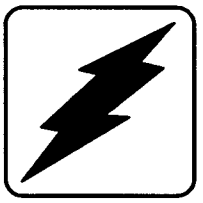
Service Manual

Standby Generator Sets



Models:
6ROY
6RFOY
10ROY
10RFOY
15ROY
15RFOY

KOHLER®
POWER SYSTEMS

TP-5555 3/94

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Safety Precautions and Instructions

A generator set, like any other electro-mechanical device, can pose potential dangers to life and limb if improperly maintained or imprudently operated. The best way to prevent accidents is to be aware of the potential dangers and to always use good common sense. In the interest of safety, some general precautions relating the to operating of a generator set follow. Keep these in mind. This manual contains several types of safety precautions which are explained below.

⚠ DANGER

Danger is used to indicate the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING

Warning is used to indicate the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION

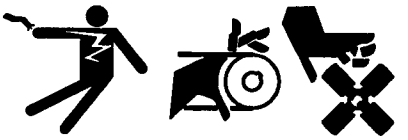
Caution is used to indicate the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the warning is ignored.

NOTE

Note is used to notify people of installation, operation, or maintenance information that is important but not hazard-related.

Safety decals are affixed to the generator set in prominent places to advise the operator or service technician of potentially hazardous situations. The decals are reproduced here to improve operator recognition and thereby increase decal effectiveness. For a further explanation of decal information, reference the accompanying safety precautions. Before operating or servicing the generator set, be sure you understand the message of these decals. Replace decals if missing or damaged.

ACCIDENTAL STARTING



⚠ WARNING

Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

FUEL SYSTEM

⚠ WARNING

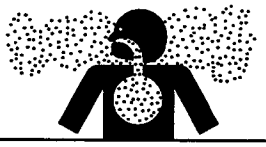
Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling, storing, and using fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running since spilled fuel may ignite on contact with hot parts or from ignition spark. Do not smoke or permit flame or spark to occur near potential sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition—don't replace flexible fuel lines with rigid lines. Flexible sections are used to avoid breakage due to vibration. Should any fuel leakage, fuel accumulation, or electrical sparks be noted, DO NOT OPERATE GENERATOR SET. Have systems repaired before resuming generator operation.

EXHAUST SYSTEM

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Carbon monoxide can cause severe nausea, fainting, or death. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside an occupied building. Avoid breathing exhaust fumes when working on or near the generator set. Carbon monoxide is particularly dangerous in that it is an odorless, colorless, tasteless, nonirritating gas. Be aware that it can cause death if inhaled for even a short period of time.

Carbon monoxide can cause severe nausea, fainting, or death. Diesel fumes can rapidly destroy copper tubing in diesel exhaust systems. Do not use copper tubing in diesel exhaust systems. Exhaust sulphur will cause rapid deterioration and this could result in exhaust leakage.

MOVING PARTS

⚠ WARNING

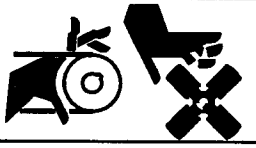
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, and clothing away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set.

HAZARDOUS VOLTAGE/ ELECTRICAL SHOCK

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING

Hazardous voltage.
Backfeed to utility system can cause property damage, severe injury, or death.

When generator is used for standby power, use of automatic transfer switch is recommended to prevent inadvertent interconnection of standby and normal sources of supply.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Hazardous voltage can cause severe injury or death. Electrical shock may occur if battery charger is not properly grounded. Connect battery charger enclosure to ground of a permanent wiring system. As an alternative, run an equipment-grounding conductor with circuit conductors and connect to equipment-grounding terminal or lead on battery charger. Battery charger installation should be performed as prescribed in equipment manual and must comply with all local codes and ordinances.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

Hazardous voltage can cause severe injury or death. Improper reconnection may damage charger and battery(ies), and create an electrical shock hazard. Installation must be done by a qualified electrician.

Hazardous voltage can cause severe injury or death. Service day tank ECM (Electrical Control Module) as prescribed in equipment manual. Before servicing, disconnect power to day tank. When day tank ECM "OFF" push button is engaged the unit is disabled. However, 120 VAC power is still present within the ECM as indicated by the "POWER ON" light. Be sure that generator and day tank are properly grounded. Do not operate when standing in water, on wet ground, or when your hands are wet.

Hazardous "backfeed" voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent connection of standby and other sources of power. Electrical backfeed into a utility electrical system can cause serious injury or death to utility personnel working on transmission lines.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. Engine block heater can cause electrical shock. Remove engine block heater plug from electrical outlet before working on block heater electrical connections.

ENGINE BACKFIRE/FLASH FIRE

⚠ WARNING

Fire.
Can cause severe injury or death.

Do not smoke or permit flame or spark to occur near fuel or fuel system.

A sudden backfire can cause severe injury or death. Do not operate with air cleaner removed.

BATTERY

⚠ WARNING

Explosion.
Can cause severe injury or death. Relays in battery charger cause arcs or sparks.

Locate in a well ventilated area. Keep explosive fumes away.

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

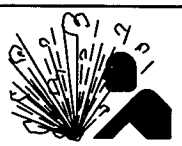
Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

HOT PARTS

⚠ WARNING



Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap stop generator, allow to cool and loosen pressure cap to relieve pressure.

⚠ WARNING

Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on generator set until unit is allowed to cool.

Hot coolant can cause severe injury or death. Allow engine to cool and release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth then turn it slowly counterclockwise to the first stop. After pressure has been completely released and the engine has cooled, remove cap. If generator set is equipped with a coolant recovery tank, check coolant level at tank.

Hot parts can cause severe injury or death. Avoid touching generator field or exciter armature. Generator field and exciter armature will get hot if shorted.

Hot parts can cause severe injury or death. Do not touch hot engine parts. An engine gets hot while running and exhaust system components get extremely hot.

HAZARDOUS NOISE

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.
Never operate generator without a muffler or with faulty exhaust system.

HEAVY EQUIPMENT

⚠ WARNING

Unbalanced weight.
Improper lift can cause severe injury, death, or equipment damage.
Do not use lifting eyes.
Use lifting bars thru holes in skid to lift set.

NOTES

NOTE

HARDWARE DAMAGE! Engine and generator may make use of both American Standard and metric hardware. Be sure to use the correct size tools to prevent rounding of bolt heads and nuts.

NOTE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for proper identification.

NOTE

Wipe up all spilled diesel fuel after bleeding system. Wash hands after any contact with fuel oil.

NOTE

Special attention should be given when checking for proper coolant level. After the coolant has been drained, it normally requires some time before complete refill of the engine water jacket takes place.

NOTE

ENGINE DAMAGE! Failure to bleed air from cooling system may cause overheating and subsequent damage to engine.

NOTE

Charge only LEAD-ACID or NICKEL-CADMIUM batteries with battery charger.

Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally in the text they will appear in complete form with the abbreviation following in parenthesis the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below.

AC	alternating current
AHWT	anticipatory high water temp.
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
AM	amplitude modulation
Amp	ampere
Amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
aux.	auxiliary
A/V	audio-visual
AWG	American Wire Gauge
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective power
Btu	British thermal unit
°C	Celsius degree
cc	cubic centimeter
CCA	cold cranking Amps.
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
CPVC	chloropoly vinyl chloride
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch, cubic inches
CWC	city water-cooled
cyl.	cylinder
dB	decibel
dBA	decibels (A weighted)
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
e.g.	example given
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPA	Environmental Protection Agency
etc.	etcetera, (and so forth)
ext.	external
°F	Fahrenheit degree
fl. oz.	fluid ounce, fluid ounces
FM	frequency modulation
fs	full scale
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
ga.	gauge
gal./ gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust temperature
Hg	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour
HWT	high water temperature
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronic Engineers
in.	inch(es)
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms
kg/cm^2	kilograms per square centimeter

kgm	kilogram meter(s)
kJ	kilojoules (btu cal)
km	kilometer, kilometers
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
LxWxH	length x width x height
LED(s)	light emitting diode
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minutes,
LOP	low oil pressure
LP	liquefied petroleum
LWT	low water temperature
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
meggar	megohmmeter
MHz	megahertz
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
mJ	millijoule, millijoules
MJ	mega joule, mega joules
mm	millimeter, millimeters
m^3/min	cubic meters per minute
MPa	megaPascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available
NBS	Natioanl Bureau of Standards
N.C.	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	Newton meter, Newton meters
no., nos.	number, numbers
NPT	National Standard taper pipe thread per general use
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed, oversize
O/S	oversize
OSHA	Occupational Safety and Health Act
OV	overvoltage
oz.	ounce, ounces
PF	power factor
PMG	permanent magnet generator
pot.	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
PVC	polyvinyl chloride
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
r.h.m.	round-head machine (screw)
rms	root mean square
RPM	revolutions per inch
RTV	room temperature vulcanization
RV	recreational vehicle
SAE	Society of Automotive Engineers
SCR	silicon controlled rectifier
sec.	second, seconds
spec, specs	specification
sq.	square
sq. cm	square centimeters
sq. in.	square inch, square inches
tach	tachometer
TDC	top dead center
tech. pub.	technical publications
temp.	temperature
TIF	telephone influence factor
TP, TPs	technical publications
turbo	turbocharger
UHF	ultrahigh frequency
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter's Laboratories, Inc.
U/S	undersize
U.S.A.	United States of America
V	volt, volts
vac	Volts alternating current
vdc	volts direct current
VHF	very high frequency
W	watt, watts

Service Assistance

For service or information, check the yellow pages of your telephone directory under the heading GENERATORS-ELECTRIC for the authorized service distributor/dealer in your area.

KOHLER CO., Kohler, Wisconsin 53044
Phone 1-414-565-3381
Fax 1-414-459-1646 (North American Sales)
1-414-459-1614 (International)
For Sales and Service in U.S.A. and Canada
Phone 1-800-544-2444

In any communications regarding your generator set, please include the MODEL, SPEC. and SERIAL numbers as found on the nameplate attached to the generator and the ENGINE number as found on the engine nameplate. Enter numbers in spaces provided below. This information will enable your authorized service distributor/dealer to supply the correct part or data for your particular configuration. Part numbers do not appear in this manual due to variations in this series of generator set models.

Model No. _____

Specification No. _____

Serial No. _____

Engine No. _____

At the time of print, this manual applied to the model numbers and specification (spec) numbers listed below. This manual may be used for specs not listed below. When similar new specs are created after the printing of this manual and prior to the updated reprint, or in cases where the manual is deemed an acceptable substitute for a manual under development.

Model	Spec. No.	Wiring Diagram	Controller	Cooling
6ROY	126501	see controller	(1)	(2)
10ROY	126601	see controller	(1)	(2)
15ROY	127701	see controller	(1)	(2)

(1) Controller is one of the following:

	Wiring Diagram(s)
Relay Controller	225084-C, ADV-5768
Decision-Maker™ 3,5 Light Controller	225085-, ADV-5770, 256876-
Decision-Maker™ 3,5 Light Controller (Remote)	225141-, ADV-5770, 256876-C

(2) Cooling System is one of the following:

Radiator Cooling or City Water Cooling.

Section 1. Introduction

This manual covers the general operation, maintenance, troubleshooting, and repair of the Kohler 6ROY/6RFOY,10ROY/10RFOY, and 15ROY/15RFOY standby generator sets.

Service requirements are minimal but are very important to the safe and efficient operation of your generator set; therefore, inspect associated parts often.

Read through this manual and carefully follow all procedures and safety precautions to ensure proper generator operation and to avoid bodily injury.

Keep this manual with the generator set for future reference. See Figure 1-1, Figure 1-2 and Figure 1-3 for identification and location of components.

It is recommended that an authorized service dealer/distributor perform required servicing to keep your set in top condition.

All information found in this publication is based on data available at time of printing. The manufacturer reserves the right to make changes to this literature and the products represented at any time without notice and without incurring obligation.

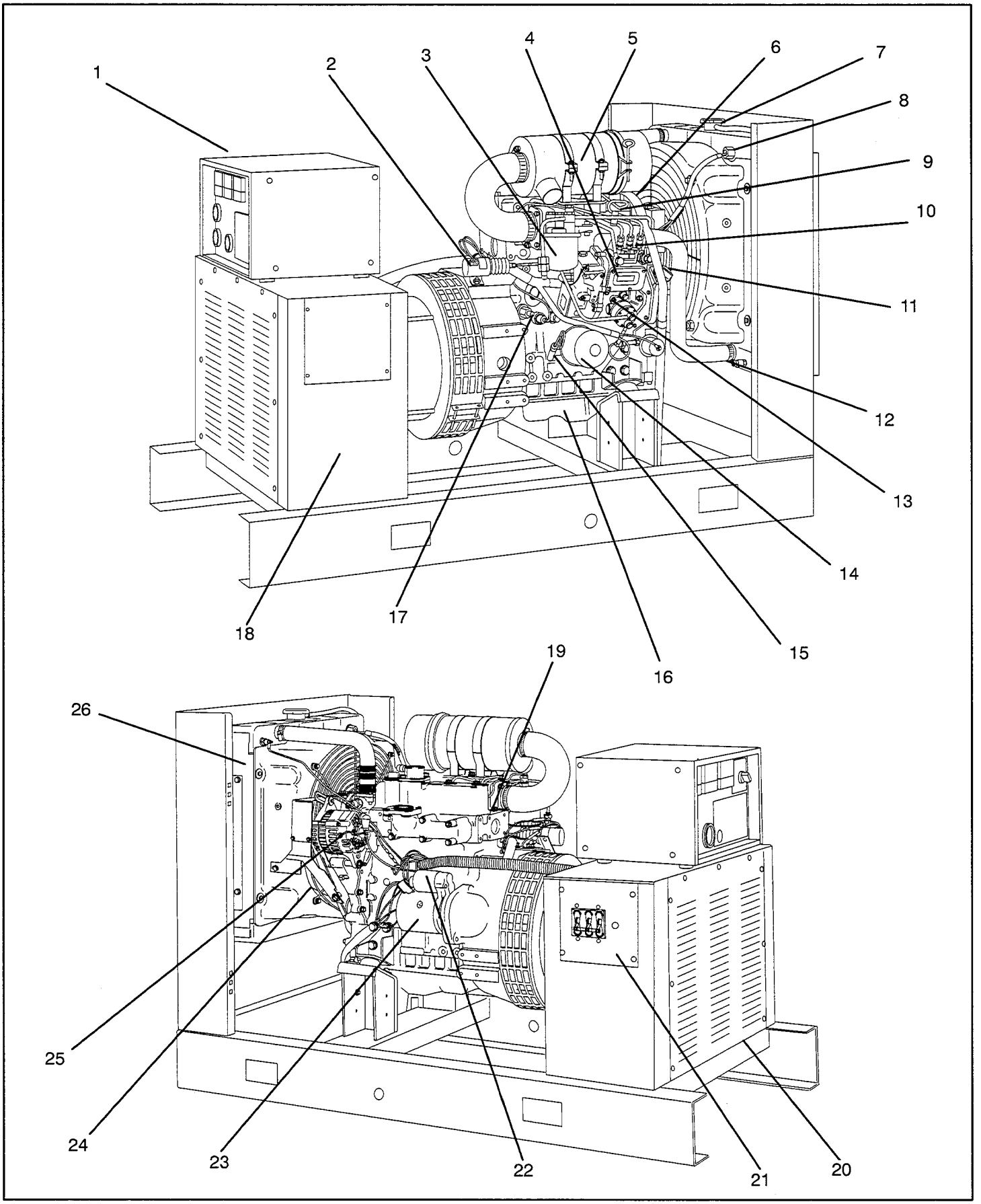


Figure 1-1. Service Views-6ROY, 6RFOY, 6ROZ, 6RFOZ Generator Sets

Service Views

1. Controller
2. Fuel Solenoid
3. Fuel Filter
4. Mechanical Governor
5. Air Cleaner
6. High Engine Temperature Shutdown
7. Coolant Fill
8. Low Coolant Level Shutdown
9. Injectors
10. Fuel Injection Pump
11. Oil Fill
12. Coolant Drain
13. Injection Pump Priming Lever
14. Oil Filter
15. Oil Check
16. Oil Drain
17. Low Oil Pressure Switch
18. Nameplate Location
19. Air Intake
20. Voltage Regulator
21. Circuit Breakers (Optional)
22. Starter Solenoid
23. Starter
24. Belt Guard
25. Battery Charging Alternator
26. Radiator

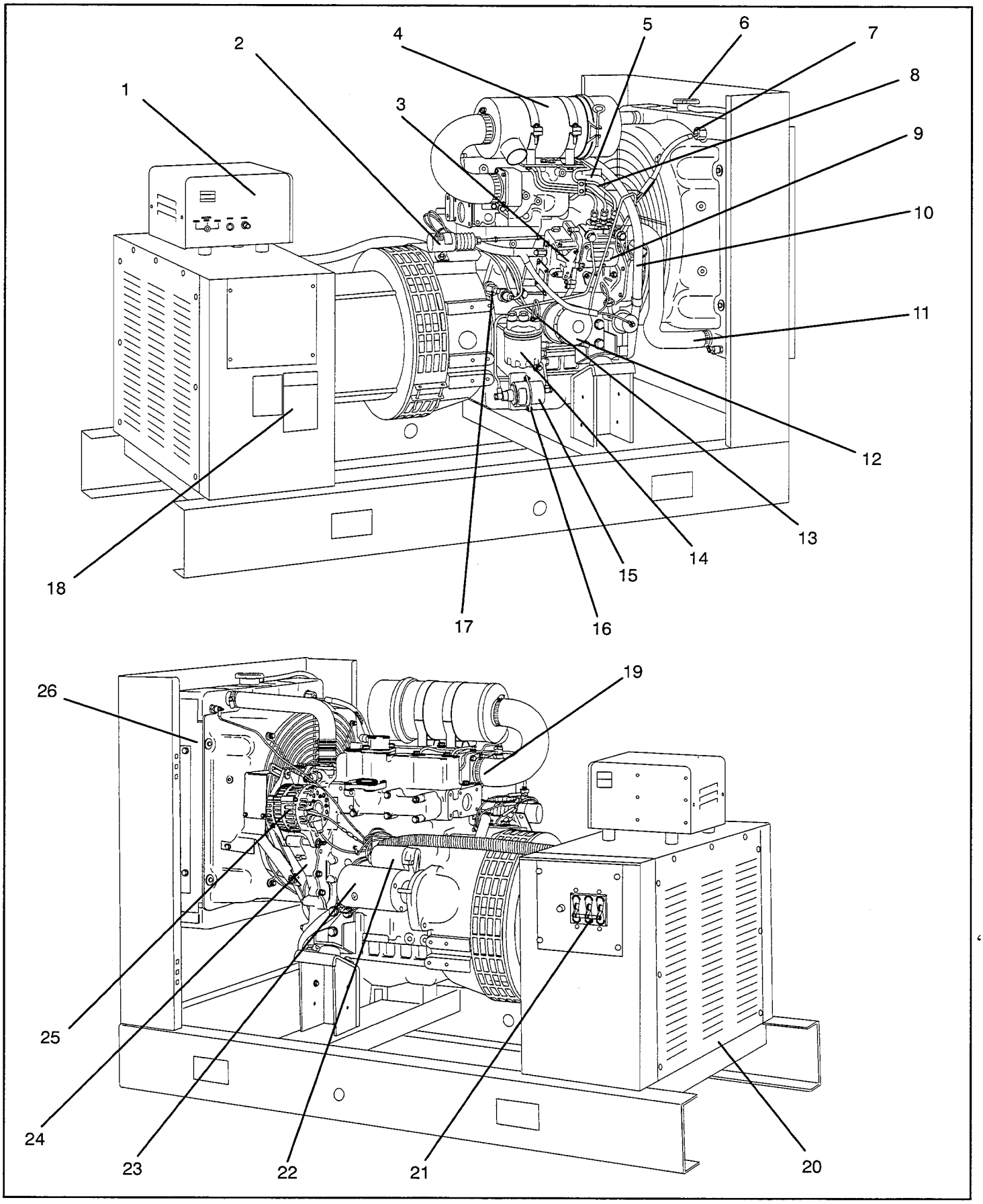


Figure 1-2. Service Views-10ROY, 10RFOY, 10ROZ, 10RFOZ Generator Sets

1. Controller
2. Fuel Solenoid
3. Mechanical Governor
4. Air Cleaner
5. High Engine Temperature Shutdown
6. Coolant Fill
7. Low Coolant Level Shutdown
8. Injectors
9. Fuel Injection Pump
10. Oil Fill
11. Coolant Drain
12. Oil Filter
13. Oil Check
14. Fuel Filter
15. Fuel Pump
16. Oil Drain
17. Low Oil Pressure Switch
18. Nameplate Location
19. Air Intake
20. Voltage Regulator
21. Circuit Breakers (Optional)
22. Starter Solenoid
23. Starter
24. Belt Guard
25. Battery Charging Alternator
26. Radiator

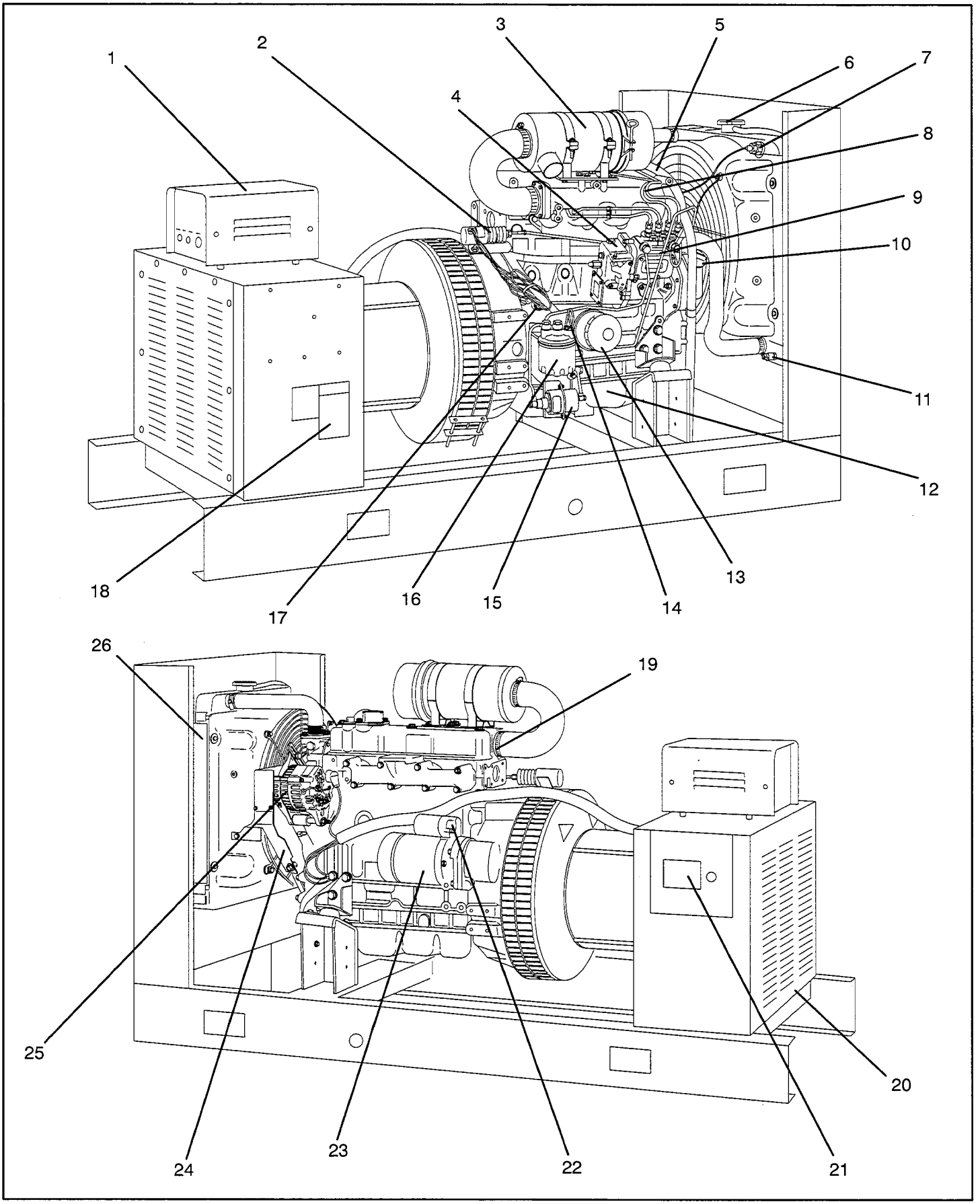


Figure 1-3. Service Views-15ROY, 15RFOY, 15ROZ, 15RFOZ Generator Sets

1. Controller
2. Fuel Solenoid
3. Air Cleaner
4. Mechanical Governor
5. High Engine Temperature Shutdown
6. Coolant Fill
7. Low coolant Level Shutdown
8. Injectors
9. Fuel Injection Pump
10. Oil Fill
11. Coolant Drain
12. Oil Drain
13. Oil Filter
14. Oil Check
15. Fuel Pump
16. Fuel Filter
17. Low Oil Pressure Switch
18. Nameplate Location
19. Air Intake
20. Voltage Regulator
21. Circuit Breakers (Optional)
22. Starter Solenoid
23. Starter
24. Belt Guard
25. Battery Charging Alternator
26. Radiator

Generator Features

Standard Features

- PowerBoost™ Voltage Regulator
- Instant Response to Load Changes
- Sustained Short Circuit Capability
- Superior Motor Starting
- Integral Vibration Isolation
- Low Coolant Shutdown
- Radio Suppression to Commercial Standards
- Generator built within NEMA, IEEE, and ANSI standards for temperature rise.
- Single-phase:static excited Three-phase:brushless exciter.
- Uses skewed rotor for smooth voltage wave form.
- Self-ventilated, drip-proof construction.

Controllers

Standard Relay Controller

- Type: Relay
- Power Source, with circuit protection: 12 Volt DC
- Low Coolant Level safety shutdown and lamp (red)*
- High Engine Temperature safety shutdown and lamp (red)*
- Low Oil pressure safety shutdown and lamp (red)*
- Overspeed safety shutdown and lamp (red)*
- Overcrank safety shutdown and lamp (red)*
- Cyclic cranking: three attempts of 8 seconds each—adjustable.
- Run-Off/Reset-Auto switch (engine start), Local/Remote two-wire.
- Hourmeter.

* common lamp

Optional Microprocessor Controller

- Type: 5-Light Microprocessor (NFPA-110, level 2)
- Power source, with circuit protection: 12 Volt DC
- AC meters, 2.5 in. (63.5 mm) 2% full-scale accuracy (Volts, Amps, Frequency).
- Meter phase selector switch.
- DC meters, 2 in. (51 mm), 2% full-scale accuracy (Volts, Engine Water Temperature, And Oil Pressure).
- Running time meter.
- Alarm horn and silencing switch per NFPA-110.
- Lamp test switch.
- Front-mounted voltage adjusting rheostat.
- Panel lamps (2).
- Cyclic cranking per NFPA-110.
- Engine cooldown timer, 5-minute.
- High Engine Temperature safety shutdown and lamp (red)
- Low Oil pressure safety shutdown and lamp (red)
- Overspeed safety shutdown and lamp (red)
- Overcrank safety shutdown and lamp (red)
- Low Coolant Temperature/Level alarm lamp (red)
- Run-Off/Reset-Auto switch (engine start), Local/Remote two-wire.

Accessories

Several accessories are available to finalize the installation, to add convenience to operation service, and to comply with state and local codes. Accessories vary with each generator set model and controller. Accessories are offered factory installed and/or shipped loose. All the most current information can be obtained by contacting your local dealer/distributor. Several accessories available at the time of print of this publication are as follows.

Remote Annunciator Kit (Decision-Monitor™) (Microprocessor Controller Only)

A remote annunciator allows convenient monitoring of the set's condition from a location remote from the generator. See Figure 1-4. Remote Annunciator includes alarm horn, alarm silence switch, lamp test, and the same lamp indicators as the Decision-Maker™ 3 microprocessor controller, plus the following:

Line Power—lamp lights when commercial utility power is in use.

Generator Power—lamp lights when generator power is in use.

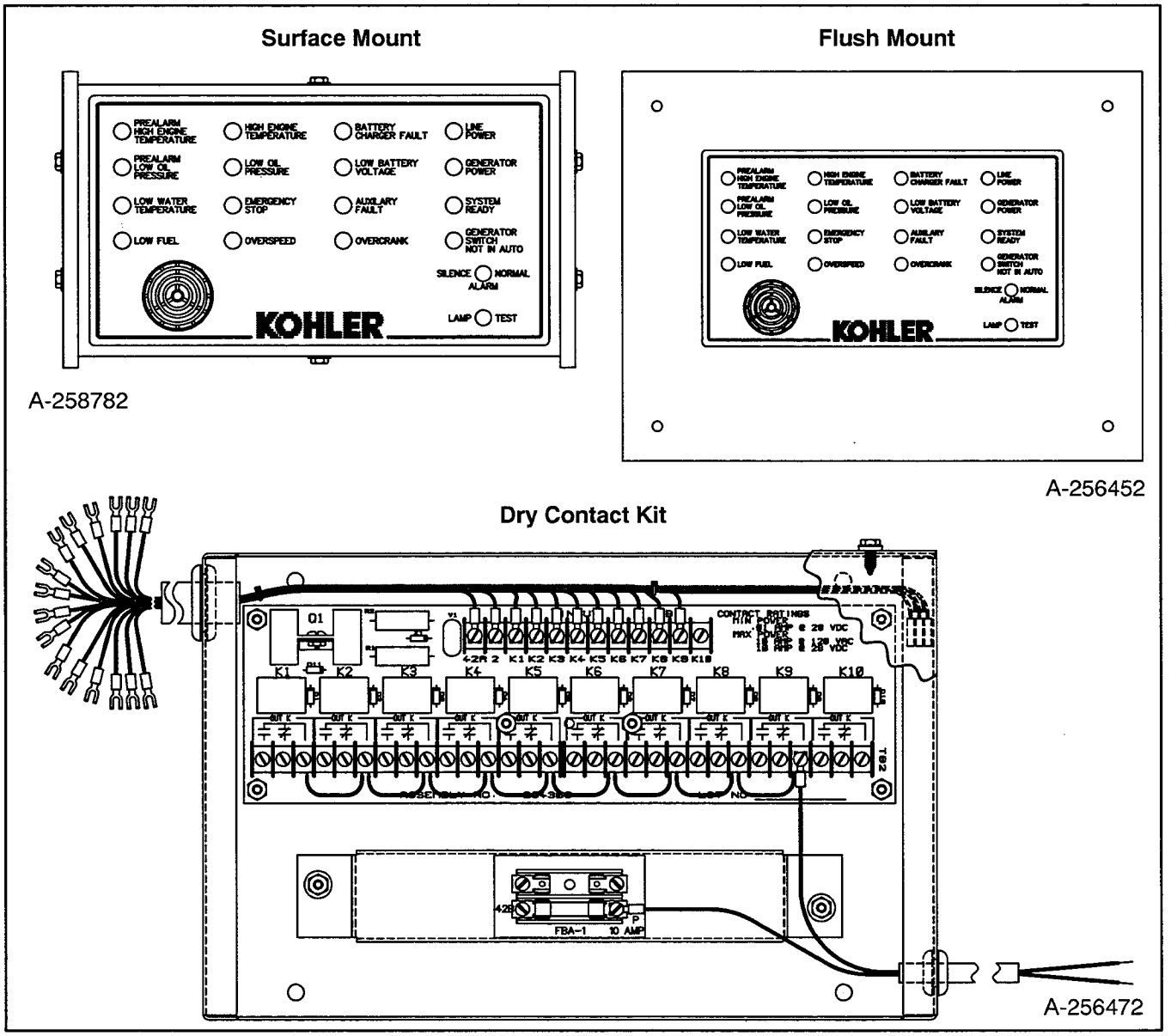


Figure 1-4. Remote Annunciator (Decision Monitor)

Audio-Visual (A/V)Alarm (Microprocessor Controller Only)

An A/V alarm warns the operator of fault shutdowns and prealarm conditions (except battery charger fault and low battery voltage) from a location remote from the generator. A/V alarms include alarm horn, alarm silence switch, and common fault lamp. See Figure 1-5.

NOTE

Any combination of remote annunciators and/or A/V alarms totaling three may be connected to the generator controller.

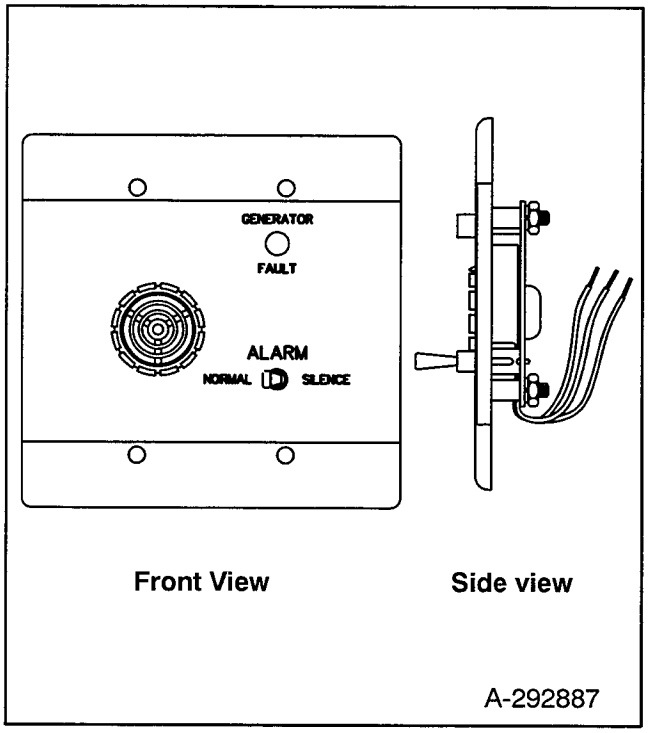


Figure 1-5. Audio-Visual Alarm

Line Circuit Breaker

The line circuit breaker interrupts generator output in the event of an overload or short circuit. It should be opened manually to disconnect the generator from the load when servicing the generator set. See Figure 1-6.

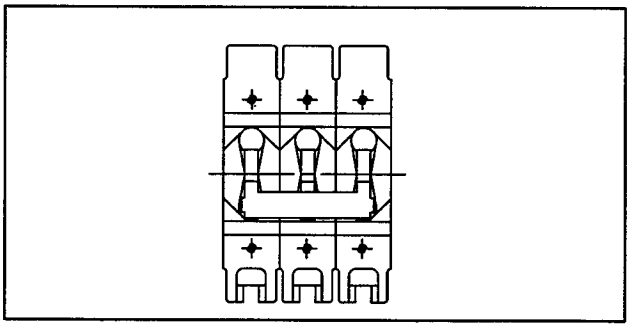


Figure 1-6. Safeguard Breaker

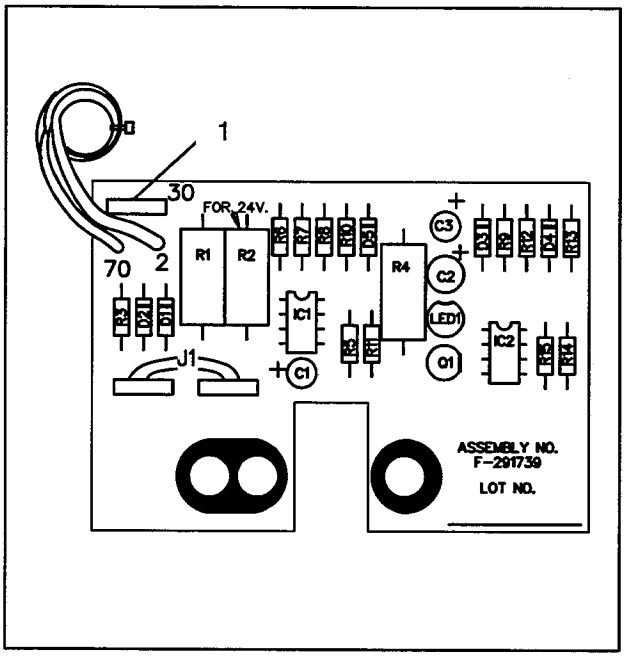
Common Fault Relay Kit (Microprocessor Controller Only)

The common fault relay kit uses one set of relay contacts to trigger customer-provided warning devices if a fault condition occurs. A wiring harness included with the kit links the relay kit with the controller terminal strip or controller connection kit. Refer to the accessory wiring diagram for proper connection of relay kit wiring harness. Although the common fault alarm can be connected to any controller fault output (on TB1 terminal strip), the kit is typically used to signal the following fault conditions:

Emergency Stop
Auxiliary
Overspeed
Low Oil Pressure
High Engine Temperature

Overvoltage Kit (Microprocessor Controller Only)

The overvoltage circuit will cause immediate engine shutdown when it is triggered by a DC signal from an overvoltage shutdown option. The generator set will automatically shut down if output voltage is 15% above nominal voltage longer than one second. The overvoltage option connects to wire 30 in the controller. See Figure 1-7.



