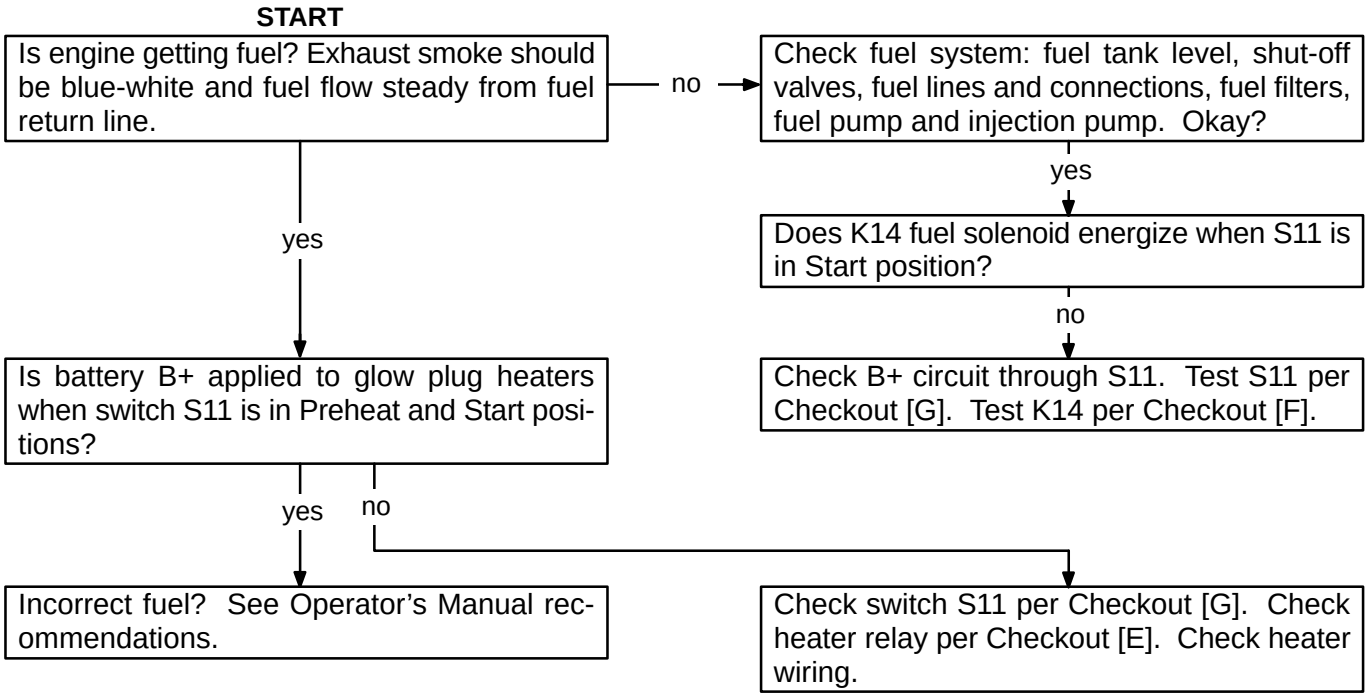
FLOW CHART A. ENGINE DOES NOT CRANK

⚠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.***



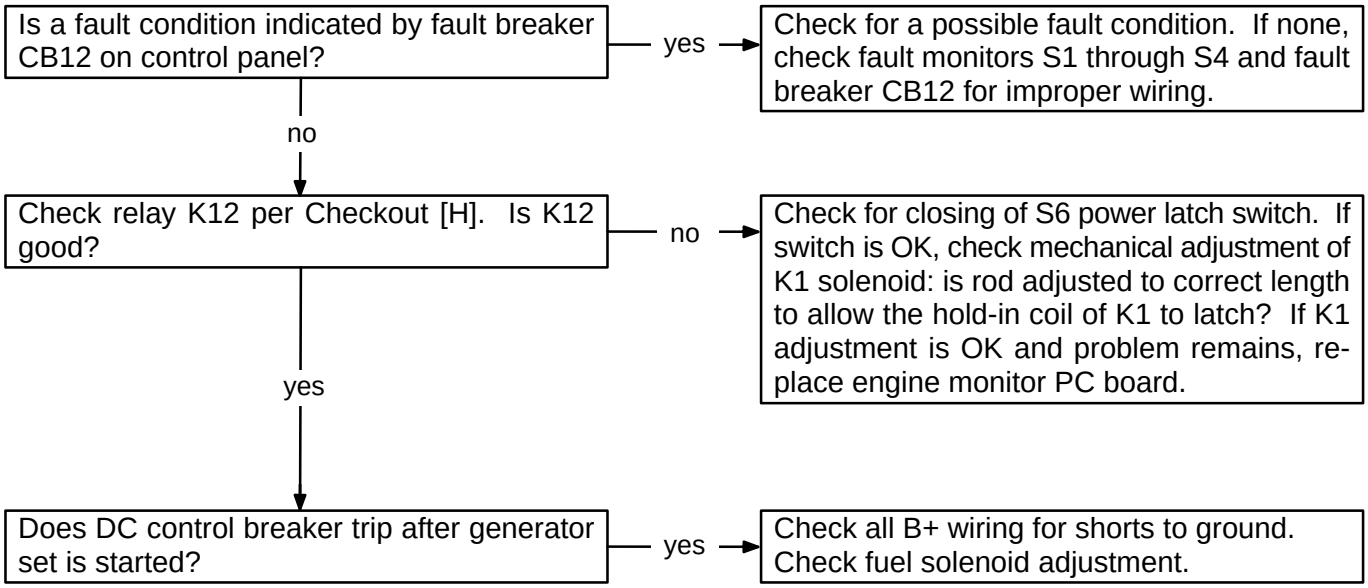
FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

⚠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.***



FLOW CHART C. ENGINE STARTS BUT STOPS AFTER RUNNING SEVERAL SECONDS

⚠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.***



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3. Engine Control Service

GENERAL

The following checks are referred to in the Control Troubleshooting flow charts. They isolate circuit problems caused by faulty engine control components. Disconnect leads before testing components.

⚠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.***

[A]

BATTERY CHECK (BT1)

Check the battery charge condition with a hydrometer. Electrolyte specific gravity should be about 1.260 for a fully charged battery at 80°F (27°C). If not, add distilled water to keep electrolyte at proper level, then recharge the battery. If the battery will not recharge, replace it.

If the battery loses excess water, the charge rate may be too high. If the battery charge is not maintained, the charge rate may be too low. See procedure [C].

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. Do not permit any flame, spark, cigarette, or other ignition source near the battery.***

[B]

BATTERY CABLE CHECK

With the starter motor running, check these voltage drops:

1. From the battery negative post (not the cable clamp) to the cylinder block
2. From the battery positive post to the battery terminal stud on the solenoid

Normally these should be less than 0.3 volts. If extra-long battery cables are used, slightly higher voltage drops may result. Thoroughly clean all connections in any part of the circuit showing excessive voltage drop.

[C]

BATTERY CHARGING CHECK

With the engine running, check the DC voltmeter (control option). The 12-volt system should read 13.5 to 15 volts.

The power source is a belt-driven alternator. The charge rate/voltage is determined by a voltage regulator located inside the control box.

Improper output may be caused by a loose drive belt, poor terminal connections, broken wires, bad regulator or alternator. Checkout procedures for the regulator and alternator are found in the engine service manual. The charge circuit is protected by circuit breaker CB13.

If the output voltage is high (over 15 volts), check for loose or corroded voltage regulator leads. If this does not correct the problem, the regulator is probably shorted and should be replaced.

[D]

START SOLENOID CHECK (K11)

1. Apply battery positive (B+) to the terminal marked S.
2. Connect a ground wire to the solenoid terminal marked I. The solenoid should activate.
3. If the contacts are good, battery voltage should be read between terminal 1 and ground. The voltage drop measured across the contacts should never exceed one volt in circuit application.

[E]

HEATER (GLOW PLUG) RELAY CHECK (K13)

1. Connect the relay coil voltage across the relay coil terminals. The relay should activate if coil is okay.

2. Connect a voltage source to one side of relay contacts.

3. Connect a voltmeter to other side of relay contact and voltage source. If voltage appears when relay energizes, the contact is good. The voltage reading appears in reverse order when checking normally closed (NC) contacts.

[F]

FUEL SOLENOID CHECK (K14)

If there is fuel to the injection pump, but no fuel at the injection nozzle, the fuel solenoid may be defective.

To check solenoid operation, watch for solenoid actuation when B+ is applied (start switch in start or run position). If there is no actuation when B+ is applied, the fuel solenoid must be replaced. When B+ is removed, the solenoid must de-activate.

[G]

START/STOP SWITCH CHECK (S11)

1. Remove battery B+ cable.

2. Place ohmmeter leads across switch.

3. Open and close switch while observing the ohmmeter. A normally open (NO) switch should indicate infinite resistance when open and continuity when closed. A normally closed (NC) switch should indicate continuity when closed and infinite resistance when open.

4. Replace switch if defective.

[H]

POWER RELAY CHECK (A11-K12)

Make certain that the genset starting battery is good before beginning this check.

1. Unplug CB12-2A from the circuit breaker. Note the markings on the wire to select the correct one.

2. Locate S6 (oil pressure switch) on the genset (see Figure 2-2). Find the grounded side of S6, using a continuity tester.

3. Use a jumper to ground the non-grounded side of S6.

4. Use a second jumper from the B+ terminal on the control board to apply B+ to the SW B+ (switched B+) terminal. Fuel pump E5 should start and run.

5. Remove the B+ jumper. If the fuel pump continues to run, K12 is good. If the fuel pump stops, K12 has failed and the A11 control board should be replaced.

6. Push the genset STOP button.

7. Remove the jumpers and reconnect CB12-2A.

4. Generator/Voltage Regulator

GENERAL DESCRIPTION

The YK generator (Figure 4-1) is a four-pole, revolving field, brush-type design with drip-proof construction.

The generator rotor is directly coupled to the engine flywheel with a rigid drive disc. Engine speed determines generator output voltage and frequency. A centrifugal blower on the drive disc circulates generator cooling air which is drawn in through the end bell and discharged through an outlet in the blower end.

A ball bearing in the end bell supports the outer end of the rotor shaft. The end bell is attached with four studs that thread into the generator adapter casting. The genset brushes are mounted in the end bell (see Figure 4-2).