1. Connects to Controller Wire 30

Figure 1-7. Overvoltage Kit

Run Relay Kit

The run relay kit is energized only when the generator set is running. The three sets of contacts in the kit are typically used to control air intake and/or radiator louvers. However, alarms and other signalling devices can also be connected to the contacts. Refer to the accessory wiring diagram in Section 5 for proper connection of the run relay kit. See Figure 1-8.

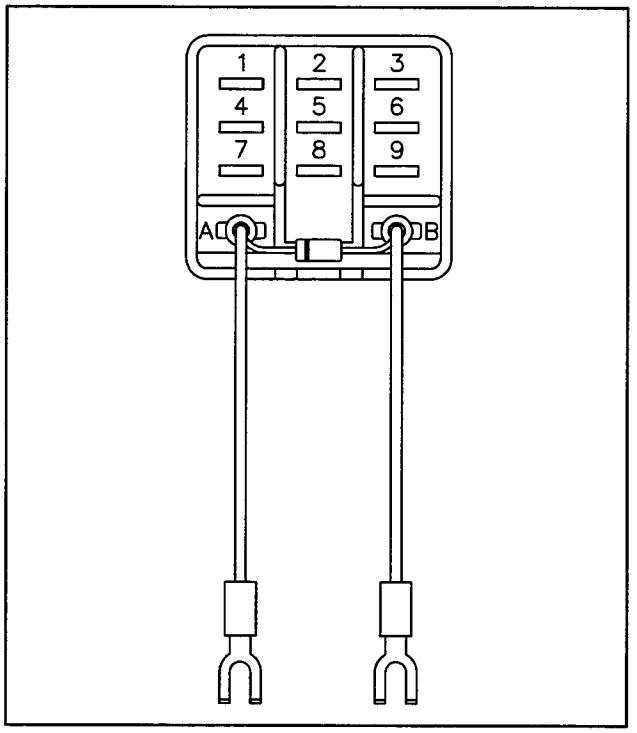


Figure 1-8. Run Relay Kit

Remote Emergency Stop Kit (Microprocessor Controller Only)

The emergency stop kit allows immediate shutdown of the generator set from a station remote from the generator set (Figure 1-9). If the emergency stop switch is activated, the EMERGENCY STOP lamp lights and the unit shuts down. The generator set cannot be restarted until the emergency stop switch is reset (by replacing glass piece) and the controller is reset by placing generator master Switch in the OFF/RESET position. On models using Detroit Diesel engines, the engine air damper switch must also be reset. See Section 2 Resetting Emergency Stop Switches.

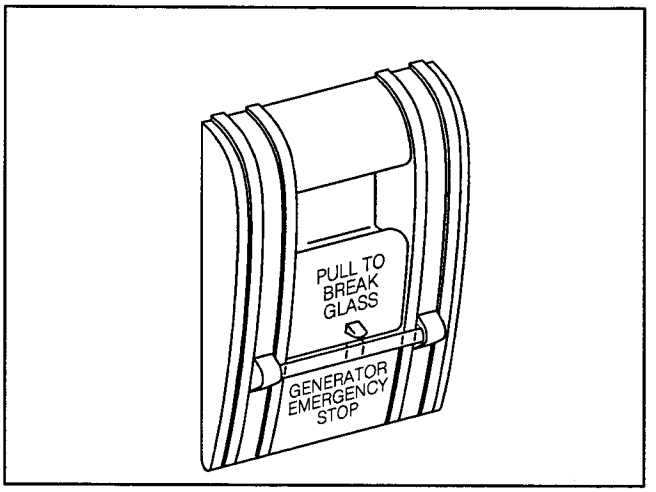


Figure 1-9. Emergency Stop Kit

Single-Relay Dry Contact Kit (Microprocessor Controller Only)

The single relay dry contact kit uses one set of contacts to trigger customer-provided warning devices if a fault condition occurs. While any controller fault output (from TB1 terminal strip) can be connected to the single-relay kit, this accessory is typically used to signal an overspeed condition. The single-relay dry contact kit is shown in Figure 1-10.

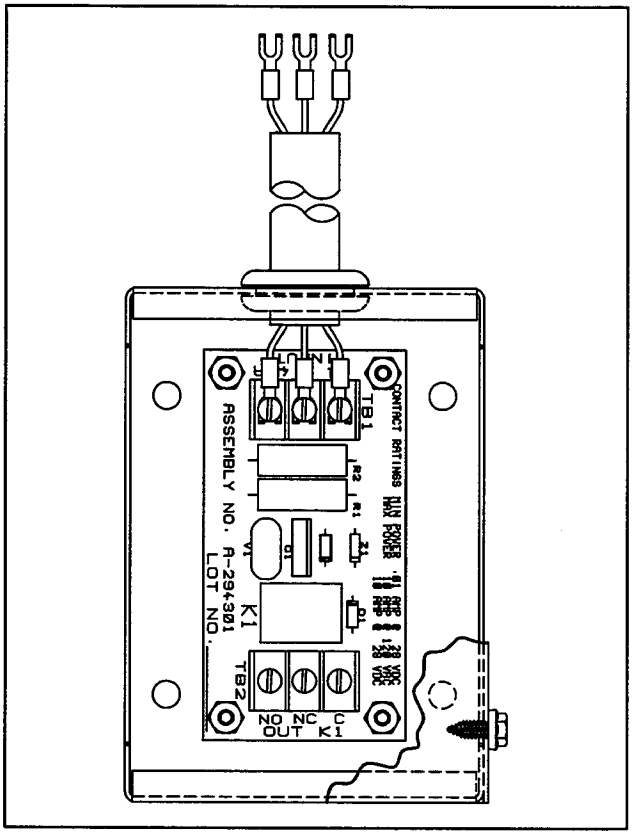


Figure 1-10. Single-Relay Dry Contact Kit

Ten-Relay Dry Contact Kit (Microprocessor Controller Only)

The ten-relay dry contact kits allow monitoring of the standby system and/or the ability to activate accessories such as derangement panels. The kit includes ten sets of relay contacts for connection of customer-provided devices to desired generator functions. Warning devices (lamps, audible alarms) and other accessories are typically connected to controller outputs listed. A total of three dry contact kits may be connected to the controller. An internal view of the contact kit is shown in Figure 1-11.

Typical Contact Kit Output Connections:
Overspeed
Overcrank
Low Oil Pressure
Auxiliary Fault
Emergency Stop

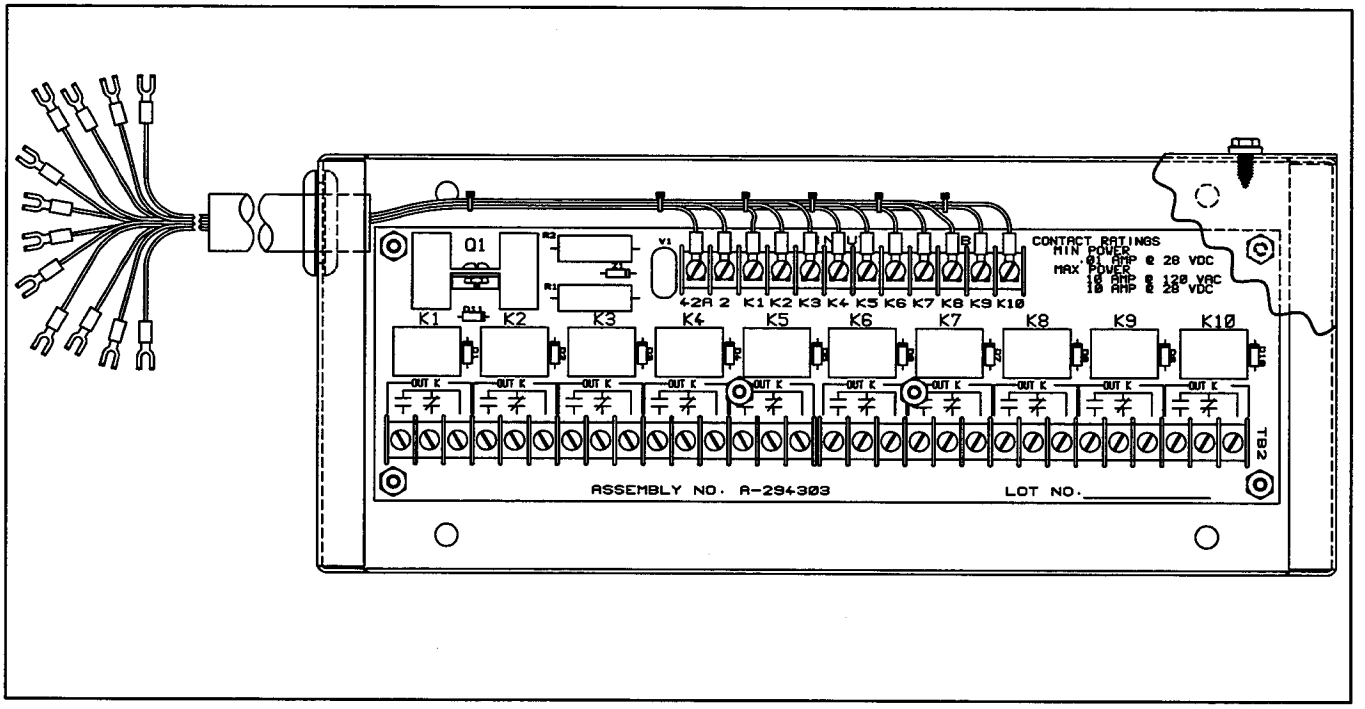
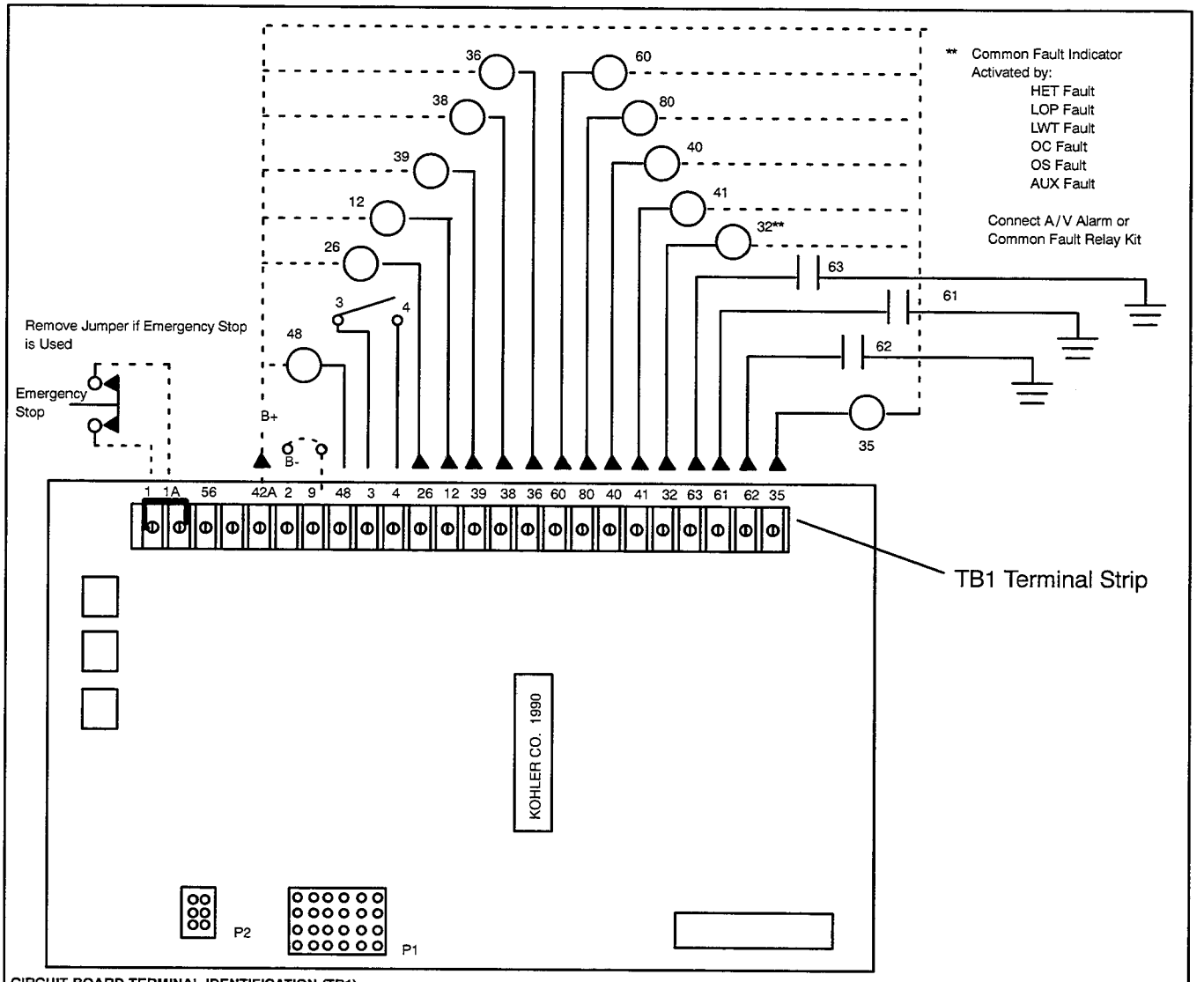


Figure 1-11. Ten-Relay Dry Contact Kit

Accessory Connection (Microprocessor Controller Only)

The Decision-Maker™ 3 controller circuit board is equipped with a terminal strip (TB1) for easy connection of generator set accessories. Accessories should not be direct-connected to the controller terminal strip. All accessories should be connected to either a single-relay dry contact kit or ten-relay dry contact kit. The dry contact kit(s) should then be connected to the controller terminal strip. Alarms, battery chargers, remote switches, and other accessories can be connected to the dry contact kit relay(s) using 18 or 20 gauge stranded wire.

To connect accessories to the controller TB1 terminal strip, lower the controller circuit board panel until it is lying flat. Route dry contact relay leads through the controller grommet and guide loops to the circuit board terminal strip. The controller circuit board panel must be lying flat to ensure adequate slack in dry contact relay leads and/or harnesses. For specific information on accessory connections, refer to Figure 1-12, the accessory wiring diagram, and the instruction sheet accompanying each kit.



CIRCUIT BOARD TERMINAL IDENTIFICATION (TB1)

- 1 - Ground—Emergency Stop Relay (K4) - Connect Emergency Stop Across Terminals TB1-1 and 1A.
- 1A - Emergency Stop Relay (K4) Coil; Negative - Connect Emergency Stop Across Terminals TB1-1 and 1A.
- 56 - Not Used
- 42A - Battery Voltage (Fuse #1 Protected) - Accessory Power Supply; Customer May also Provide Separate Accessory Power Source
- 2 - Ground Terminal
- 9 - Crank Mode Selection (open—cyclic crank; ground—continuous crank) Connect TB1-2 to TB1-9 for Continuous Cranking; Leave TB1-9 open for cyclic cranking. See Starting.
- 48 - Emergency Stop Signal *
- 3 - Remote Start Ground - Connect Remote Start Switch to TB1-3 and TB1-4
- 4 - Remote Start - Connect Remote Start Switch to TB1-3 and TB1-4
- 26 - Auxiliary Signal *
- 12 - Overcrank Signal *
- 39 - Overspeed Signal *
- 38 - Low Oil Pressure Signal *
- 36 - High Engine Temperature Signal *
- 60 - System Ready Signal *
- 80 - Not In Auto Signal *
- 40 - Anticipatory High Engine Temperature Signal *
- 41 - Anticipatory Low Oil Pressure Signal *
- 32 - Common Fault/Prealarm Line - A/V Alarm or Common Fault Relay Activated by HET, LOP, LWT, OC, OS, and AUX Faults
- 63 - Low Fuel - Connect Fuel Level Sensor to TB1-63 to Activate Fault Lamp (If Used)
- 61 - Battery Charger Fault - Connect Battery Charger to TB1-61 to Activate Fault Lamp (If Used)
- 62 - Low Battery Volts - Connect Battery Charger to TB1-62 to Activate Fault Lamp (If Used)
- 35 - Low Water Temperature - Connect LWT Sensor (Anticipatory Kit) to TB1-35 to Activate LWT or LWT/AUX Lamp

NOTE: Not all terminals are used for all generator sets (see Wiring Diagrams).

* Optional signals used to drive A/V alarms, remote annunciator, and/or dry contact controls.

Figure 1-12. Controller TB1 Terminal Strip Connection

Section 2. Operation

Prestart Checklist

The following items should be checked before each startup of manually controlled generator sets and at regular intervals on sets equipped with automatic transfer switches. See generator set operation/maintenance manual for specific service procedures.

OIL LEVEL: Should be at or near FULL mark on dipstick but not over.

AIR CLEANER: Must be clean and properly installed to prevent unfiltered air from entering engine.

DRIVE BELTS: Make visual check of radiator fan, water pump, and battery charging alternator belt to make sure it is tight and in good condition.

OPERATING AREA: Make sure there are no obstructions that could block the flow of cooling air. Make sure area is clean. Rags, tools, or debris must not be left on or near the generator set.

EXHAUST SYSTEM: Exhaust outlet must be clear; silencer and piping must be tight and in good condition.

LAMP TEST (5-Light Controller Only): Press the lamp test button (if equipped) to verify all controller lamps are operational.

FUEL LEVEL: Make sure there is adequate supply; keep tanks full to allow operation for extended periods.

BATTERY: Check connections and level of battery electrolyte.

COOLANT LEVEL: Maintain coolant level at approximately 3/4 to 1 1/2 in. (19-38 mm) below the radiator filler neck seat when the engine is cold. See Safety Precautions before filling radiator. A coolant solution of 50% ethylene glycol and 50% clean, softened water is recommended to inhibit corrosion and prevent freezing to –34°F (–37°C). Do not use alcohol or methanol antifreeze or mix them with the speciied coolant. Do not add coolant to an engine that has overheated until engine has cooled. Adding coolant to an extremely hot engine can cause a cracked block or cylinder head.

NOTE

Do not turn on block heater (if equipped) before filling cooling system. Run engine until warm and refill radiator to purge air from the system. Block heater may be damaged if not immersed in water.

Exercising the Generator

If the generator set is not equipped with an automatic transfer switch or the transfer switch does not have the automatic exercise option, run the generator set under load once a week for one hour operator attended. Be sure to make all Prestart Checks before starting the exercise procedure. Start the generator set according to the procedure given for the generator controller. See Relay Controller Operation and 5-Light Controller Operation sections following for specific starting instructions.

Relay Controller Operation

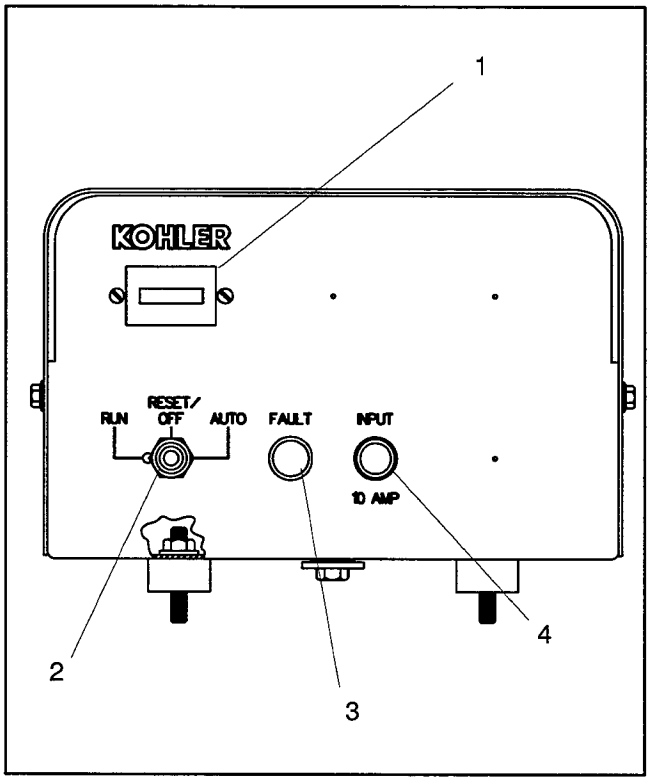
If the generator set is equipped with a relay controller, refer to Figure 2-1 and the following descriptions to identify controller components.

Fault Lamp lights to indicate a fault condition. Generator will shut down on Overcrank, Overspeed, High Engine Temperature, Low Oil Pressure, and Low Water Level faults. See Fault Shutdowns section following. (Fault lamp will not stay lit after unit shuts down. Fault lamp will only light as fault occurs.)

Hourmeter records total generator set operating hours for reference in maintenance scheduling.

Generator Master Switch dual function of generator operation and generator reset. Refer to Start/Stop and Resetting procedures following.

Controller 10-Amp Fuse protects controller circuitry.



1. Hourmeter
2. Generator Master Switch
3. Fault Lamp
4. Controller Fuse

Figure 2-1. Relay Controller Features.

Start/Stop Procedure (Relay Controller)

Starting

Move controller or remote Start/Stop switch to Run position until the engine starts. If the engine fails to start after cranking for 30 seconds, the unit will stop due to overcrank fault shutdown. Wait for the engine to come to a completer stop before attempting restart. Place switch in RESET/OFF position and then to RUN position.

NOTE

Do not crank engine continuously for more than 30 seconds at a time. A 60 second cooldown period must be allowed between cranking attempts if the engine does not start. If the unit does not start after three attempts, see Section 4 General Troubleshooting for possible causes.

Stopping

1. Run generator set at no load for 5 minutes to allow engine cooldown.
2. Move controller or remote Start/Stop switch to Off/Reset position.

Fault Shutdowns (Relay Controller)

The generator will shut down automatically under the following fault conditions. The shutdown switches will automatically reset when the problem is corrected or the generator set cools (if overheating was the fault).

Overcrank shutdown occurs if engine does not start after 30-60 seconds of continuous cranking.

Overspeed generator will shut down immediately if governed frequency exceeds 70 Hz (2100 rpm) on 50 and 60 hz models.

High Engine Temperature shutdown occurs approximately 8 seconds after fault. Fault occurs when engine coolant temperature reaches 230°F (110°C).

Low Oil Pressure shutdown occurs approximately 8 seconds after fault. Fault occurs when engine oil pressure drops to 7.1 psi (49 kPa).

Low Coolant Level shutdown occurs approximately 8 seconds after coolant level sensor detects no coolant at sensor tip. Coolant level sensor is located in radiator upper tank.

NOTE

If the cause of a high engine temperature, low oil pressure, or low coolant level shutdown is not corrected, the generator can be restarted (after controller reset) and will run approximately 8 seconds before shutting down again. See Resetting Procedure Fault Shutdowns for full resetting procedure.

Circuit Protection

An optional line circuit breaker (sized for generator output) is available to protect the generator from damage due to overload or short circuits. If the circuit breaker trips, reduce the load and switch the breakers back to the ON position. With the breaker in the OFF position, the generator will run but there will be no output voltage.

NOTE

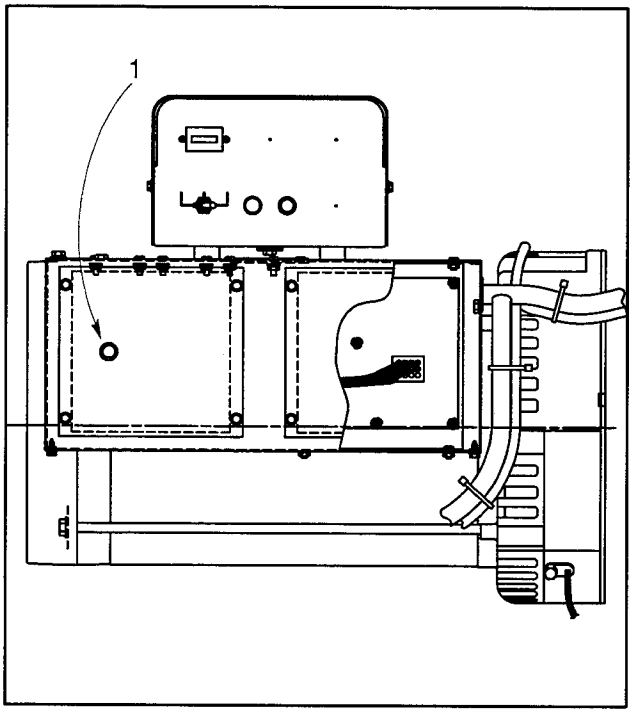
If the generator circuit breaker trips repeatedly, see Section 4 General Troubleshooting for possible causes.

The controller circuitry is protected by a replaceable 10-Amp fuse. If the generator will not crank and the battery and/or connections appear okay, the controller fuse may be blown. Replace fuse. If fuse blows again, see Section 4 General Troubleshooting for possible causes.

A replaceable 10 amp fuse protects the voltage regulator circuitry **on ROY/RFOY** models. If this fuse is blown, the generator set will shut down. Typically with this condition, the unit will start and then shutdown in 8 seconds. If this fuse is replaced and then blows again, see Section 4 General Troubleshooting for possible causes. Location of the voltage regulator fuse is shown in Figure 2-2.

Resetting Procedure-Fault Shutdown (Relay Controller)

If the generator set stops running due to a fault shutdown, the controller must be reset and the fault corrected before the generator can be restarted.



1. Fuse

Figure 2-2. Voltage Regulator Fuse

NOTE

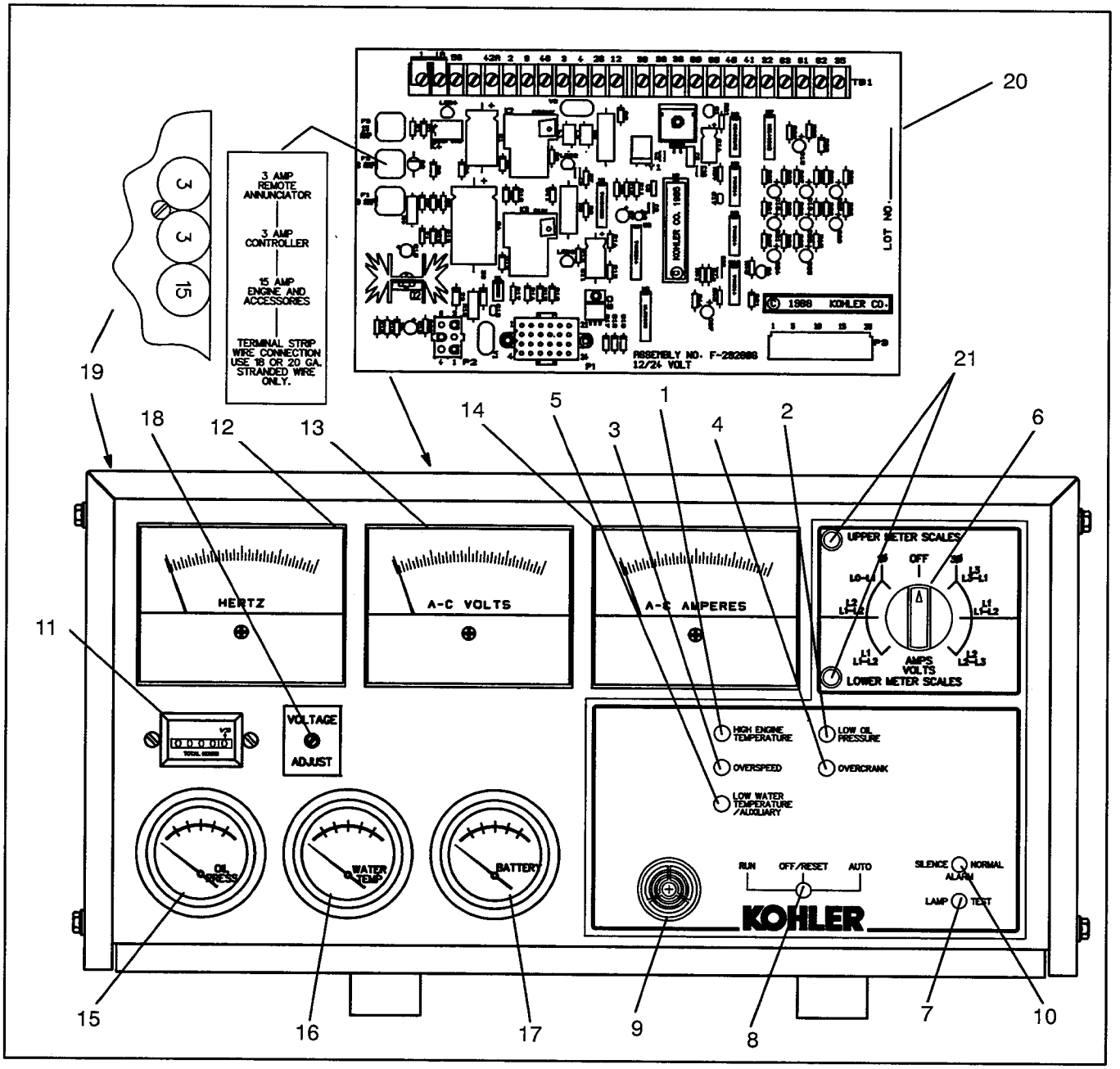
If the fault is not corrected, the unit will start and then shutdown in 5-10 seconds.

1. Move generator master switch to the OFF/RESET position until the fault lamp goes out.
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Move generator master switch to the RUN position to restart the generator set. Refer to Section 4 General Troubleshooting for possible causes of fault shutdown.
4. Return generator master switch to the OFF/RESET position.
5. Correct cause of fault shutdown. See Safety Precautions before proceeding.
6. Move generator master switch to normal position (RUN or AUTO) for start-up.

5-Light Microprocessor Controller Operation

Features

If the generator set is equipped with a 5-Light Microprocessor Controller, refer to Figure 2-3 and the following descriptions to identify controller components.



1. High Engine Temperature
2. Low Oil Pressure
3. Overspeed
4. Overcrank
5. Low Water Temperature/Auxiliary
6. Selector Switch
7. Lamp Test
8. Generator master Switch
9. Alarm Horn
10. Alarm Silence
11. Hourmeter
12. Frequency Meter
13. AC Voltmeter
14. AC Ammeter
15. Oil Pressure
16. Water Temperature
17. DC Voltmeter
18. Voltage Adjustment Pot
19. Fuses
20. Controller TB1 Terminal Strip
21. Meter Scale Lights

Figure 2-3. 5-Light Controller Features

1. **High Engine Temperature** lamp lights if engine has shut down due to high engine coolant temperature. Shutdown occurs 5 seconds after engine reaches temperature of approximately 230°F (110°C).
2. **Low Oil Pressure** lamp lights if set shuts down due to insufficient oil pressure. Shutdown occurs 5 seconds after engine oil pressure drops to 7.1 psi (49 kPa).
3. **Overspeed** lamp lights if set shuts down due to overspeed condition governed frequency exceeds 70 Hz [2100 rpm] on 50 and 60 Hz models.
4. **Overcrank** cranking stops and overcrank lamp will light if engine does not start after 45 seconds of continuous cranking or 75 seconds of cyclic cranking. See Auto Starting.
   - Cranking stops and overcrank lamp will light after 15 seconds if starter or engine will not turn (locked rotor).
   - Overcrank lamp will flash if speed sensor signal is absent longer than one second.

   NOTE

   The Microprocessor Controller is equipped with an automatic restart function. The genset will attempt to restart if the engine speed drops below 13 Hz (390 rpm). Failure to correct the cause of the decreased engine speed will result in an overcrank condition.

5. **Low Water Temperature (LWT) Auxiliary** lamp will flash or will be continuously on to indicate a fault has occurred.

   Flashing Lamp Conditions

   - The LWT/auxiliary lamp will flash immediately if the controller senses no AC output while the unit is running (except during first 10 seconds after start-up). When AC output is sensed, the flashing will stop and the lamp will be off. No manual reset is required.
   - The LWT/auxiliary lamp will flash if the battery power was reconnected or was low and then came back up again while the generator master switch was in the RUN or AUTO position. This may be caused by a temporarily low battery condition where the battery is weak or undersized for the application. To clear this condition, place master switch in the OFF/RESET position.

   Continous On Lamp Conditions

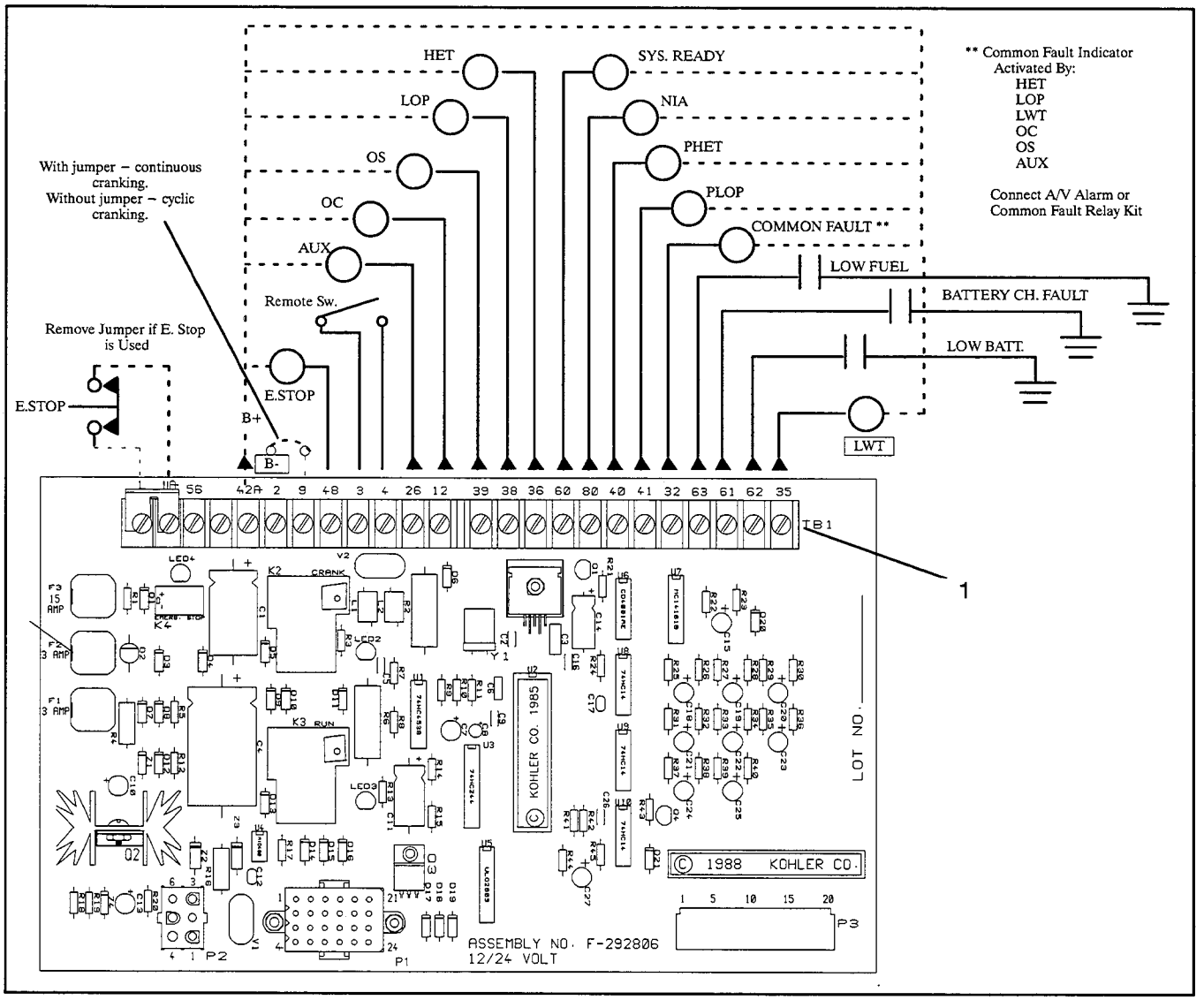
   - The LWT/auxiliary lamp lights and unit shuts down immediately if the optional emergency stop switch is activated (if equipped with optional emergency stop switch).
   - The LWT/auxiliary lamp lights if the optional emergency stop switch is reset while the generator master switch is in the AUTO or RUN position. To clear this condition. place master switch to OFF/RESET position.
   - The LWT/auxiliary lamp lights and engine shuts down 5 seconds after high oil temperature (P1-13), low coolant level (P1-14), or aux. delay shutdown (P1-15) faults occur (if so equipped). These conditions are inhibited during first 30 second after crank disconnect.
   - The LWT/auxiliary lamp lights and engine shuts down if overvoltage condition arises (if equipped with overvoltage shutdown kit).
   - The LWT/auxiliary lamp lights and engine shuts down if activated by customer-supplied sensing devices connected to auxiliary immediate shutdown ports (P1-24 and P1-18).
   - The LWT/auxiliary lamp lights if engine low water temperature (P1-24) condition occurs (if sensor equipped).
6. **Selector Switch** selects generator output circuits to be measured. When switched to a position with three circuit lead labels, amperage is measured on the upper lead and voltage is measured between the lower two leads. AC ammeter and voltmeter will not register with switch in the OFF position.
7. **Lamp Test** press to test the controller indicator lamps.
8. **Generator Master Switch** dual function of controller reset and generator operation switch. Refer to Starting, Stopping, and Resetting sections following.
9. **Alarm Horn** sounds if any fault or pre-alarm condition exists. The Alarm Horn can only be silenced with the generator master switch in the AUTO position. See Resetting Procedure following.