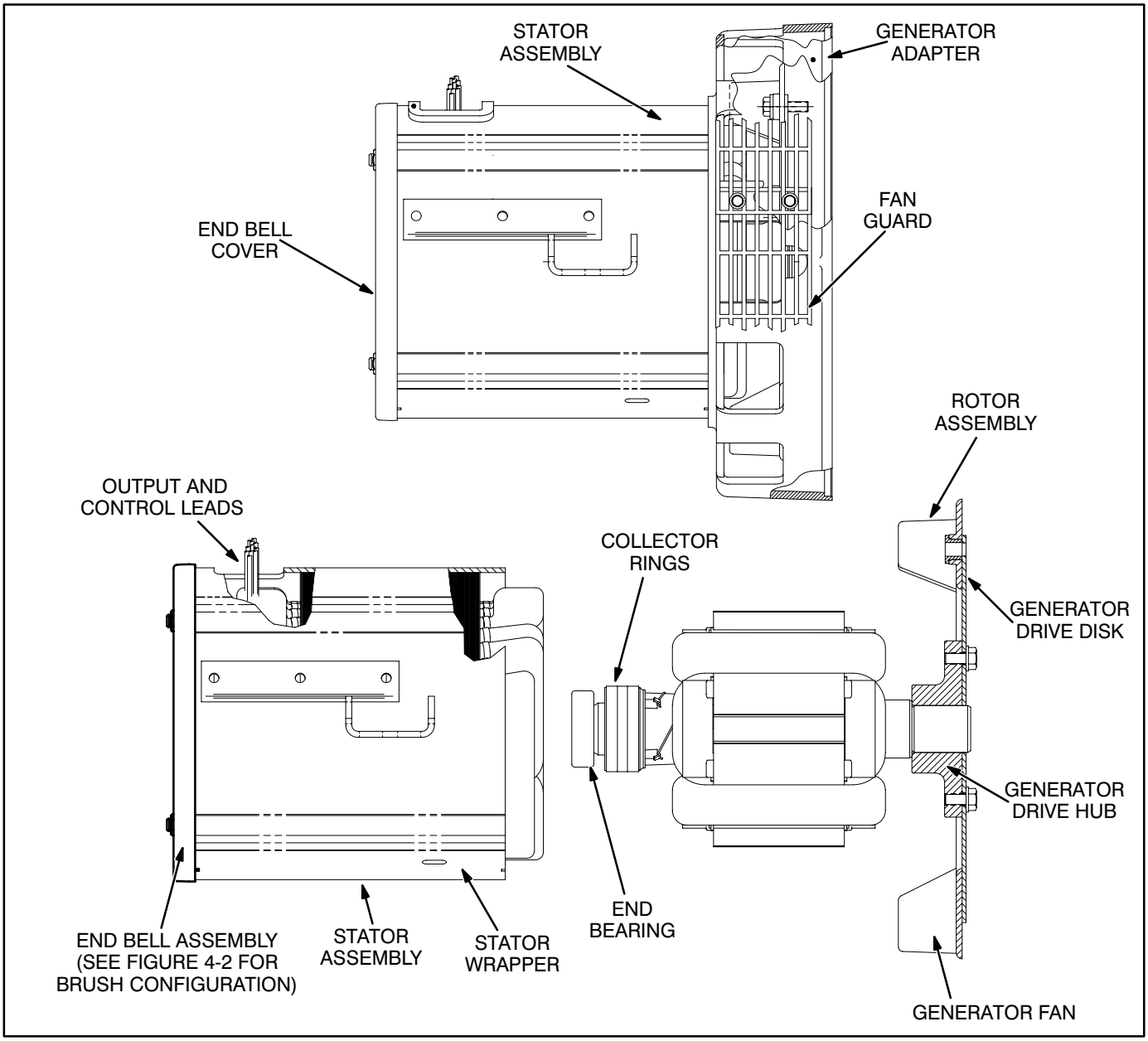

FIGURE 4-1. YK SERIES GENERATOR

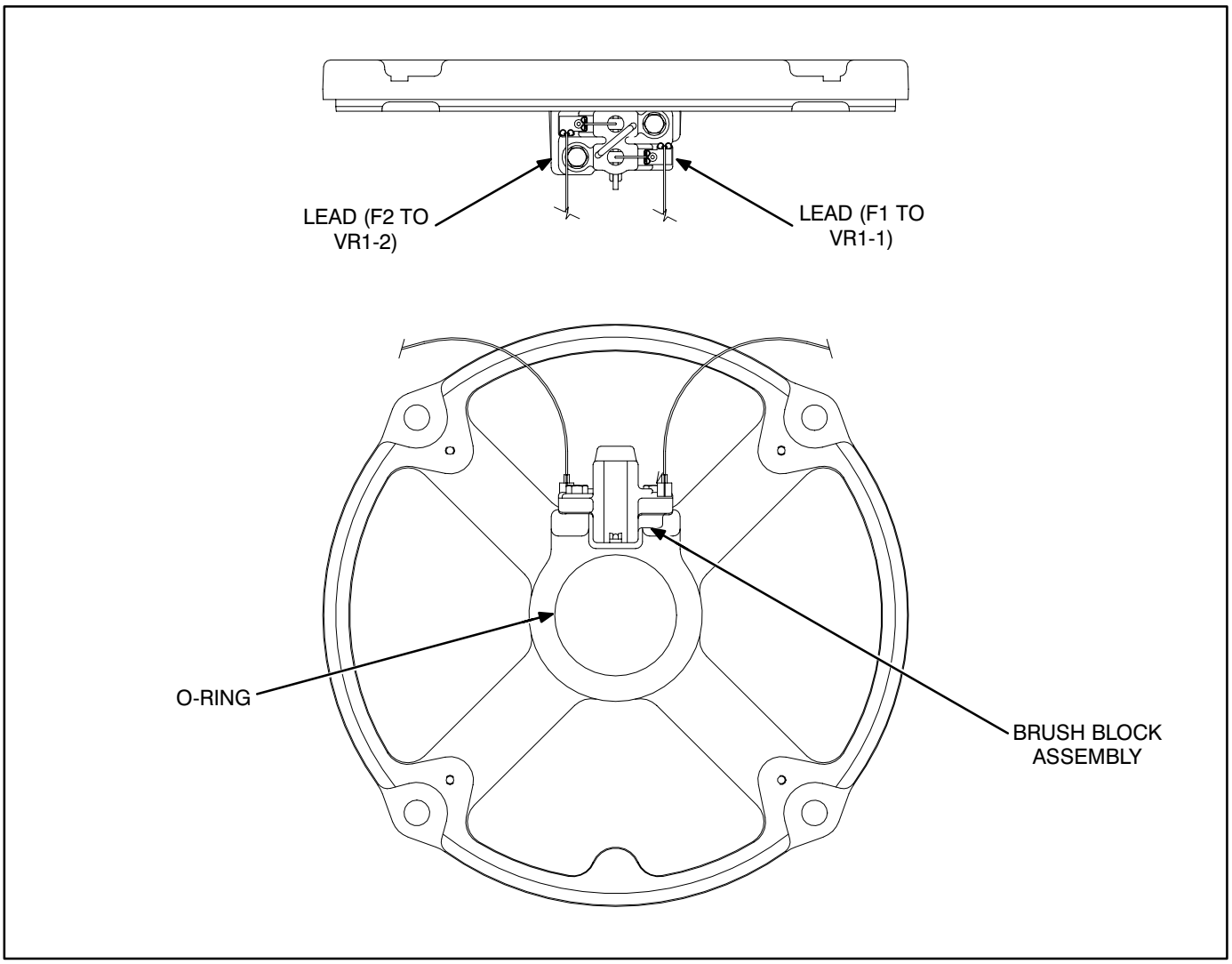

FIGURE 4-2. GENSET END BELL WITH BRUSHES

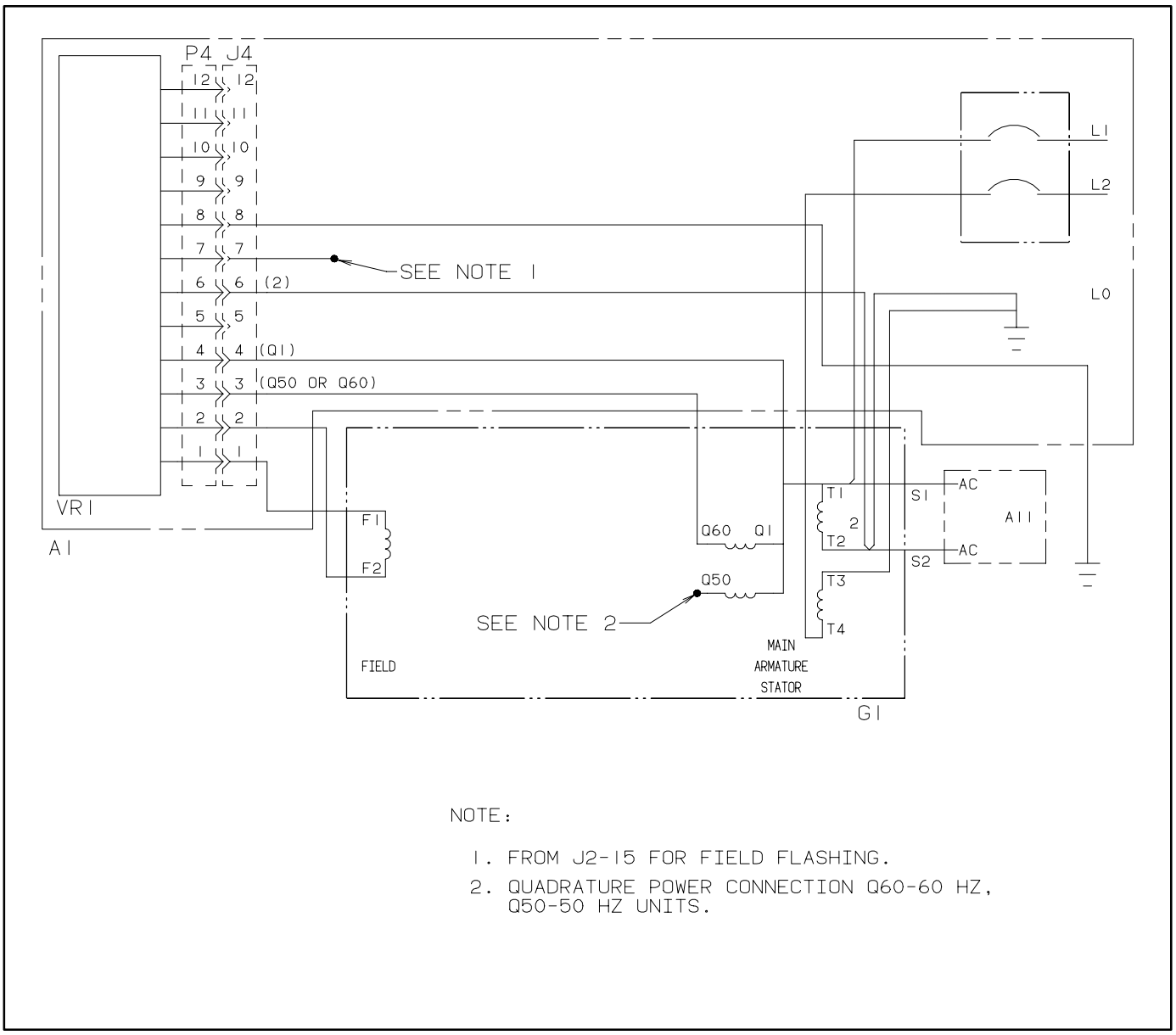

FIGURE 4-3. SINGLE-PHASE GENERATOR SCHEMATIC

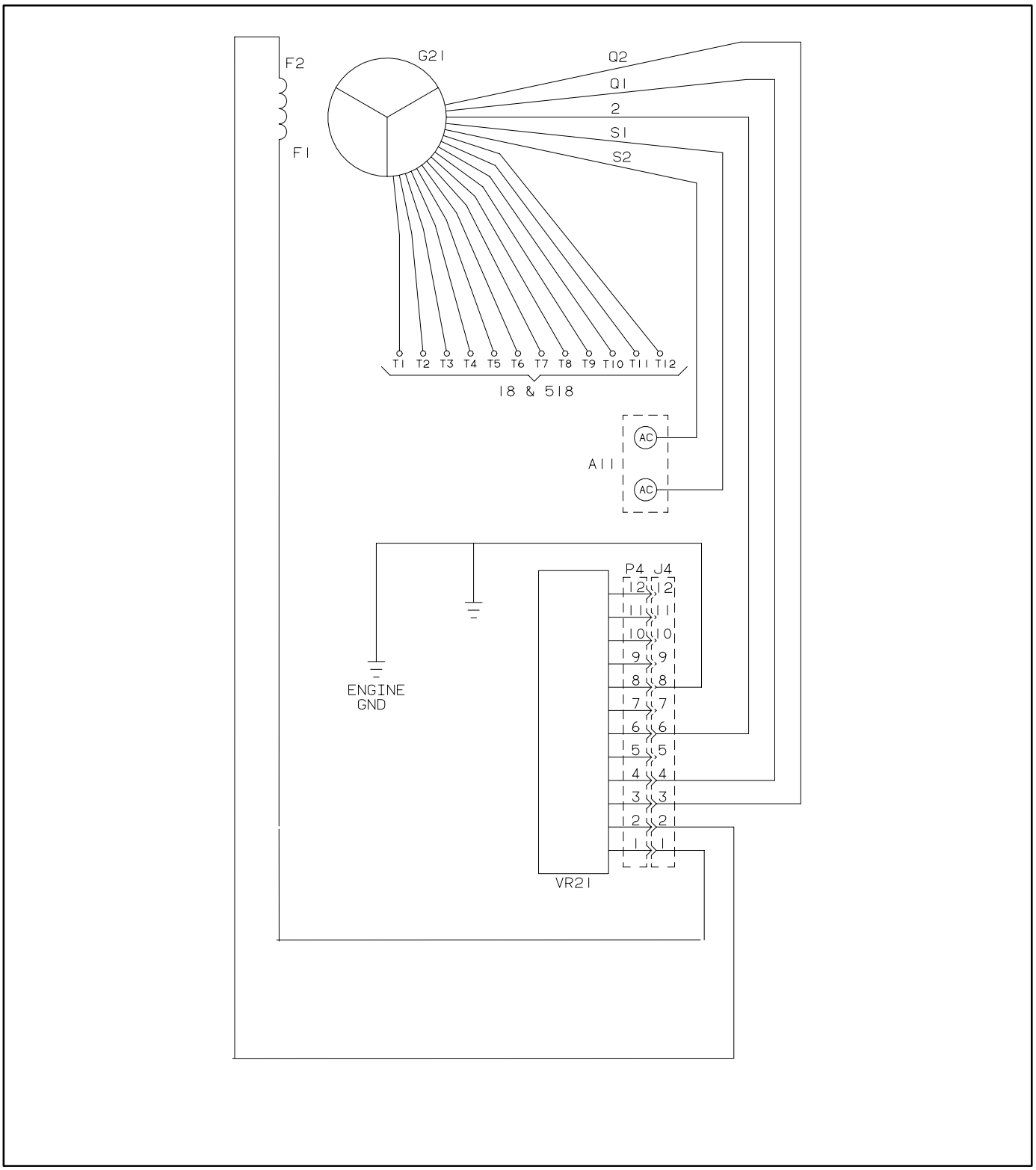

FIGURE 4-4. THREE-PHASE GENERATOR SCHEMATIC

GENERATOR OPERATION

Refer to Figures 4-3 and 4-4, the generator schematics, while working through the following description.

1. Voltage regulator VR1 (three-phase: VR21) supplies DC to the field winding (F1 - F2 leads) through brushes and slip rings, thereby establishing a revolving 4-pole magnetic field. The battery is connected during startup to initiate field excitation. Voltage regulator VR1 supplies field current during operation. Rated output voltage is maintained as the generator load varies, by varying field current to maintain field strength proportional to the load.
2. The revolving magnetic field induces AC in the stator windings (T1 - T2 and T3 - T4) which are connected to the load.
3. Under light load, the stator windings can supply sufficient current for the field to maintain rated output voltage.
4. As the load increases, load currents increase, resulting in a proportional increase of current, which in turn supplies the field. Rated output voltage is thereby maintained as the load varies.

ELECTRONIC VOLTAGE REGULATOR

The voltage regulator controls the output of the generator so that a constant voltage is maintained under varying load conditions.

Only the basic functions of the regulator are described (Figure 4-5). Voltage from quadrature windings Q1/Q2 supply power to the voltage regulator itself. The voltage regulator in turn supplies an excitation voltage (F1/F2) that is directly proportionate to the output voltage (L1/L0) it senses. Any changes in the generator output voltage produce a corresponding change in the excitation voltage provided by the regulator.

On the HDKAG, the voltage regulator assembly includes a potentiometer which enables a slight degree of output voltage adjustment. The voltage regulator assembly contains no user-serviceable parts. If the assembly fails, it must be replaced.

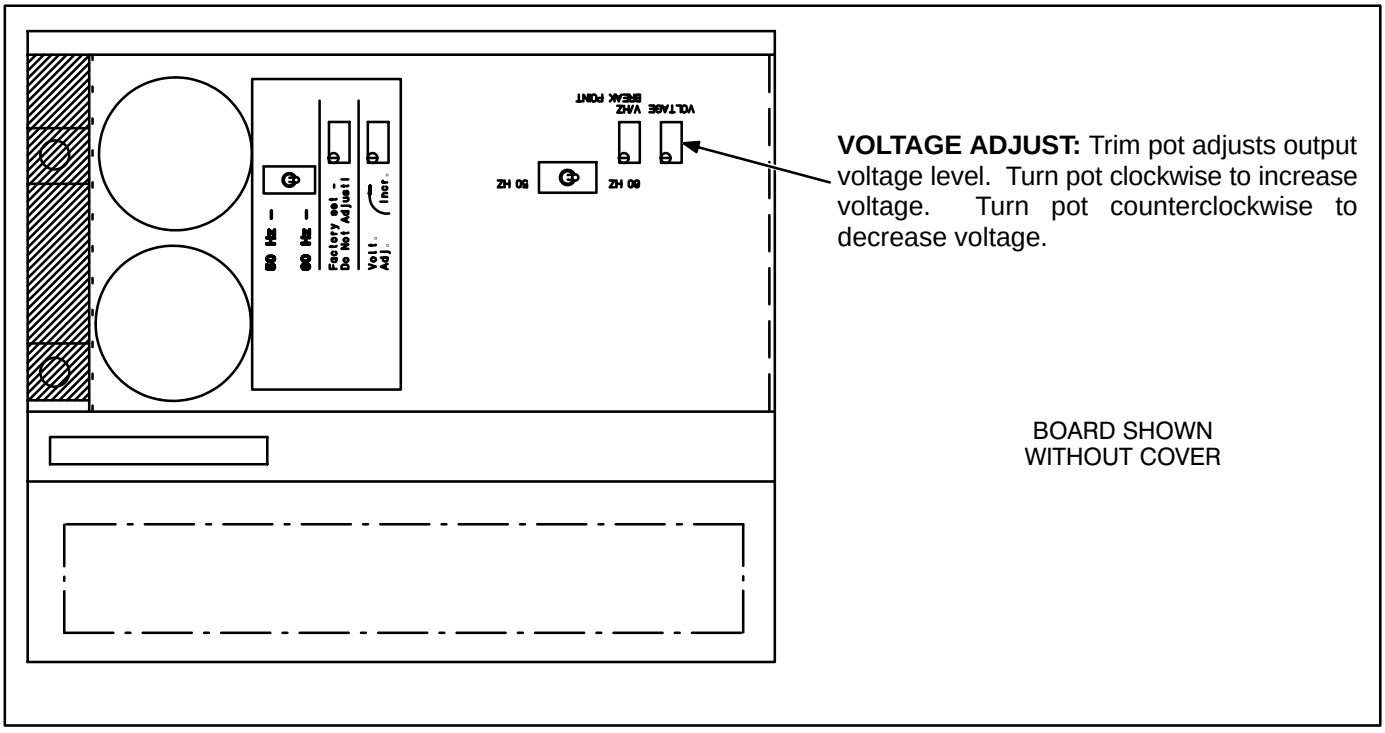

FIGURE 4-5. ADJUSTMENTS ON GENSET VOLTAGE REGULATOR BOARD

GENERATOR SERVICE

Always disconnect the battery cables (negative [-] first) from the battery to prevent accidental starting of the set while servicing the generator.

⚠WARNING ***Accidental starting of the set while working on it can cause severe injury. To prevent accidental starting, disconnect the battery cables (negative [-] first) from the battery.***

The negative (-) cable is always disconnected first, and connected last, to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while disconnecting or connecting the positive (+) cable. Arcing can ignite the explosive hydrogen gas given off by the battery, and cause severe injury.

Brush Inspection/Replacement

The generator should be inspected for brush wear and cleaning every six months.

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

1. Remove the access cover for the brush assembly.
2. Check the brushes for wear with a piece of wire marked off 1 inch (25 mm) from one end (Figure 4-6). Replace the brush and the spring if the wire goes into the brush holder 1 inch or more.
3. To replace brushes, remove the brush holder by disconnecting the two leads to the holder and removing the two mounting screws.
4. Install the new brushes and springs in the holder and keep them in place during assembly by inserting a piece of wire through the holder, as shown in Figure 4-7.
5. Install the brush holder. After tightening the mounting screws, pull out the brush retaining wire.
6. Connect the F1 lead to the inner brush terminal (nearest the rotor windings). Connect the F2 lead to the outer brush terminal (nearest the end bell).

Slip Ring Inspection/Replacement

Inspect the slip rings for grooves, pits or other damage. If dust has accumulated on any generator components, they can be cleaned with filtered low-pressure air.

1. Examine the slip rings while servicing the brushes.
2. If the rings need cleaning or service, remove the rotor from the generator and dress the rings on a lathe.

⚠ CAUTION ***Dressing the slip rings on a lathe improperly may damage the generator rotor. Make certain that only an experienced technician performs this job.***

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years, because the bearing grease gradually deteriorates due to oxidation.

Replace the O-ring if it shows evidence of wear or deterioration. Renew grease if necessary (moly only).

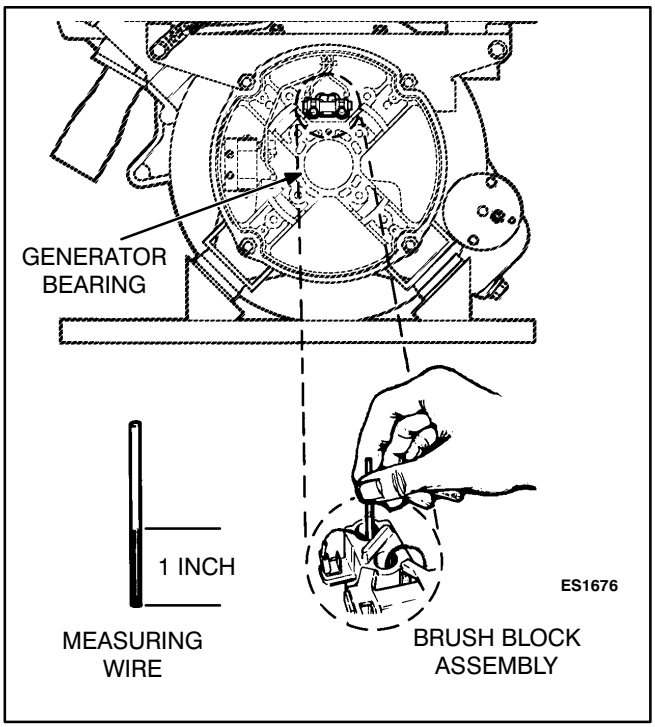

FIGURE 4-6. CHECKING GENERATOR BEARING AND BRUSH BLOCK

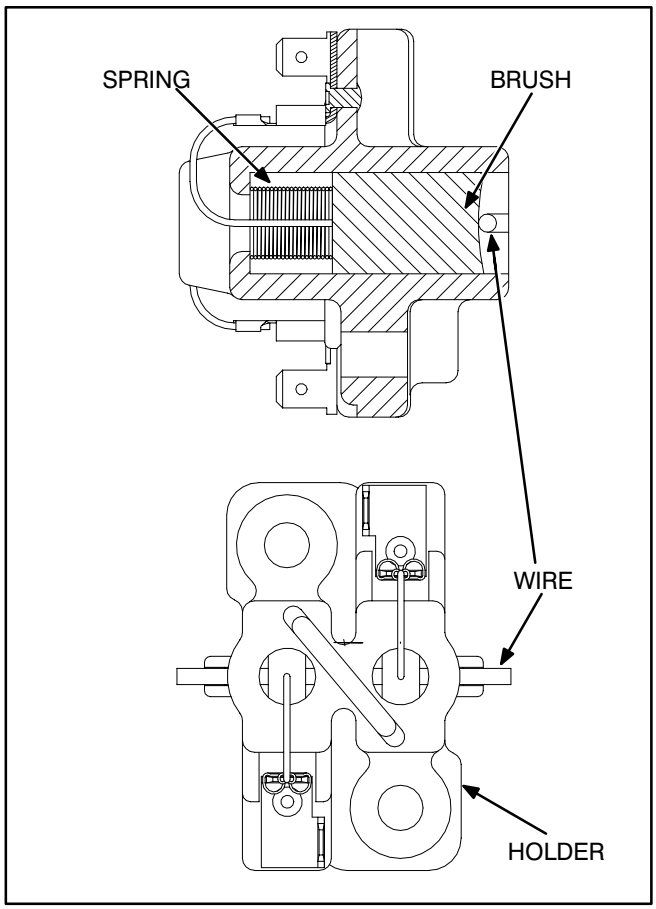

FIGURE 4-7. BRUSH REPLACEMENT

GENERATOR DISASSEMBLY/ASSEMBLY

The following sections describe the disassembly and reassembly procedures for the generator. Figure 4-8 illustrates generator disassembly.

⚠WARNING ***Generator components are heavy and can cause severe personal injury if dropped during service. Be careful, use appropriate lifting techniques, keep hands and feet clear during service, and use the recommended service procedures.***

Note that the control box and air cleaner assembly need not be removed from the set to disassemble the generator. These components may remain attached to the stator housing, and will be removed with it.

Disassembly

1. Remove the generator set from the vehicle and place it on a sturdy work bench. Refer to Section 1 of this manual for removal guidelines.

   ⚠WARNING ***Accidental starting of the set can cause severe personal injury or death. Disconnect the battery cables, negative (-) lead first, when repairs are made to the engine, controls or generator.***

2. Remove the cover from the AC control box and disconnect all stator leads (Q1-Q50/60, T1-T2-T3-T4, F1-F2, S1-S2). Disconnect leads at the load circuit breaker(s). If the lead markings do not clearly identify reconnection, mark the leads with tape.

3. Remove the bonding strap between the stator assembly and the drip pan.

4. Loosen and remove the two bolts that extend through the rear genset mounts (under the stator housing).

5. Lift the rear of the set and place a wooden block under the generator adapter to hold the stator and housing in place. Make certain that the engine-to-generator adapter (bolted to the engine) is propped up high enough for the generator adapter assembly (bolted to the generator) to clear the rear genset mounts when it is pulled off the set. A block approximately 3.5 inches wide (standard 2 x 4 lumber width) will hold the adapter high enough. Remove the two rubber vibration isolators whose bolts were removed in the last step.

6. Remove the end bell cover and disconnect F1 (outer) and F2 (inner) lead wires from the brush holder terminals.

7. Pull each brush away from the commutator rings and insert a piece of stiff wire into the small hole in the brush holder. See Figure 4-7.

   Note that the brushes may be secured (as described in the last two steps) at any convenient point during this procedure.

8. Remove four nuts and lock washers from the generator stud bolts. Remove the end bell cover and pry the end bell free of the rotor bearing. Be careful not to damage the brush holder.

9. Pull the stator/wrapper assembly with the control boxes off the rotor and away from the engine. Set it aside.

10. Remove the four bolts that hold the generator adapter and fan guard to the engine-to-generator adapter. Pull the adapter/guard assembly off the adapter and set it aside.

11. Loosen the six bolts that hold the rotor drive disk to the engine flywheel. Loosen these bolts in an alternating pattern, so that the drive disk does not bend from the weight of the rotor.

12. Pull the rotor, fan and drive disk assembly off the flywheel and set them aside.

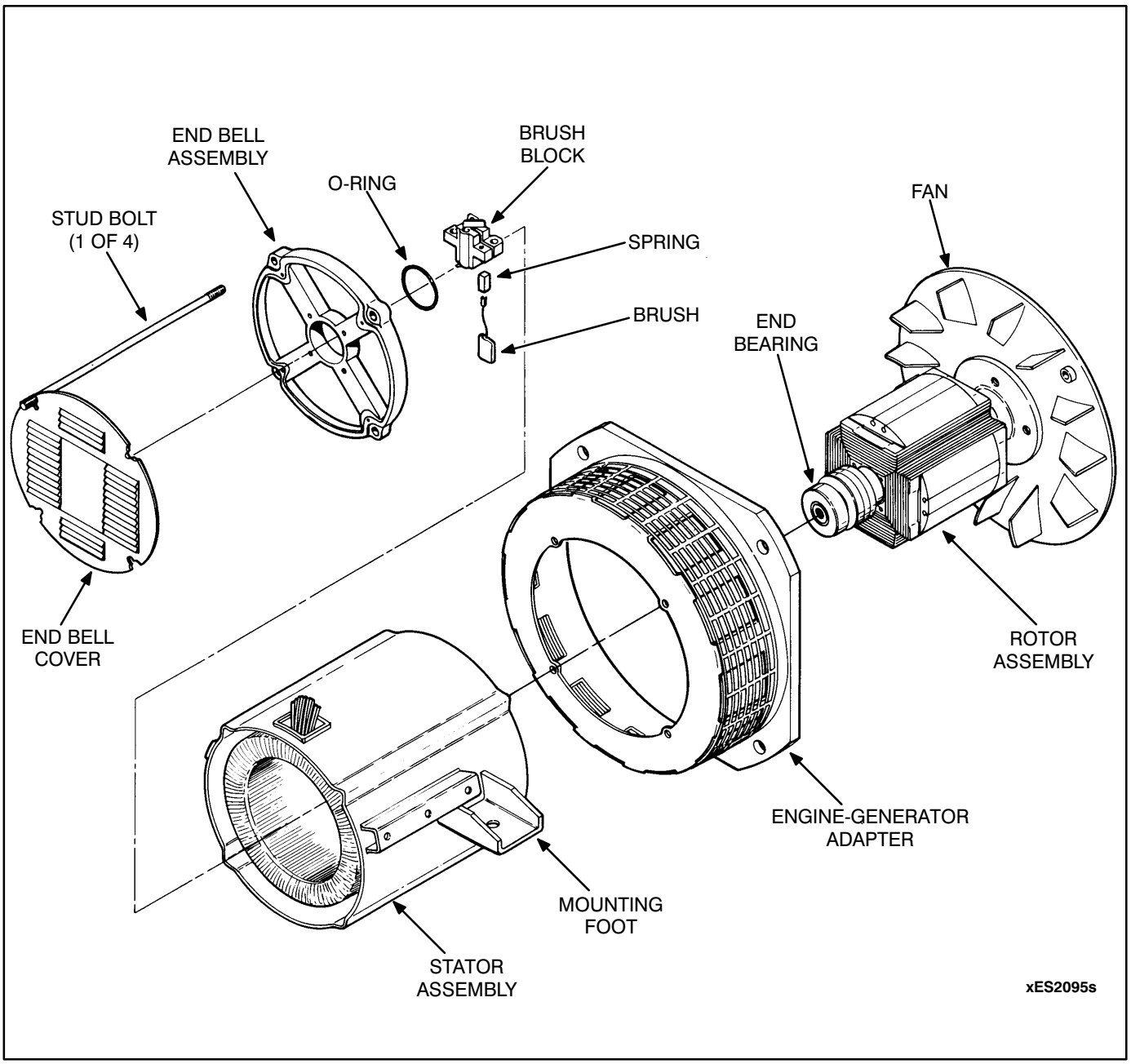

FIGURE 4-8. GENERATOR DISASSEMBLY/REASSEMBLY

Rotor Disassembly

1. Place the rotor assembly on a wood block in the horizontal position. **The drive disc and fan should not be resting on anything, or distortion may occur.**

2. Remove the six bolts that hold the drive disk and fan to the rotor hub. Remove the drive disk and fan.

3. Use a gear puller to remove the end bearing from the rotor shaft.

   ⚠ CAUTION ***The end bearing will be damaged if pulled on the outer race. If the bearing must be removed, replace it; this bearing should not be reused.***

Rotor Bearing Replacement

1. Clean the bearing and shaft mating surfaces.
2. Apply Loctite #680 adhesive to the shaft mating surface.
3. Apply Loctite #747 activator to the bearing mating surface.
4. Install the bearing and allow ten minutes curing time before handling the assembly.

Rotor Reassembly

After necessary service checks and repairs are made, the rotor and generator are reassembled using the reverse procedure of disassembly except for the rotor as noted below. Regrease the O-ring using moly grease only. Apply required torque value shown in Figure 4-9.

⚠ CAUTION ***The drive disk will be damaged if the bolts are tightened and it is not properly centered. Center the disk accurately before beginning to tighten the drive disk.***

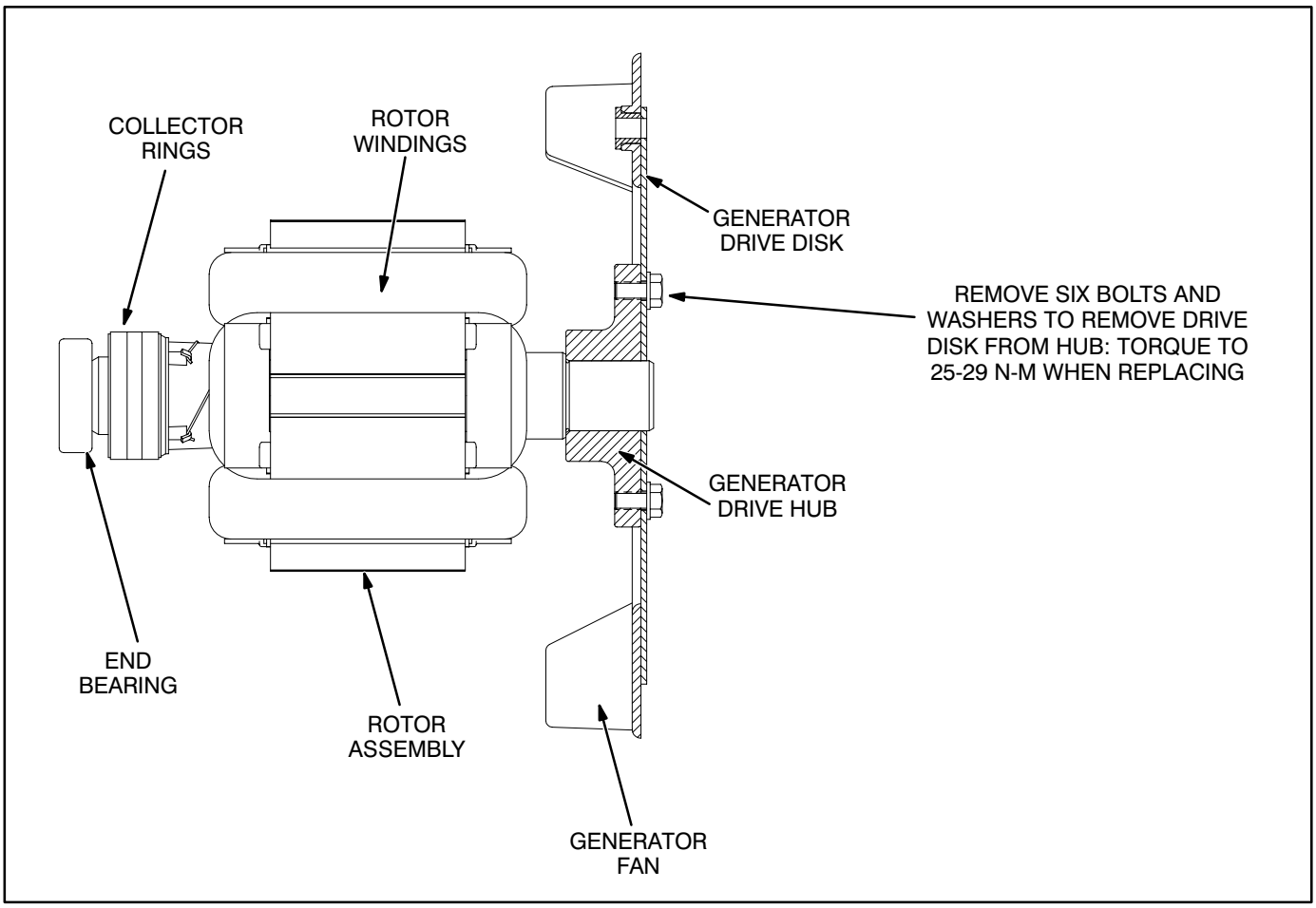

FIGURE 4-9. ROTOR ASSEMBLY COMPONENTS

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Section 5. Generator/Regulator Troubleshooting

GENERAL

This section contains troubleshooting information for the HDKAG generator and voltage regulator. Make the following visual checks before starting:

- Check any modification or repair that was done since the last satisfactory operation of the set. Verify that it was done properly.
- Check to see that generator leads are connected correctly. Also check the voltage regulator and control component connectors. A loose, contaminated, or misplaced wire connection can be detected by close inspection.
- Check for an open circuit breaker. If the breaker is open, check for an overloaded circuit and correct load problems before resetting the breaker.

TROUBLESHOOTING PROCEDURES

Determine the type of problem, then refer to the corresponding flow chart (A, B, C, or D) for troubleshooting procedures.