10. **Alarm Silence** disconnects alarm during servicing (generator master switch must be in the AUTO position). Alarm Horn switches at all locations (controller, remote annunciator, or A/V alarm) must be restored to normal position after fault shutdown is corrected to avoid reactivating alarm horn. See Resetting Procedure section following.
11. **Hourmeter** records generator set total operating hours for reference in scheduling maintenance.
12. **Frequency Meter** measures frequency (Hz) of generator output voltage.
13. **AC Voltmeter** measures voltage across output leads indicated.
14. **AC Ammeter** measures amperage from output leads indicated by selector switch.
15. **Oil Pressure** measures engine oil pressure.
16. **Water Temperature** measures engine coolant temperature.
17. **DC Voltmeter** measures voltage of starting battery(ies).
18. **Voltage Adjustment Pot** used to fine-tune generator output voltage. See Section 6 Generator Reconnection.
19. **Fuses** located on controller main circuit board.
    - **3-Amp Remote Annunciator (F1)** protects remote annunciator circuit, A/V Alarm, and Isolated Alarm Kit (if equipped).
    - **3-Amp Controller (F2)** protects controller circuit board, speed sensor, and lamp circuit board.
    - **15-Amp Engine and Accessories (F3)** protects engine/starting circuitry and accessories.
20. **Controller TB1 Terminal Strip** allows connection of generator accessories such as emergency stop switch, remote start/stop switch, audio-visual alarms, etc. Crank mode selection (cyclic or continuous) is also made on the TB1 terminal strip. Refer to Figure 2-4 for identification of TB1 terminals and connection of accessories.

CIRCUIT BOARD TERMINAL IDENTIFICATION (TB1)

Term.	Description
1	Ground Emergency Stop Relay (K4)—Connect Emergency Stop Across Terminals TB1-1 and 1A.
1A	Emergency Stop Relay (K4) Coil; Negative—Connect Emergency Stop Across Terminals TB1-1 and 1A.
56	Not Used
42A	Battery Voltage (Fuse #1 Protected) Accessory Power Supply; Customer May also Provide Separate Accessory Power Source
2	Ground Terminal
9	Crank Mode Selection (open cyclic crank; ground—continuous crank) Connect TB1-2 to TB1-9 for Continuous Cranking; Leave TB1-9 open for cyclic cranking. See Crank Mode Selection Following
48	Emergency Stop Signal *
3	Remote Start Ground—Connect Remote Start Switch to TB1-3 and TB1-4
4	Remote Start—Connect Remote Start Switch to TB1-3 and TB1-4
26	Auxiliary Signal *
12	Overcrank Signal *
39	Overspeed Signal *
38	Low Oil Pressure Signal *
36	High Engine Temperature Signal *
60	System Ready Signal *
80	Not In Auto Signal *
40	Prealarm High Engine Temperature Signal *
41	Prealarm Low Oil Pressure Signal *
32	Common Fault/Prealarm Line—A/V Alarm or Common Fault Relay Activated by HET, LOP, LWT, OC, OS, and AUX Faults
63	Low Fuel—Connect Fuel Level Sensor to TB1-63 to Activate Fault Lamp (If Used)
61	Battery Charger Fault—Connect Battery Charger to TB1-61 to Activate Fault Lamp (If Used)
62	Low Battery Volts—Connect Battery Charger to TB1-62 to Activate Fault Lamp (If Used)
35	Low Water Temperature—Connect LWT Sensor (Prealarm Kit) to TB1-35 to Activate AUX/LWT Lamp

* Optional signals used to drive A/V alarms, remote annunciator, and/or dry contact controls.



1. TB1 Terminal Strip

Figure 2-4. Controller TB1 Terminal Strip

Starting (5-Light Controller)

Local Starting

To start the generator set at the controller, move the generator master switch to the RUN position.

NOTE

The alarm horn will sound whenever the generator master switch is not in the AUTO position.

NOTE

The Microprocessor Controller is equipped with a transient Start/Stop function to avoid accidental cranking of the rotating engine. If the generator master switch is momentarily placed in the OFF/RESET position then quickly returned to RUN, the genset will slow to 249 rpm and recrank before returning to rated speed.

NOTE

The Microprocessor Controller is equipped with an automatic restart function. The genset will attempt to restart if the engine speed drops below 13 Hz (390 rpm). Failure to correct the cause of the decreased engine speed will result in an overcrank condition.

Auto (Remote) Starting

To allow start-up by automatic transfer switch or remote start-stop switch (connected to controller terminals TB1-3 and TB1-4) move the generator master switch to the AUTO position.

Crank Mode Selection

The Microprocessor Controller provides up to 45 seconds of continuous cranking or 75 seconds of cyclic cranking (crank 15 seconds, rest 15 seconds, crank 15 seconds, etc.) before overcrank shutdown. Cranking mode (cyclic or continuous) selection is made on the controller circuit board terminal strip. For cyclic cranking, leave circuit board terminal TB1-9 open. Continuous cranking is achieved by running a jumper between circuit board terminal TB1-2 (ground) and terminal TB1-9.

Stopping

Normal Stopping

1. Disconnect load from generator set and allow it to run without load for 5 minutes.

NOTE

Run the generator at no load for 5 minutes prior to stopping to insure adequate cooling of the set.

2. Move generator master switch to the OFF/RESET position. The engine will stop.

NOTE

If engine stop is signaled by a remote switch or Automatic Transfer Switch, the generator set will continue running during a 5 minute cooldown cycle.

Emergency Stopping

Move generator master switch to the OFF/RESET position or activate remote emergency stop (if equipped) for immediate shutdown. If the emergency stop switch is activated, the controller LOW WATER TEMPERATURE/AUXILIARY lamp will light and the unit will shut down. If equipped, remote annunciator and/or audio-visual alarms will signal an emergency stop.

NOTE

The Emergency Stop Switch(s) are to be used for emergency shutdowns only. Use the generator master switch to stop the generator set under normal circumstances.

Circuit Protection

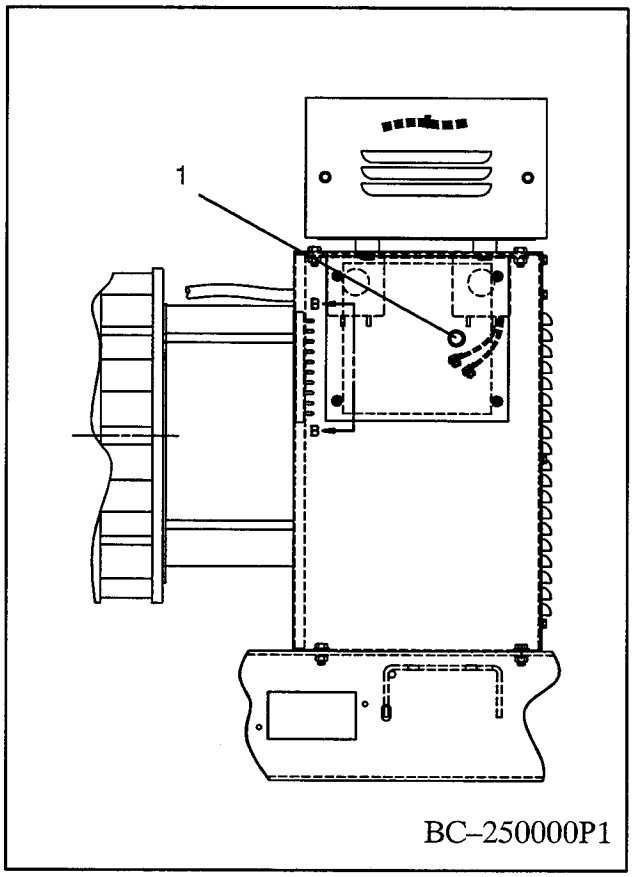
An optional line circuit breaker (sized for generator output) is available to protect the generator from damage due to overload or short circuits. If the circuit breaker trips, reduce the load and switch the breakers back to the ON position. With the breaker in the OFF position, the generator will run but there will be no output voltage.

NOTE

If the generator circuit breaker trips repeatedly, have the generator set examined by an authorized service/distributor dealer.

The engine and controller circuitry is protected by fuses F1 (3-Amp), F2 (3-Amp) and F3 (15-Amp) on the controller circuit board. See Fuses earlier in this section. If the generator will not crank or accessories will not work and the battery/connections appear okay, one of these fuses may be blown. The controller meters and lights are protected by fuses V7, V8, and V9 on the AC terminal block (TB2). If the controller lights and meters are not functioning, check the condition of the V7, V8, and V9 fuses. If a fuse is replaced then blows again, have the generator inspected by an authorized service distributor/dealer

A replaceable 10-Amp fuse protects the voltage regulator circuitry from damage due to overload or short circuits. If this fuse is blown, the generator set will shut down. If this fuse is replaced then blows again, see Section 4 General Troubleshooting for possible causes. Location of the voltage regulator fuse is shown in Figure 2-5.



1. Fuse

Figure 2-5. Voltage Regulator Fuse

Resetting Procedure Remote Emergency Stop

1. Investigate cause of emergency stop and correct problem(s).
2. Reset remote emergency stop switch by replacing glass face on switch.

NOTE

The controller LOW WATER TEMP/AUXILIARY lamp will light if the generator master switch is in the RUN or AUTO position during the resetting procedure.

3. Toggle generator master switch to OFF/RESET and then to RUN or AUTO to resume operation. The generator set will not crank until the resetting procedure is completed.

Fault Shutdowns

The generator will shut down automatically under the following fault conditions. The generator set will not run until the fault condition has been corrected. The shutdown switches will automatically reset when the problem is corrected or the generator set cools (if high engine temperature was the fault).

NOTE

Low Oil Pressure, High Engine Temperature, High Oil Temperature, and Low Coolant Level Shutdowns will not function during the first 30 seconds after start-up. If the cause of the shutdown is not corrected, the generator can be restarted (after controller reset) and will run approximately 30 seconds before shutting down again. See Resetting Procedure-Fault Shutdown for resetting procedure.

Overcrank shutdown occurs after 45 seconds of continuous cranking or after 75 seconds of cyclic cranking (crank 15 seconds, reset 15 seconds, crank 15 seconds, etc. for a total of 75 seconds). Shutdown occurs after 15 seconds if engine or starter will not turn (locked rotor).

Overspeed generator will shut down immediately if governed frequency exceeds 70 Hz (2100 rpm) on 50 and 60 hz models.

High Engine Temperature shutdown occurs approximately 5 seconds after fault. Fault occurs when engine coolant temperature reaches 230°F (103°C). High engine temperature shutdown will not function during first 30 seconds after start-up.

Low Oil Pressure shutdown occurs approximately 5 seconds after fault. Fault occurs when engine oil pressure drops to 7.1 psi (49 kPa). Low oil pressure shutdown will not function during the first 30 seconds after start-up.

Overvoltage generator (if equipped) will shut down after approximately one second of voltage 15% or more over nominal voltage. LOW WATER TEMP/AUXILIARY lamp will light.

Low Coolant Level shutdown occurs approximately 5 seconds after fault. Fault occurs when the engine coolant falls below the safe range in the radiator. The LOW WATER TEMP/AUXILIARY lamp will light upon shutdown. The Generator set will not run until coolant is added to reach the specified level and the controller is reset. (The low coolant level shutdown is inhibited during the first 30 seconds after start-up)

NOTE

Sensitive equipment may suffer damage in less than one second of an overvoltage condition. On-line equipment requiring faster shutdowns should have separate overvoltage protection.

Resetting Procedure Fault Shutdown

Use the following procedure to restart the generator set after a FAULT shutdown. Refer to Emergency Stopping earlier in this section to reset the generator after an stop.

1. Move controller alarm horn switch to the SILENCE position. If equipped, A/V annunciator alarm horn and lamp are activated. Move A/V annuniciator alarm switch to SILENCE to stop alarm horn. A/V annunciator lamp stays lit. (The A/V alarm uses one lamp to indicate a fault shutdown; the appropriate fault lamp will light on the remote annunciator to indicate a fault condition.)
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Correct cause of fault shutdown. See Safety Precautions section of this manual before proceeding.
4. Start generator set by moving the generator master switch to OFF/RESET and then to the RUN position. If equipped, A/V annuniciator alarm horn sounds and lamp goes out.
5. Verify that cause of shutdown has been corrected by test operating generator set.
6. Reconnect generator to load via line circuit breaker or automatic transfer switch.
7. Move generator master switch to AUTO position for start-up by remote transfer switch or remote start/stop switch. If equipped, move A/V annunciator alarm switch to NORMAL.
8. Move controller alarm horn switch to the NORMAL position.

NOTE

Controller alarm horn can only be silenced with Controller Master Switch in AUTO position.

Section 3. Scheduled Maintenance

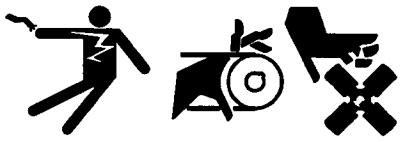
General

Schedule routine maintenance using the Maintenance Schedule following and the hourmeter located on the generator controller. If the generator will be subject to extreme operating conditions, service the unit more frequently. Instructions to perform most of the scheduled services are provided in the following pages.

Refer to the *generator operation manual* for general maintenance procedures and the *engine service manual* for engine overall procedures not provided in this manual. If the service schedule in this generator service manual differs from that of the generator operation manual, use the service schedule which provides the more stringent requirements.

Items in the maintenance schedule marked with an asterisk (*) should be performed more often if the generator set is operated in dirty, dusty conditions. Items identified with asterisks (**) should be performed only by an authorized service distributor/dealer.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

⚠ WARNING

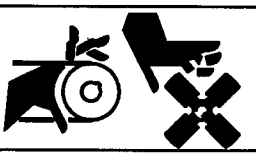
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, and clothing away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set.

Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft bolt or rotor thru-bolt counterclockwise can loosen hardware and result in serious personal injury from hardware or pulley flying off engine while unit is running.

NOTE

HARDWARE DAMAGE! Engine and generator may make use of both American Standard and metric hardware. Be sure to use the correct size tools to prevent rounding of bolt heads and nuts.

NOTE

The items listed in the service schedule must be performed at the designated intervals for the life of the generator. For example, an item to be serviced "Every 100 Hours or 3 Months" must also be serviced after 200 hours or 6 months, 300 hours or 9 months, etc. The generator will eventually accumulate enough hours to warrant a complete overhaul. The exact time at which extensive service will be necessary cannot be predicted. However, rough operation, lack of power, and excessive oil use indicate serious generator set problems. As part of a preventative maintenance program, service the engine (clean cylinder head, inspect valves, check compression, etc.,) and generator (replace bearing, inspect wiring, remove debris, etc.) at the earliest indication that a serious problem exists.

Service Schedule

Perform Service at Intervals Indicated (X)	Before Starting	After 50 Hrs./ 1 Month	Every 100 Hrs./ 3 Months	Every 300 Hrs./ 6 Months	Every 500 Hrs./ Yearly
FUEL SYSTEM					
Check the fuel level	●				
Fill fuel tank	●				
Remove sediment from fuel tank	●				
Replace the fuel filter element		●		●	
Check the injection timing **					●
Check governor operation and adjust **					●
Check the injection spray condition **					●
LUBRICATION SYSTEM					
Check the oil level in crankcase	●				
Replace the oil in crankcase *		●	●		
Replace the lube oil filter element *		●	●		
COOLING SYSTEM					
Check coolant level	●				
Adjust the tension of water pump belt		●	●		
Change coolant					●
Clean radiator fins, inspect hoses			●		
AIR CLEANER					
Replace the air cleaner element *				●	
Clean the breather pipe *			●		
ELECTRICAL SYSTEM					
Verify proper operation of gauges (if equipped) *	●				
Check the electrolyte level in the battery	●				
Check the electrical connections		●			
Check the battery specific gravity			●		
Adjust battery charging alternator belt		●	●		
CYLINDER HEAD					
Check for leakage of water and oil	●	●			
Retighten all major nuts and bolts		●			●
Check tightness mounting bolts/vibro mounts				●	
Retighten the cylinder head bolts **					●
Adjust intake/exhaust valve clearance **				●	
GENERATOR					
Blow dust out of generator *					●
Clean slip rings and inspect brushes **					●

* Service more frequently if operated in dusty areas.

** Should be performed by an authorized service distributor.

Engine Lubrication

Oil Selection

The selection of engine oil is very important to a diesel engine. If an unsuitable oil is used or an oil change is neglected, the engine may be damaged. Oil must meet the American Petroleum Institute (API) classification of CD, CD/CC, or CC. Avoid mixing different brands of oils and lubricants; oils of different manufacturers may be incompatible and deteriorate when mixed. Refer to Figure 3-1 to select the proper grade oil for the temperature range in which the generator set will be operated.

NOTE

Failure to observe these standards may cause inadequate lubrication/oil pressure and cold-starting difficulties.

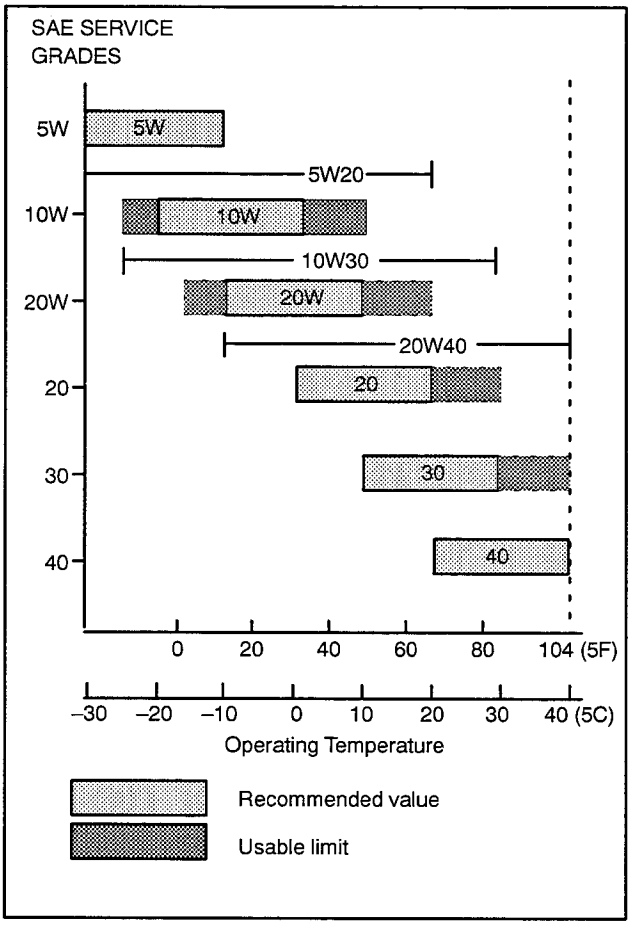


Figure 3-1. Engine Oil Selection

Fuel System

Specifications

Use clean, good quality No. 2-D (DIN 51 601) diesel fuel. The fuel must meet the requirements of the American Society of Testing and Materials (ASTM) diesel fuel classification D975 (Federal Specification W-F-800a). Cleanliness of the fuel is especially important with diesel engines which have easily clogged precision fuel injectors and pumps. See chart following for fuel specifications.

United States ASTM/D975 No. 2 Diesel	
United Kingdom BS2869 Class A1 or Class A2	
Other Fuel Considerations:	
Sulfer Content	Less than 0.5%
Sediment and Water Content	Not to exceed 0.1%
Cetane Number	Greater than 45
Pour Point	At least 10 F (5.6 C) below the lowest outside air temperature

NOTE

Never store diesel fuel in galvanized containers; diesel fuel and the galvanized coating react chemically to produce flaking which quickly clogs filters or causes failure of the fuel pump or injectors. Do not run the generator set out of fuel. Air will be drawn into the fuel lines and the entire system will have to be bled before the unit can be restarted.

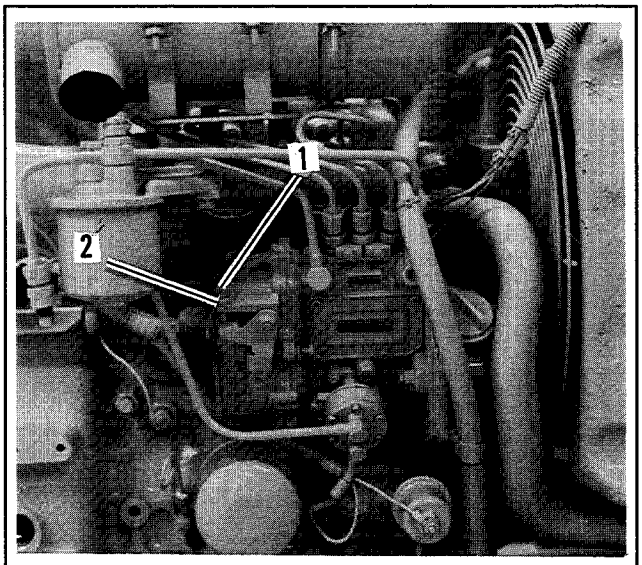
NOTE

Avoid storing fuel over long periods of time. Take special precautions to keep all dirt, water, and other contaminants out of the fuel. Storage tanks containing diesel fuel contaminated with water may cause the formation of microbes which will form a slime which will clog fuel filters and lines.

Governor

The centrifugal, mechanical-type governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. No regular service is required on the unit. The governor is adjusted during run-in at the factory and further adjustment should not be needed unless the generator is reconnected for a different frequency, varying load conditions are encountered, or poor governor control develops after extended usage.

ROY generator sets are designed to operate at 60 Hz., 1800 rpm under full load and 63 Hz., 1890 rpm under no load. RFOY generator sets are designed to operate at 50 Hz., 1500 rpm under full load and 53 Hz., 1590 rpm at no load. To check speed, use a frequency meter or hand tachometer. See Figure 3-2. Loosen locking nut on speed-adjusting screw. Turn screw in counterclockwise direction to increase speed or in clockwise direction to decrease speed. Tighten lock nut to secure screw at new setting.



1. Speed Adjusting Screw
2. Locking Nut

Figure 3-2. Mechanical Governor

Cooling System

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap stop generator, allow to cool and loosen pressure cap to relieve pressure.

Hot coolant can cause severe injury or death. Allow engine to cool and release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth then turn it slowly counterclockwise to the first stop. After pressure has been completely released and the engine has cooled, remove cap. If generator set is equipped with a coolant recovery tank, check coolant level at tank.

NOTE

Block heater (if equipped) will fail if not immersed in water. Always unplug block heater(s) before draining coolant and fill engine block with coolant prior to plugging in block heater(s). Block heater element MUST be immersed in engine coolant before being energized.

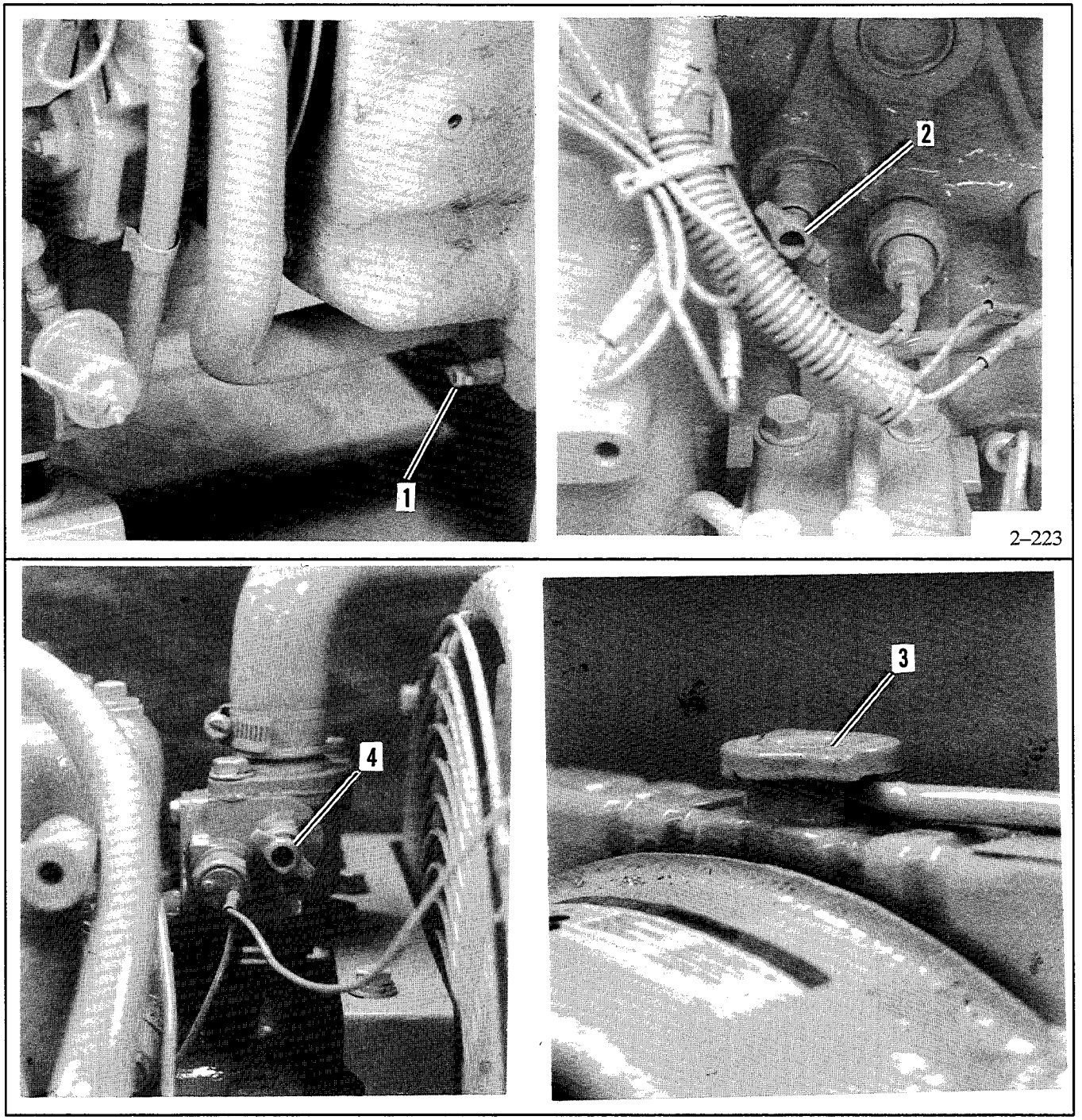
The cooling system may be drained by opening the petcock on the bottom of the radiator, removing the drain plug on the engine block and removing the radiator cap. To refill the cooling system, close drain plug and petcock and fill radiator to the proper level with the recommended coolant mixture. See Figure 3-2. Replace radiator cap and operate the engine until the thermostat opens and the radiator upper hose becomes hot. Stop the engine and add coolant to the radiator to just below the overflow tube on the filler neck. Replace radiator cap. Cooling system capacity for each model is found in Section 10 Specifications.

Use only a permanent-type coolant that meets specifications. A coolant solution of 50% etheylene glycol and 50% clean, softened water is recommended to inhibit corrosion and prevent freezing to -34°F (–37°C). Do not use alcohol or methanol antifreeze or mix them with the coolant. The coolant system is equipped with an air bleed feature.

NOTE

Be sure coolant is at proper level before operating the generator set. When refilling the cooling system, allow several minutes for complete refill of all air cavities in the radiator and engine block.

To prevent generator shutdown and/or damage due to overheating, service the cooling system at the intervals specified in the maintenance schedule. Inspect the exterior of the radiator for obstructions; remove all dirt and foreign material with a soft brush or cloth (to avoid damaging radiator fins). If available, clean radiator with compressed air or a stream of water in direction opposite normal air flow. Check all hoses and connections for leaks and replace any hoses that are cracked, frayed, or feel spongy. When coolant level checks are made, check condition of radiator cap rubber seal; replace if cracked or deteriorating. Remove dirt and other debris from radiator cap and filler neck.



1. Cooling System Drain
2. Engine Block Drain
3. Cooling System Fill
4. Thermostat Housing Air Bleed Petcock

Figure 3-3. Cooling System Drain/Fill/Air Bleed Locations

Generator Service

Under normal conditions, generator service will not be required on a regular basis. If operating under extremely dusty and dirty conditions, use dry compressed air to blow dust out of the generator at frequent intervals. Do this with the generator set operating and direct the stream of air in through the cooling slots at the end of the generator. The end bracket bearing should be replaced every 10,000 hours of operation in standby and prime power applications. Service more frequently if bearing inspection indicates excessive rotor end play or bearing damage from corrosion or heat build-up. The end bracket bearing is sealed and requires no additional lubrication. All generator service must be performed by an authorized service dealer/distributor.

Storage Procedure

If the generator set is to be out of service for a considerable length of time (three months or longer), perform the following steps before placing the set in storage.

1. Drain the oil (while still warm) from the crankcase and then refill with proper viscosity oil.
2. Drain fuel from fuel tank to prevent accumulated moisture with the fuel.
3. Check engine coolant protection.
4. Disconnect battery (negative lead first) and place in storage.
5. Seal all openings in engine with non-absorbent adhesive tape. Mask off all areas to be used for electrical contact (cover all pin connectors and terminals).
6. Clean exterior surface of the generator. Spread a light film of oil over unpainted metallic surfaces which could rust or corrode.

Section 4. General Troubleshooting

Use the following table as a quick reference in troubleshooting individual problems. Generator faults are listed by specific groups and correlated with possible causes and suggested remedies. Sources of additional information include various sections of this manual, the engine service manual, and are provided in the last column. Testing and corrective action often requires knowledge of electrical and electronic circuits. Improper repair by unauthorized personnel can lead to additional costs and failures. For these reasons, repairs should be done only by authorized service dealers/distributor.