A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM

B. UNSTABLE OUTPUT VOLTAGE, ENGINE SPEED STABLE

C. OUTPUT VOLTAGE TOO HIGH OR TOO LOW

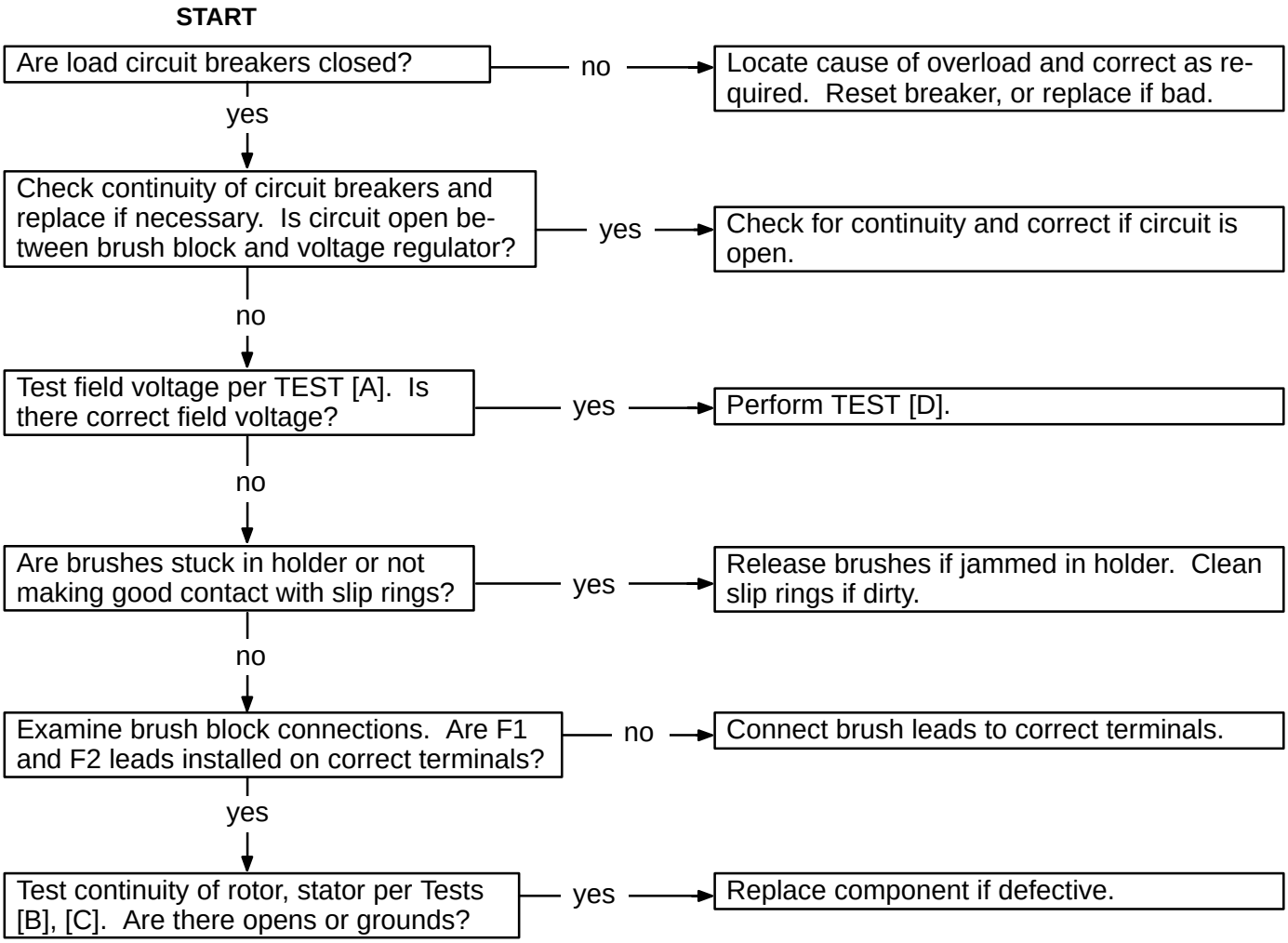
D. UNBALANCED OUTPUT VOLTAGE

To troubleshoot a problem, start at the upper left corner of the chart that corresponds to the problem, and answer all questions either YES or NO. Follow the chart until the problem is found. Perform the referenced test or adjustment procedures in the Generator/Regulator Tests section.

Components referenced in the flow charts, tests and adjustment procedures are found in the schematics and wiring diagrams in Section 9 of this manual.

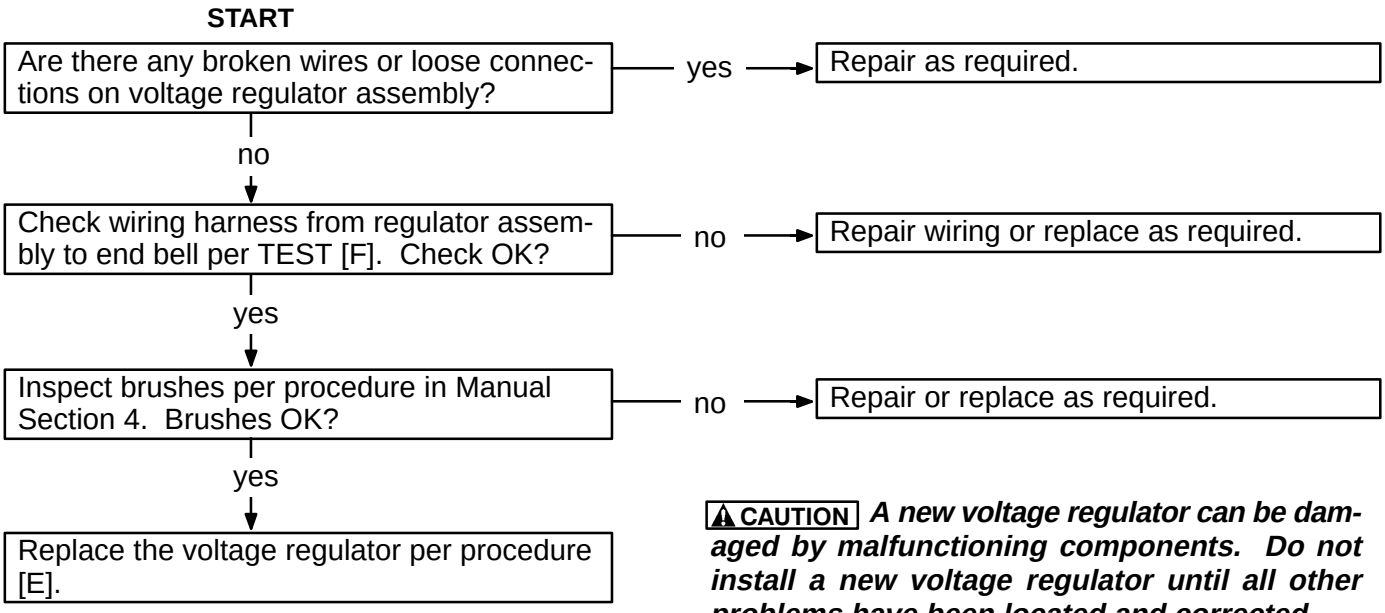
FLOW CHART A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM

⚠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.



FLOW CHART B. UNSTABLE VOLTAGE, ENGINE SPEED STABLE

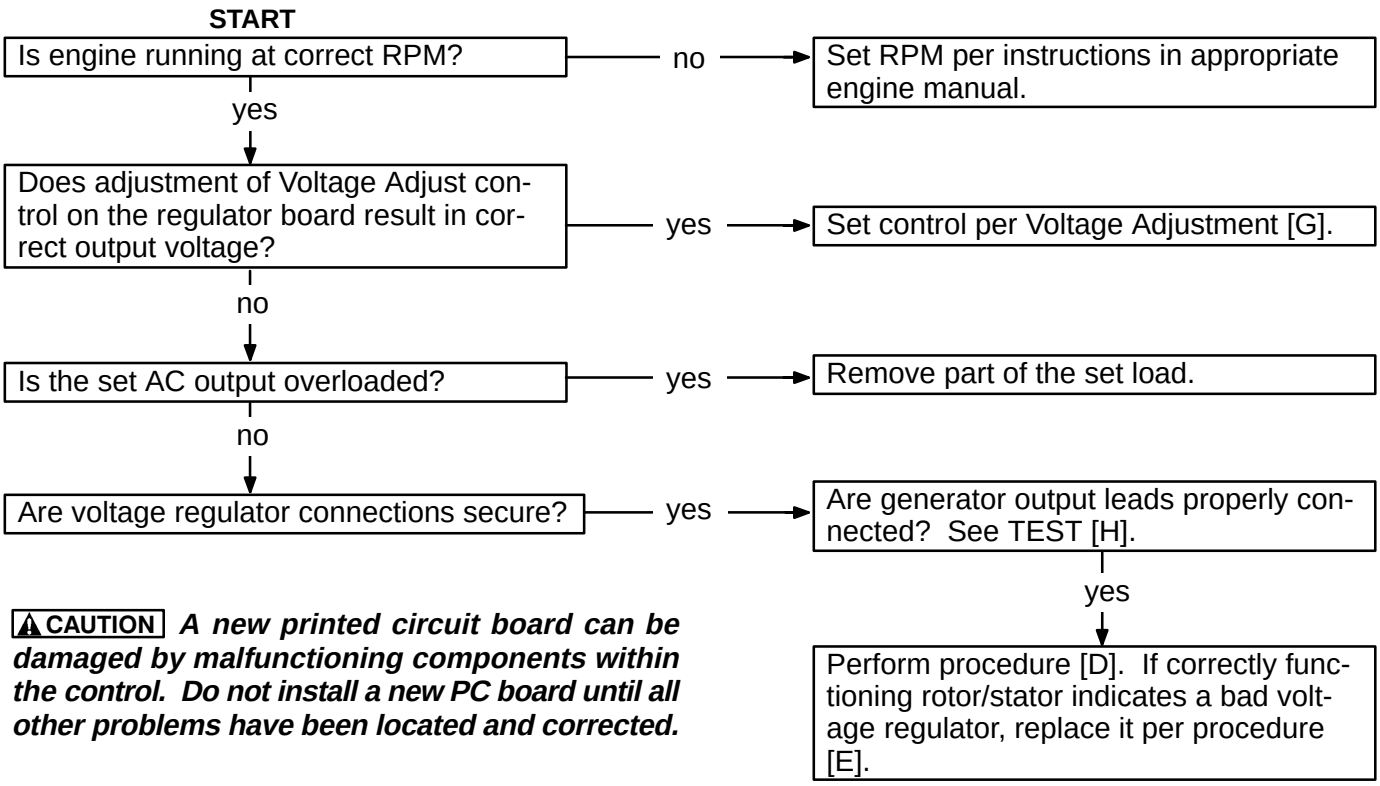
***WARNING** Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.*



***CAUTION** A new voltage regulator can be damaged by malfunctioning components. Do not install a new voltage regulator until all other problems have been located and corrected.*

FLOW CHART C. OUTPUT VOLTAGE TOO HIGH OR TOO LOW

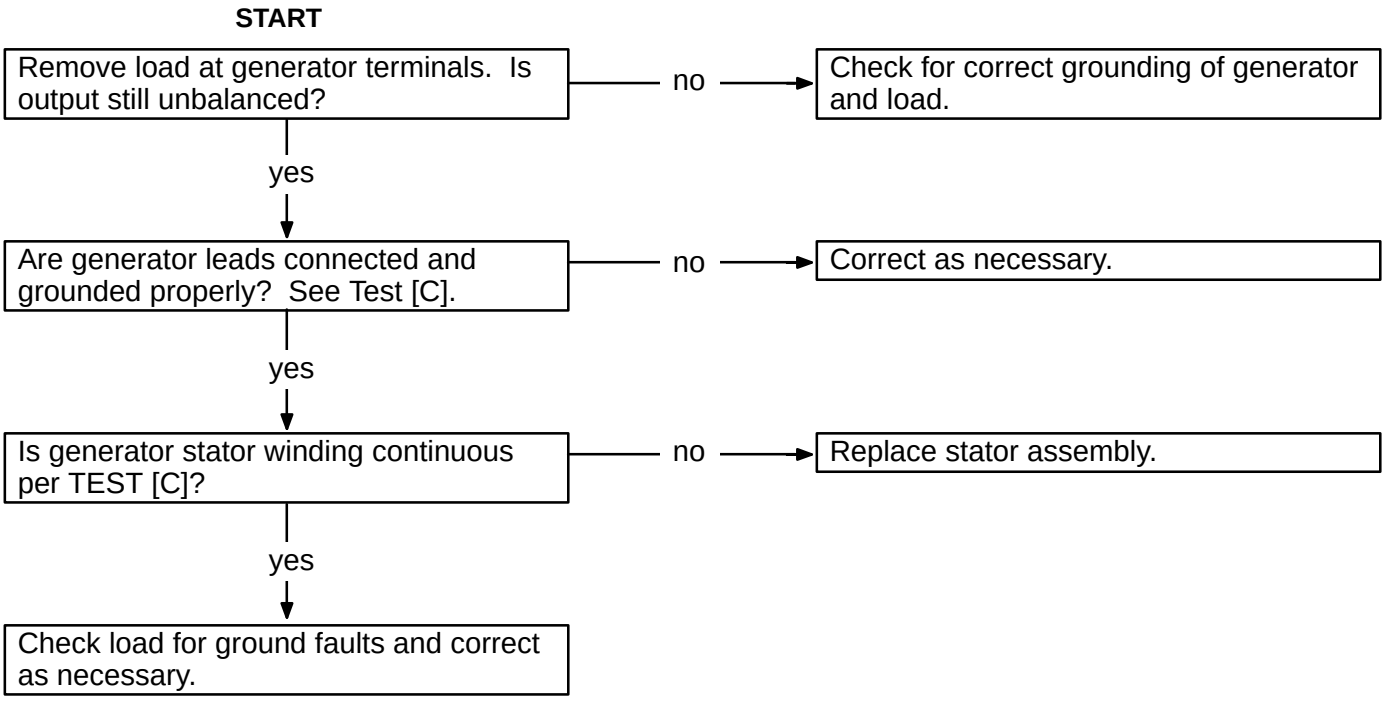
⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***



⚠CAUTION ***A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.***

FLOW CHART D. UNBALANCED GENERATOR OUTPUT VOLTAGE

⚠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.



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Section 6. Generator/Regulator Tests

GENERAL

The following tests and adjustments can be performed without disassembly of the generator. These procedures should be used for testing the generator components and the regulator in conjunction with the Troubleshooting Flow Charts in the Generator/Regulator Troubleshooting section.

⚠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 inside cover page.***

[A] TESTING FIELD VOLTAGE

Field voltage can be tested at the brush holder terminals with a DC voltmeter. Field voltage should fall between 18 and 60 volts. Test at no load and at full load. See Figure 6-1.

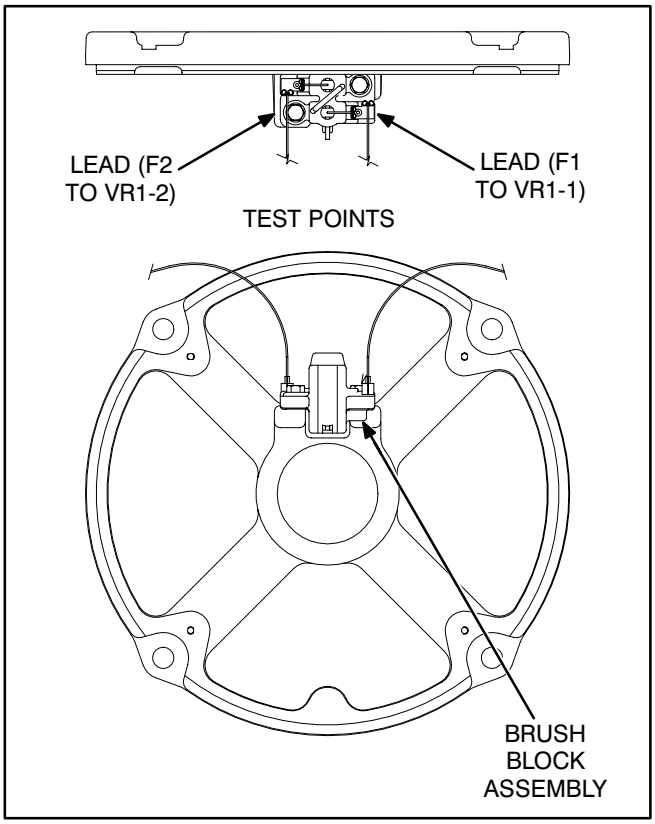

FIGURE 6-1. FIELD VOLTAGE TEST POINTS

[B] TESTING GENERATOR ROTOR

The generator circuits can be tested without having to disassemble the generator. It is recommended that an ohmmeter be used to check for open circuits and an insulation resistance meter for grounded circuits. An ohmmeter can be used to check for grounded circuits, but it may not be able to detect marginal insulation breakdown.

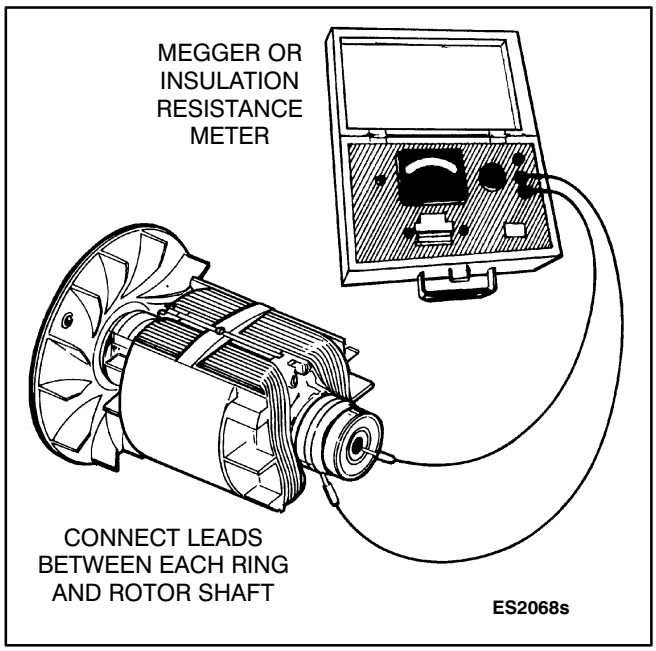

FIGURE 6-2. TESTING ROTOR FOR GROUNDS

Testing for Grounds

Check for grounds between each slip ring and the rotor shaft, Figure 6-2. Use a Megger or insulation resistance meter which applies 500 VDC or more at the test leads. Perform test as follows:

1. Isolate the rotor windings by disconnecting the two leads to the brush holder.
2. Connect test leads between each ring and the rotor shaft in turn. Meter should register 100,000 ohms or greater.
3. If less than 100,000 ohms, rotor is questionable. Thoroughly dry the rotor and retest.
4. Replace a grounded rotor with a new identical part.

Testing for Open or Shorted Windings

Perform this test with an accurate meter such as a digital ohmmeter.

1. Isolate the rotor windings by disconnecting the two leads to the brush holder.

2. Using ohmmeter, check resistance between F1 and F2 by connecting leads between the F1 and F2 slip rings, Figure 6-3.

   Rotor resistances (measured at 25° C) are:

   Standard single-phase: **17.2 ohms**

   Standard three-phase: **19.4 ohms**

   Extended-stack three-phase: **22.5 ohms**

   Extended-stack three-phase “husky”: **25.5 ohms**

   If there is a large difference, replace the defective rotor with a new, identical part.

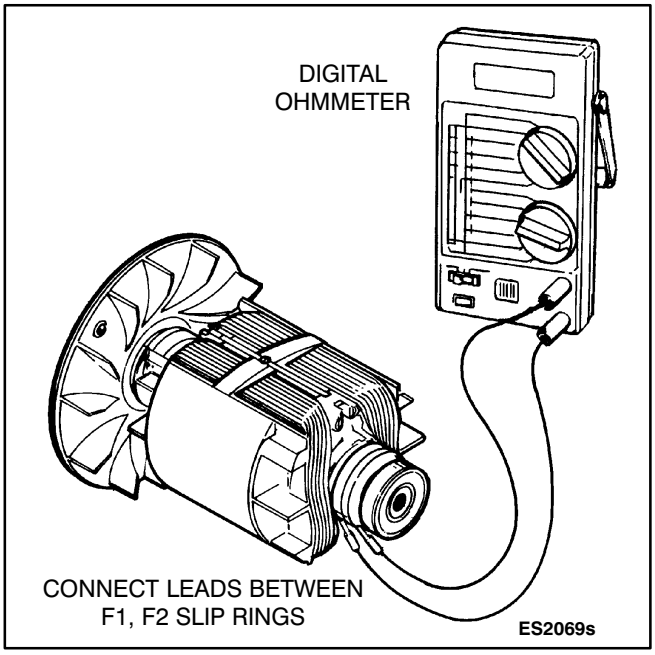

FIGURE 6-3. TESTING ROTOR FOR AN OPEN CIRCUIT

[C] TESTING GENERATOR STATOR

Isolate the stator windings by disconnecting all six stator leads. Test for open circuits between T1-T2, T3-T4 and Q1-Q2, and for grounded circuits between T1, T3 and B1 and the stator laminations or other unpainted grounding point.

Using proper test equipment, check the stator for grounds, opens, and shorts in the windings.

Testing for Grounds

Some generators have ground connections to the frame. Check wiring diagram. All stator leads must be isolated for testing.

Use a megger or insulation resistance meter which applies not more than 500 VDC to the test leads (Figure 6-4). Test each stator winding for short to laminations. A reading less than 100,000 ohms indicates a questionable stator. Thoroughly dry the stator and retest.

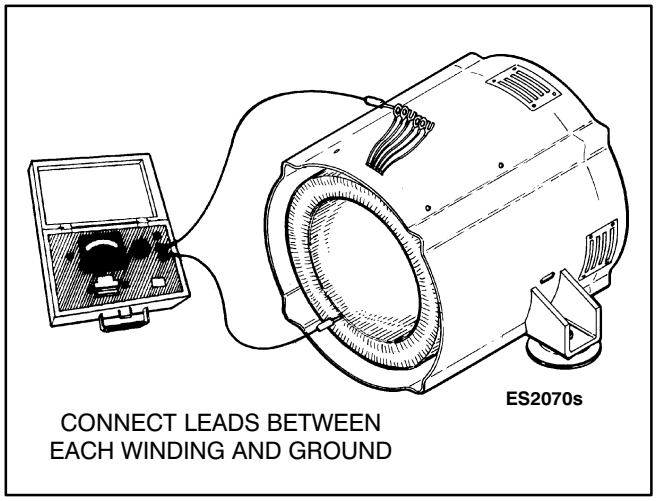

FIGURE 6-4. TESTING STATOR WINDING FOR GROUNDS

Testing for Open or Shorted Windings

Test for continuity between coil leads as shown in Figure 6-5; all pairs should have equal resistance. Use an accurate instrument for this test such as a Wheatstone Bridge.

Stator resistances (measured at 25° C) are:

Standard single-phase:
T1-T2, T3-T4: **0.221 ohms**
Q1-Q60: **1.997 ohms**
Q1-Q50: **2.405 ohms**

Standard three-phase:
T1-T4, T2-T5, T3-T6,
T7-T10, T8-T11, T9-T12: **0.505 ohms**
Q2-T11: **0.252 ohms**

Extended-stack three-phase:
T1-T4, T2-T5, T3-T6,
T7-T10, T8-T11, T9-T12: **0.153 ohms**
Q2-T11: **0.305 ohms**

Extended-stack three-phase heavy-duty:
T1-T4, T2-T5, T3-T6,
T7-T10, T8-T11, T9-T12: **0.107 ohms**
Q2-T11: **0.214 ohms**

If a winding is shorted, open or grounded, replace the stator assembly. Before replacing the assembly, check the leads for broken wires or insulation.

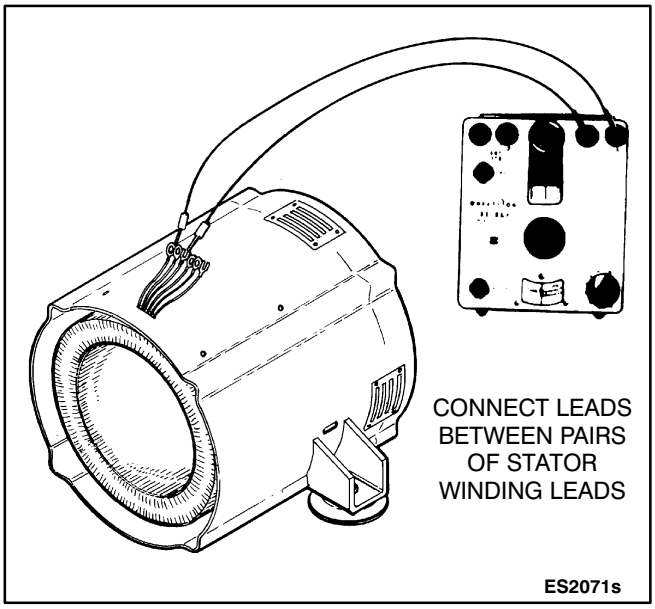

FIGURE 6-5. TESTING STATOR WINDING RESISTANCE

[D] DYNAMIC ROTOR/STATOR TEST

The following procedure serves as a functional voltage regulator check, by determining if the problem is in the voltage regulator or in the generator. The voltage regulator is temporarily replaced with a 12-volt battery (the genset starting battery is usable here); 12 volts applied to the F1/F2 exciter stator should produce approximately 125 volts generator output voltage at L1 and L2, with no load.

⚠WARNING ***Electrical shock can cause severe personal injury or death. Do not touch electrical wiring or components during testing. Disconnect electrical power by removing starting battery negative (-) cable before handling electrical wiring or components.***

Use a sharp voltage probe and touch it carefully to the connector pins or output terminals when making these tests.

1. Stop the generator set.
2. Unplug the voltage regulator from the wiring harness.

   ⚠CAUTION ***Failure to unplug the voltage regulator at this point in the procedure could lead to equipment damage.***

3. Using jumpers and a spare plug or other connector, connect a 12-volt battery to the F1/F2 terminals as illustrated in Figure 6-6.
4. Start the generator set. Use a voltmeter to measure the outputs at J4-4 - J4-6, L1 - L2, L1 - L0, L2 - L0, Q60 - Q1 (50 Hz sets: Q50 - Q1), and S1 - S2. The output voltages should read as follows (all voltages apply to both 50 Hz and 60 Hz sets):

   J4-4 - J4-6: 62 VAC ± 20 VAC
   L1 - L2: 125 VAC ± 20 VAC
   L1 - L0: 62 VAC ± 20 VAC
   L2 - L0: 62 VAC ± 20 VAC
   Q60 - Q1: 75 VAC ± 20 VAC
   (50 Hz sets) Q50 - Q1: 75 VAC ± 20 VAC
   S1 - S2: 62 VAC ± 20 VAC

   If these voltages are measured, then the generator is operating correctly and the problem is elsewhere.

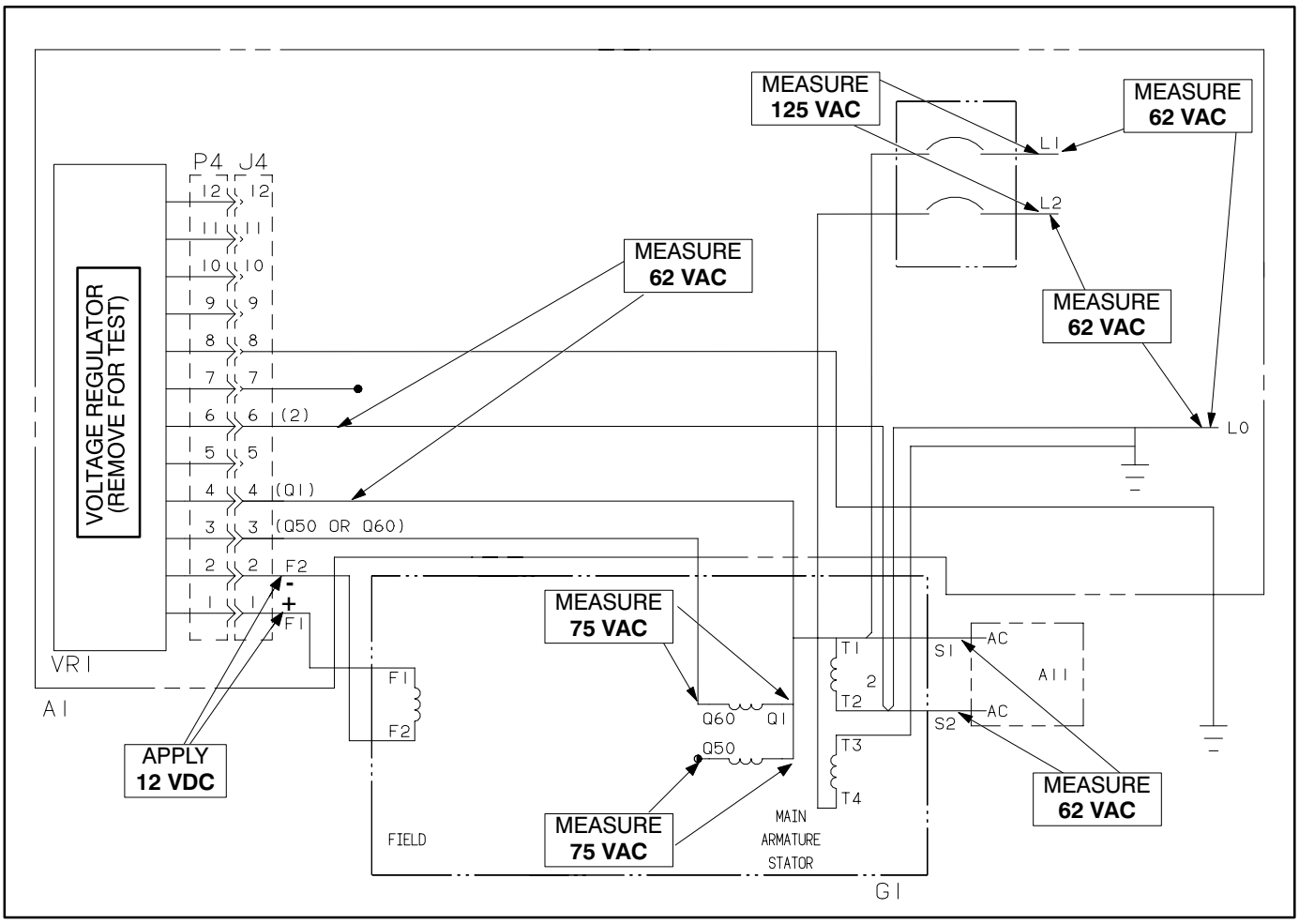

FIGURE 6-6. DYNAMIC ROTOR/STATOR TEST

[E] VOLTAGE REGULATOR REPLACEMENT

Use the following procedure for replacing the AC voltage regulator assembly.

1. Stop the generator set and disconnect the starting battery leads, negative (-) lead first.
2. Unscrew the voltage regulator from the control box.
3. Disconnect the regulator from the wiring harness.
4. Remove the mounting screws from the old voltage regulator, then install the new regulator.
5. Reconnect the plug connection to the wiring harness.
6. Set voltage as outlined in [G] Voltage Adjustment.

[F]

WIRING HARNESS CHECK

Carefully check the wiring harness as follows:

1. Inspect all wires for breaks, loose connections, and reversed connections. Refer to applicable wiring diagram.
2. Remove wires from terminals at each end and with an ohmmeter, check each wire end to end for continuity or opens.
3. Using an ohmmeter, check each wire to other wires and to ground for possible shorts or insulation breaks under areas covered by wrapping material.
4. Reconnect or replace wires/harness according to applicable wiring diagram.

[G]

VOLTAGE ADJUSTMENT

This section describes adjustment of the genset output voltage. When checking output voltage, be sure the generator set has stabilized and is running at the correct speed (frequency). The regulator is adjusted with the set running.

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

⚠WARNING ***Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any part of the body, clothing, tool or jewelry. Do not use non-insulated tools inside the control. Stand on an insulating mat or dry wood platform when the control doors are open.***

Output voltage adjustments are found on the voltage regulator board under the DC control box. A removable cover protects the board. See Figure 6-7.

1. Attach a voltmeter securely to the L1 and L2 leads.
2. Start the generator set and place a typical load on its output.
3. Use a flat-blade screwdriver to set the voltage adjust potentiometer for correct voltage.

For most 60 Hz applications, the ideal setting is 117 VAC at 60-61 hz, measured at the power input of the application. Retighten the locking nut when complete.

Note that the voltage adjustment pot on the voltage regulator board is a 10-turn potentiometer: it may take several turns to change the voltage noticeably.

[H]

RECONNECTION

Generator reconnection is dependent upon the nameplate code. See Section 8 for reconnection diagrams.

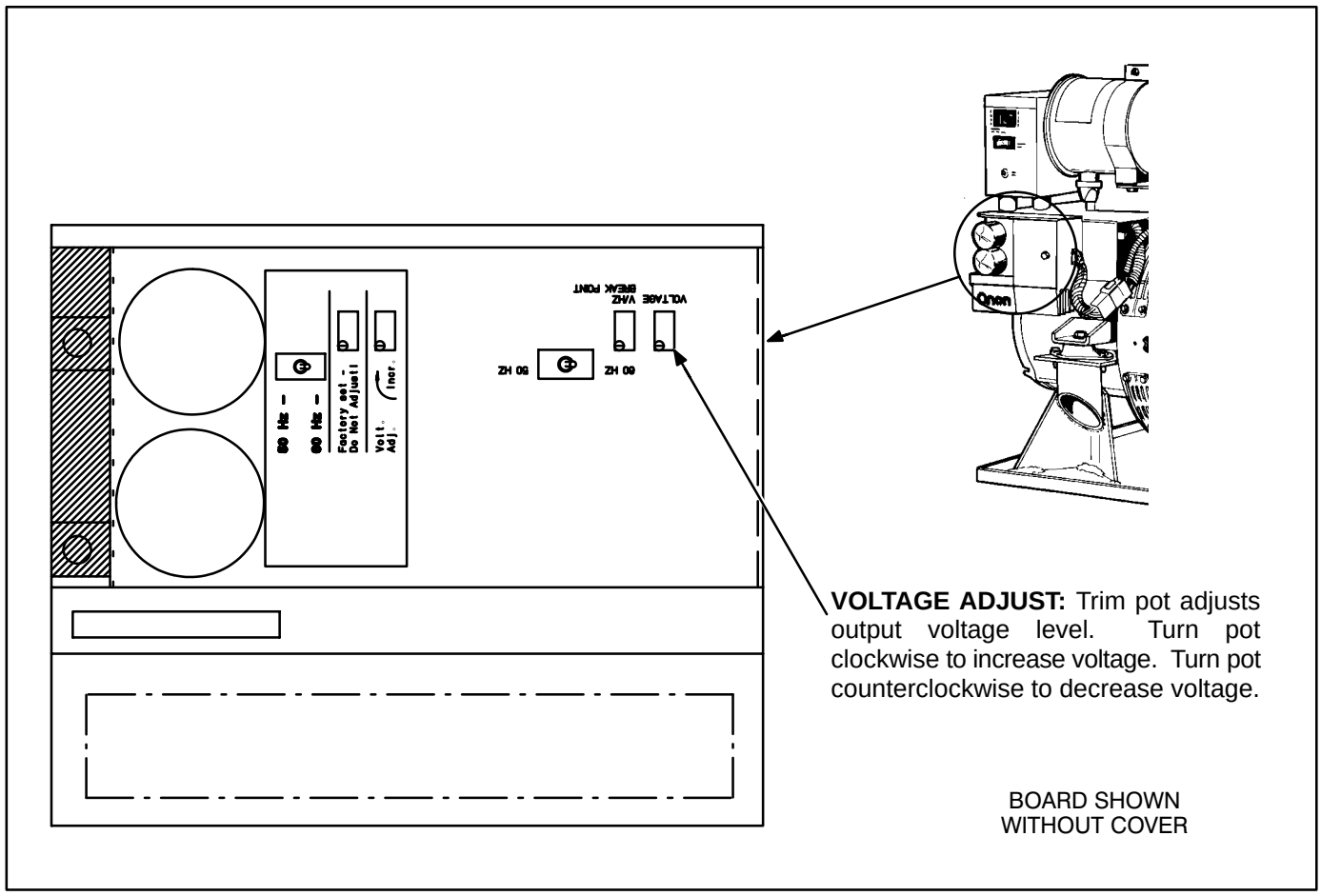

FIGURE 6-7. LOCATION, OUTPUT VOLTAGE ADJUSTMENT

Section 7. Routine Maintenance

INTRODUCTION

This section describes routine maintenance procedures to be performed on the generator set. Most of this information is duplicated in the Operator's Manual, publication #981-0137.