General Troubleshooting

Problem	Possible Cause	Corrective Action	Reference
Unit will not crank	Weak or dead battery	Recharge or replace battery	See Operation Manual
	Reversed or poor battery connections	Check connections	
	Defective starter/starter solenoid	Rebuild or replace	See Engine Service Manual
	Defective start/stop switch (local or remote)	Test function; replace if defective	See Section 5 or 6 Controller Troubleshooting
	Fuse blown in controller	Replace fuse; if fuse blows again, check circuit and components	See Section 2 Operation and Section 5 or 6 Controller Troubleshooting
	Open in wiring, terminals, pin, circuit board, etc.	Check continuity	See Section 5 or 6 Controller Troubleshooting and Section 9 Wiring Diagrams
	Defective circuit board	Check circuit board operation	See Section 5 or 6 Controller Troubleshooting
	Overcrank shutdown	Check engine fuel supply. Shutdown occurs after 30 seconds of continuous cranking (relay controller) or 45 seconds of continuous cranking or 75 seconds of cyclic cranking (5-light controller). Cyclic cranking available on 5-Light Microprocessor Controller only.	
Cranks but will not start	Out of fuel	Replenish fuel supply	
	Air cleaner clogged	Clean or replace filter element	See Operation Manual
	Defective fuel solenoid	Test fuel solenoid	See Section 7 Component Testing
	Defective fuel pump	Test fuel pump	See Engine Service Manual
	Clogged fuel filter	Replace fuel filter	See Operation Manual
	Air in fuel system	Bleed air from system	See Operation Manual
	Bad fuel mixture	Replace fuel	
	Water, dirt in fuel system	Drain, flush fuel system	
	Dirty, faulty fuel injectors	Clean/repair injectors	See Engine Service Manual

Problem	Possible Cause	Corrective Action	Reference
Engine-continued	Faulty ground (–) connection	Clean and re-tighten	See Operation Manual
	Weak or dead battery	Recharge or replace	See Operation Manual
	Poor engine compression		See Engine Service Manual
	Blown voltage regulator fuse	Replace fuse	See Section 7 Component Testing
	Oil viscosity too heavy for ambient temperature		See Engine Service Manual
	Defective controller circuit board		See Section 5 or 6 Controller Troubleshooting
	Open in wiring,terminals, pin, circuit board, etc.	Check continuity	Section 5 or 6 Controller Troubleshooting and Section 9 Wiring Diagrams
Engine knocks	Faulty fuel injector(s)		See Engine Service Manual
	Air in fuel injectors	Bleed air from system	See Generator Operation Manual
	Improper fuel	Use proper fuel; consult fuel supplier	
	Incorrect fuel injection timing	Clean/Injectors	See Engine Service Manual
	Improper cylinder top clearance		See Engine Service Manual
	Defective piston pin bearing		See Engine Service Manual
	Defective crankshaft bearing or piston pin bearing		See Engine Service Manual
	Improper valve clearance	Check clearance	See Engine Service Manual
Starter motor does not work properly	Loose or corroded connections	Clean and tighten connections	See Operation Manual
	Battery not fully charged	Check battery electrolyte level and specific gravity. Recharge battery if necessary	See Operation Manual
	Defective starter solenoid	Test starter solenoid. Replace solenoid, if required	See Section 7 Component Testing
	Defective Starter motor	Rebuild or replace starter motor	See Engine Service Manual
	Engine lube oil viscosity too heavy for ambient temperature	Use proper viscosity oil	See Operation Manual
	Defective start/stop switch	Test/replace switch	See Section 7 Component Testing
	Defective wiring	Check wiring	Section 9 Wiring Diagrams
	Battery cables undersize	Select proper size cable	See Section 10 Specifications
Engine runs irregularly or stalls frequently	Vent in fuel tank obstructed	Remove obstruction	

Problem	Possible Cause	Corrective Action	Reference
Engine-continued	Clogged fuel filter	Replace fuel filter element	See Operation Manual
	Water, dirt, or air in fuel system	Drain, flush, bleed fuel system	See Operation Manual
	Dirty or faulty fuel injectors	Clean/repair injectors	See Engine Service Manual
	Faulty governor linkage or governor incorrectly adjusted	Check linkage	See Section 3 Governor and/or Governor Operation Manual
	Defective fuel feed pump	Replace fuel pump	See Engine Service Manual
	Improper valve clearance		See Engine Service Manual
	Defective valve spring(s)		See Engine Service Manual
	Poor engine compression		See Engine Service Manual
	Air intake restriction	Check air intake	
	Dirty air cleaner	Check and clean air cleaner element	
	Stale or bad fuel	Replace fuel	
	Improper cooling (Check hoses for blockage and components for function)	Inspect cooling system	See Operation Manual
	Engine overloaded	Reduce electrical load	
	Carbon build-up	Clean carbon from cylinder heads	See Engine Service Manual
	Engine malfunction	Troubleshoot engine	See Engine Service Manual
Stops Suddenly	Out of fuel	Replenish fuel supply	
	Air cleaner clogged	Replace air cleaner element	See Operation Manual
	Fuse blown in controller	Replace fuse	See Section 2 Operation & Operation Manual
	High engine temperature (HET) shutdown	Check engine coolant level, loose fan belt, radiator obstructions, etc.	See Section 2 Operation & Generator Operation Manual
	Low oil pressure (LOP) shutdown	Check engine lube oil level	See Section 2 Operation and Operation Manual
	Overcrank shutdown		See Section 2 Operation and Section 7 Component Testing
	Overspeed shutdown		See Section 2 Operation and Section 7 Component Testing
	Low Coolant Level (LCL) shutdown	Add coolant	See Section 2 Operation and Generator Operation Manual
	Defective fuel pump		See Engine Service Manual
	Clogged fuel filter	Replace filter	See Operation Manual
	Defective fuel solenoid		See Section 7 Component Testing
	Blown voltage regulator fuse	Replace fuse	See Section 7 Component Testing

Problem	Possible Cause	Corrective Action	Reference
	Remote emergency stop switch activated (if equipped)		See Section 2 Operation, Resetting
	Engine overheated (hot engine only)	Check air intake, oil level, cooling system	See Operation Manual
	Defective temperature safety shutdown switch		See Section 7 Component Testing
	Defective low oil pressure safety shutdown switch		See Section 7 Component Testing
Lacks Power	Air cleaner clogged	Replace air cleaner element	See Operation Manual
	Generator overloaded	Reduce load	
	Bad or stale fuel	Replace fuel	
	Engine not running at rated rpm	Check engine speed	See Section 3 Scheduled Maintenance, Governor
	Governor defective or misadjusted	Check engine speed	See Section 3 Scheduled Maintenance, Governor
	Improper cooling	Check engine coolant level, loose fan belt, radiator obstructions, etc.	See Operation Manual
	Fuel line restriction	Inspect fuel lines	
	Dirty fuel filter	Replace fuel filter	See Operation Manual
	Improper valve clearance		See Operation Manual or Engine Service Manual
	Dirty or faulty fuel injectors		See Engine Service Manual
	Incorrect fuel injection timing		See Engine Service Manual
	Poor engine compression		See Engine Service Manual
	Fuel tank vent obstructed	Remove obstruction	
Engine Overheats	Improper cooling	Check engine coolant level, loose fan belt, radiator obstructions, thermostat, etc.	See Operation Manual, Cooling and Engine Service Manual
	Clogged air cleaner	Replace air cleaner element	See Operation Manual
	Generator set overloaded	Reduce load	
Engine emits black or gray exhaust smoke	Improper type of fuel	Use proper fuel	See Operation Manual
	Clogged or dirty air cleaner	Replace air cleaner element	See Operation Manual
	Defective fuel injection pump		See Engine Service Manual
	Faulty fuel injectors		See Engine Service Manual
	Incorrect fuel injection timing		See Engine Service Manual
	Improper valve clearance		See Operation Manual or Engine Service Manual
	Lube oil level too high	Remove surplus lube oil	

Problem	Possible Cause	Corrective Action	Reference
Engine-continued	Improper grade engine lube oil	Use proper viscosity oil	See Operation Manual
Low lube oil pressure	Low lube oil level	Add engine lube oil	See Operation Manual
	Improper lube oil viscosity	Replace with lube oil of proper viscosity	See Operation Manual
	Defective lube oil pump		See Engine Service Manual
	Worn engine components		See Engine Service Manual
High lube oil consumption	Too light viscosity oil	Use proper viscosity oil	See Operation Manual
	Oil leakage from engine	Check for leakage in lines, around gaskets, drain plug, etc.	
	Clogged breather system	Clean breather system	See Operation Manual
	Defective piston ring, cylinder liner, valve guide, valve seat, etc.		See Engine Service Manual
High Fuel Consumption	Improper type fuel	Use proper fuel	See Operation Manual
	Clogged or dirty air cleaner element	Replace air cleaner element	See Operation Manual
	Engine overloaded	Reduce load	
	Improper valve clearance		See Engine Service Manual
	Incorrect fuel injection timing		See Engine Service Manual
	Poor engine compression		See Engine Service Manual
	Fuel leakage	Check for leakage at fuel tank, fuel lines, connections, etc.	
No battery charging output	Loose or corroded connections		See Operation Manual
	Sulfated or worn-out battery		See Generator Operation Manual
	Defective battery charging alternator	Rebuild or replace alternator	See Engine Service Manual
	Loose alternator belt	Retighten alternator belt	See Operation Manual

Problem	Possible Cause	Corrective Action	Reference
Generator			
No AC output	Circuit breaker open or defective (if equipped)	Reset circuit breaker to ON position Check for voltage on line side	
	Circuit breaker tripping due to overload on generator set	Reduce load	
	No battery voltage to voltage regulator during cranking ± terminals on regulator	Check for DC voltage at voltage regulator terminals ±	See Section 7 Component Testing
	Blown voltage regulator fuse	Replace fuse; if fuse blows again, check voltage regulator and/or stator winding	See Section 7 Component Testing
	Open wiring, terminal, or pin in build-up circuit or voltage regulator circuit	Check continuity	See Section 7 Component Testing and Section 9 Wiring Diagrams
	Brushes sticking in brush holder or broken brush springs	Check brush position and condition	See Section 7 Component Testing
	Rotor slip rings dirty or corroded	Check slip ring condition	See Section 7 Component Testing
	Defective rotor (open, shorted, or grounded windings)	Check voltage and continuity	See Section 7 Component Testing
	Defective stator (open, grounded, or shorted windings)	Check voltage and continuity	See Section 7 Component Testing
	Defective or misadjusted voltage regulator (PBIIIE only)	Excite rotor separately and check for AC output Readjust voltage regulator	See Section 7 Component Testing
	Defective circuit board K4 relay (field flashing)(relay controller only)	Test/replace relay controller circuit board	See Section 5 Controller Troubleshooting
	Defective K1 relay (field flashing) (5-Light Controller only)	Test/replace K1 relay	See Section 6 Generator/Controller Troubleshooting
Low output or excessive drop in voltage	Engine speed too low	Check engine speed	See Section 3 Scheduled Maintenance, Governor
	Generator overloaded	Reduce load	
	Defective voltage regulator	Test/readjust voltage regulator	See Section 7 Component Testing
	Voltage regulator improperly adjusted	Test/readjust voltage regulator	See Section 7 Component Testing
	Defective rotor	Test and/or replace	See Section 7 Component Testing
	Defective stator	Test and/or replace	See Section 7 Component Testing

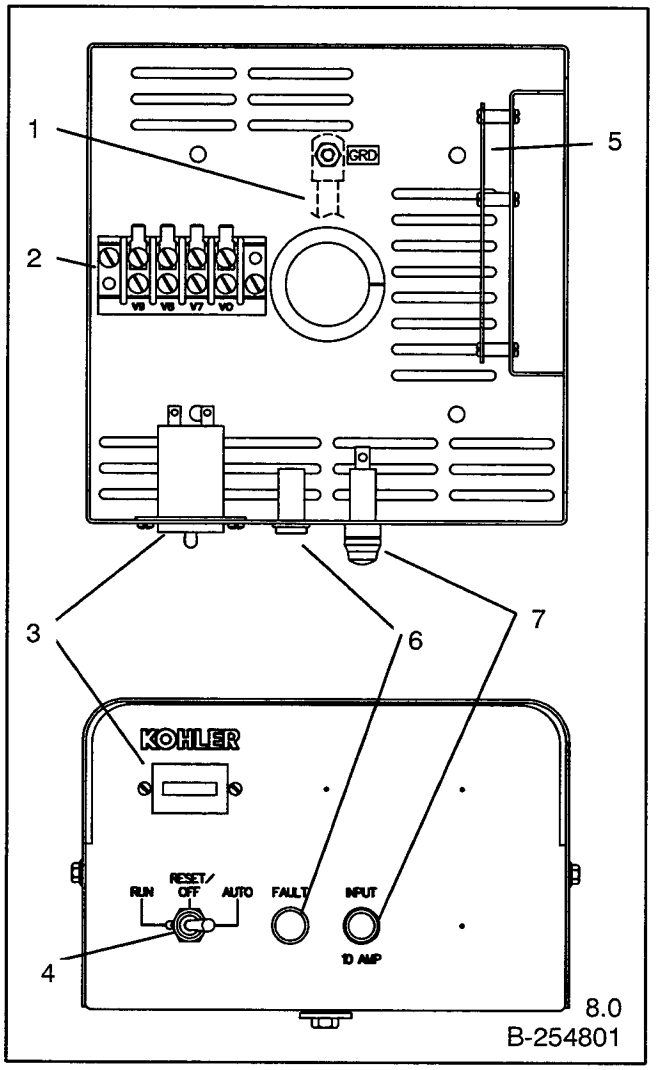
Problem	Possible Cause	Corrective Action	Reference
High generator output voltage	Engine speed too high	Check engine speed	See Section 3 Scheduled Maintenance, Governor
	Defective voltage regulator	Test/readjust voltage regulator	See Section 7 Component Testing
	Voltage regulator improperly adjusted	Check voltage regulator connections	See Section 7 Component Testing
	Loose voltage regulator connections (including stator sensing leads)		

Section 5. Controller Troubleshooting

Relay Controller

Description

This section covers the controller troubleshooting procedure for generators equipped with local or remote relay controller and related engine components. Refer to Section 2 Relay Controller Operation to identify controller external components. Refer to Figure 5-1 to identify the internal components of the relay controller.



1. Ground Strap
2. TB2 AC Terminal Strip
3. Hourmeter
4. Generator Master Switch
5. Controller Main Circuit Board
6. Fault Lamp
7. 10 Amp Fuse

Figure 5-1. Relay Controller Internal Components

Sequence Of Operation

This section covers the controller sequence of operation during generator start, run, stop, and fault shutdown modes. Use this section as a starting point for controller fault identification. The LEDs on the controller circuit board are intended to assist in the troubleshooting process. An illuminated LED indicates that the respective relay is receiving power; the LED does not indicate that the relay is energized. (Additional relay test procedures are covered later in this section.) Refer to the diagrams in Figure 5-2 and Figure 5-3 to assist in the troubleshooting procedure.

Starting

1. Close the start/stop switch between N and 47 (local or remote).
2. K2 relay is energized (LED 2 lights). Normally-open K2 (A) contacts close to energize engine components (fuel pump, fuel solenoid, governor system, hourmeter, and gauges [if so equipped]) and K4 relay (LED 4 lights).
3. Normally-open K4 (B) contacts close to supply field flash current to rotor and energize K20 relay. K20 relay normally-open contacts (C) close to energize S relay. S relay normally-open contacts close to energize starter motor.
4. When engine comes up to speed normally- closed low oil pressure switch contacts open.

Running

When proper AC output is obtained from generator 1-2 (V0-V7) winding or engine speed reaches 1100 rpm, K3 relay is energized (LED 3 lights). K3 normally-closed contacts (D) open to deenergize K4 relay. K4 normally-open contacts (B) open to de-energize K20 relay and disconnect field flash circuit. K20 normally-open contacts (C) open to de-energize C relay. C relay normally-open contacts open to de-energize starter motor.

NOTE

After AC voltage is sensed by the crank disconnect circuit. The K3 relay has a 5-second time delay before energizing. When the K3 relay is energized the low water level, high engine temperature, and low oil pressure shutdown switches will function.

Stopping

Move start/stop switch to open circuit between N and 47.

K2 relay is deenergized (LED 2 goes out) and K2 contacts (A) open to deenergize engine components. Generator stops.

Low Oil Pressure (LOP) Shutdown

Five to eight seconds after engine lube oil pressure falls below 7.1 psi (49 kPa) and LOP switch contacts close, the K1 relay is energized (LED 1 lights). Normally-open K1 contacts (F) close and fault lamp lights. Normally-closed K1 contacts (G) open to deenergize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to off/reset before set can be restarted.)

High Engine Temperature (HET) Shutdown

Five to eight seconds after the engine operating temperature reaches 230°F (110°C) and HET switch contacts close, K1 relay is energized (LED 1 lights). Normally-open K1 contacts (F) close and fault lamp lights. Normally-closed K1 contacts (G) open to deenergize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to off/reset before set can be restarted.)

Low Water Level (LWL) Shutdown

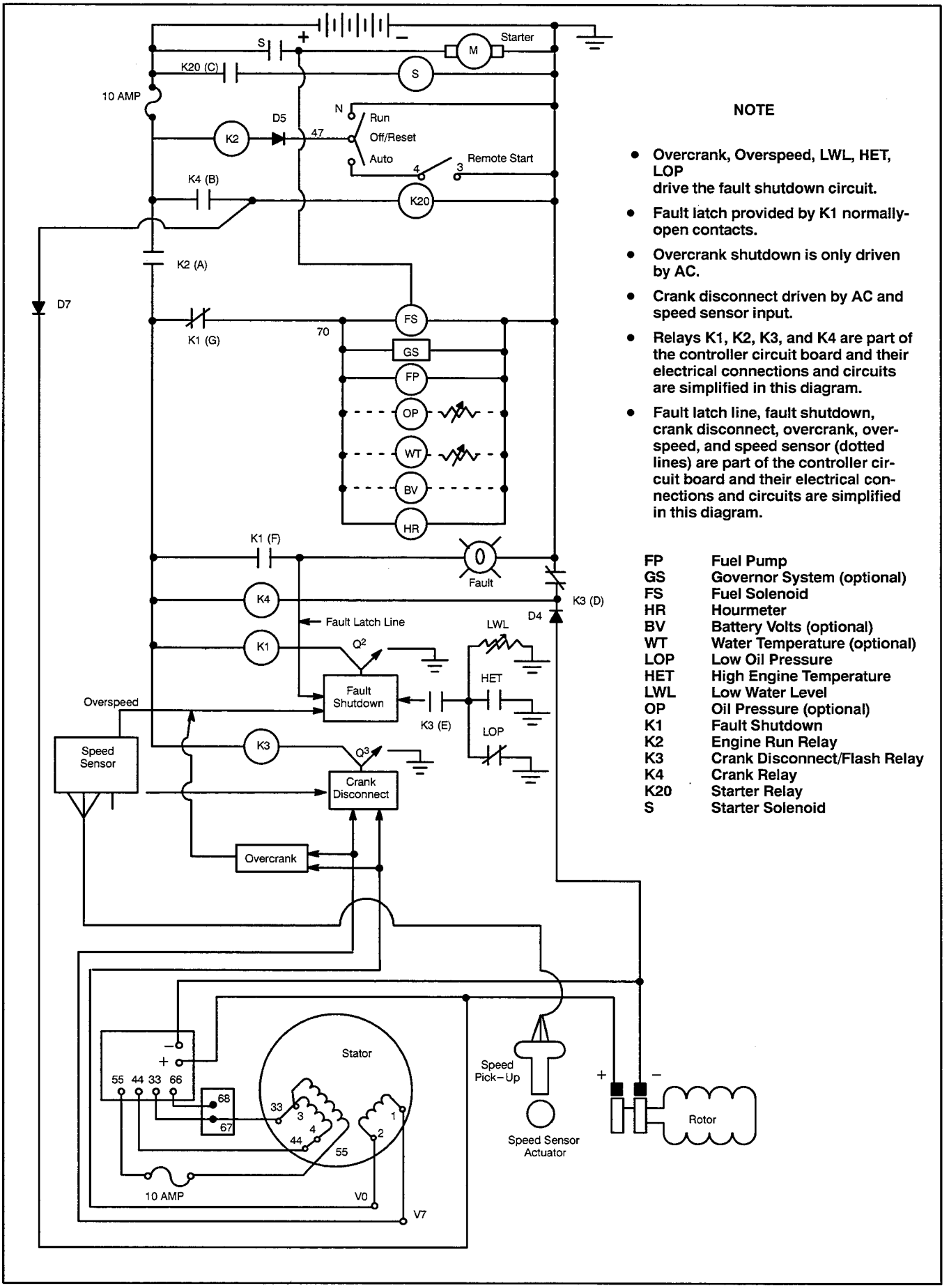
Five to eight seconds after the engine coolant level falls below the safe range and LWL sensor decreases circuit resistance, K1 relay is energized (LED 1 lights). Normally-open K1 contacts (F) close and fault lamp lights. Normally-closed K1 contacts (G) open to deenergize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to off/reset before set can be restarted.)

Overspeed Shutdown

When engine speed exceeds 70 Hz (2100 rpm) on 50/60 Hz sets, K1 relay is energized (LED 1 lights). Normally-open K1 contacts (F) close and fault lamp lights. K1 normally-closed (G) contacts open to deenergize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to off/reset before set can be restarted.)

Overcrank Shutdown

If the generator does not start after three crank cycles (crank-rest, crank-rest, crank), the K1 relay is energized (overcrank). Normally-open K1 contacts (F) close and the fault lamp will light. K1 normally-closed contacts open to deenergize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to off/reset before set can be restarted.)



NOTE

- Overcrank, Overspeed, LWL, HET, LOP drive the fault shutdown circuit.
- Fault latch provided by K1 normally-open contacts.
- Overcrank shutdown is only driven by AC.
- Crank disconnect driven by AC and speed sensor input.
- Relays K1, K2, K3, and K4 are part of the controller circuit board and their electrical connections and circuits are simplified in this diagram.
- Fault latch line, fault shutdown, crank disconnect, overcrank, overspeed, and speed sensor (dotted lines) are part of the controller circuit board and their electrical connections and circuits are simplified in this diagram.

FP	Fuel Pump
GS	Governor System (optional)
FS	Fuel Solenoid
HR	Hourmeter
BV	Battery Volts (optional)
WT	Water Temperature (optional)
LOP	Low Oil Pressure
HET	High Engine Temperature
LWL	Low Water Level
OP	Oil Pressure (optional)
K1	Fault Shutdown
K2	Engine Run Relay
K3	Crank Disconnect/Flash Relay
K4	Crank Relay
K20	Starter Relay
S	Starter Solenoid

Figure 5-2. ROY/RFOY Sequence of Operation Diagram (Relay Controller)

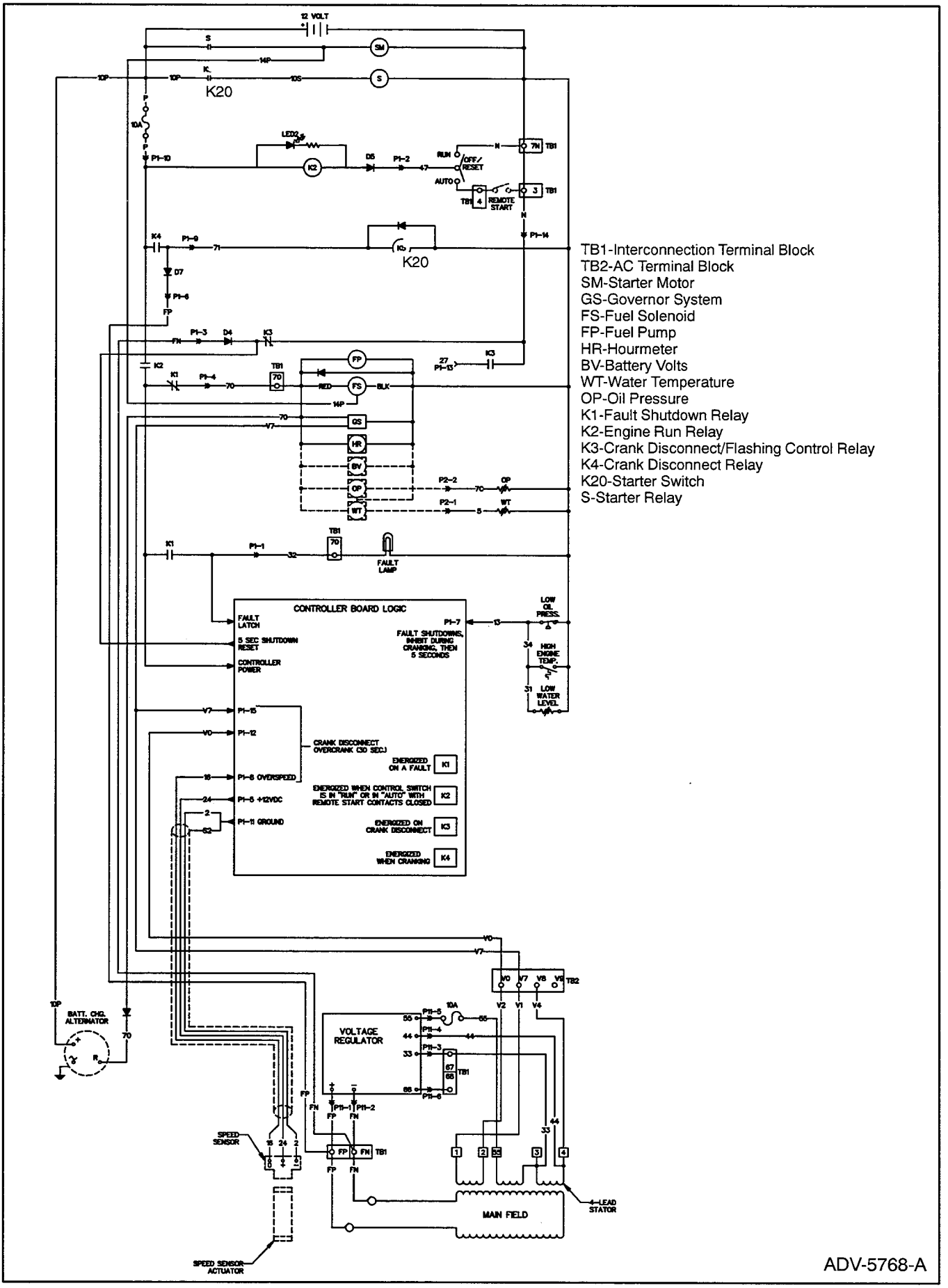
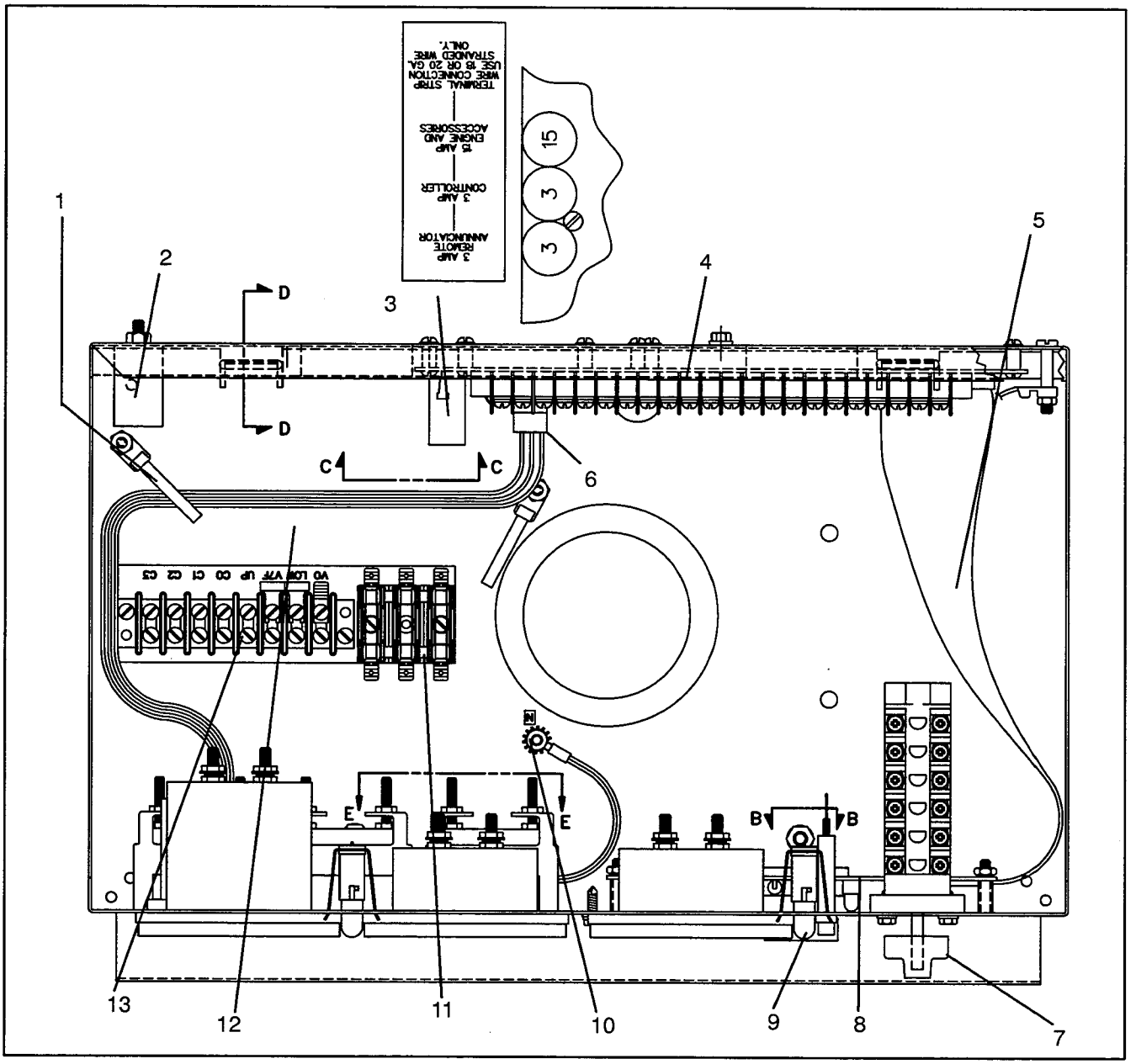


Figure 5-3. ROY/RFOY Logic Schematic (Relay Controller)

5-Light Microprocessor Controller

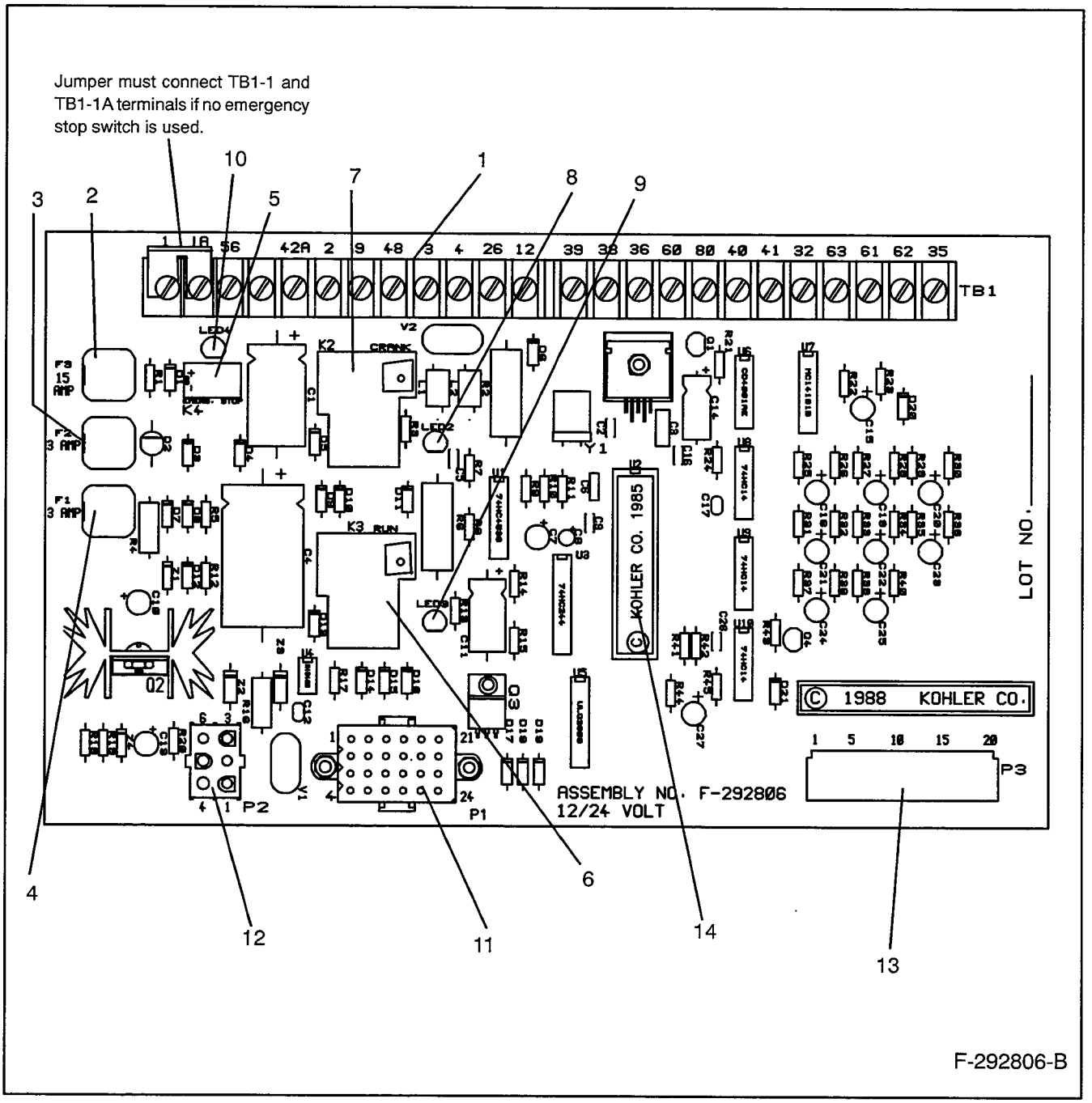
Introduction

Troubleshooting the microprocessor controller and related engine components is done through a combination of methods including fault detection flow charts and Fast Check diagnostic testing. These methods are described in the following pages. To identify external features, see Section 2 5-Light Microprocessor Controller Operation. Refer to Figure Figure 5-4 to identify controller internal components. Refer to Figure 5-5 to identify controller circuit board components. Figure 5-6 and Figure 5-7 is a logic schematic showing input/output circuits for reference in troubleshooting the controller.



1. Accessory Wire Guide Loops
2. K1 Relay (Field Flash)
3. Controller Fuses F1, F2, F3
4. Controller Main Circuit Board
5. P3/P4 Harness
6. Selector Switch
7. Lamp Circuit Board
8. Panel Lamps
9. DC Ground Terminal (TB3)
10. AC Fuse Terminal Block (TB3)
11. Lamp Selection Jumper
12. CT/Meter Scale Terminal Block (TB2)

Figure 5-4. 5-Light Microprocessor Controller Components



1. TB1 Terminal Strip (Accessories)
2. Fuse-15 Amp (F3) Engine and Accessories
3. Fuse-3 Amp (F2) Controller
4. Fuse-3 Amp (F1) Remote Annunicator
5. K4 Relay (Emergency Stop Relay)
6. K3 Relay (Run Relay)
7. K2 Relay (Crank Relay)
8. LED2
9. LED3
10. LED4
11. P1 Connector (DC Harness)
12. P2 Connector (AC Harness)
13. P3 Connector (Control Panel Harness)
14. Microcomputer Chip (U6)

Figure 5-5. 5-Light Microprocessor Controller Circuit Board Components

CIRCUIT BOARD TERMINAL IDENTIFICATION (TB1)

1. 1—Ground—Emergency Stop Relay (K4)
2. 1A—Emergency Stop Relay (K4) Coil; Negative
3. 56—Air Damper
4. Not Used
5. 42A—Battery Voltage (Fuse #1 Protected)
6. 2—Ground
7. 9—Crank Mode
   (open—cyclic crank; ground—continuous crank)
8. 48—Emergency Stop Indicator
9. 3—Remote Start Ground
10. 4—Remote Start (Active Low*)
11. 26—Auxiliary Indicator
12. 12—Overcrank Indicator
13. 39—Overspeed Indicator
14. 38—Low Oil Pressure Indicator
15. 36—High Engine Temperature Indicator
16. 60—System Ready Indicator
17. 80—Not In Auto Indicator
18. 40—Prealarm High Engine Temperature Indicator
19. 41—Prealarm Low Oil Pressure Indicator
20. 32—Common Fault/Prealarm Line
21. 63—Low Fuel (Active Low*)
22. 61—Battery Charger Fault (Active Low*)
23. 62—Low Battery Volts (Active Low*)
24. 35—Low Water Temperature

P1 CONNECTOR PINS

1. Output to K1 Relay (Crank Relay), Wire 71
2. Ground for Speed Sensor, Wire 2
3. Output to Safeguard Breaker Terminal, Wire 70
4. Not Used
5. Ground (-), Wire N
6. Speed Sensor Shield Ground, Wire S2
7. Output to Governor System (GS), Wire 70
8. Battery Positive to Speed Sensor, Wire 24
9. Input from Speed Sensor, Wire 16
10. Not Used
11. Not Used
12. Input from Battery Positive (P)
13. Not Used
14. Input from Water Level Switch, Wire 31
15. Not Used
16. Not Used
17. Not Used
18. Not Used
19. Not Used
20. Not Used
21. Input from High Engine Temperature Switch, Wire 34
22. Input from Low Oil Pressure Switch, Wire 13
23. Not Used
24. Not Used

P2 CONNECTOR PINS

1. Output to Oil Pressure Sender, Wire 70
2. Input from Overvoltage Board, Wire 30
3. Input for AC Crank Disconnect and Instrumentation, Wire V7
4. Not Used
5. Input for AC Crank Disconnect and Instrumentation, Wire V0
6. Engine Ground, Wire 2

P3 CONNECTORS PINS

7. Output to Low Water Temperature/Aux Indicator (E.Stop), Wire 48
8. Output to Low Water Temperature/Aux Indicator, Wire 26
9. Output to Overcrank Indicator, Wire 12
10. Output to Overspeed Indicator, Wire 39
11. Output to Low Oil Pressure Indicator, Wire 38
12. Output to High Engine Temperature Indicator, Wire 36
13. Not Used
14. Voltage (+) to Front Panel, Wire 24
15. Not Used
16. Not Used
17. Not Used
18. Output to Low Water Temperature/Aux Indicator, Wire 35
19. Not Used
20. Not Used
21. Not Used
22. Not Used
23. Input from Generator Master Switch, RUN position, Wire 47
24. Input from Generator Master Switch, OFF/RESET position, Wire 43
25. Input from Generator Master Switch, AUTO position, Wire 46
26. Ground (-), Front Panel, Wire 2

P4 CONNECTORS PINS

1. Input to Low Water Temperature/Aux Indicator (E. Stop),Wire 48
2. Input to Low Water Temperature/Aux Indicator, Wire 26
3. Input to Overcrank Indicator, Wire 12 **
4. Output to Overspeed Indicator, Wire 39 **
5. Input to Low Oil Pressure Indicator, Wire 38 **
6. Input to High Engine Temperature Indicator, Wire 36 **
7. Not Used
8. Voltage (+) to Front Panel, Wire 24
9. Not Used
10. Not Used
11. Not Used
12. Input to Low Water Temperature/Aux Indicator, Wire 35 **
13. Not Used
14. Not Used
15. Not Used
16. Not Used
17. Output from Generator Master Switch, RUN position, Wire 47
18. Output from Generator Master Switch, OFF/RESET position,Wire 43
19. Output from Generator Master Switch, AUTO position, Wire 46
20. Ground (-), Front Panel

* Active low circuits may be checked for proper operation by placing ground on terminals so designated.

** Common alarm triggered by High Engine Temperature, Low Oil Pressure, Low Water Temperature, Overcrank, Overspeed , and Auxiliary Faults.

Fault Shutdowns—5-Light Microprocessor Controller

If the generator set will not start or stops running due to a fault shutdown (fault lamp lit), refer to the following chart to identify fault conditions. Consult the Engine Service Manual for detailed information on correcting engine related faults. To reset the set after a fault shutdown, see Section 2 Microprocessor Controller (5-Light), Resetting Procedure—Fault Shutdown.

Fault Shutdowns (5-Light)

Indicator	Fault Condition
High Engine Temperature Lamp Lights	Engine coolant temperature above 230° F (110° C).
	Cooling system malfunction
Low Oil Pressure Lamp Lights	Engine oil pressure drops to 7.1 psi (49kPa).
Overspeed Lamp Lights	Governed frequency in excess of 70 Hz (50 and 60 Hz models).
Overcrank Lamp Lights	More than 45 seconds of continuous cranking.
	Locked rotor
Overcrank Lamp Flashes	Speed Sensor signal absent longer than one second.
Low Water Temp/Auxiliary Lamp Lights	Engine coolant below safe range in radiator.
	Overvoltage condition (if overvoltage equipped)—output voltage 15% above nominal voltage (for one second or longer).
	Activated by fault sensing devices connected to auxiliary immediate shutdown port (P1-17).
Emergency Stop (if equipped)	Emergency stop switch activated.
	Emergency stop switch disconnected from controller terminals TB1-1 or 1A.