Many of the items in this section refer to the genset engine: for more information, refer to the Engine Workshop Manual.

MAINTENANCE SCHEDULE

Perform each maintenance procedure at the time period indicated or after the number of operating hours indicated, whichever comes first. Refer to the *Maintenance Procedures* section for instructions. If the generator set will be subjected to extremely hot or dusty conditions, a more frequent maintenance schedule may be necessary.

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

TABLE 7-1. PERIODIC MAINTENANCE SCHEDULE

	SERVICE TIME				
SERVICE THESE ITEMS	**Daily or after 8 hours**	**Weekly or after 50 hours**	**Monthly or after 100 hours**	**6 Months or after 250 hours**	**Yearly or after 500 hours**
Inspect set	x[1]				
Check oil level	x				
Check coolant level	x				
Check fuel level	x				
Check air cleaner dust cap (clean if required)		x[3]	x		
Check battery charging system			x		
Check drive belt tension			x[4]		
Clean out spark arrester		x			
Check battery specific gravity			x		
Change crankcase oil and filter			x[2]		
Drain water/sediment from fuel filter			x		
Check antifreeze				x	
Clean generator assembly				x	
Drain sediment from fuel tank				x[5]	
Clean crankcase breather				x[3]	
Check fuel shut-off linkage				x	
Change fuel filter element				x	
Check genset brushes				x	
Change air cleaner element					x[3]
Clean cooling system					x

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

GENERATOR SET INSPECTION

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

Engine Gauges (Remote Installation)

Check these gauges while the set is running.

Oil Pressure Gauge: Oil pressure should be 40 to 60 psi (276 to 414 kPa) when the engine is at operating temperature.

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

DC Voltmeter: Battery voltage during operation should be 14 to 15 volts.

Exhaust System

With the set running, inspect the entire exhaust system including the exhaust manifold, exhaust elbow, muffler and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints. If any leaks are detected, **shut down the genset and do not operate until corrected.** Replace corroded exhaust components before leaks occur.

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

Fuel System

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

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

DC Electrical System

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

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

Mechanical

Check for any signs of mechanical damage. Start the set and listen for any unusual noises that may indicate mechanical problems.

Check the mounting fasteners to make sure the set is secure in its compartment. If an under-floor housing is used, make sure that the set is secured to the housing. Check the condition of the housing components and make sure they are secure to the vehicle.

Make sure that the generator set air inlet and outlet areas are not blocked with debris.

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

OIL AND FILTER CHANGE

Change the oil and filter at the intervals listed in Table 7-2. Use oil that meets the API classification and SAE viscosity grade indicated in the previous section.

Engine Oil Change

Run the engine until thoroughly warm. Stop the engine, open the drain valve (Figure 7-1) and drain the oil into a container. When completely drained, close the valve and refill the crankcase with new oil.

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

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

Oil Filter Change

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

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

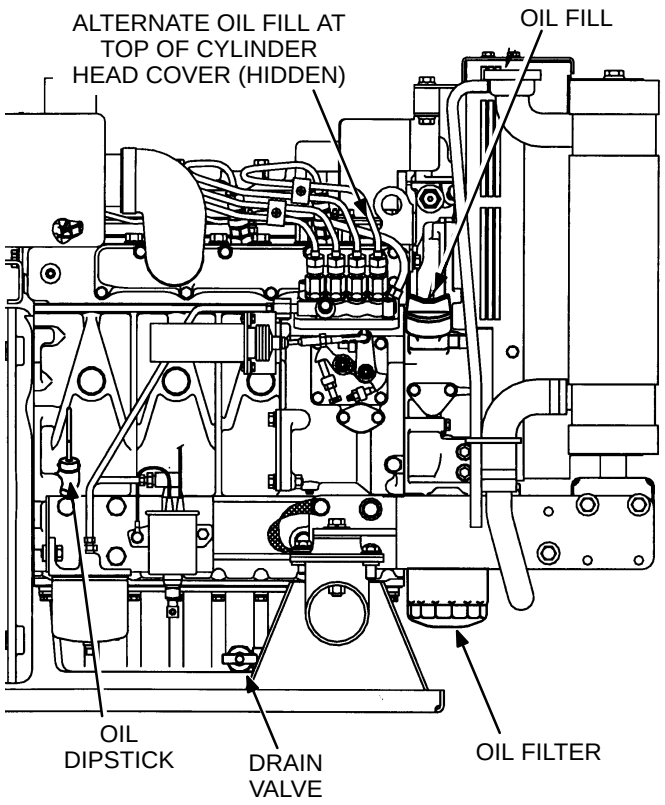

FIGURE 7-1. ENGINE OIL

COOLING SYSTEM

The cooling system must be filled with coolant before the genset can be operated. Cooling system capacity is listed in the *Specifications* section.

Coolant Requirements

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

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

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

Filling the Cooling System

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

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

Add coolant to the recovery tank (or separate expansion tank if equipped) to the full-cold level.

Start the engine, then remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop. Add coolant to replace it. Replace the pressure cap when the coolant level is stable.

Coolant Level

Check the coolant level at the intervals specified in the Periodic Maintenance Schedule. Check by observing the coolant level in the recovery tank (or separate expansion tank if equipped) when the system is cold. See Figure 7-2 for a typical cooling system. Engine coolant is at the proper level when the recovery tank level is between FULL and LOW marks.

⚠WARNING ***Coolant in a warm engine is under pressure and can flash to steam causing severe burns if the radiator cap or drain cock are opened. Let the engine cool down before opening the radiator cap or drain cock.***

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

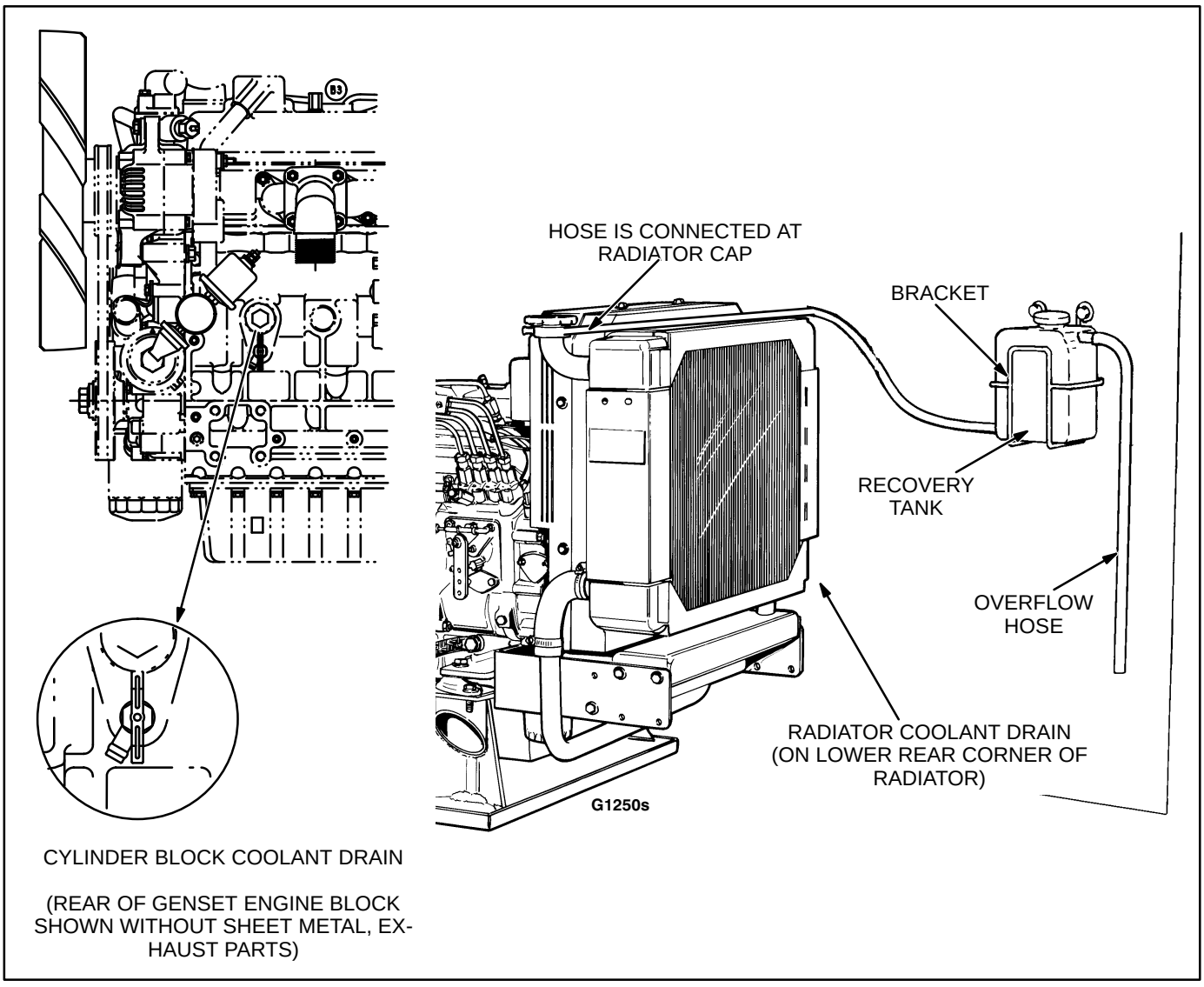

FIGURE 7-2. COOLING SYSTEM COMPONENTS

Flushing and Cleaning

Once a year, drain, flush and refill the cooling system with new coolant. To drain the system, open the radiator coolant drain and the cylinder block drain on the the rear (non-service access) side of engine. See Figure 7-2.

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

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

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

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

Thermostat

If the engine overheats or does not reach and maintain a minimum operating temperature, have the thermostat removed and tested. Replace the thermostat with the gasket if necessary. See the Engine Workshop Manual for instructions on thermostat removal and testing.

Pressure Cap

Closed cooling systems use a pressure cap to increase the boiling point of the coolant and allow higher operating temperatures. Replace the pressure cap every two years, or sooner if it malfunctions.

FAN BELT

A loose fan belt can cause the engine to overheat. The belt tension must be correct for the set to run well.

First, remove the generator set's starting battery cables (negative [-] cable first).

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

To reach the fan belt, remove the belt guard from the front of the set. **Do not operate the genset without the belt guard in place.**

To adjust the belt, loosen the bolt that passes through the long slot in the alternator mounting bracket and slide the alternator until the tension is right. See Figure 7-3.

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

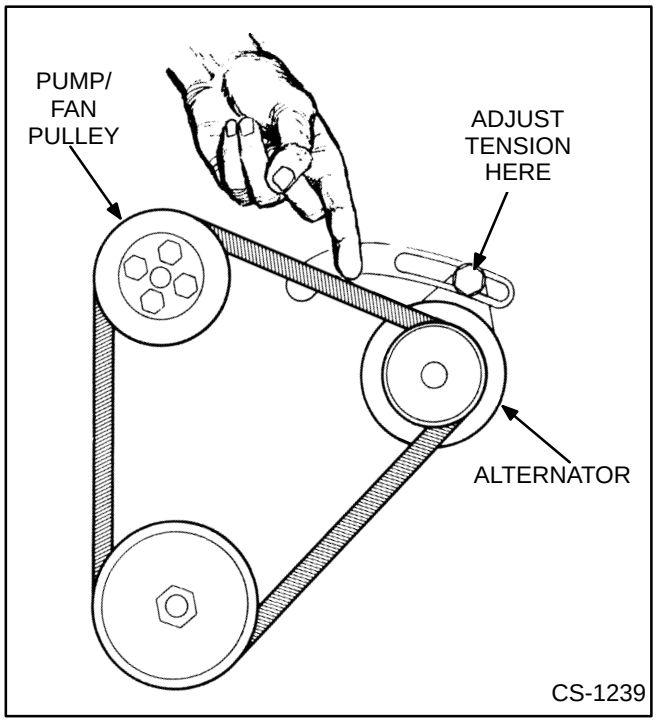

FIGURE 7-3. FAN BELT ADJUSTMENT

FUEL SYSTEM

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

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

Fuel Recommendation

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

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

Fuel Handling Precautions

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

⚠ CAUTION ***Due to the precise tolerances of diesel injection systems, dirt or water in the system will cause severe damage to both the injection pump and the injection nozzles. It is extremely important that the fuel be kept clean and water free.***

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

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

Fuel Filter

The wrong fuel or dirty fuel will shorten the life of the fuel filter. See the *Periodic Maintenance Schedule* for the filter change interval.

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

Refer to the Periodic Maintenance Schedule for the recommended filter change interval. However, if the engine shows signs of fuel starvation (reduced power or surging), the fuel filter must be changed. This involves purging the fuel system of trapped air. See *Priming the Fuel System* later in this section.

High Pressure Fuel System: The injection pump, fuel injection lines and fuel injectors are the high pressure fuel system. See Figure 7-4. The high-pressure system is self-priming; trapped air is forced out through the injection nozzles.

Low Pressure Fuel System

The electric fuel pump, fuel filter and injection pump inlet comprise the low pressure fuel system. See Figure 7-4. These components are normally primed (purged of trapped air) at set installation. Be sure to check the fuel level in the tank and that the shutoff valve is open.