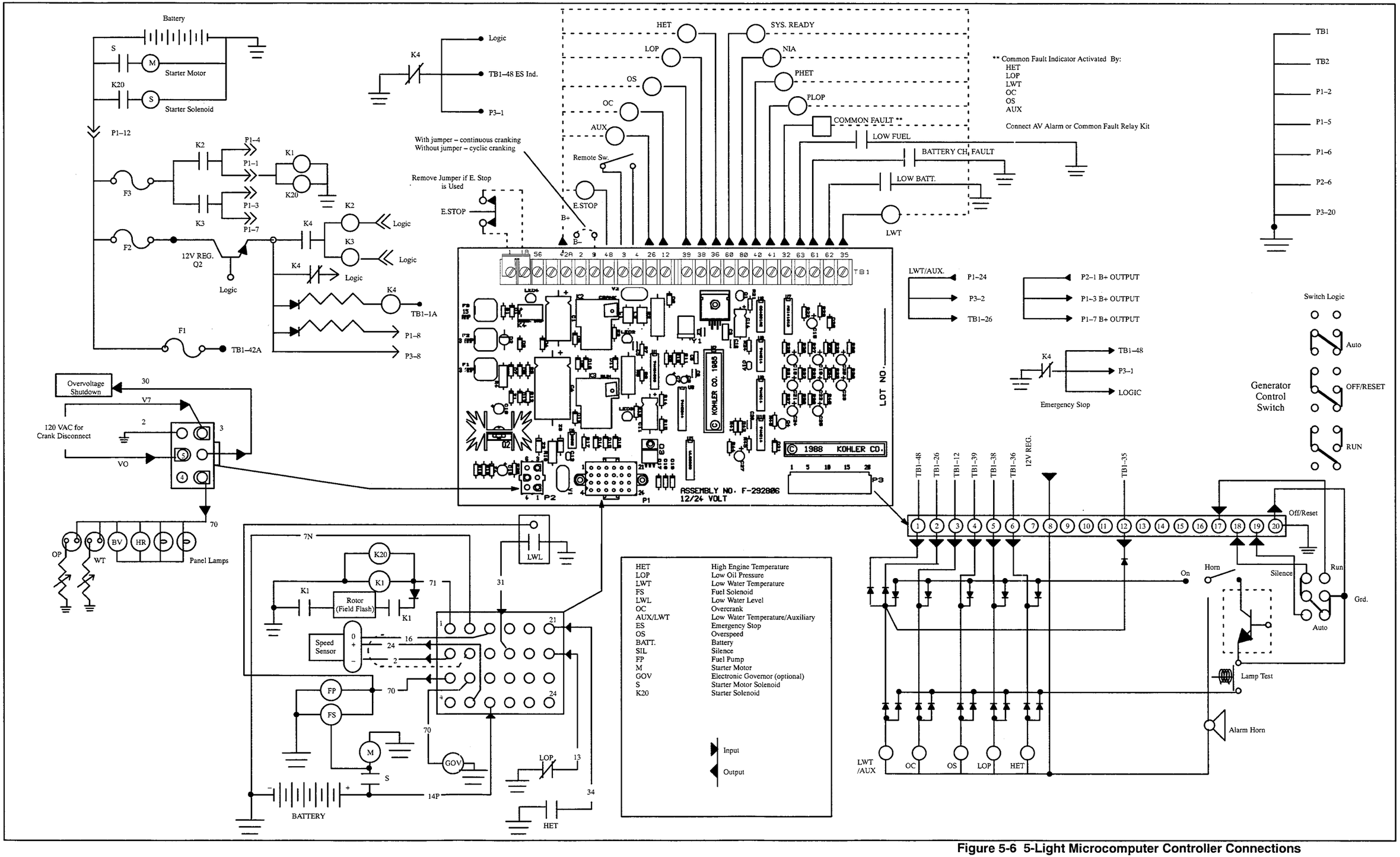


Figure 5-6 5-Light Microcomputer Controller Connections

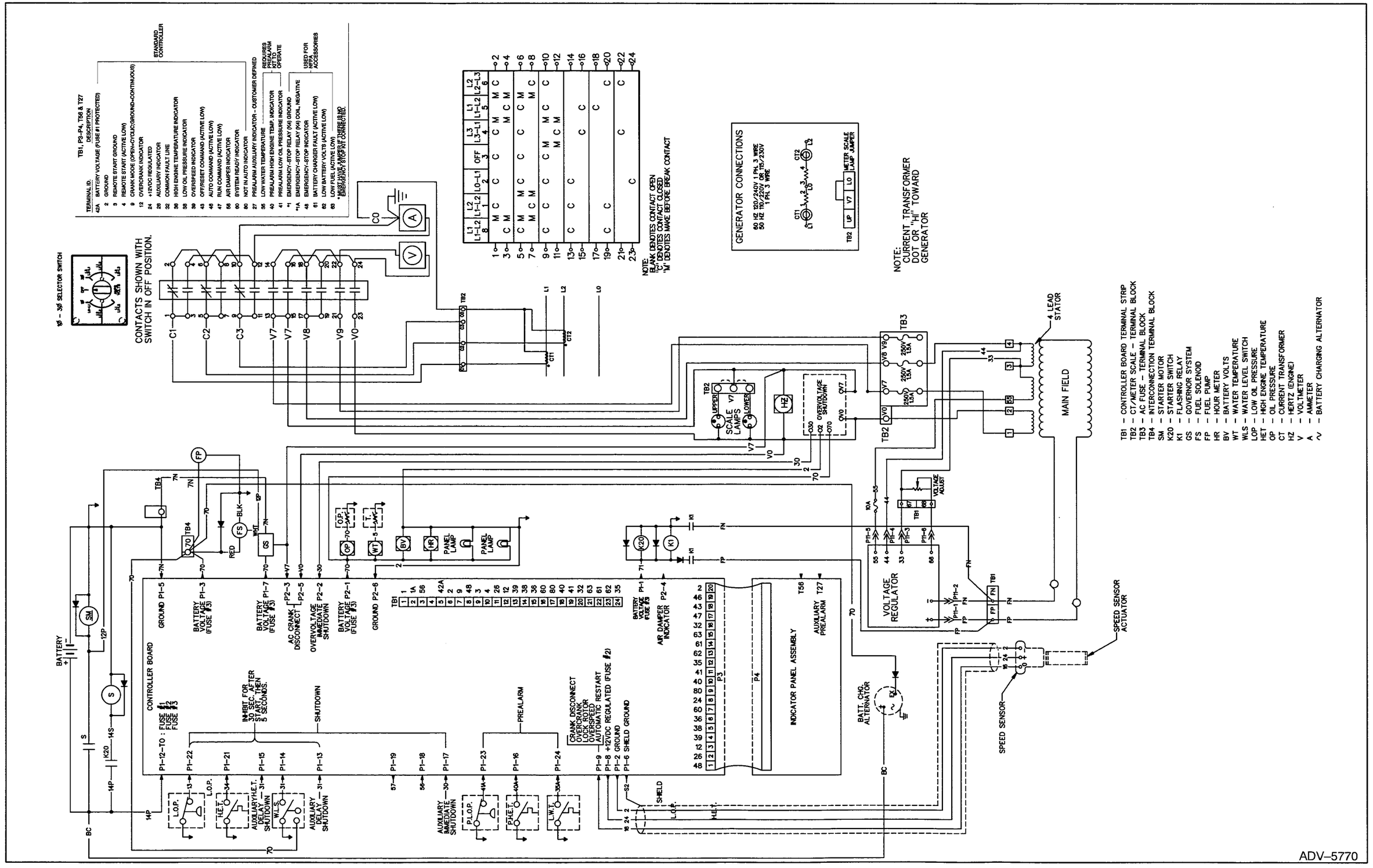
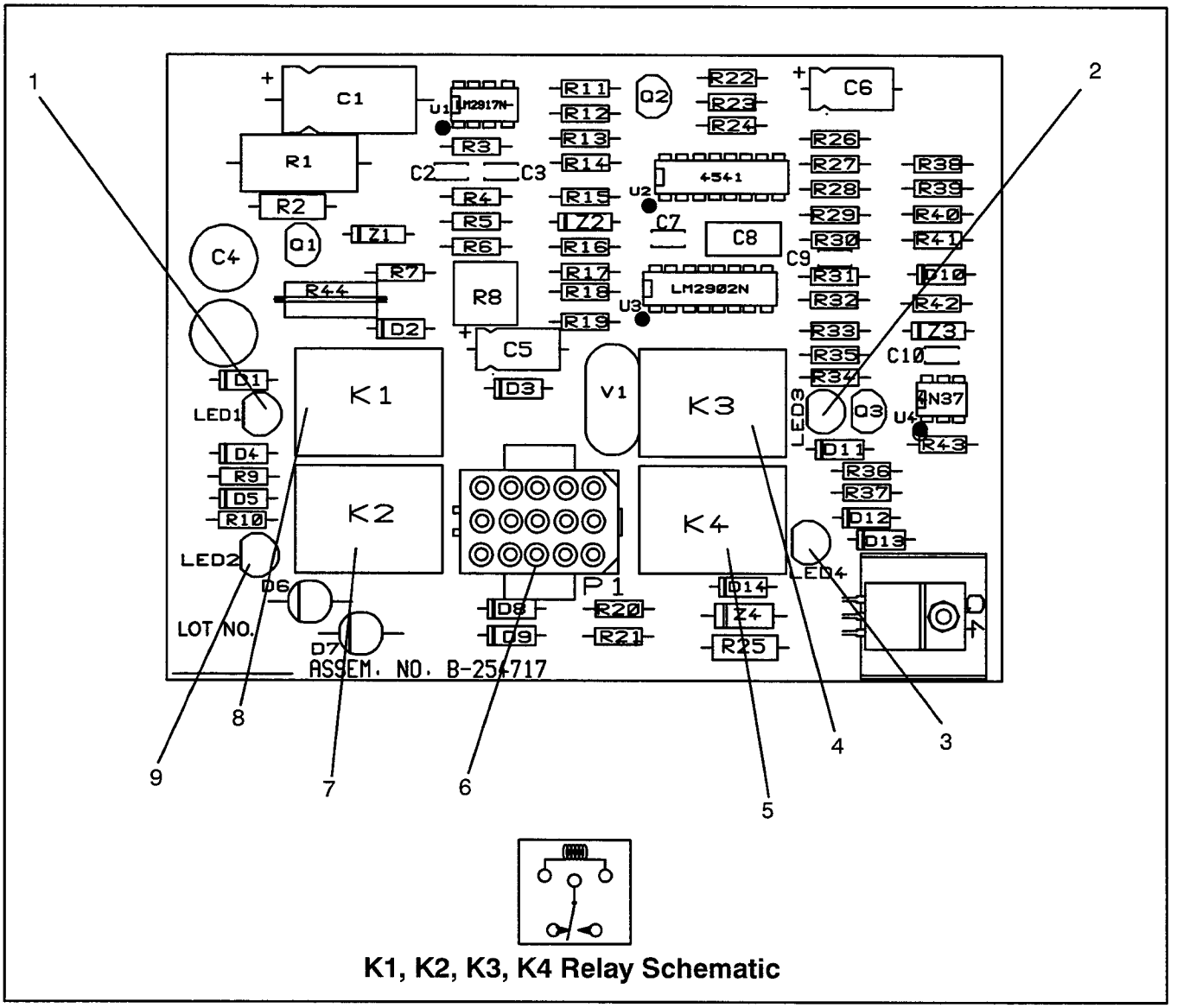


Figure 5-7 Logic Schematic, 5–Light Microprocessor Controller

Section 6. Generator/Controller Troubleshooting

Relay Controller

Use the following flow chart as an aid in troubleshooting the main circuit board and the entire generator set. If the prescribed remedy does not correct the problem, the circuit board may have to be replaced. The controller circuit board is equipped with LEDs (light emitting diodes) to indicate relay coil power and aid in circuit board and generator fault detection. When the K1, K2, K3, or K4 relays are receiving power, the corresponding LED will light. The LED does not indicate whether the relay coil is energized. This conclusion can only be reached through analysis of generator faults and by performing a continuity test on the relay coil (covered later in this section).



K1, K2, K3, K4 Relay Schematic

1. LED1
2. LED3
3. LED4
4. K3 Relay
5. K4 Relay
6. P1 Connector
7. K2 Relay
8. K1 Relay
9. LED2

Figure 6-1. Controller Circuit Board Testing (Relay Controller)

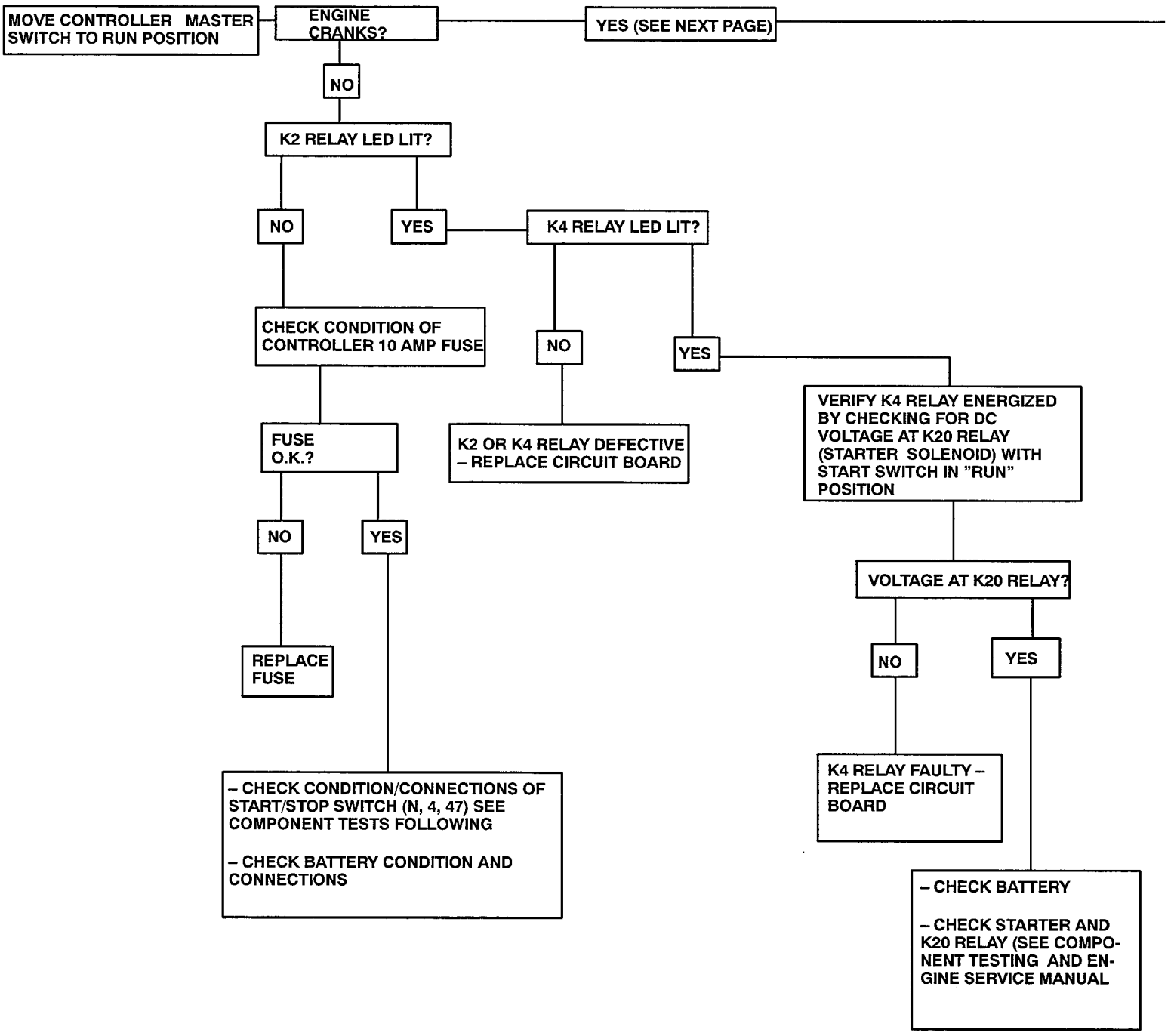


Figure 6-2. Troubleshooting Relay Controller Circuit Board. (1 of 3)

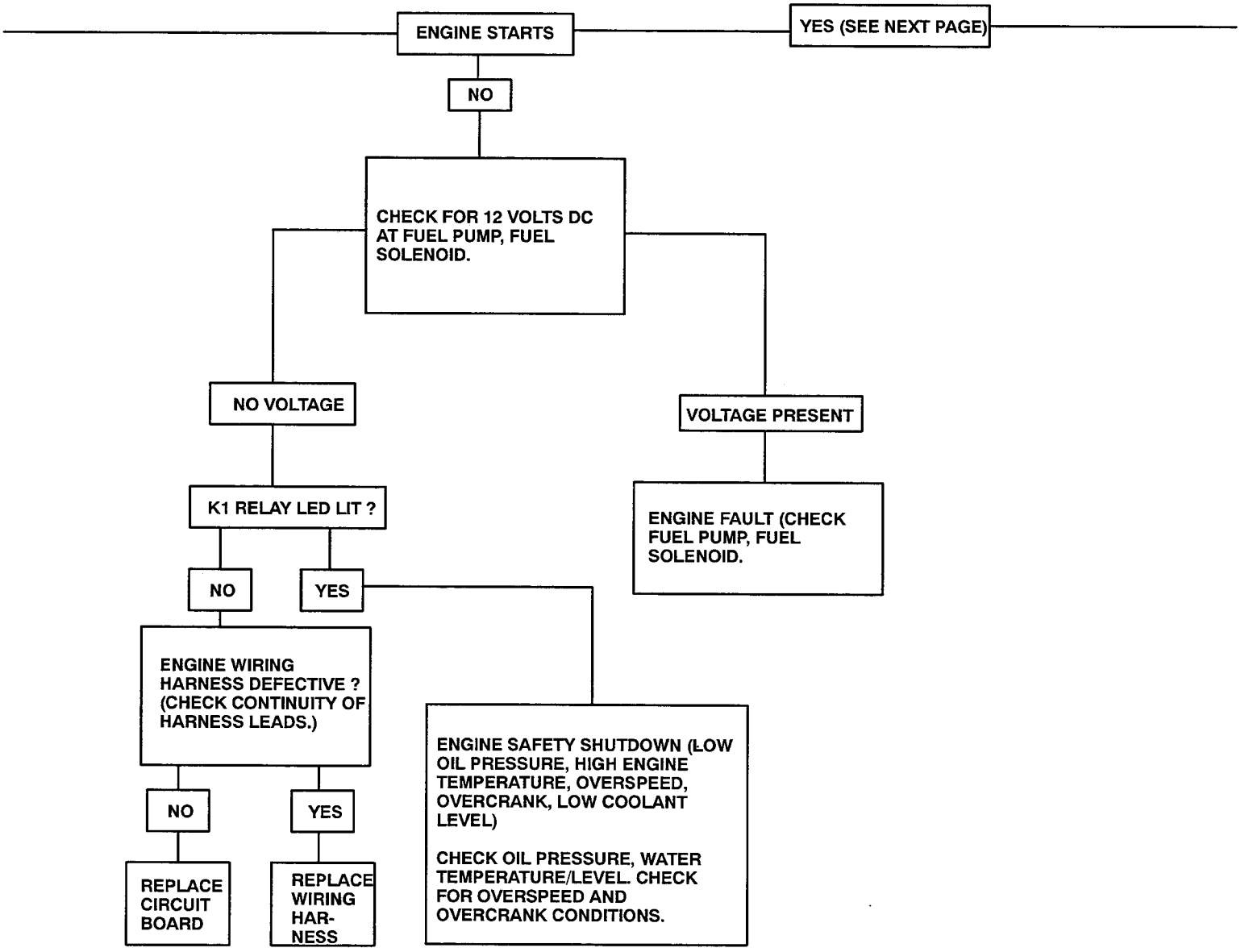


Figure 6-3. Trouble Shooting Relay Controller Circuit Board. (2 of 3)

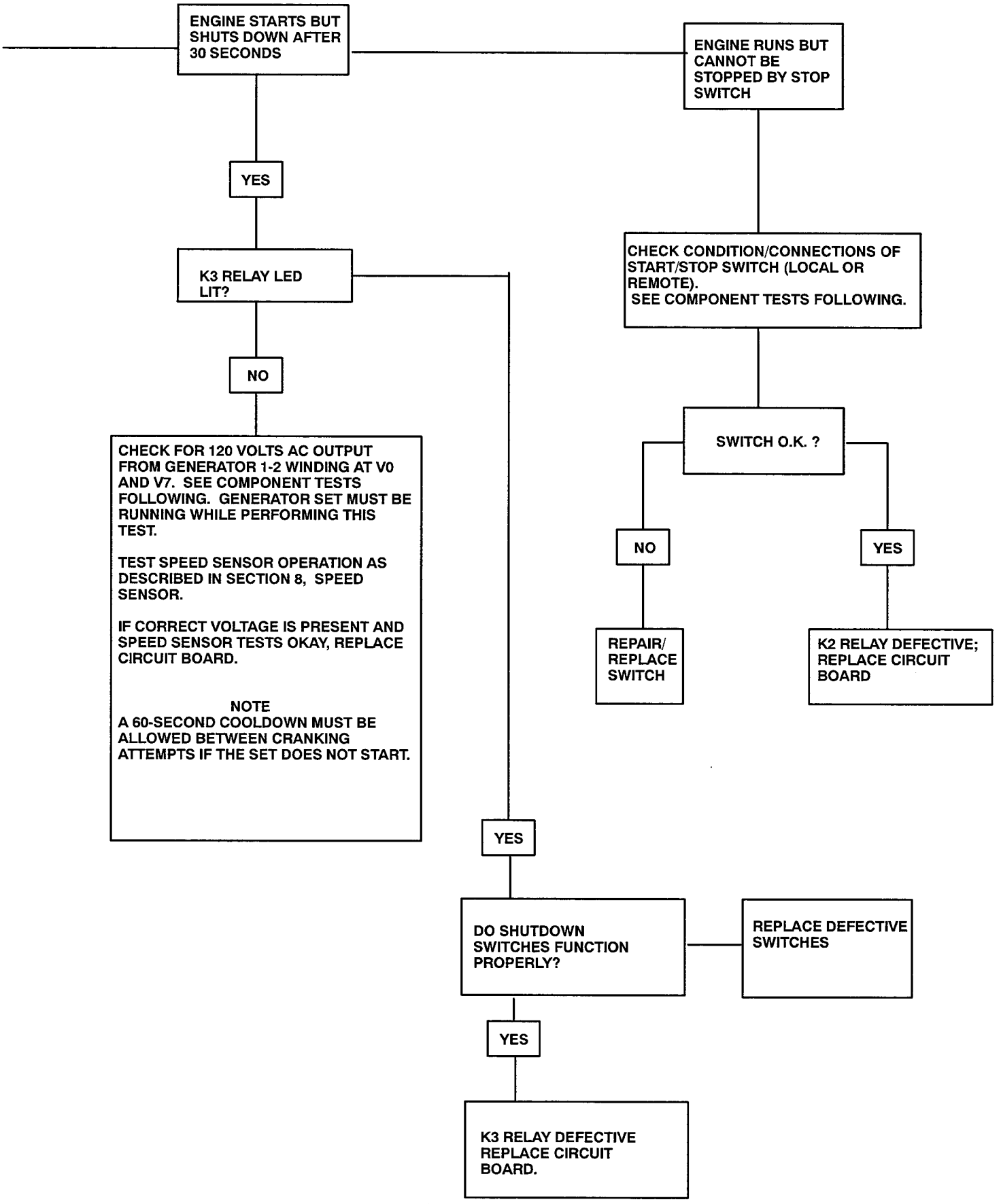


Figure 6-4. Troubleshooting Relay Controller Circuit Board. (3 of 3)

5-Light Microprocessor Controller

Relay Descriptions

Descriptions of the relays used on sets with 5-light microprocessor controllers are given below. This information is useful in troubleshooting the generator and should be used in conjunction with the troubleshooting flow charts on the following pages.

K20 Relay (Starter Solenoid)

Energizes starter—K20's relay located on engine.

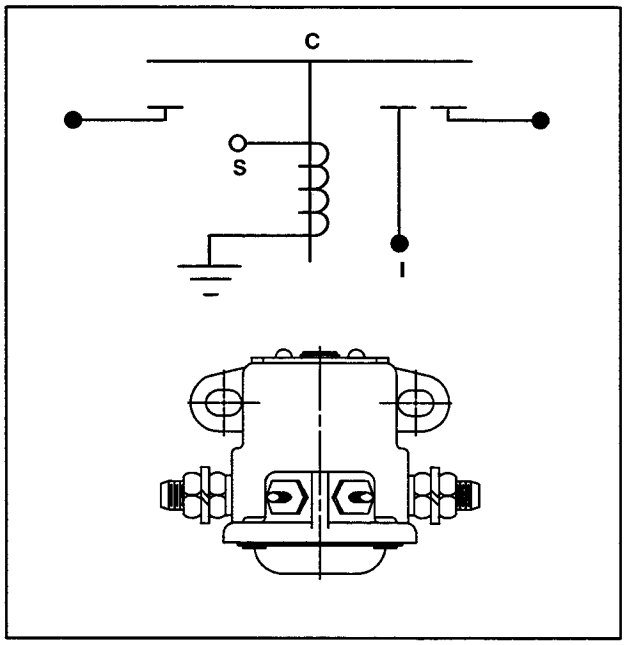


Figure 6-5. K20 Starter Solenoid

K2 Relay (Crank Relay)

Energizes K1 Relay. LED2 lights when energized during crank mode. K2 relay located on controller circuit board.

K3 Relay (Run Relay)

Energizes fuel pump, fuel solenoid, water solenoid (city water cooling) and meters/gauges.

Energizes engine safety shutdowns after time delay. LED3 lights when energized during crank and run modes. K3 relay located on controller circuit board.

K4 Relay (Emergency Stop Relay)

The K4 relay is energized continuously except during emergency stop conditions. LED4 is lit at all times except during emergency stop. K4 relay located on controller circuit board. If (local or remote) emergency stop kit is connected, remove jumper from circuit board TB1-1 and 1A. If no emergency stop kit is connected, a jumper must connect terminals TB1-1 and 1A.

K1 Relay (Field Flashing Relay)

Provides field flashing current to main field (rotor) during start-up. The K1 relay is located in the controller and is energized only during cranking.

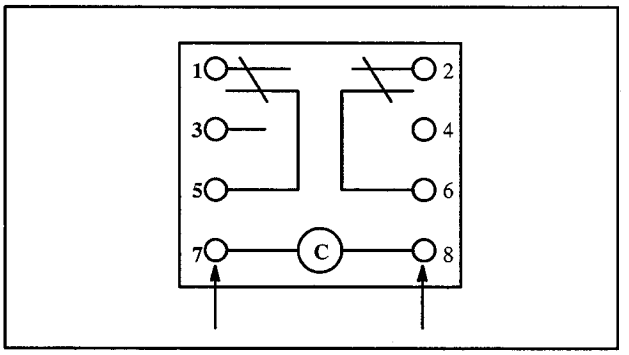
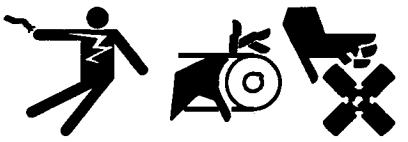


Figure 6-6. K1 Flashing Relay

Use the following charts as a quick reference in troubleshooting specific generator set problems. Consult the first chart for aid in locating the cause of blown fuses. In the successive charts, generator faults are listed by specific groups and correlated with possible causes and corrective action. Before beginning any troubleshooting procedure, read all safety precautions at the beginning of this manual and those included in the text. Do not neglect these precautions.



⚠ WARNING

Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

NOTE

If starting unit by remote switch, verify proper operation of remote switch before troubleshooting controller. Test remote switch operation by placing generator master switch in the AUTO position and running a jumper between terminals 3 and 4 on controller circuit board. If the generator does not start, proceed with the controller troubleshooting procedure outlined in the following pages.

The chart below lists the possible causes of blown controller fuses F1, F2, and F3. If a fuse is blown, replace it and resume operation. If the fuse blows again, use the chart to identify the faulty component(s).

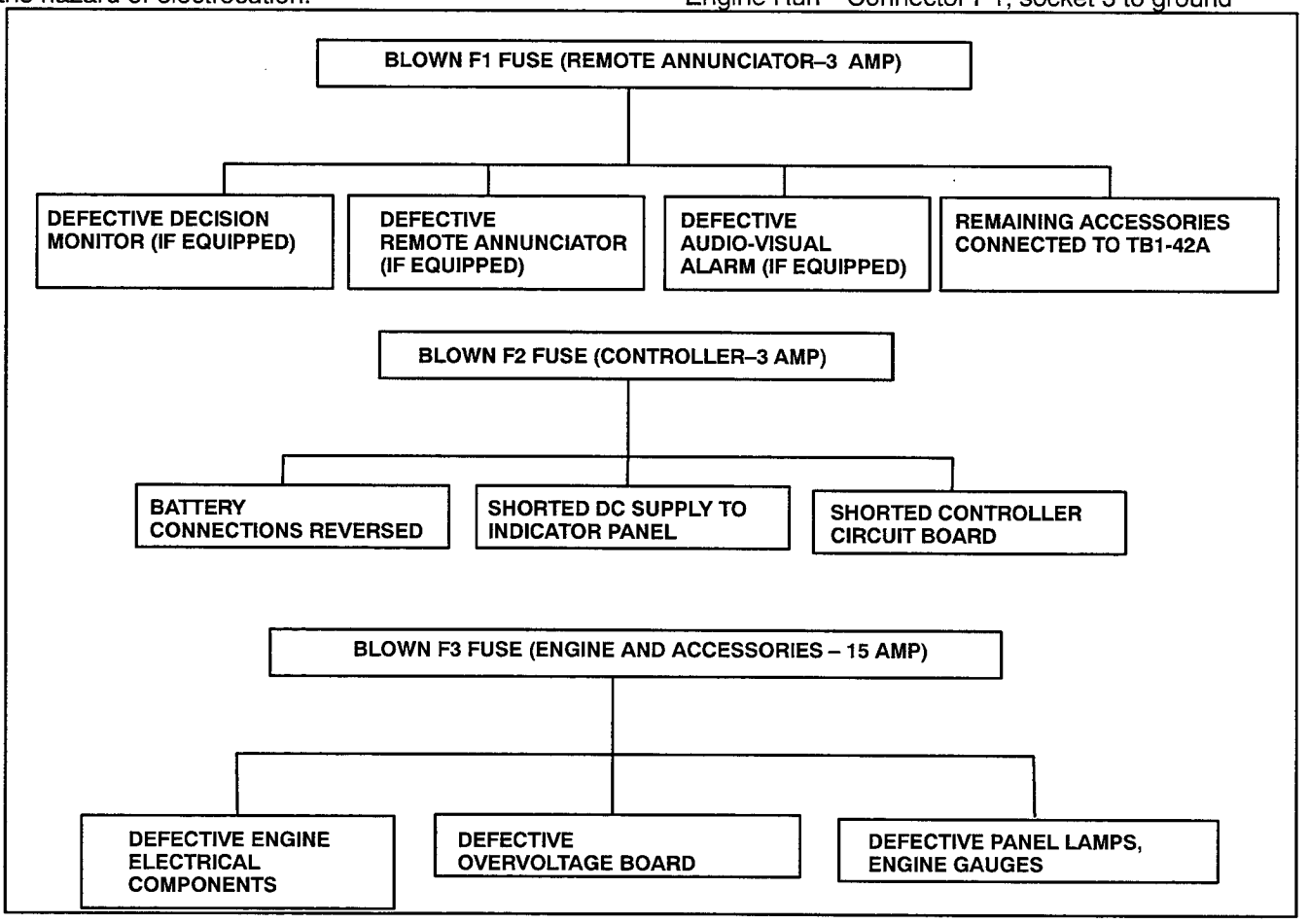
To quickly check the condition of the components listed under F3, use an ohmmeter to read resistance between the designated terminal and ground. See Figure 6-7. With ohmmeter on the R x 1 scale, a reading of less than one ohm (continuity) indicates that component may be defective. Isolate the defective component and repair or replace.