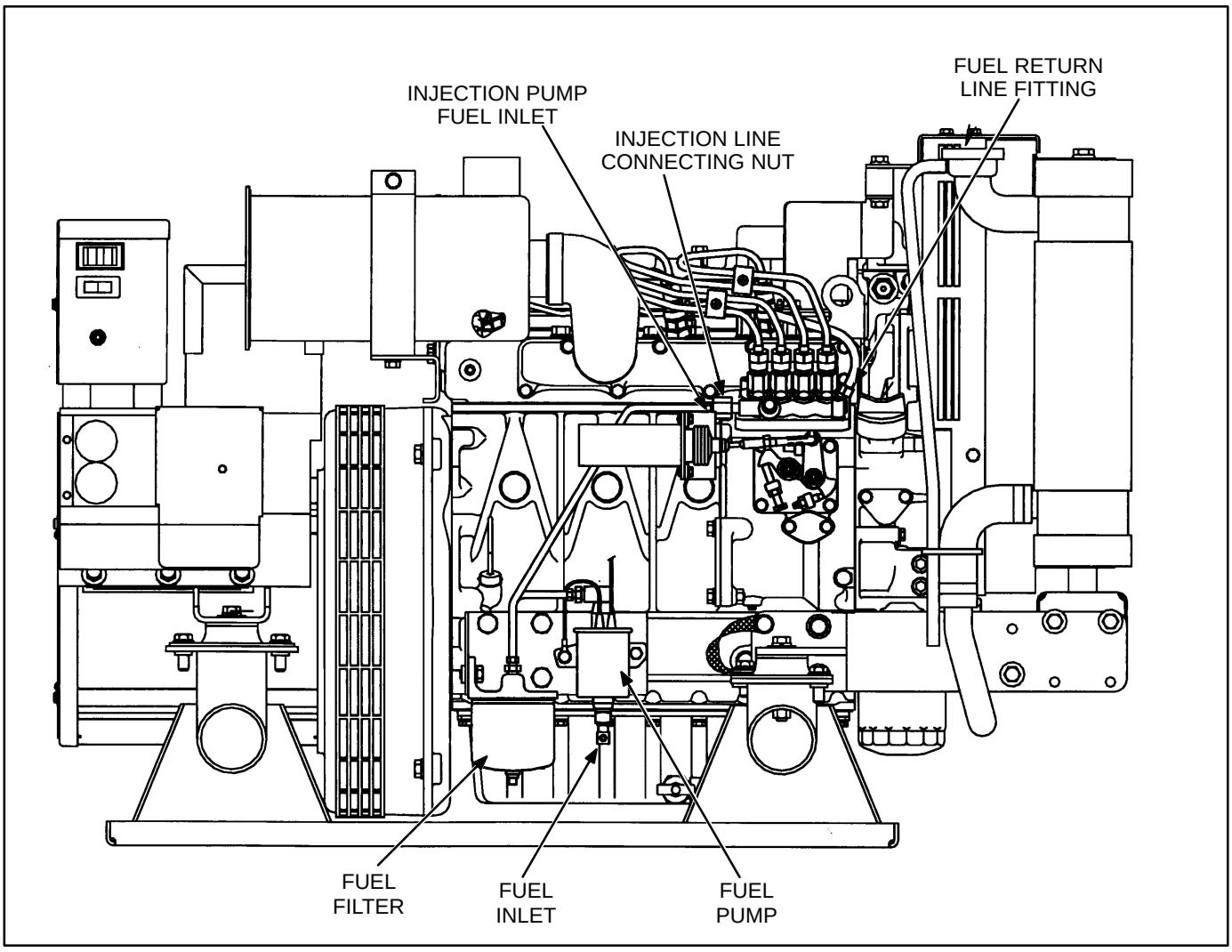

FIGURE 7-4. FUEL SYSTEM

AIR CLEANER

The air cleaner element (Figure 7-5) is a dry type and should never have oil applied to it. Avoid touching the element except when cleaning it. Instructions for cleaning the element are on a label attached to the element. Change the element yearly, or more often in extremely dusty conditions.

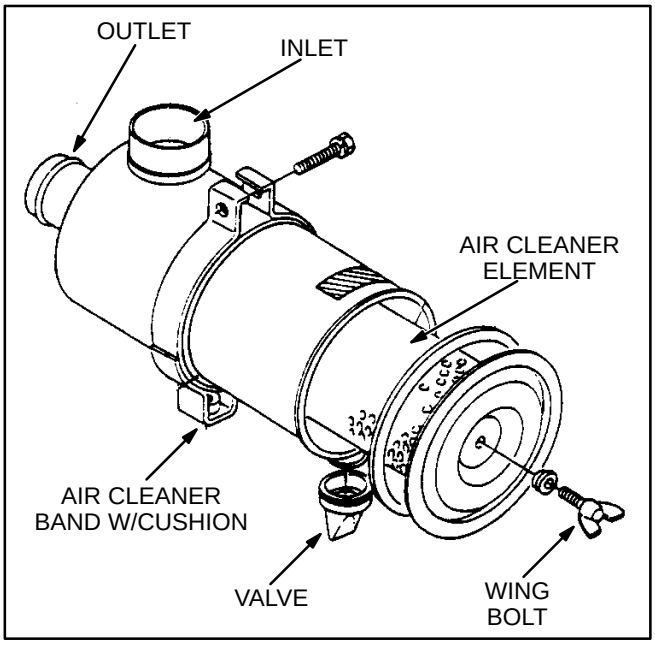

FIGURE 7-5. AIR CLEANER ASSEMBLY

BATTERY CARE

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

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

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

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

   Remove corrosion from the battery terminal connections. Wash the terminals with an ammonia solution or a solution consisting of 1/4 pound (about 100 grams) of baking soda in 1 quart (about 1 liter) of water. Be sure the vent plugs are tight to prevent cleaning solution from entering the cells. After cleaning, flush the outside of the battery and the surrounding areas with clean water.
3. Identify the cable as positive (+) or negative (-) before making the battery connections. Always connect the negative (-) cable last, to reduce the risk of arcing.
4. Maintain the electrolyte level by adding distilled water. Fill each cell to the split-level marker in the battery. The water component of the electrolyte evaporates, but the sulfuric acid component remains. For this reason, add water, not electrolyte to the battery.
5. Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell (Figure 7-6). Charge the battery if the specific gravity measures less than 1.215. Do not overcharge the battery. Stop charging the battery when the electrolyte specific gravity reaches 1.260, at approximately 80° F (27° C).

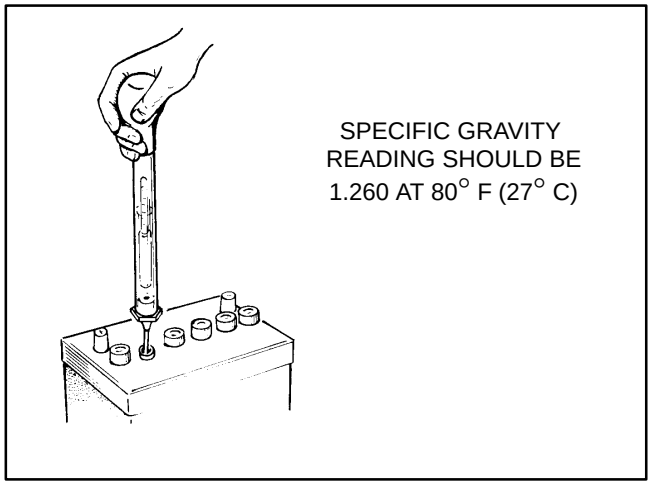

FIGURE 7-6. BATTERY CHECK

AC GENERATOR

Generator Brushes

The generator should be inspected for brush wear and cleaning as required per the Periodic Maintenance Schedule. Perform this procedure according to the steps in Section 4 of this manual.

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

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years, because the bearing grease gradually deteriorates due to oxidation. See Section 4 of this manual for information on the generator bearing.

CRANKCASE BREATHER

Clean the crankcase breather element at the scheduled intervals, using the following procedure (see Figure 7-7).

1. Remove the cap nuts and gaskets from the top of the cylinder head cover. Carefully remove the cover. Avoid damaging the gasket.

2. From inside the cover, remove two machine screws securing the breather element, plates and shield.

3. Clean the element in a suitable solvent. Dry the element, then saturate with engine oil before replacing.

   ⚠WARNING ***Many cleaning solvents present a hazard of severe personal injury or death. Follow the manufacturer's instructions and proceed with care.***

4. If necessary, clean other breather components in solvent before reassembling.

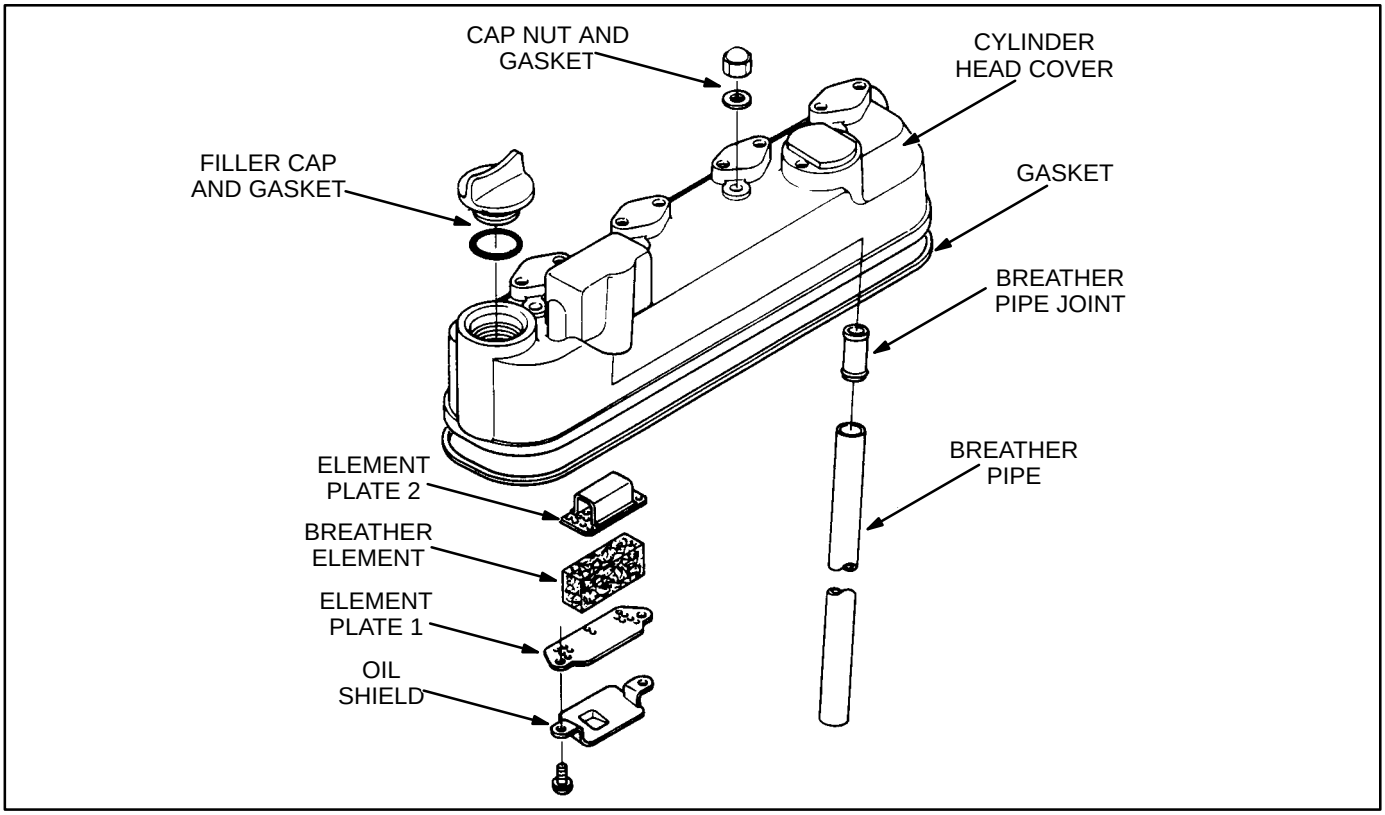

FIGURE 7-7. CRANKCASE BREATHER

MUFFLER/SPARK ARRESTER

The exhaust spark arrester mounted inside the muffler is necessary for **safe operation**. It must be periodically cleaned out for maximum efficiency, and to meet Forest Service requirements (RV use). See the maintenance schedule for cleaning intervals.

To clean the spark arrester, park the vehicle on a non-flammable, washable surface, and remove the 1/8 inch pipe plug from the bottom of the muffler. Run the generator set with a full load for five minutes. Stop the generator set and allow the muffler to cool. Replace the pipe plug in the muffler. See Figure 7-8.

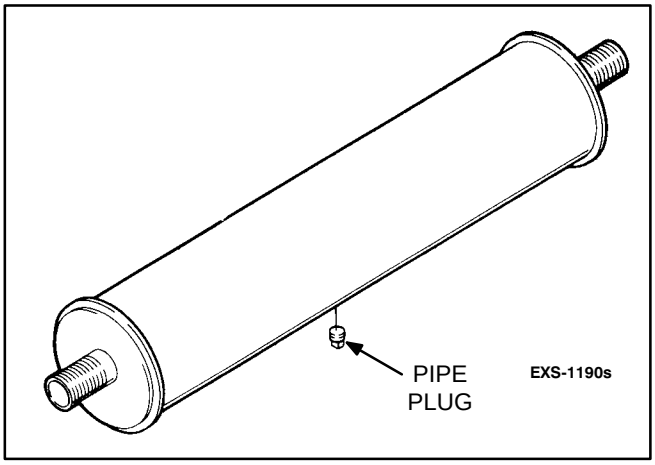

FIGURE 7-8. EXHAUST MUFFLER

CLEANING THE GENERATOR SET

Clean the generator set at least every six months. Dust usually can be removed with a damp cloth. Some road contaminants may require steam cleaning. Do not steam clean the generator set while the engine is running. When cleaning, protect the area so spray is not directed into the generator, air cleaner, control box, fuel solenoid, or electrical connections. Do not clean with solvents; they can damage electrical connectors.

INITIAL STARTING AND CHECKS

⚠WARNING ***Exhaust gas presents the hazard of severe personal injury or death. Do not operate the generator set inside any room or building.***

If none of the fuel line junctions have been loosened between the electric fuel pump and the injection pump, the fuel system should not need priming. However, if priming is necessary, it should be done according to the following procedure.

Priming the Fuel System

⚠CAUTION ***Priming the fuel system should only be done by a skilled and experienced diesel technician. Incorrect priming could lead to equipment damage or faulty operation.***

1. Turn off both DC breakers on the set control box.
2. Disconnect the B+ lead to the fuel pump.
3. Use a clip lead to jumper B+ to the fuel pump. Run the fuel pump for five to ten seconds until the air is purged from the low-pressure fuel system.

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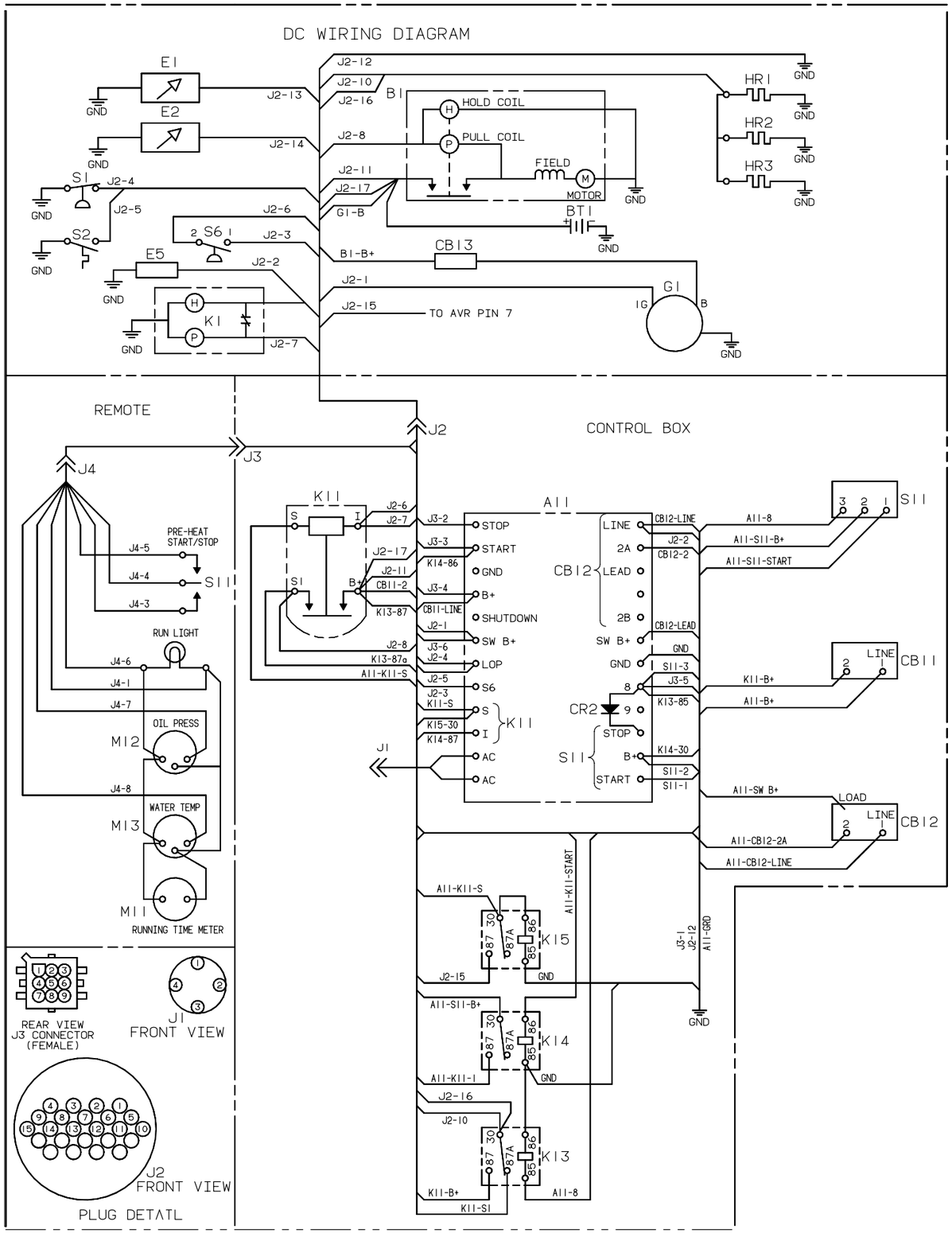
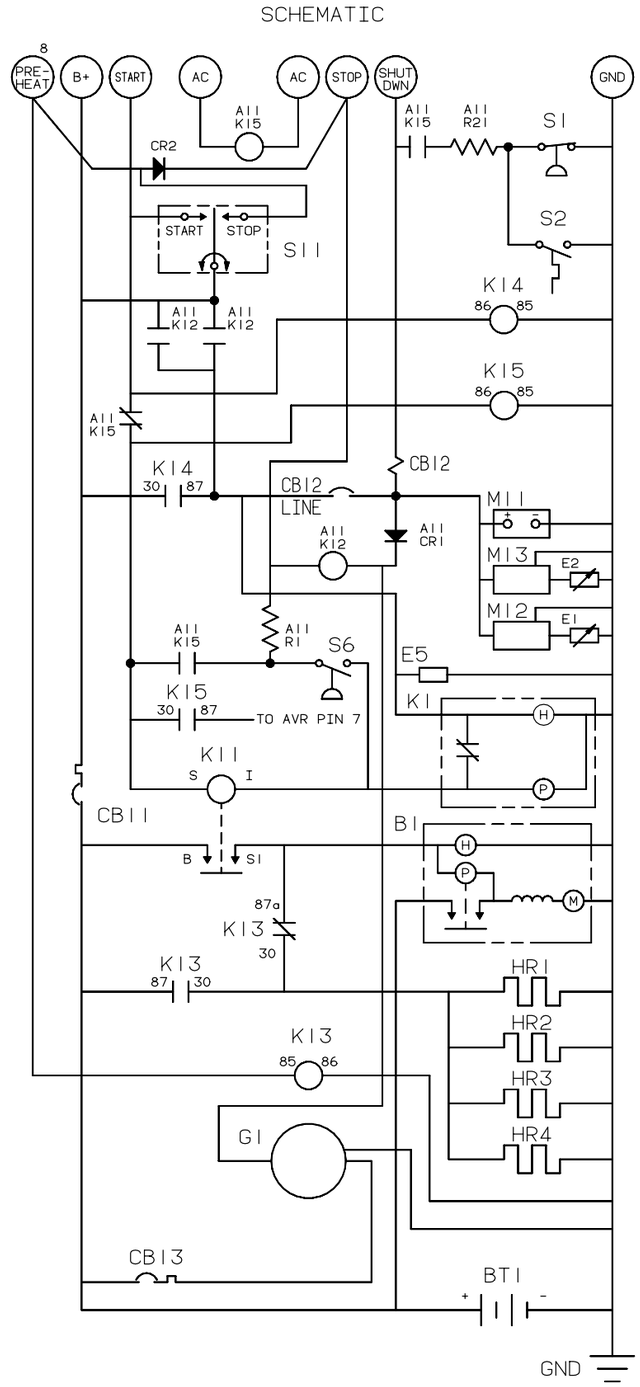
8. Wiring Diagrams