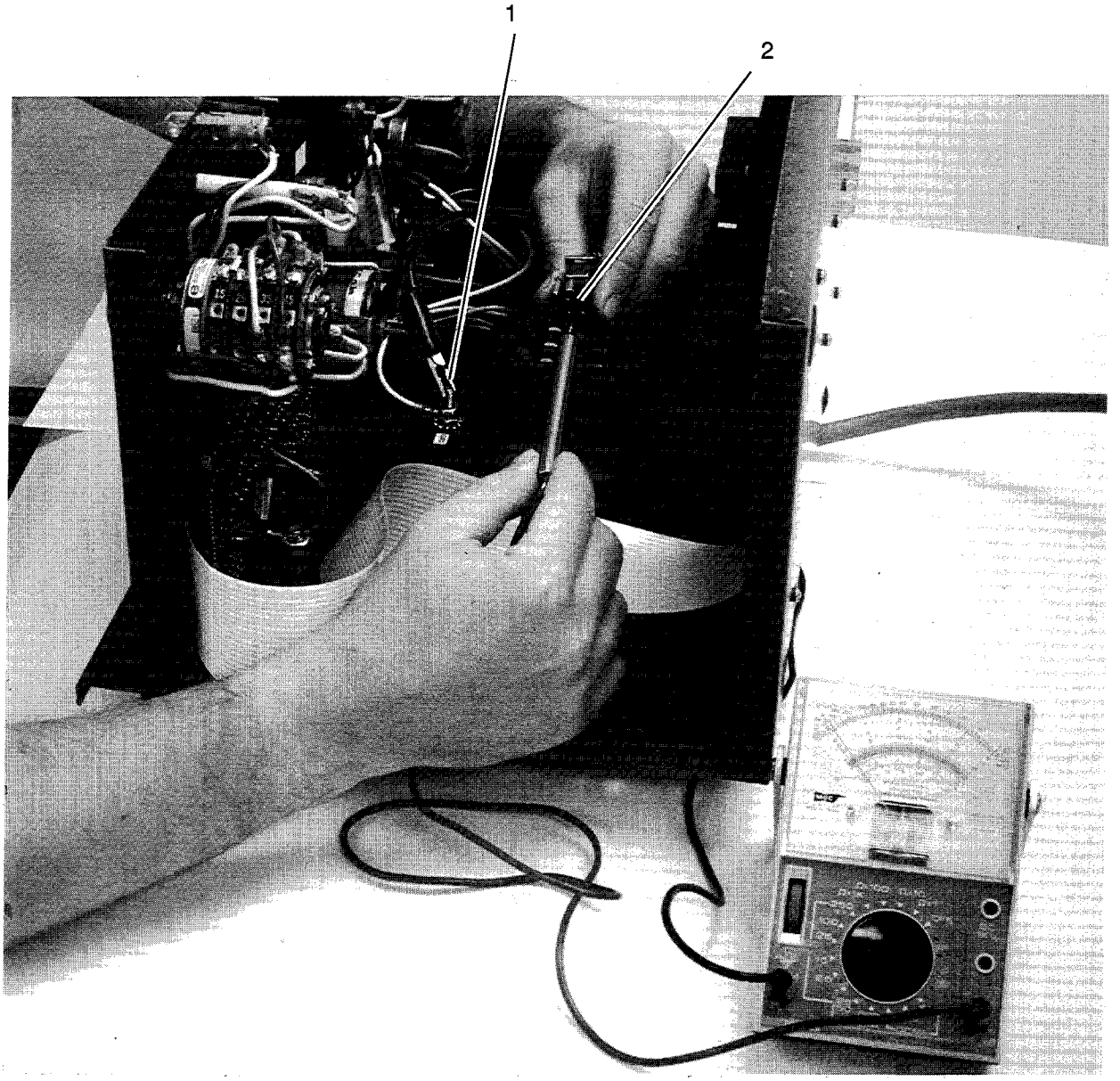
Gauges—Connector P2, socket 1 to ground

Overvoltage—Connector P2, socket 2 to ground

Crank—Connector P1, socket 1 to ground

Engine Run—Connector P1, socket 3 to ground





1. Ground Connection
2. P2 Connection

Figure 6-7. Checking P1/P2 Components

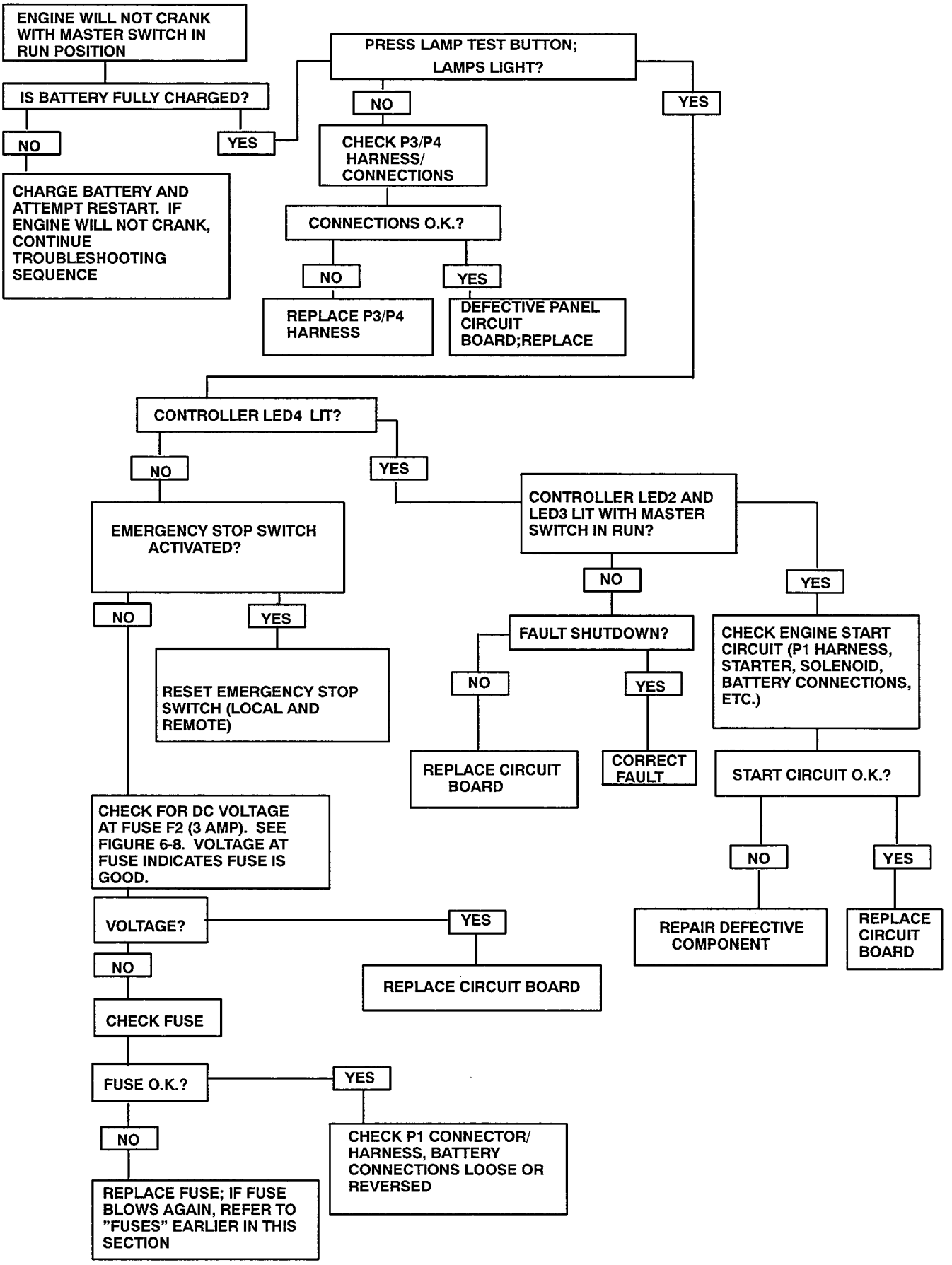
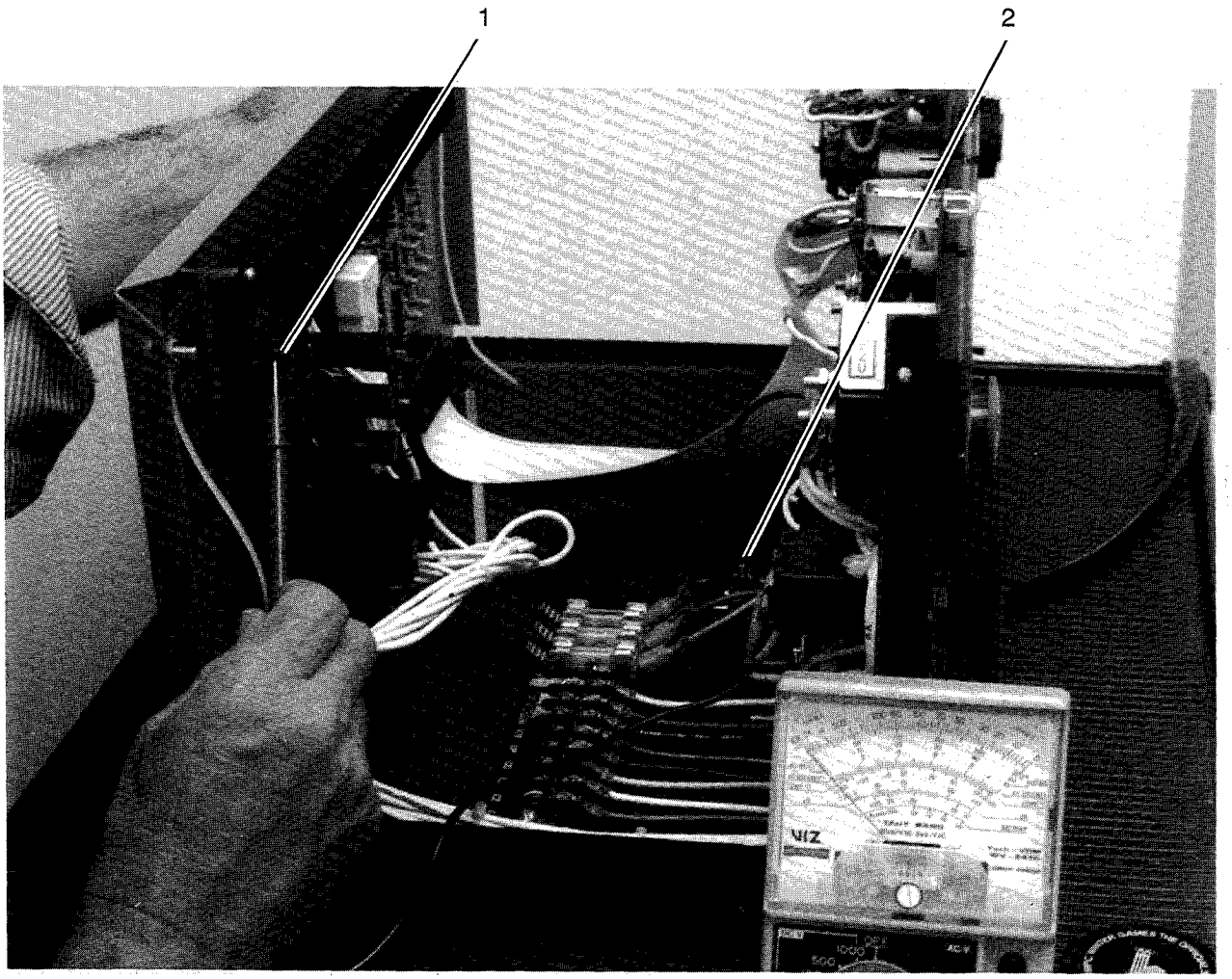


Figure 6-8. Troubleshooting Microprocessor Circuit Board. (1 of 5)



1. Fuse Terminal
2. Ground Connection

Figure 6-9. Checking Condition of Fuse

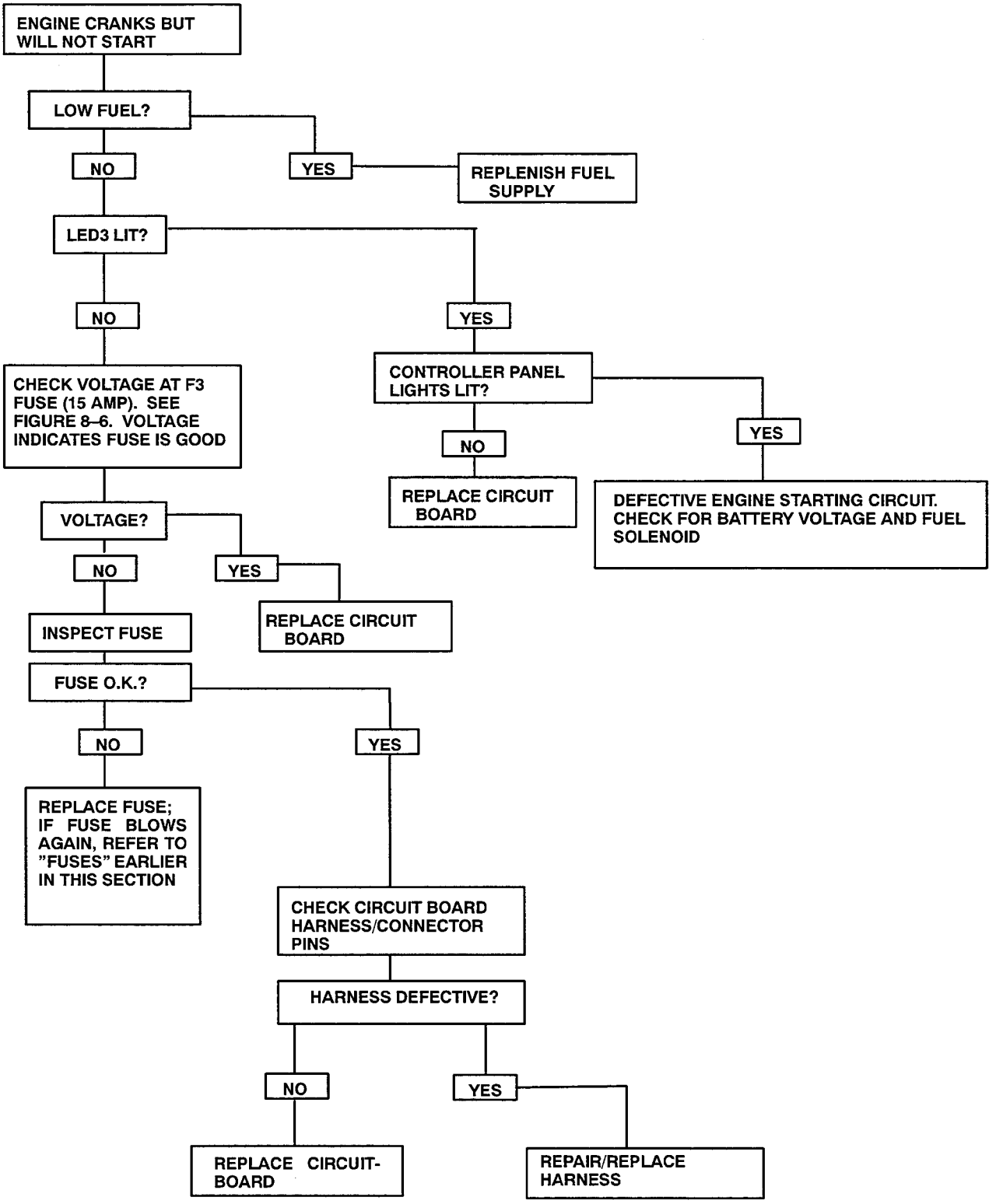


Figure 6-10. Troubleshooting Microprocessor Circuit Board (2 of 5)

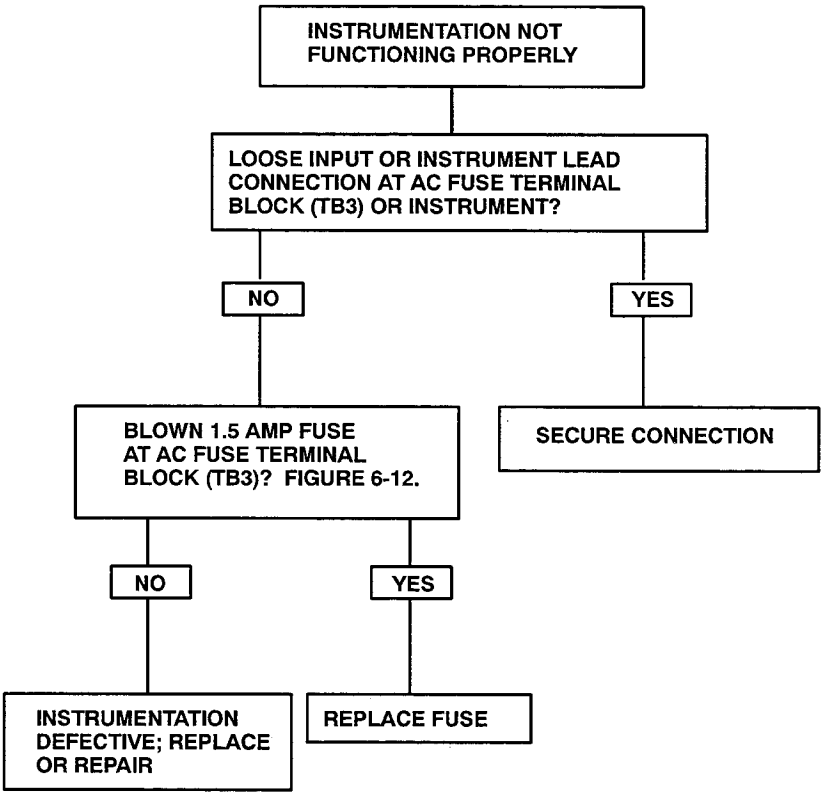
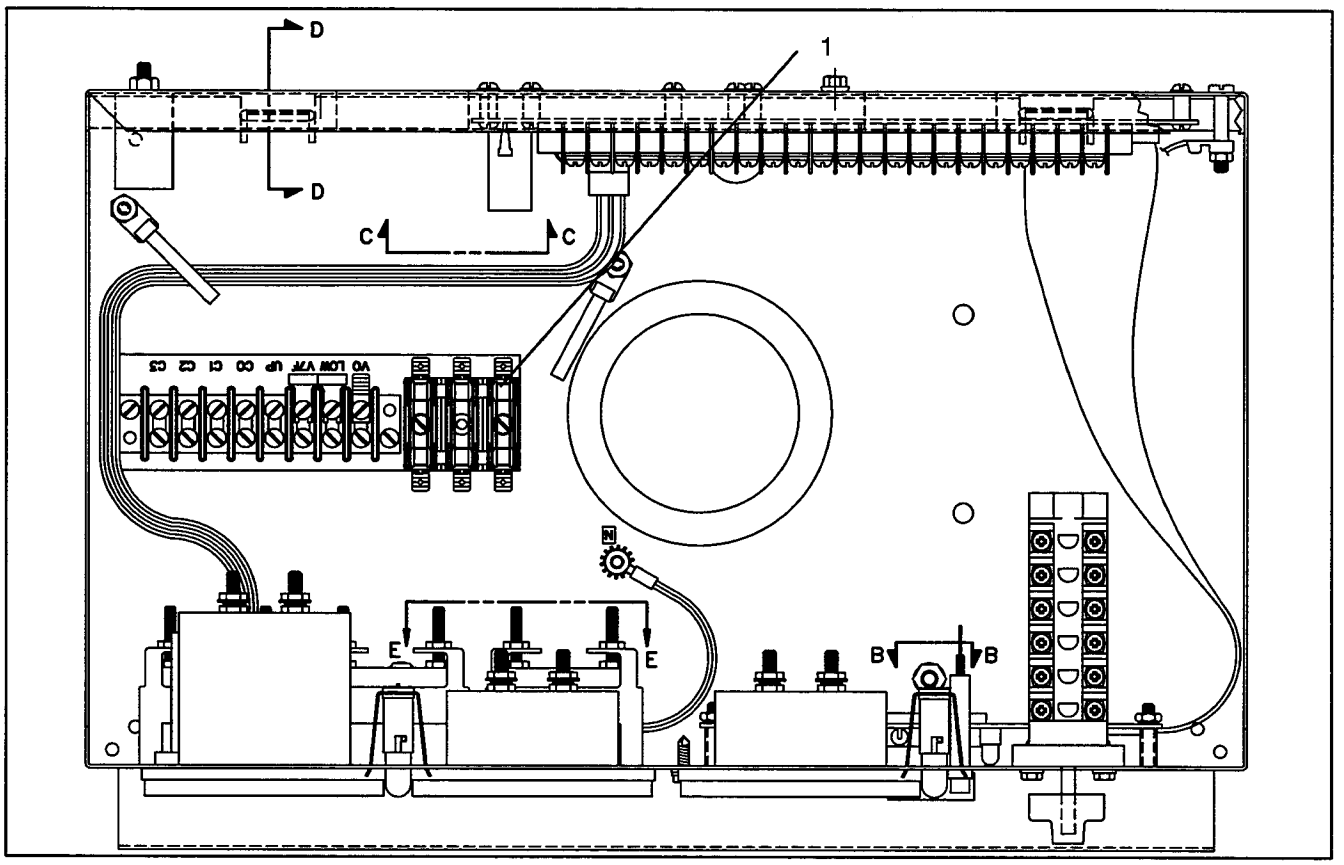


Figure 6-11. Troubleshooting Microprocessor Circuit Board (3 of 5)



1. AC Fuse Terminal Block (TB3)

Figure 6-12. AC Fuse Terminal Block (TB3)

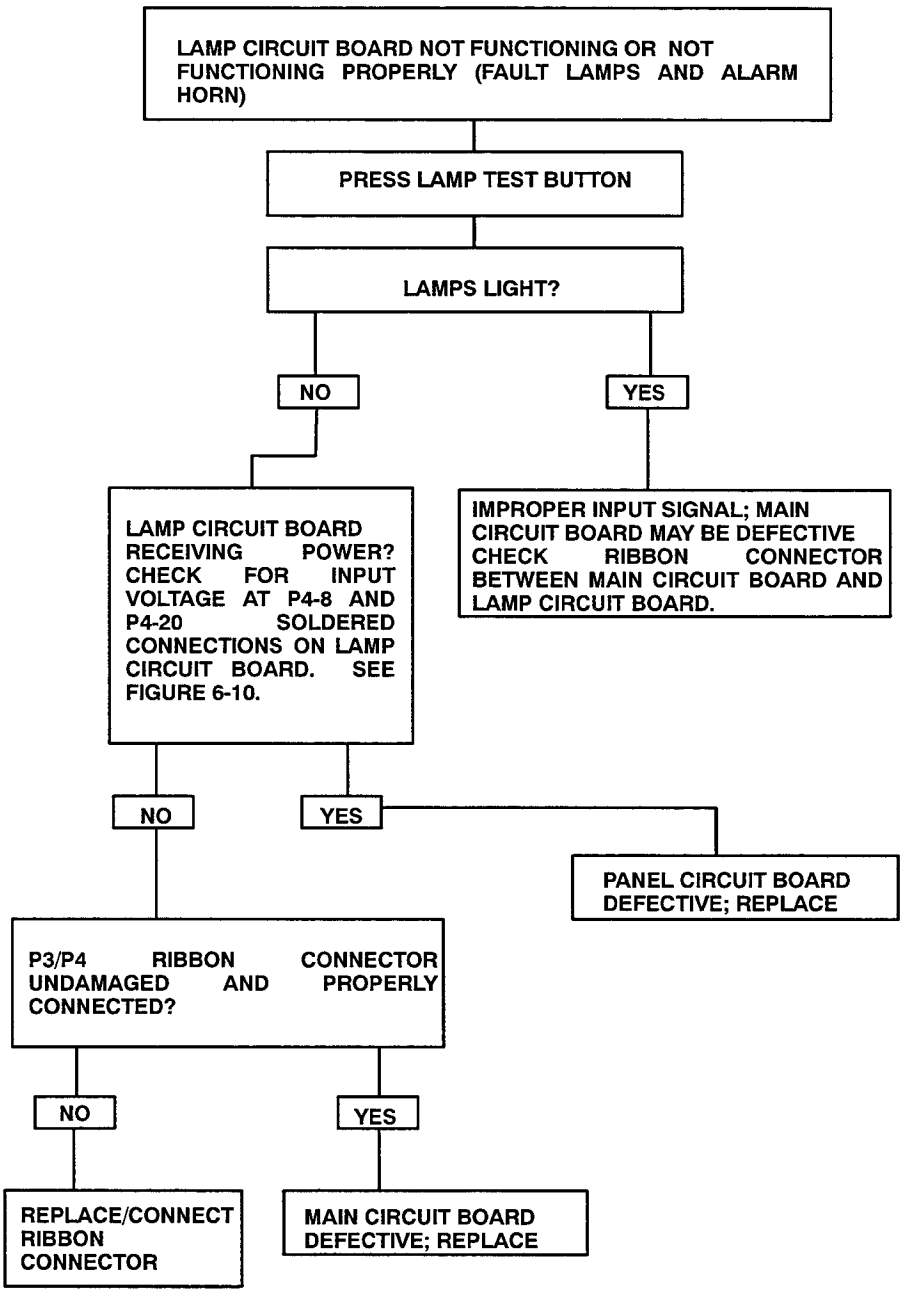
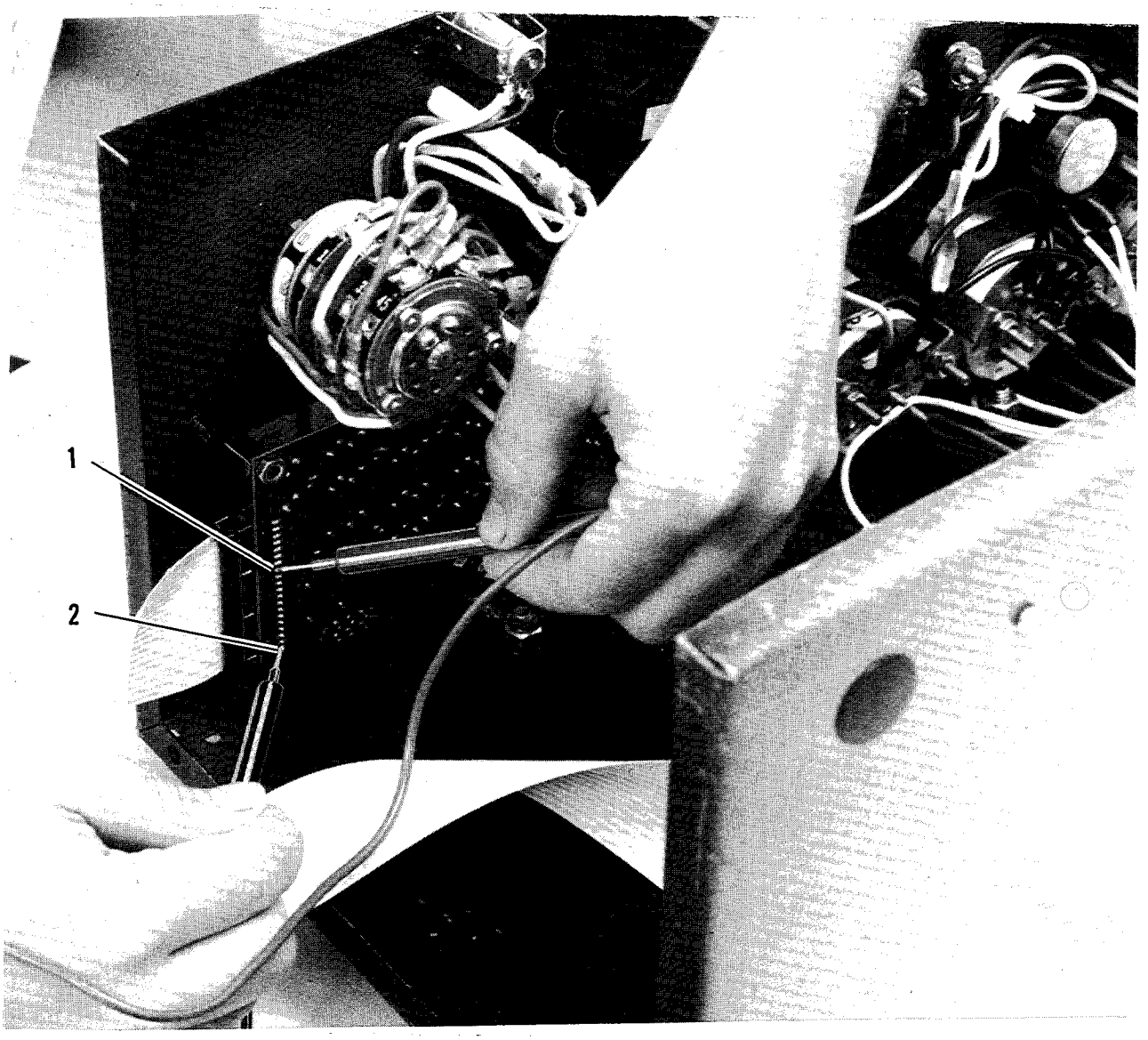


Figure 6-13. Troubleshooting Microprocessor Circuit Board. (4 of 5)



1. P4-8 (+) Connection
2. P4-20 (-) Connection

Figure 6-14. Checking Input to Lamp Circuit Board

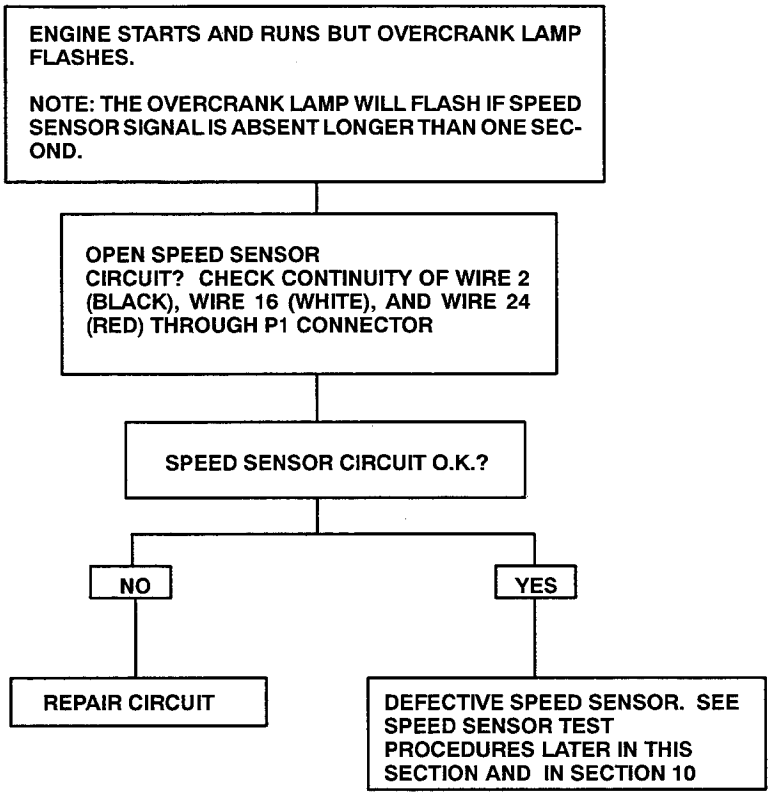


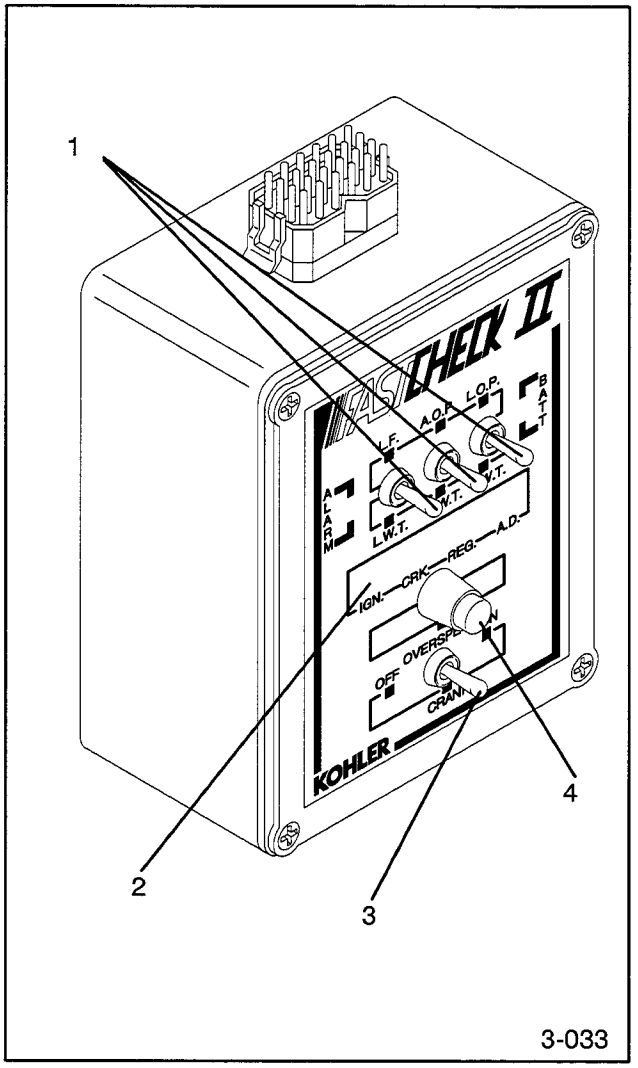
Figure 6-15. Troubleshooting Microprocessor Circuit Board. (5 of 5)

FASTCHECK® Features and Operation

The FASTCHECK® is an engine simulator for testing and troubleshooting the 5-Light Microprocessor Controller.

Features (Figure 6-16)

Engine conditions are simulated by the following engine switch position:



1. Toggle Switches
2. Indicator Lamps
3. Engine Switch
4. Overspeed Button

Figure 6-16. FASTCHECK® Simulator

- **OFF**—locked engine (starter energized but not turning).
- **CRANK**—engine cranking, but not started.
- **RUN**—engine running

Indicator lamps:

IGN.—(ignition) lamp

- shows battery voltage supplied to fuel pump, fuel solenoid, and water valve (city water cooled sets)
- lights during cranking and running

CRK.—(crank) lamp

- shows battery voltage switched to starter (engine not necessarily turning)
- lights only during on-crank cycles

REG.—(regulator) lamp

- shows battery voltage supplied to generator's AC voltage regulator
- lights only during cranking and running

BATT.—(battery) lamp:

- lights when test battery(ies) or DC power supply is live and properly connected

NOTE

LOP, HWT and OVERSPEED simulate malfunctions causing engine shut-down. LOP and HWT circuits will start timing after engine has been running for 30 seconds. Engine shutdown should occur 5 seconds after pushing fault switch.

Switches:

LOP—low oil pressure

HWT—high water (engine) temperature

OVERSPEED—simulates a 70 Hz overspeed condition

L.F.—low fuel (not used for testing)

L.W.T.—low engine water temperature

A.O.P.—anticipatory (low) oil pressure

A.W.T.—anticipatory (high) water temperature

Operation

The FASTCHECK® can be used to test the 5-Light Controller on the generator set when troubleshooting start-up problems, or to test and troubleshoot the controller when removed from the generator set.

To operate the FASTCHECK® the following equipment is required:

- FASTCHECK® simulator (A-291930) and harness (255915)
- Variable low-voltage DC power supply; 0 to 30 Volt, 3 Amp minimum current, 0.5% maximum output voltage ripple at 30 Volts DC. A 12-Volt battery can also be used to operate the FASTCHECK®.

To Connect/Operate the FASTCHECK® Tester:

1. Unplug DC engine harness from DC harness connector (P1). Figure 6-17.
2. Connect FASTCHECK® harness to DC harness connector (P1) and top of FASTCHECK®.
3. Move generator master switch to OFF/RESET position.
4. Move FASTCHECK® engine switch to OFF.

NOTE

Proper polarity must be observed.

5. Clip red (+) and black (-) harness leads to battery(ies) to DC power supply set at 14 volts. Generator set's battery(ies) may be used if accessible and fully charged.

NOTE

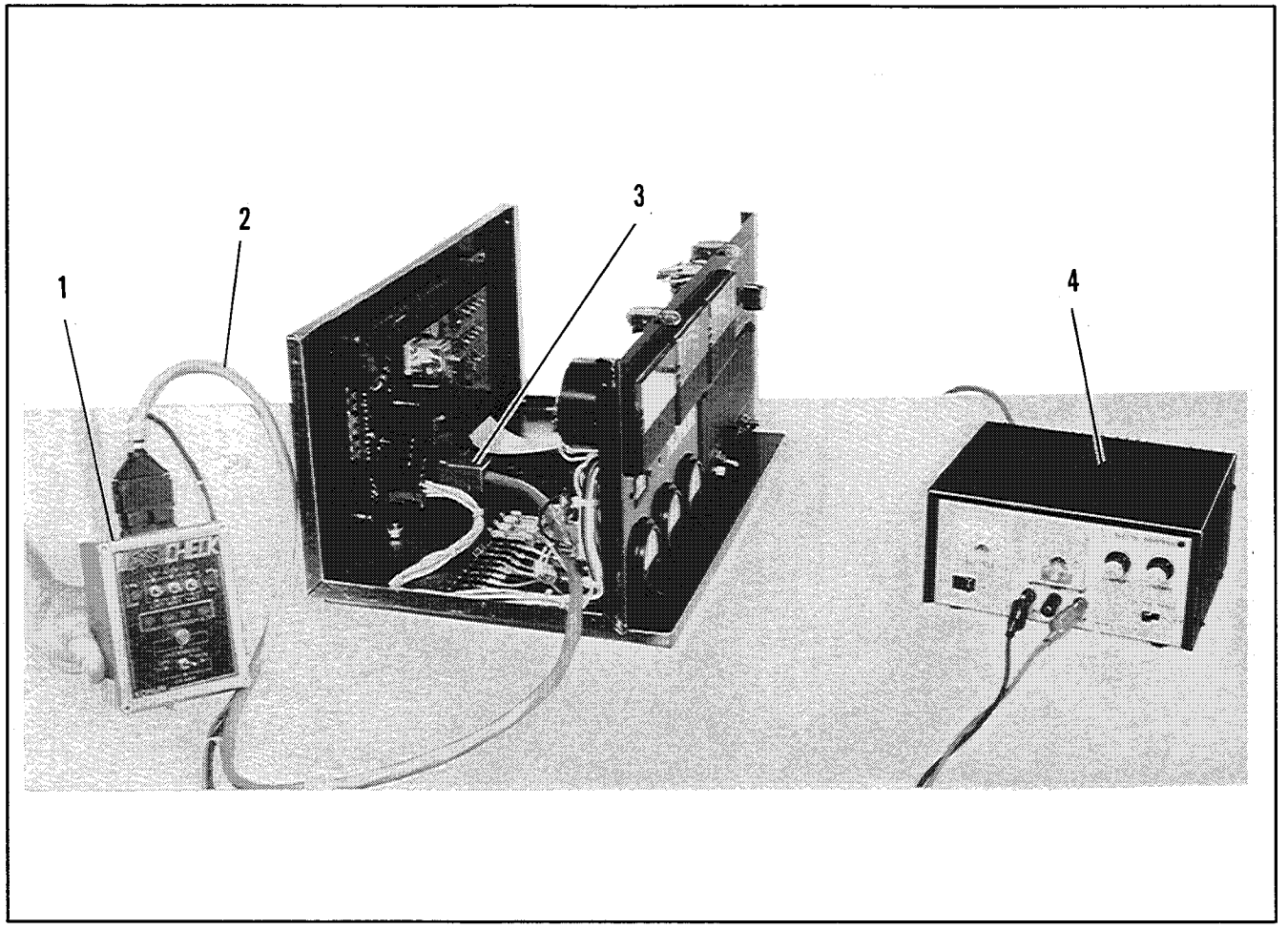
Due to the absence of AC output, the LOW WATER TEMP/AUXILIARY lamp will flash during controller testing.

6. Move controller master switch to RUN.
7. Move FASTCHECK® engine switch to CRANK. FASTCHECK® IGN., CRK., and REG. lamps should light. Controller will simulate cyclic cranking (15 seconds on, 15 seconds off, 15 seconds on, etc.) until FASTCHECK® switch is moved to RUN or Overcrank shutdown appears on controller.
8. Move FASTCHECK® engine switch to RUN, CRK. lamp should go out and REG. and IGN. lamps should stay on.
9. Simulate engine malfunctions by pressing FASTCHECK® fault switches. Corresponding fault lamp on controller should light during each simulated engine malfunction.

NOTE

Leave FASTCHECK® engine switch in RUN position for at least 30 seconds before pushing toggle switches. Toggle Generator Master Switch to OFF/RESET and FASTCHECK® engine switch to OFF, then back to RUN after simulated fault shutdowns.

10. Procedures to test Overcrank circuitry, speed sensor circuitry, and generator condition indicators are described later in this section.



1. FASTCHECK®
2. FASTCHECK® Wiring Harness
3. DC Harness Connector
4. DC Power Supply

Figure 6-17. FASTCHECK® Connections

Overcrank

To test the controller's ability to:

- Detect a locked engine.
- Stop a start-up attempt if the starter locks or will not engage.

1. Move FASTCHECK® engine switch to OFF.
2. Move Generator Master Switch to OFF and then move switch to RUN.
3. IGN., CRK., and REG. lamps on FASTCHECK® should light for approximately 5 seconds and then go out. 5 seconds later the IGN., CRK., and REG. lamps should relight for 5 seconds before going out again (15 seconds total elapsed time). Controller OVERCRANK lamp lights.
4. This test verifies the proper operation of the entire overcrank circuit. If the OVERCRANK shutdown fails to function, check the speed sensor and related circuitry.

Controller Speed Sensor Circuitry

To test speed sensor output, refer to Section 8 Speed Sensor. To check the controller's ability to respond to signals from the speed sensor perform the following test:

1. Move generator master switch to OFF/RESET position.
2. Move FASTCHECK® engine switch to OFF position.
3. Move generator master switch to RUN position. Observe IGN., CRK., and REG. lamps light.
4. Within 5 seconds, move FASTCHECK® engine switch to RUN.
5. If CRK. lamp goes out on FASTCHECK®, the controller speed sensor circuitry is functioning properly.

Generator Condition Indicator Terminals (TB1 Terminal Strip)

Remote accessories (A/V alarm, Decision Monitor, Alarm Contact Kits, etc.) may be connected to the controller TB1 terminal strip to signal the condition of the generator set. (Your set may not be equipped with the sending devices necessary to operate all generator condition indicators.) If remote accessories will not operate, test for output voltage at the TB1 terminal strip. To test the operation of each indicator, move the generator master switch and FASTCHECK® engine switch the position indicated (see TB1 Terminal Strip Testing on following page). Check for voltage at the prescribed test points with the FASTCHECK® toggle in the position prescribed. Test point voltage should be slightly less than the voltage being supplied to the controller (12-Volts). If proper voltage is not detected at the test point, remote accessories (A/V alarm, Decision Monitor, Isolated Alarm Contacts, etc.) will not function. Test point connections are shown in Figure 6-18.

NOTE

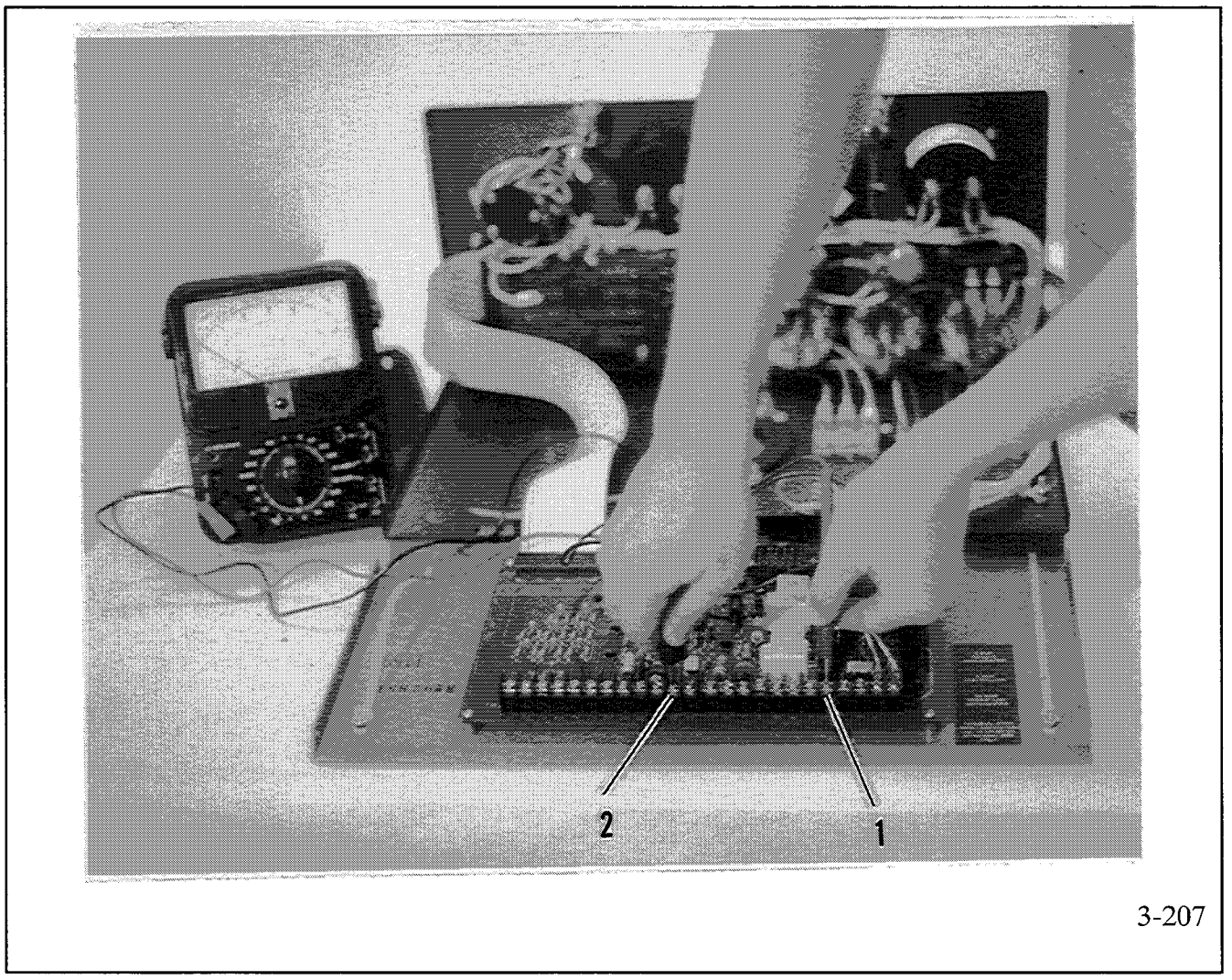
When checking controller test point voltage, place negative (-) lead of voltmeter on terminal designated in table and voltmeter positive (+) lead on TB1- 42A.

NOTE

Due to the absence of AC output, the Low Water Temperature/AUX. lamp will flash during controller testing.

NOTE

Leave FASTCHECK® engine switch in the RUN position for at least 30 seconds before pushing toggle switches. Toggle Generator Master Switch to OFF/RESET position. Move FASTCHECK® engine switch to OFF position. Move generator master switch to RUN position. Observe IGN., CRK., and REG. lamps light. Within 5 seconds, move FASTCHECK® engine switch to RUN.



1. TB1-42A(+)
2. TB1-(see chart)

Figure 6-18. Indicator Lamp Test Connections

TB1 Terminal Strip Testing

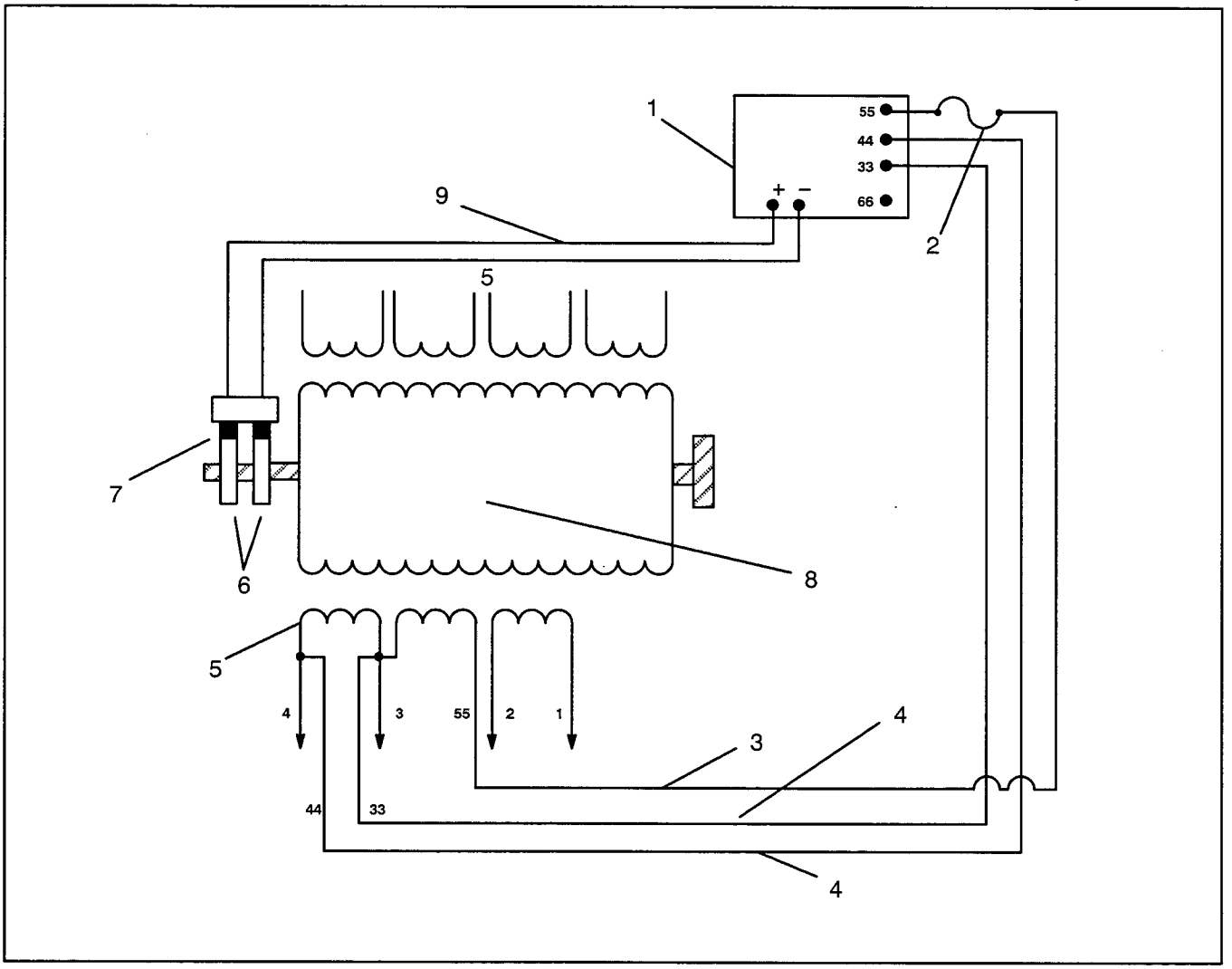
Indicator	Switch Position /Remarks	Check for Presence of 12 Volts DC Between:
System Ready	Master Switch in AUTO position; engine switch in Off Position	TB1-42A (+) and TB1-60 (–)
High Engine Temperature (H.E.T.)	Master Switch in RUN position; engine switch in RUN position; hold toggle switch to HWT for at least 5 seconds	TB1-42A (+) and TB1-36 (–)
Low Oil Pressure (LOP)	Master Switch in RUN position; engine switch in RUN position; hold toggle switch to LOP for at least 5 seconds	TB1-42A (+) and TB1-38 (–)
Auxiliary (AUX.)	Master Switch in RUN position; engine switch in RUN position; wait 10 seconds. Flashing AUX. lamp indicated proper operation of al Auxiliary functions	TB1-42A (+) and TB1-26 (–)
Low Water Temp (L.W.T.)	Master Switch in RUN position; engine switch in RUN; hold toggle switch to L.W.T.	TB1-42A (+) and TB1-35 (–)
Emergency Stop (local/remote)	Master Switch in RUN position; engine switch in RUN position; remove switch lead connected to controller terminals TB1-1 or 1A.	Not Applicable
Not in Auto	Master Switch in RUN or OFF/RESET; engine switch in any position	TB1-42A (+) and TB1-80 (–)
Pre (High) engine Temperature (A.W.T.)	Master Switch in RUN position; engine switch in RUN; hold toggle to A.W.T.	TB1-42A (+) and TB1-40(–)
Pre (Low) Oil Pressure (A.O.P.)	Master Switch in RUN position; engine switch in RUN; hold toggle to A.O.P.	TB1-42A (+) and TB1-41 (–)
Low Fuel	Generator Master Switch in OFF/RESET; engine switch in RUN position Ground controller terminal TB-63 to test. If Low Fuel Lamp lights, circuit is functioning properly	Not Applicable
Battery Charger Fault (if battery charger equipped)	Generator master Switch in OFF/RESET;engine switch in RUN position Ground controller terminal TB1-61 to test. If Low Battery Volts lamp lights, circuit if functioning properly	Not Applicable
Low Battery Volts (if battery charger equipped)	Generator Master Switch in OFF/RESET; engine switch in RUN position Ground controller terminal TB1-62 to test. If Low Battery Volts lamp lights, circuit if functioning properly	Not Applicable

Indicator	Switch Position /Remarks	Check for Presence of 12 Volts DC Between:
Common Fault Line	Master Switch in RUN position; engine switch in RUN; hold toggle switch to L.W.T., HWT or LOP	TB1-42A (+) and TB1-32 (–)
Overspeed	See Controller Speed Sensor Circuitry earlier in this section	Not Applicable
Overcrank	See Overcrank earlier in this section	Not applicable

Section 7. Component Testing and Adjustment

Theory of Operation, Single-Phase with PowerBoost™ IIIE

The ROY/RFOY 4-lead models utilize a rotating field generator to produce AC current. When the start switch is activated, the rotor (field) is magnetized by DC current from the battery. When the magnetized rotor is rotated within the stator windings, an electrical current develops within the stator. As engine speed and generator output increase, stator output current (rectified by the voltage regulator) is fed to the rotor through the brushes/slip rings to increase the strength of the rotor field. As the rotor field increases in strength, generator output also increases. The voltage regulator monitors the generator output voltage through leads 33 and 44 and allows the correct amount of DC current to flow to the rotor to meet load requirements. See Figure 7-1.



1. Voltage Regulator (PB IIIE)
2. Fuse
3. Power Lead
4. Sensing Lead
5. Stator
6. Slip Rings
7. Brushes
8. Rotor
9. DC Output Exciation

Figure 7-1. RY/RFY 4-Lead Generator Schematic

Generator Troubleshooting

To determine the cause of no or low AC output, refer to the troubleshooting flow chart Figure 7-2 and the separate excitation procedure following. Before beginning the troubleshooting procedures, read all safety precautions at the beginning of this manual. Additional safety precautions are included with the tests; OBSERVE THESE PRECAUTIONS!

Begin the troubleshooting procedure by checking the condition of the voltage regulator 10 amp fuse. See Section 2 (for fuse location) and Section 7 Component Testing. If the fuse is okay, separately excite the generator. The generator field (rotor) may be excited (magnetized) using an outside power source (12 Volt automotive battery). In the separate excitation test, you will be duplicating the role of the voltage regulator in providing excitation current to the rotor. By separately exciting the generator to determine the presence of a faulty voltage regulator, it is possible to determine if a running fault exists in the rotor and/or stator. A generator component that appears good while static (stationary) may exhibit a running open or short while dynamic (moving). This fault can be caused by centrifugal forces acting on the windings during rotation or insulation breakdown as temperatures increase. The flow chart in Figure 7-2 summarizes the troubleshooting procedure.

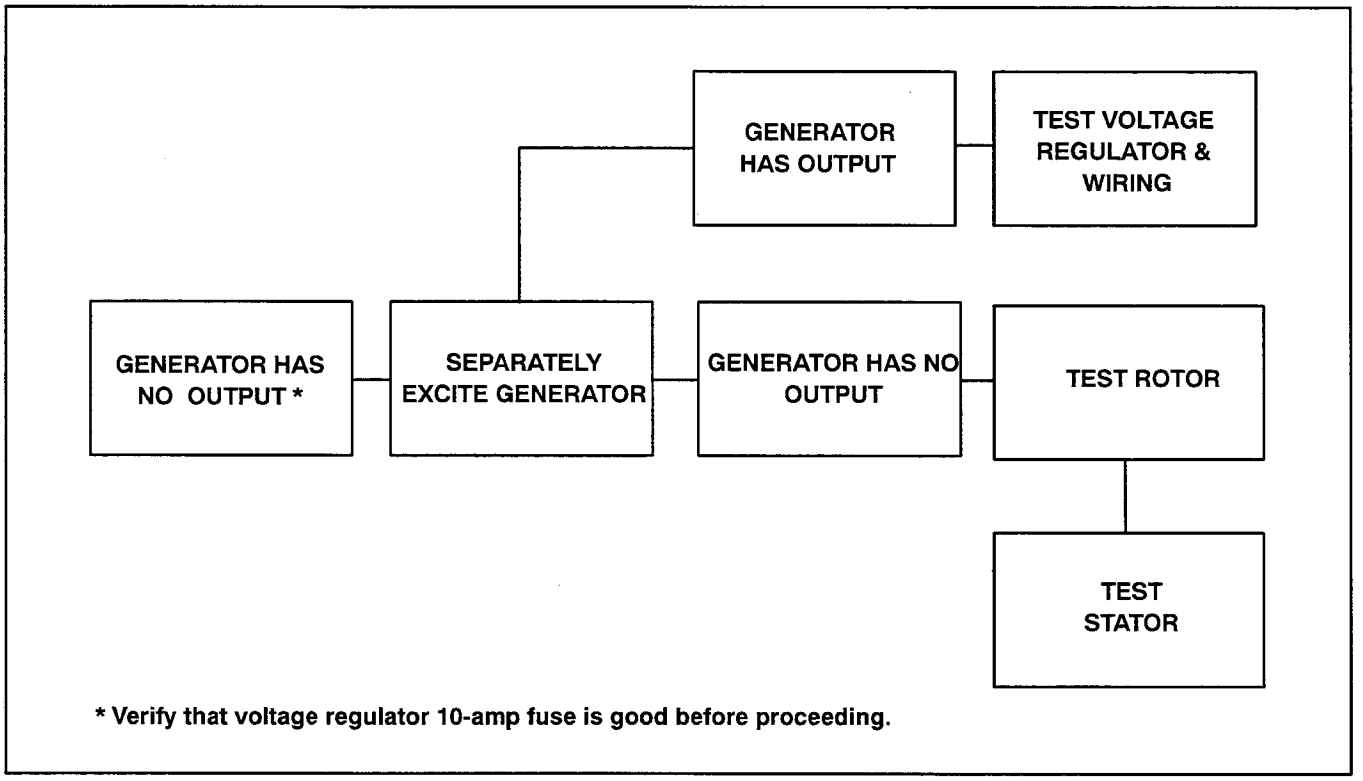


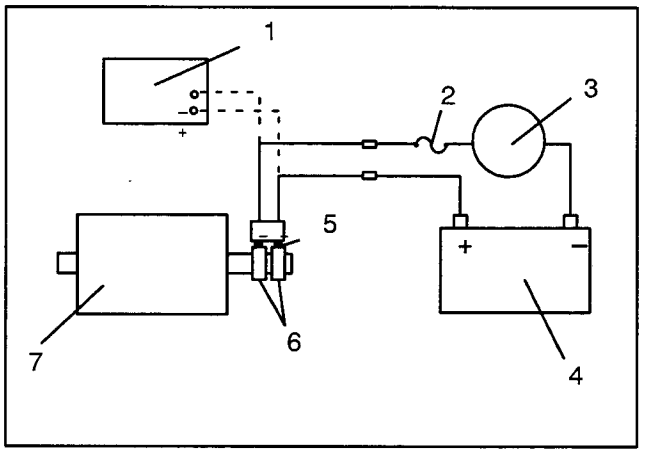
Figure 7-2. Generator Troubleshooting—ROY/RFOY 4-Lead Generators

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Separate Excitation

1. Disconnect all leads from voltage regulator. See Figure 7-4.
2. Connect a DC ammeter, 10 Amp fuse, and a 12-Volt automotive battery to the positive (+) and negative (–) brush leads as shown in Figure 7-3. Note and record the ammeter reading.



1. PowerBoost™ IIIE Voltage Regulator
2. 10 Amp Fuse
3. DC Ammeter
4. Battery
5. Brushes
6. Slip Rings
7. Rotor

Figure 7-3. Separate Excitation Connections

3. The approximate ammeter reading should be battery voltage divided by specified rotor resistance. Specified rotor resistance values are found in Section 10 Specifications.
4. Start engine and check that ammeter remains stable. An increasing meter reading indicates a shorted rotor. A decreasing meter reading to zero or an unstable reading suggests a running open. Refer to Section 7 Component Testing, Rotor to test rotor. If ammeter is stable proceed to Step 5.

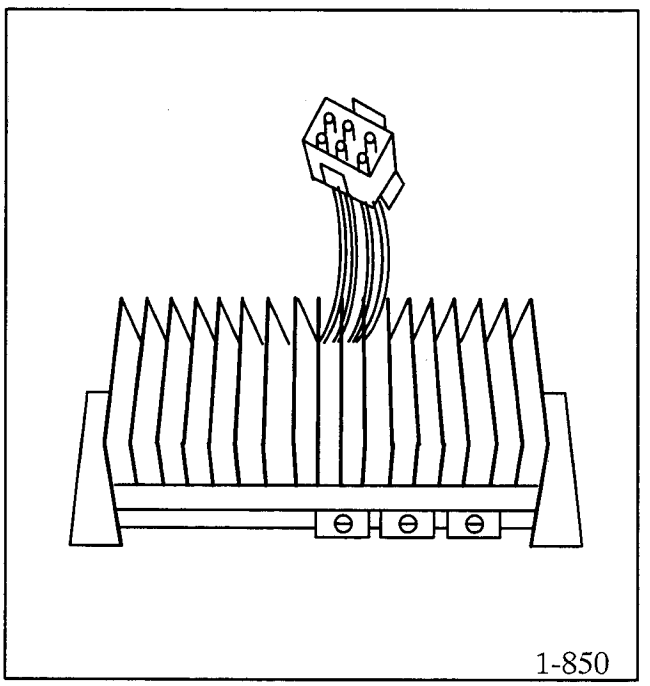


Figure 7-4. PowerBoost™ IIIE Voltage Regulator

Example: 6ROY Generator

$$\frac{\text{12 Volts (Battery Voltage)}}{\text{5.1 Ohms (Rotor Resistance)}} = \text{2.4 amps Rotor Current}$$

5. Check for AC output across stator leads (See Section 7 Component Testing, Stator) and compare to readings in Section 10 Specifications. If readings vary considerably, a faulty stator is likely. Refer to Section 8 Component Testing, Stator for further information.
6. If rotor and stator test good in prior steps, the voltage regulator is probably defective. See Section 7 Component Testing, Voltage Regulator.

Voltage Regulator Test—PowerBoost™ IIIE

The voltage regulator used on the ROY/RFOY models is PowerBoost™ IIIE. See Figure 7-5.

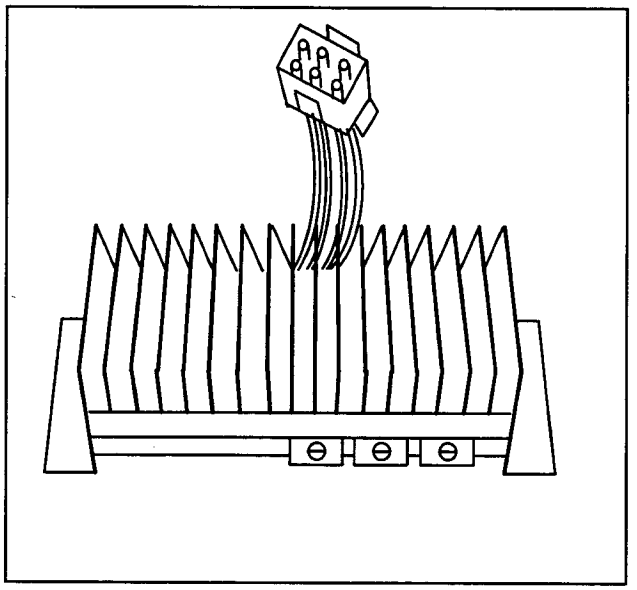


Figure 7-5. PowerBoost™ IIIE Voltage Regulator

The voltage regulator monitors output voltage magnitude and frequency to supply current to the generator exciter field. If the regulator 10 Amp fuse is blown, the generator will shut down; Verify regulator fuse is good before proceeding with test. To determine if the voltage regulator is functioning properly, reduce engine speed (Hz) and watch for a corresponding drop in AC voltage. AC voltage should remain constant until engine speed drops below 57.5 Hz (on 60 Hz models) or 47.5 Hz (on 50 Hz models). When frequency drops below 57.5/47.5 Hz, AC voltage should decline. If this test proves inconclusive, perform the following test to check regulator output. To test the voltage regulator the following components will be needed:

- Variable Transformer, 0-140 Volts (0.5-amp minimum)
- 120 volt AC Plug
- 120 volt, 100 watt Lamp
- AC voltmeter
- #14 AWG insulated copper wire (minimum)

⚠ WARNING

Hazardous voltage. **Moving rotor.**

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Test Procedure

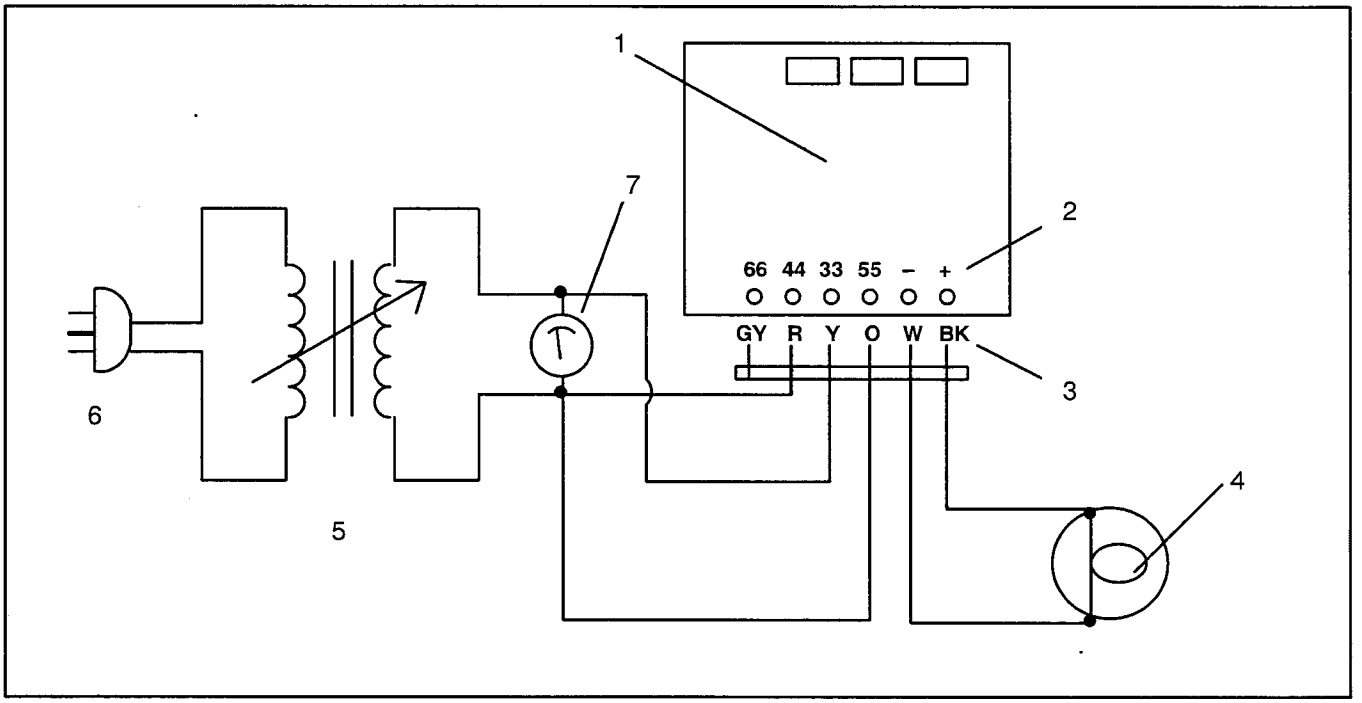
1. Connect components as shown in Figure 7-6.
2. Turn variable transformer setting to zero. Plug in variable transformer.
3. Turn variable transformer on. Slowly increase variable transformer voltage to 100 Volts. The lamp should go on. If the lamp does not light, turn the voltage adjustment Pot clockwise. If the light still does not go on, the voltage regulator is defective and should be replaced. A voltage regulator testing bad as described would cause a generator no/low output condition.

4. Slowly increase voltage to 120 Volts. The lamp should go out and stay out as voltage is further increased. If the lamp does not go out, turn the voltage adjustment Pot counterclockwise. If the light still does not go out, replace the voltage regulator. A voltage regulator testing bad as described would cause a generator high voltage output condition.

5. Turn variable transformer to zero and unplug AC cord.

NOTE

Terminal 66 on PowerBoost™ IIIE voltage regulator is intended for connection of a remote rheostat in applications where fine voltage adjustment is required.

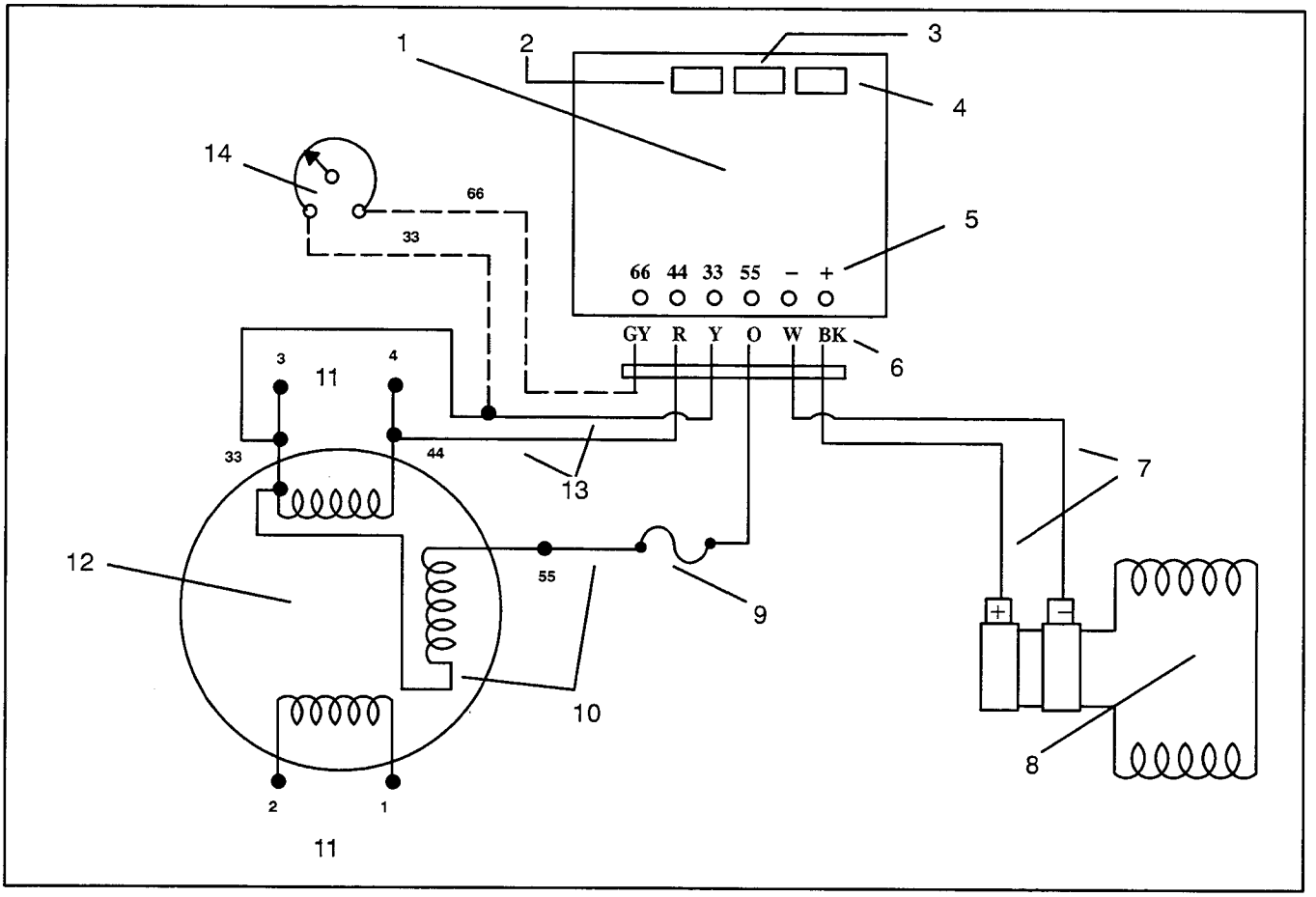


1. Voltage Regulator PowerBoost™ IIIE
2. Stator/Rotor Connections
3. Lead Color
4. 120 Volt, 100 Watt Lamp
5. Variable Transformer
6. 120 Volts AC
7. AC Voltmeter

Figure 7-6. PowerBoost™ IIIE Voltage Regulator

Voltage Regulator Adjustment

The PowerBoost™ IIIE voltage regulator monitors generator output to control current flow to the generator field. PowerBoost™ IIIE maintains generator output at specified voltage under load until the generator engine speed drops to a preset level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). At this point the regulator allows generator voltage and current to drop. The voltage/current drop enables the engine to pick up the load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, generator output also returns to normal. The voltage regulator is factory set for proper generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if the regulator is replaced or has been tampered with, readjust according to the procedure in section 9 Voltage/Frequency Adjustment Procedure. Voltage regulator components are identified in Figure 7-7.



1. Voltage Regulator PowerBoost™ IIIE
2. Voltage Adjustment Pot
3. Stability Pot
4. Volts/HZ. Pot
5. Stator/Rotor connections
6. Lead Color
7. D.C. Output
8. Rotor
9. 10 Amp Fuse
10. A.C. Power Input (Aux.)
11. Main
12. Stator
13. Sensing
14. Remote Rheostat

Figure 7-7. PowerBoost™ IIIE Voltage Regulator

Rotor

The four-pole rotor creates the magnetic field needed to produce alternating current in the stator windings. Prior to testing, inspect the rotor for visible damage to pole shoes, insulation, exposed coil windings, and slip ring surfaces. Check bearing for noise when rotated, wear, or heat discoloration.

Slip rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly-machined appearance. Ordinary cleaning with a dry, lint-free cloth is usually sufficient. Very fine sandpaper (#00) may be used to remove roughness. Use light pressure on the sandpaper. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator. If the rings are black or pitted, remove the rotor and remove some of the surface material using a lathe.

1. Disconnect generator starting battery (negative lead first) and power to battery charger (if equipped).
2. Check the rotor for continuity and resistance. Measure the rotor resistance (ohms) between the two slip rings (Figure 7-8). Raise the brushes from the slip rings while performing ohmmeter tests. See Section 10 Specifications for rotor resistance readings. If the resistance test proves inconclusive, perform megohmmeter test on rotor as described in next step.

NOTE

Since ohmmeters do vary in their accuracy, use resistance readings as a reference for approximate readings. Readings must be at room temperature.

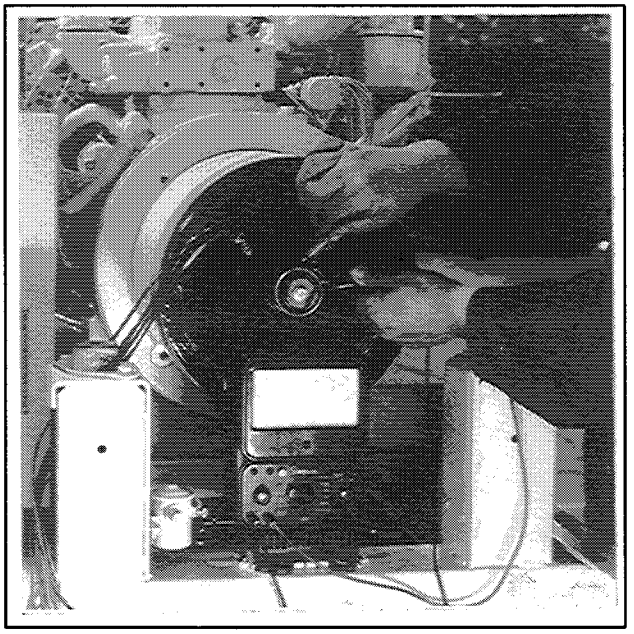


Figure 7-8. Rotor Resistance Check

Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high voltage test on rotor or stator. Improper test procedure can damage equipment or lead to future generator failures.