The electrical schematics and wiring diagrams that apply to the generator set covered in this manual are listed below.

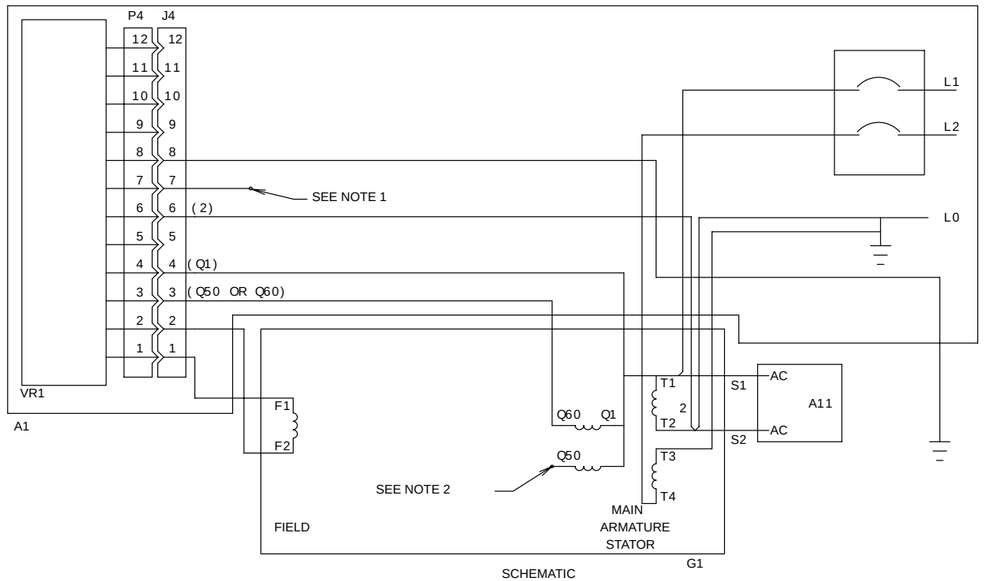




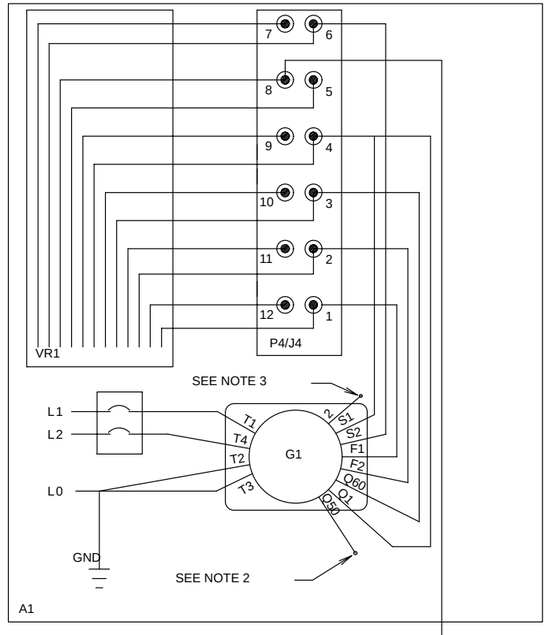
ENGINE PARTS LIST (FOR REF ONLY)			
B1		(1)	STARTER & SOLENOID
BT1		(1)	BATTERY (12V)
E1		(1)	SENDER-OIL PRESSURE
E2		(1)	SENDER-COOLANT TEMP
E5		(1)	FUEL PUMP-ELECTRIC
G1		(1)	ALTERNATOR
HR1-3		(3)	HEATER-GLOW PLUG
K1		(1)	SOLENOID-FUEL
S1		(1)	SWITCH-LOW OIL PRESSURE
S2		(1)	SWITCH-HIGH COOLANT TEMP
S6		(1)	SWITCH-CONTROL POWER LATCH

CONTROL BOX PARTS				
	319-1448	D	1	CONTROL ASSY
	338-2910	D	1	HARNESS-ENG
AII	300-2604	D	(1)	PCB ASSY-ENGINE MONITOR
CB11	320-1140	C	(1)	CIRCUIT BREAKER (CONTROL)
CB12	320-1141	A	(1)	CIRCUIT BREAKER (FAULT)
CB13	320-1658	B	(1)	CIRCUIT BREAKER
J3-J4			REF	CONNECTOR-REMOTE
K11	307-1617	B	(1)	RELAY-START SOLENOID(STARTER)(12V)
AII-K12			REF	RELAY-POWER
K13	307-1886	P	(1)	RELAY-HEATER (12V)
K14	307-1886	P	(1)	RELAY-FUEL SOLENOID
AII-K15			REF	RELAY-STARTER PROTECTION
K15	307-1886	P	(1)	RELAY-
AII-R1			REF	RESISTOR (K12)
AII-R2			REF	RESISTOR (LOP TIMING)
SII	308-0739	A	(1)	SWITCH-START STOP

612-6635



110/220V, 115/230V & 120/240V AS SHOWN
SEE RECONNECTION CHART FOR OTHER VOLTAGES



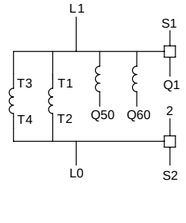
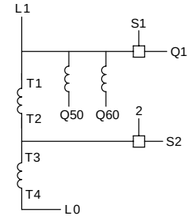
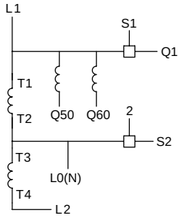
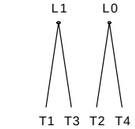
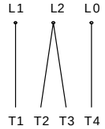
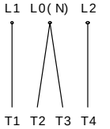
WIRING DIAGRAM

110/220V, 115/230V & 120/240V AS SHOWN
SEE RECONNECTION CHART FOR OTHER VOLTAGES

REF DES	PART N0	DWG SIZE	QTY	DESCRIPTION
1	---	--	1	WIRE HARNESS
2	---	--	1	LEAD (F1)
3	---	--	1	LEAD (F2)
G1	---	--	1	GENERATOR
VR1	---	--	1	VOLTAGE REG-EXP AVR

NOTE:

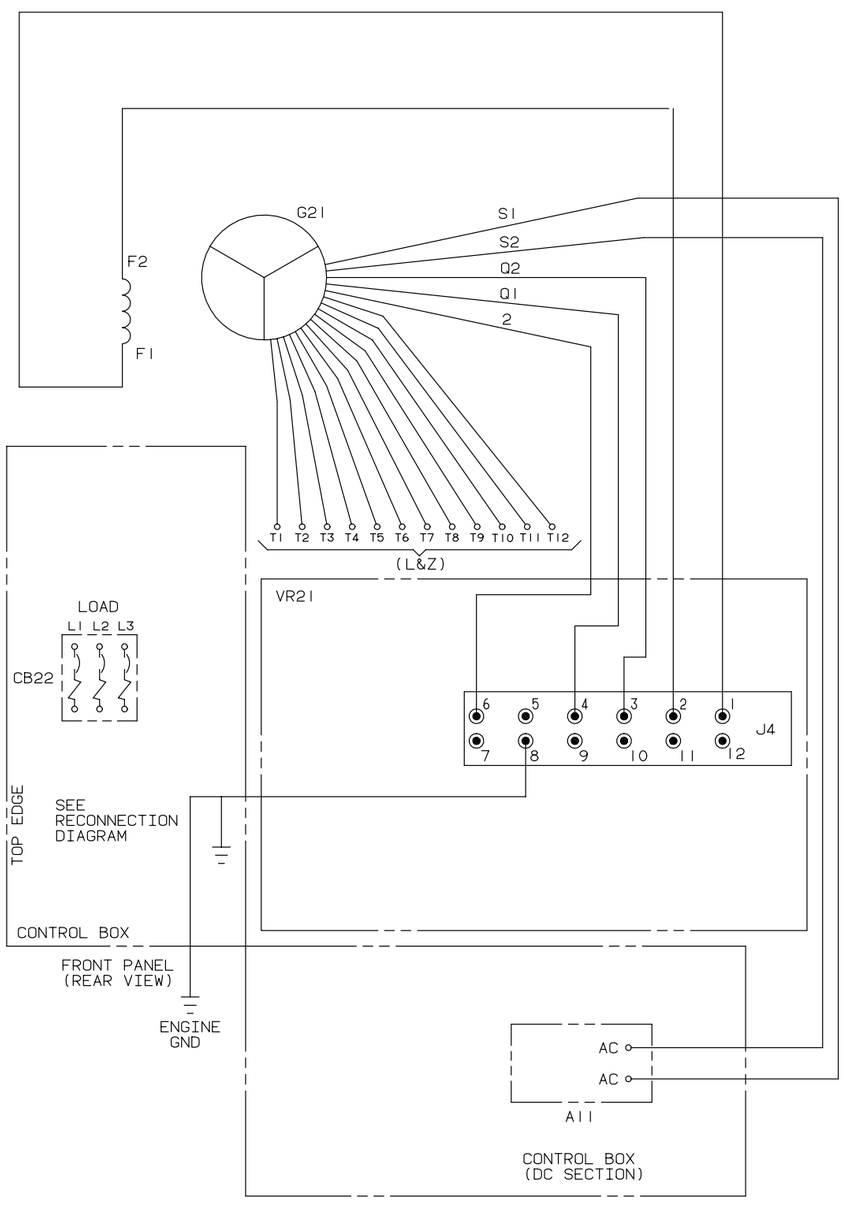
1. FROM J2-15 FOR FIELD FLASHING.
2. QUADRATURE POWER CONNECTION Q60-60 HZ, Q50-50 HZ UNITS.
3. AVR REFERENCE VOLTAGE.

	A	B	C	HZ	CODE
VOLTAGE	100 120	200 240	100/200 120/240	60	J
	110 115	220 230	110/220 115/230	50	P
SCHEMATIC					
DIAGRAM					

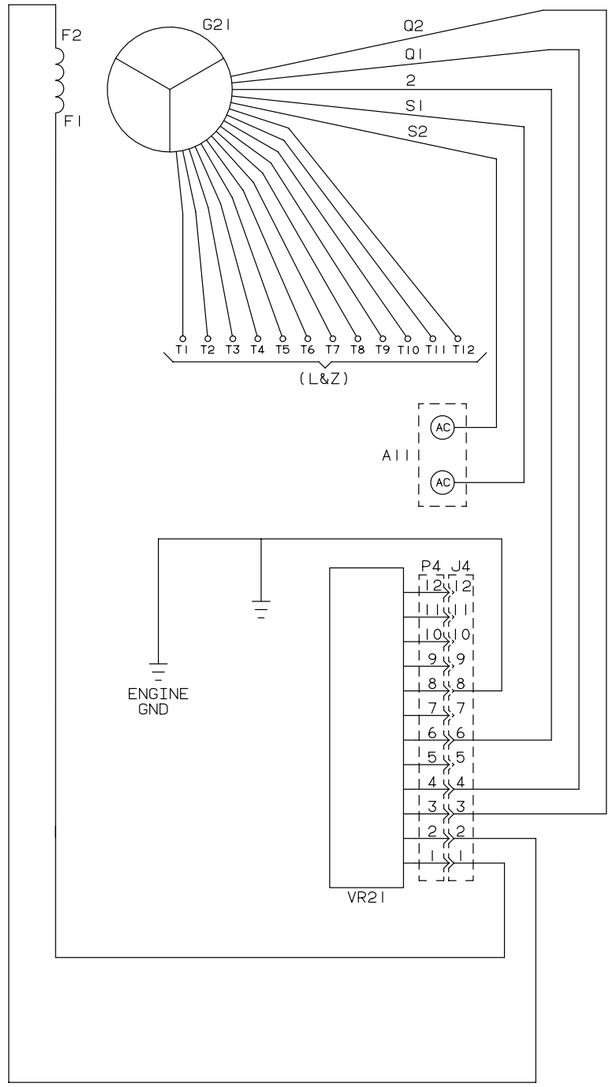
GENERATOR
RECONNECTION CHART

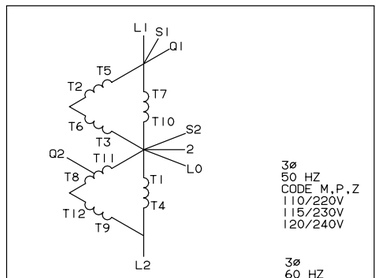
612-6637

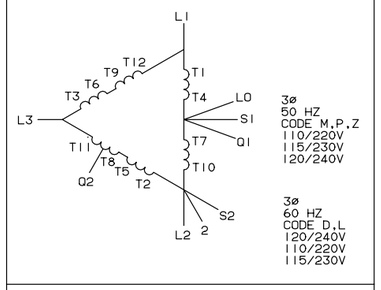
AC WIRING DIAGRAM-ELECTRONIC REGULATION CODE L, Z

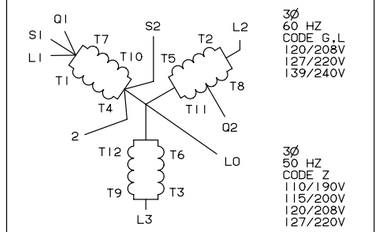


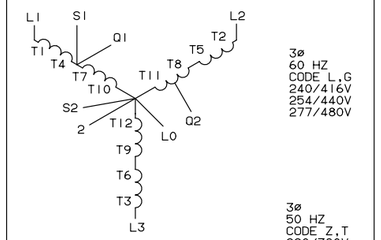
AC SCHEMATIC-ELECTRONIC REG VOLTAGE CODES (L&Z)











NOTE:

1. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN DE-ENERGIZED POSITION.
2. DASHED LINES INDICATE CONNECTIONS WHEN USED.
3. INSULATE ALL UNUSED OR INTERCONNEDTED GENERATOR LEADS WITH SLEEVING AND SECURE WITH CABLE TIE

612-6732

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