3. Determine whether the rotor is shorted to ground by performing a megohmmeter test. Raise brushes away from slip rings and secure in this position by inserting a retaining wire in the brush holder hole.

   Using a megohmmeter, apply 500 Volts DC to either rotor slip ring and rotor poles or shaft. See Figure 7-9 (Follow the instructions of the megohmmeter manufacturer when performing this test.)

   A reading of approximately 500K ohms (1/2 megohm) and higher indicates the rotor is good

   A reading of less than 500K ohms (approximately) indicates deterioration of the winding insulation and possible current flow to ground. Repair or replacement of the rotor is necessary.

   Following test, remove retainer wire from brush holder and verify that brushes are properly positioned on slip rings.

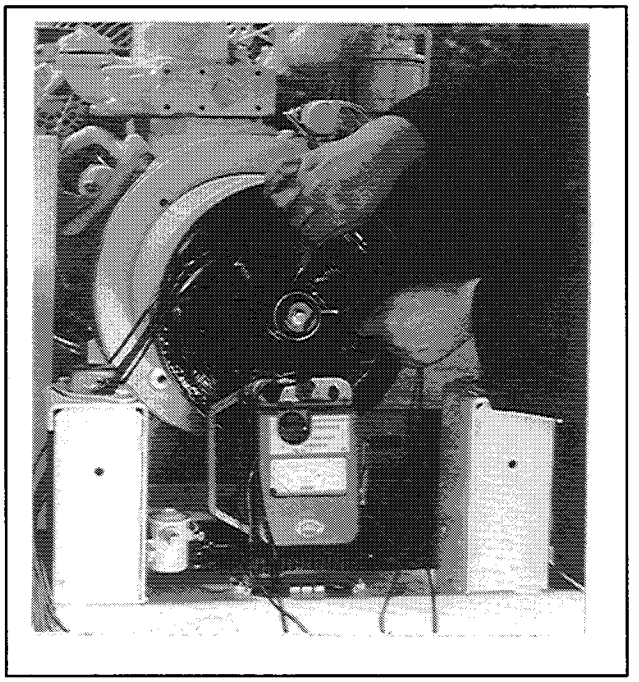


Figure 7-9. Performing Megohmmeter Test on Rotor

Stator

The stator consists of a series of coils of wire laid in a laminated steel frame. The stator leads supply voltage to the AC load and exciter regulator. Prior to testing, inspect the stator for heat discoloration and visible damage to housing lead wires, exposed coil windings, and exposed and varnished areas of frame laminations. Be sure the stator is securely riveted in the stator housing.

NOTE

Disconnect all stator leads prior to performing all stator tests.

Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high voltage test on rotor or stator. Improper test procedure can damage equipment or lead to future generator failures.

1. Disconnect generator starting battery (negative lead first) and power to battery charger (if equipped).
2. To check stator continuity, set ohmmeter on R x 1 scale. Contact the red and black meter leads; adjust ohmmeter to zero ohms. Check stator

continuity by connecting meter leads to stator leads as shown in Figure 7-10.

Leads 1, 2, 3, and 4 are the generator output leads. Leads 33, 44, and 55 are the voltage regulator sensing and supply leads. Refer to the schematic in Figure 7-11 when performing the following tests.

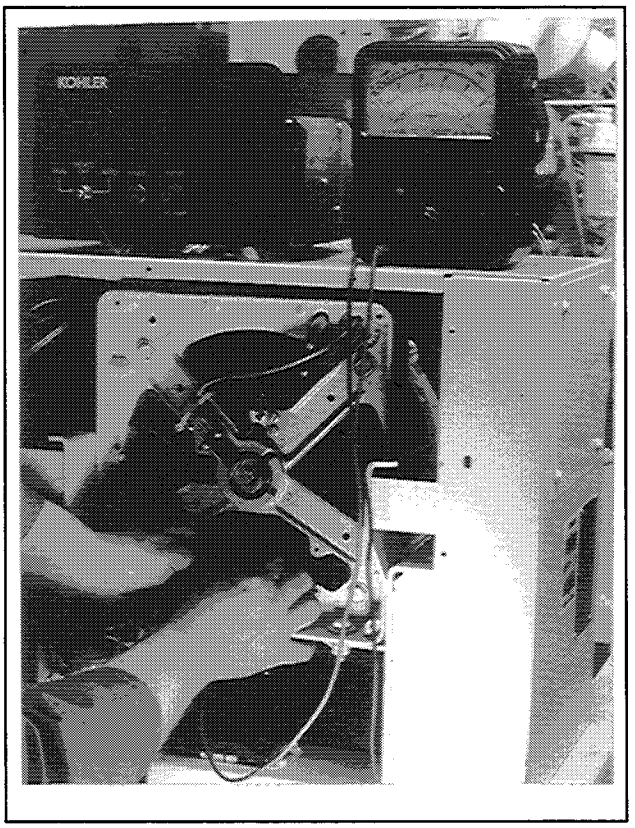


Figure 7-10. Testing Stator Windings

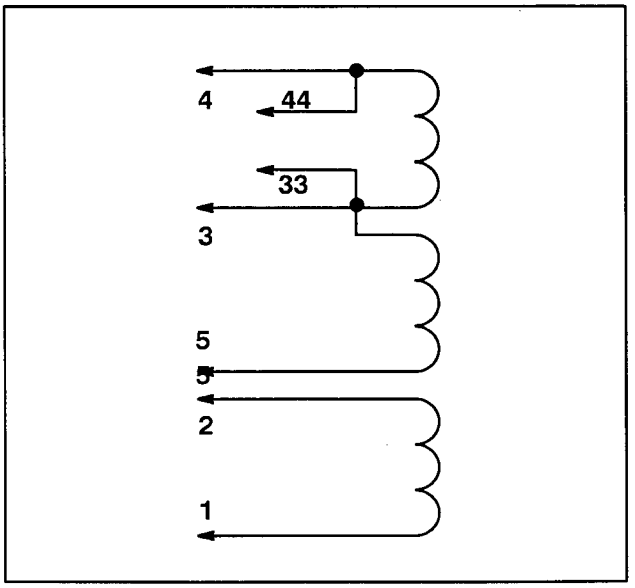


Figure 7-11. Generator Stator Leads

The continuity should be as follows:

Between leads	Continuity
1 and 2	yes
3 and 4	yes
33 and 44	yes
3 and 44	yes
55 and 3	yes
55 and 33	yes
1 and 3,4,33,44,55	no
Any stator lead and ground	no

Figure 7-12. Stator Continuity

3. Contact ohmmeter leads and readjust ohmmeter to zero ohms. Check cold resistance of stator windings by connecting meter leads to stator leads 1-2, 3-4, 33-44, and 55-33. Typical stator winding resistance readings are found in Section 10 Specifications. If the resistance test proves inconclusive, perform a megohmmeter test on stator as described in next step.

NOTE

Since ohmmeters do vary in their accuracy, use resistance readings as a reference for approximate readings. Ohmmeter readings must be taken at room temperature.

NOTE

Most ohmmeters will not provide accurate readings when measuring less than 1 ohm. The stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (heat discoloration).

Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high voltage test on rotor or stator. Improper test procedure can damage equipment or lead to future generator failures.

4. Determine whether the stator is shorted to ground by performing a megohmmeter test. Using a megohmmeter, apply 500 Volts DC to any stator lead and stator frame. (Follow the instructions of the megohmmeter manufacturer when performing this test.) Repeat test on other stator leads until each coil is tested. See Figure 7-13.

   A reading of approximately 500K ohms (1/2 megohm) and higher indicates the stator is good.

A reading of less than 500K ohms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replacement of the stator is necessary.

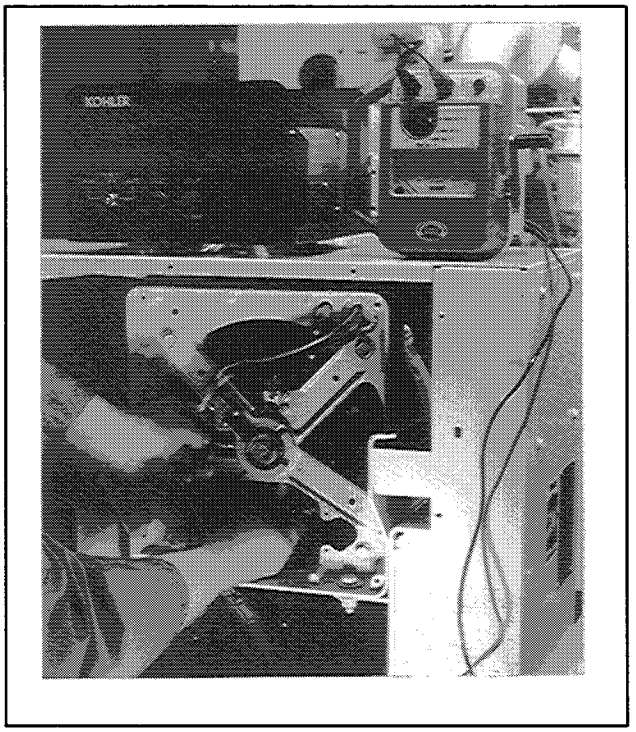


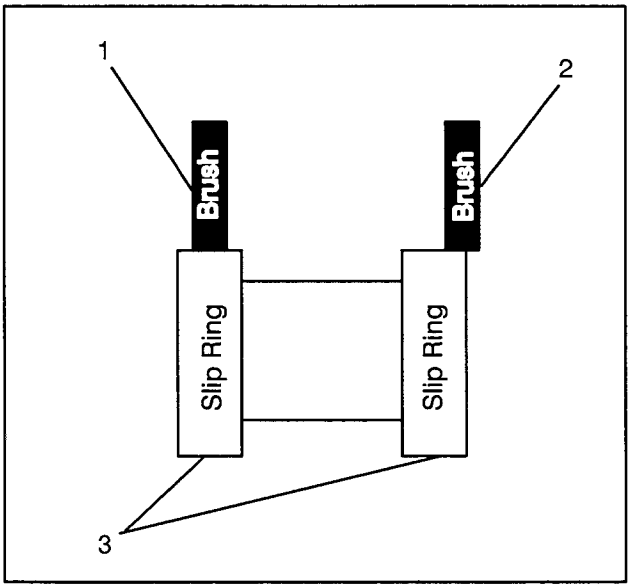
Figure 7-13. Performing Megohmmeter Test on Stator

Brushes

The brushes transfer current from the voltage regulator to the slip rings. Since the brushes carry a very low current (approximately 2 Amps), they should last the life of the generator. Abrasive dust on the slip rings could, however, shorten the life of the brushes. Excessive arcing at the brushes could damage the voltage regulator. Arcing could be caused by weak springs, damaged slip rings, sticking brushes, loose holder, or poor brush contact.

The brushes must be free to move within the holder and be held in proper contact by the springs. When properly positioned, spring pressure on the brush surface will cause the brush to wear evenly. Brushes must ride 100% on the rings or arcing will occur and cause burned rings or failure of the voltage regulator. Figure 7-14 shows the correct positioning of the brushes. Add or remove shims as necessary to center brushes on slip rings.

Replace brushes if they show excessive or uneven wear.



1. Correct Positioning
2. Improper Positioning
3. Slip Rings

Figure 7-14. Brush Positioning

Controller Circuit Board

It is possible to check controller circuit board relays without removing the relay from the board. These checks should be made prior to installing a new board and attempting start-up. Most of the tests are referenced in Section 4 Troubleshooting. Use a high quality multimeter and follow the manufacturer's instructions. To obtain accurate readings when testing, remove all circuit board connectors and conformal coating (transparent insulation) from component terminals. Use the following chart and the controller circuit board illustration, Figure 7-15.

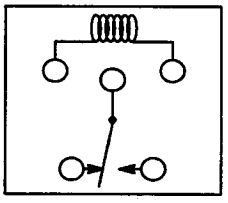
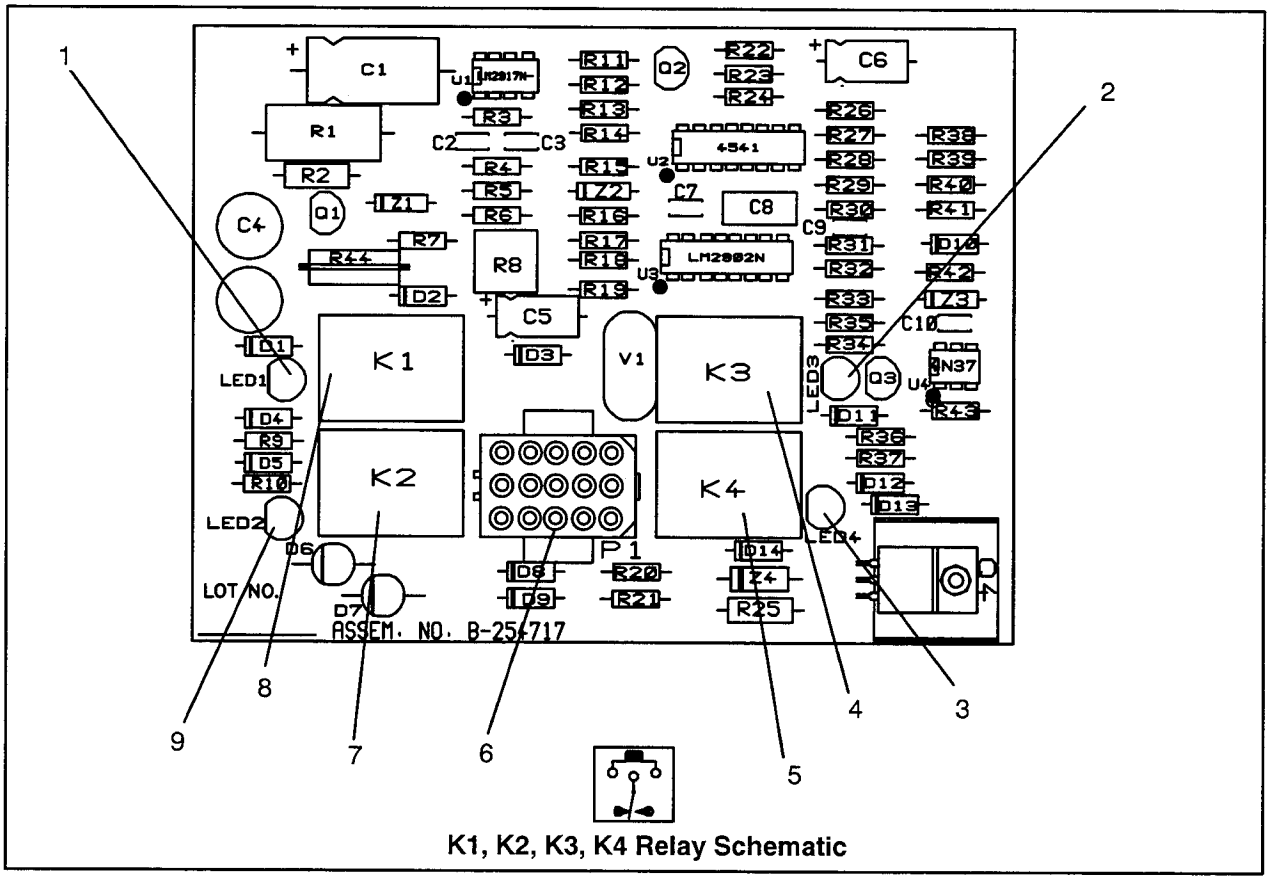
Component	Ohmmeter connection	Remarks	Results
K1,K2,K3,K4 Relay Coil 	K1 Coil Terminals (See Relay Schematic)	Ohmmeter on R x 10 scale	If good, approx. 400 ohms. Low resistance (continuity)—shorted coil. High resistance—open coil.

Figure 7-15. Checking Circuit Board Relays



K1, K2, K3, K4 Relay Schematic

1. LED1
2. LED3
3. LED4
4. K3 Relay
5. K4 Relay
6. P1 Connector
7. K2 Relay
8. K1 Relay
9. LED2

Figure 7-16. Controller Circuit Board Testing (Relay Controller)

Engine/Generator Components

With the generator set battery connected, the wiring harness and some engine/generator components can be checked. Place the controller master switch or remote start/stop switch in the prescribed position and check for voltage at each component using a voltmeter. This will verify that the switches function and voltage is present at each component. See Figure 7-17.

Engine/Generator Component Testing

Component	Voltmeter Connections	Procedure	Results
Hourmeter and wiring	Red test clip to hourmeter (+) terminal. Black test clip to hourmeter (–) terminal.	Voltmeter setting 12 Volts DC or greater. Start generator set.	12 Volt DC reading indicates wiring harness is okay. Hourmeter will function if good.
Fault Lamp and wiring	Red test clip to fault lamp (+) terminal. Black test clip to fault lamp (–) terminal.	Voltmeter setting 12 Volts DC or greater. Start generator set. Connect a jumper from LOP (low oil pressure) switch to ground to cause LOP shutdown.	12 Volt DC reading indicates wiring harness is okay. Fault lamp should light if good.
Stator 1-2 winding (control winding)	V0 and V7 terminals in controller	Voltmeter setting 150 Volts AC or greater. Start generator set and allow to reach reated speed.	Reading of 120 Volts AC (approx.) indicates stator 1-2 winding is good.
Governor Actuator	None	Disconnect actuator harness and apply12 Volts DC to actuator.	If good, actuator will extend. Actuator should retract when DC is removed.
Water Temperature Gauge (if equipped)	Red test lead to positive side (wire 70) of gauge. Black test lead to generator ground connection.	Start generator set to test voltage. Battery voltage (approx. 12 Volts DC) should be read. If no voltage,check controller circuit board and wiring. If voltage is present at gauge, stop set and check continuity of wiring between gauge and ground. (Resistance of sender will be read during continuity check.	See Section 7 Component Testing and Adjustment —Meter Senders (optional). If wiring test okay, replace gauge.

Component	Voltmeter Connections	Procedure	Results
Oil Pressure Gauge (if equipped)	Red test lead to positive side (wire 70) of gauge. Black test lead to generator ground connection.	Start generator set to test voltage. Battery voltage (approx. 12 Volts DC) should be read. If no voltage,check controller circuit board and wiring. If voltage is present at gauge, stop set and check continuity of wiring between gauge and ground. (Resistance of sender will be read during continuity check. See Section 7 Component Testing and Adjustment —Meter Senders (optional).	If wiring test okay, replace gauge.
Voltmeter (if equipped)	Red test lead to positive side (wire 70) of gauge. Black test lead to generator ground connection.	Start generator set. Battery voltage (approx. 12 Volts DC) should be read. If no voltage,check controller circuit board and wiring. If voltage is present,stop set and check continuity of wiring between meter and ground.	If wiring tests okay,replace meter.

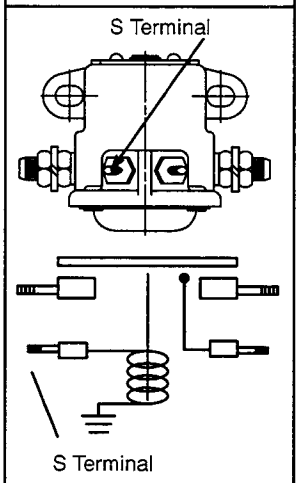
To further check generator set components, disconnect the batter and remove wiring harness plugs from the controller circuit board. Use and ohmmeter to check continuity and to isolate defective components. Use the following chart and Figure 7-17.

NOTE

Before performing ohmmeter checks, disconnect generator set battery to prevent damage to the ohmmeter.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

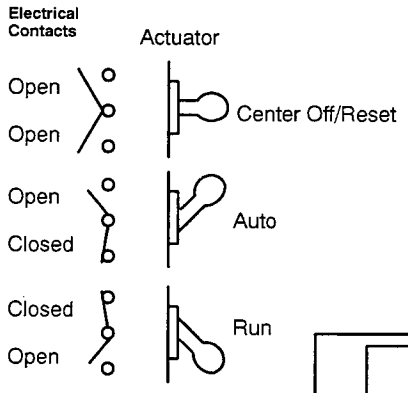
Component	Ohmmeter Connections	Procedure	Results
Controller Master Switch	P1-2 (47) and P1-14 (N)	Ohmmeter o R x 1000 scale. Place master switch in RUN position.	If good—zero ohms (continuity). Any resistance other than zero indicates defective switch.
	P1-2 (47) and P1-14 (N)	Ohmmeter on R x 1000 scale. Place master switch in OFF/RESET position	If good—no reading (infinity). Any other reading indicates defective switch.
Hourmeter	(+) and (–) terminals	Ohmmeter on R x 1 scale.	If good—continuity. No continuity—replace hourmeter
P1 wiring harness	P1-14 and ground	Ohmmeter on R x 1 scale	If good—zero ohms. Any other reading indicates a poor ground connection.
	P1-12 and P1-15 (1 and 2 stator leads)	Ohmmeter on R x 1 scale	If good—continuity (zero ohms).

Component	Ohmmeter Connections	Procedure	Results
Controller 10 Amp fuse	P1-10 and battery positive (+) cable	Ohmmeter on R x 1 scale	If good—zero ohms. No continuity—open circuit and/or blown fuse.
Voltage regulator circuit 10 Amp fuse	J11-5 and stator lead 55 at fuse holder	Ohmmeter on R x 1 scale	If good-zero ohms. No continuity—blown fuse or open wiring.
K20 relay coil (starter relay) 	K20 S terminal and relay base (ground)	Ohmmeter on R x 1 scale	If good—3-4 ohms. Low resistance—shorted K20 relay coil and/or wiring. High resistance—open K20 relay coil and/or wiring.
High Engine Temperature (HET) Switch *	P1-7 and ground (engine block)	Ohmmeter on R x 1000 scale. Low Oil Pressure (LOP) and Low Water Level (LWL) switches disconnected.	If good—open circuit (infinity). Any other reading indicates defective switch and/or wiring.
Low Oil Pressure (LOP) Switch *	P1-7 and ground (engine block)	Ohmmeter on R x 1000 scale. High Engine Temperature (HET and Low Water Level (LWL) switches disconnected.	If good—zero ohms (continuity). No reading—defective switch and/or wiring.
Low Water Level (LWL) Switch	P1-7 and ground (engine block)	Ohmmeter R x 1000 scale. High Engine Temperature (HET) and Low Oil Pressure Switches disconnected.	If good—approx. 50 ohms (continuity). No reading—defective switch and/or wiring.

* See Fault Shutdown Test Procedure following.

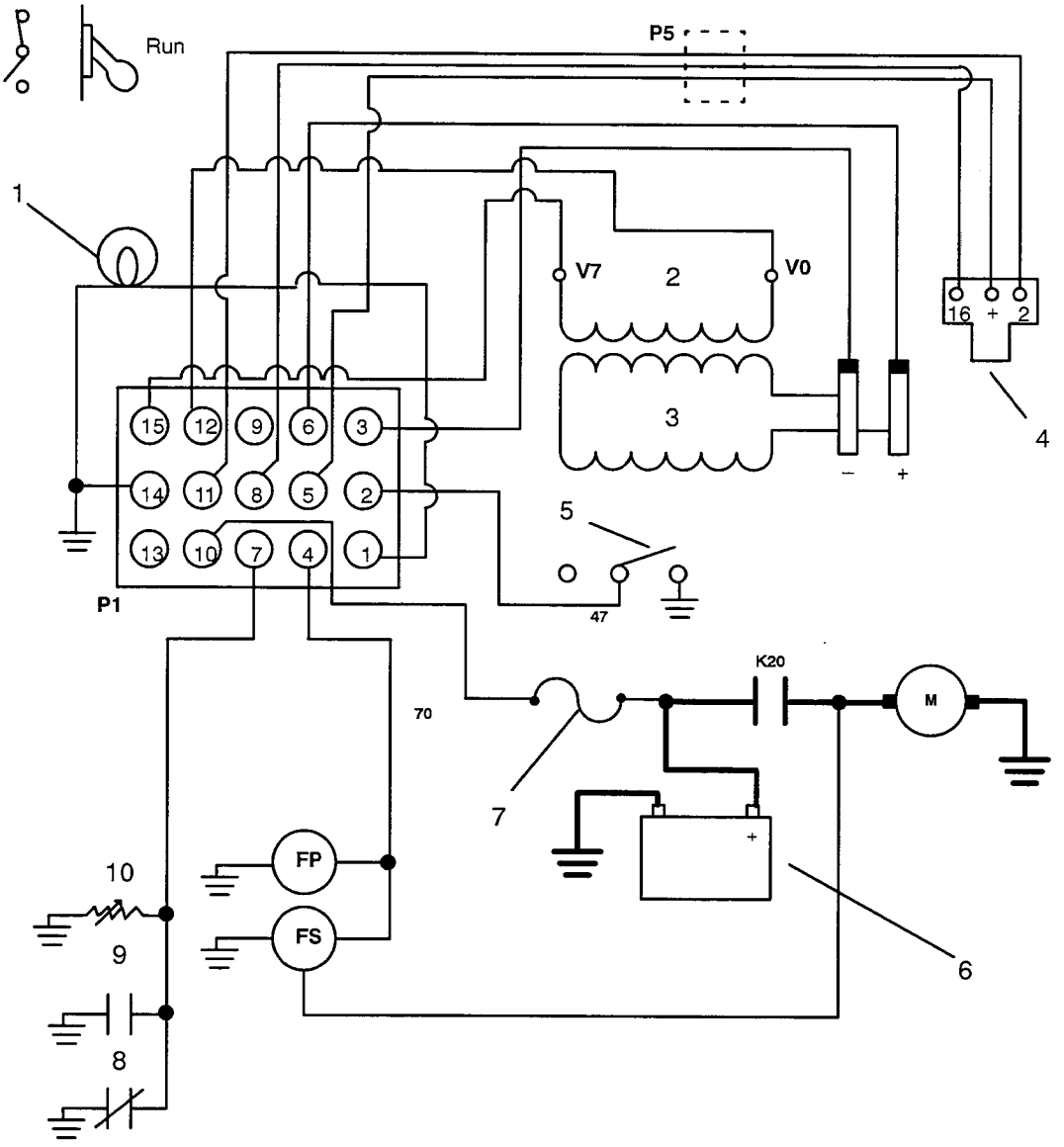
Control Master Switch Electrical Contacts
and Corresponding Actuator Position

NOTE: Controller switch electrical connections are reversed from position of switch.



Legend

FS	Fuel Solenoid
FP	Fuel Pump
HR	Hourmeter
K20	Starter Relay
M	Starter Motor
SDR	Overspeed Shutdown Relay
TDR	Time Delay Relay
LWL	Low Water Level Sensor
HET	High Exhaust Temperature Switch
LOP	Low Oil Pressure Switch



1. Fault Lamp
2. Control Winding
3. Rotor
4. Magnetic Pickup
5. On/Off Switch
6. 12 Volt Battery
7. 10 Amp Fuse
8. LOP (Low Oil Pressure)
9. HET (High Engine Temperature)
10. LWL (Low Water Level)

Figure 7-17. ROY/RFOY (4-Lead Generator) Wiring Harness Schematic

Fault Shutdown Test Procedure

Proper operation of the generator overspeed, overcrank, low coolant level, low oil pressure, and high engine temperature shutdowns can be verified by performing the following tests with the generator set running. If these tests are inconclusive, test individual shutdown circuit components (circuit board, wiring harness, switch, etc.) as described earlier in this section.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set.

Overspeed

Start generator set and manually adjust engine speed (by moving throttle linkage) to exceed rated engine rpm (1800 rpm). Generator will shut down and fault lamp will light at engine speed between 68 and 71 Hz.

Low Oil Pressure (LOP) Shutdown

Connect a jumper wire from the LOP switch (lead 13) to the generator set ground. See Section 7 Engine Safety Shutdown Switches. Start generator set. After approximately 5-8 seconds the generator set should shut down and the fault lamp will light.

Low Water Level (LWL) Shutdown

Connect a jumper wire from LWL sensor (lead 31) to generator set ground. See Section 7 Engine Safety Shutdown Switches. Start generator set. After approximately 5-8 seconds, the generator set should shut down and the fault lamp will light.

High Engine Temperature (HET) Shutdown

Connect a jumper from the HET switch (lead 34) to the generator set ground. See Section 7 Engine Safety Shutdown Switches. Start generator set. After approximately 5-8 seconds, the generator set should shut down, the alarm horn will sound, and the High Engine Temperature lamp will light.

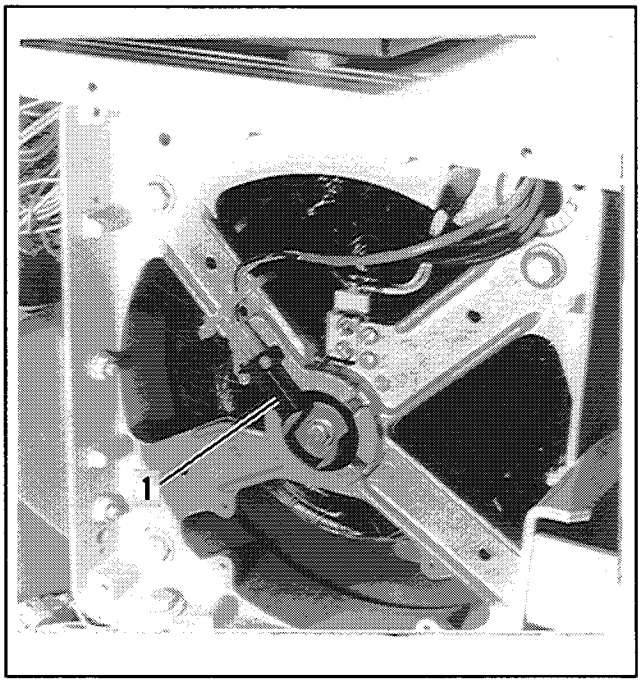
Overcrank Shutdown

Disconnect lead between starter solenoid K20 and starter motor at K20 terminal. Move controller master switch to the RUN position. Generator set will simulate cranking for 30 seconds. At the end of the crank cycle the generator set alarm horn will sound and the Overcrank lamp will light.

With the generator set battery connected, the wiring harness and some engine/generator components can be checked. Place the controller master switch or remote start/stop switch in the prescribed position and check for voltage at each component using a voltmeter. This will verify that the switches function and voltage is present at each component.

Speed Sensor (Overspeed/Overcrank Shutdown)

The Speed Sensor monitors engine speed (frequency) to signal overspeed and overcrank conditions. Location of the Speed Sensor is shown in Figure 7-18. To determine if the Speed Sensor is emitting a signal, follow the procedure outlined below. (Additional Speed Sensor test information for models equipped with 5-light controllers is included in Section 6 5-Light Microprocessor Controller.)



1. Speed Sensor

Figure 7-18. Generator Speed Sensor

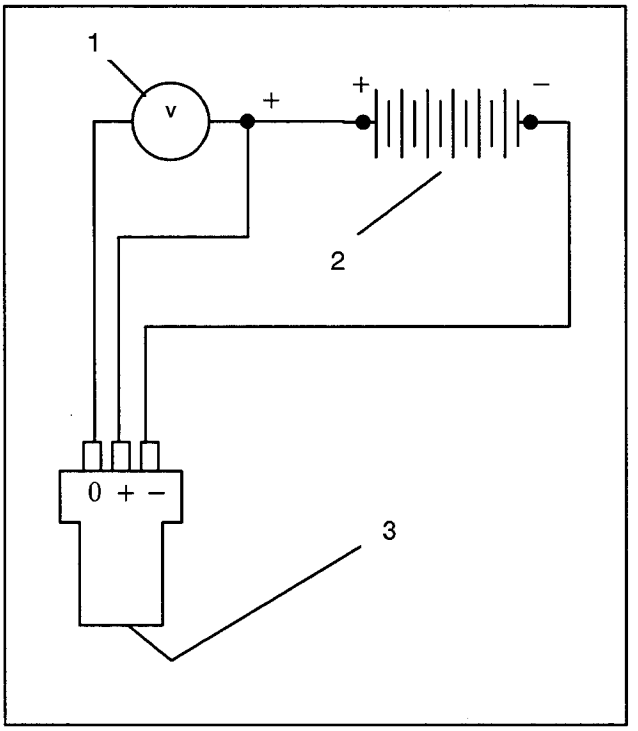
1. With generator master switch in OFF or OFF/RESET position, connect a DC voltmeter between positive (+) lead (wire 24) at Speed Sensor and ground (wire 2). Voltmeter should read approximately 9-5 Volts DC.

2. With generator set running, connect DC voltmeter negative (–) probe to 0 terminal (wire 16-white) on Speed Sensor. Place voltmeter positive (+) probe on positive (+) terminal (wire 24-red). Voltmeter should indicate approximately 7 Volts DC.

If Speed Sensor is emitting a signal, check continuity of Speed Sensor leads (wires 2, 16, and 24). If the Speed Sensor is not emitting a signal, test the Speed Sensor through the following procedure:

Speed Sensor Test Procedure

1. Remove Speed Sensor from end bracket. Connect Speed Sensor, voltmeter, and DC voltage source as shown in Figure 7-19.
2. Touch sensing surface with a flat piece of iron or steel-contact surface area of iron or steel piece should be at least 1/4 cubic inch (4.1 cm).
3. Voltmeter test reading should equal source voltage.
4. Remove iron or steel from sensing surface-voltmeter should should indicate no voltage.
5. Reinstall Speed Sensor to end bracket using all original hardware. When properly installed, air gap between Speed Sensor and actuator should be 0.030 in. (0.76 mm) ±0.010 in. (0.25 mm).

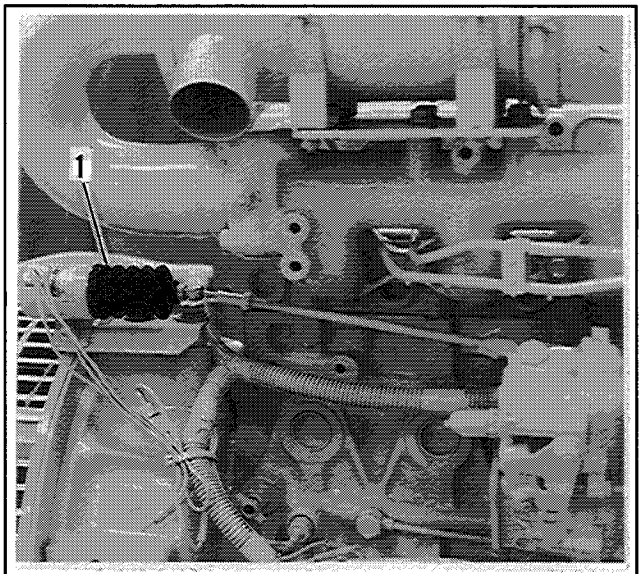


1. DC Voltmeter
2. 12 Volt DC Power Supply
3. Speed Sensor Sensing Surface

Figure 7-19. Speed Sensor Test

Fuel Solenoid

The fuel solenoid (Figure 7-20) serves to pull the injector pump lever to the fuel on position when energized. The fuel solenoid is spring loaded to return the fuel injector pump to the fuel off position when de-energized.



1. Fuel Solenoid

Figure 7-20. Fuel Solenoid

These models make use of a three-lead fuel solenoid. This solenoid has a white lead (14P) which energizes the pull-in coil only during cranking. During the operation the red lead energizes the hold coil and the black lead is the common ground.

Current (Amps) and resistance readings are shown in Figure 7-21. Resistance readings can be taken to determine if the solenoid windings are open or shorted. These tests must be made with fuel solenoid disconnected from engine wiring harness.

Fuel Solenoid	Readings
pull-in	50 Amps
hold	1.0 Amp
Black-White (14P) leads	0.12-0.26 Ohms
Black-Red leads	11-13 Ohms

Figure 7-21. Fuel Solenoid Readings

In addition to the ohmmeter and ammeter tests, check for smooth, non-binding movement of the plunger. It is important that the linkage between the fuel solenoid and the fuel injection pump lever be properly adjusted to allow the solenoid plunger to fully compress. Improper adjustment may cause burn-out of the pull-in coil.

If the fuel solenoid is removed or the setting is believed incorrect, readjust according to the following procedure. Do not modify solenoid linkage during reconnection.

1. Remove linkage to allow fuel solenoid plunger to be manually compressed.

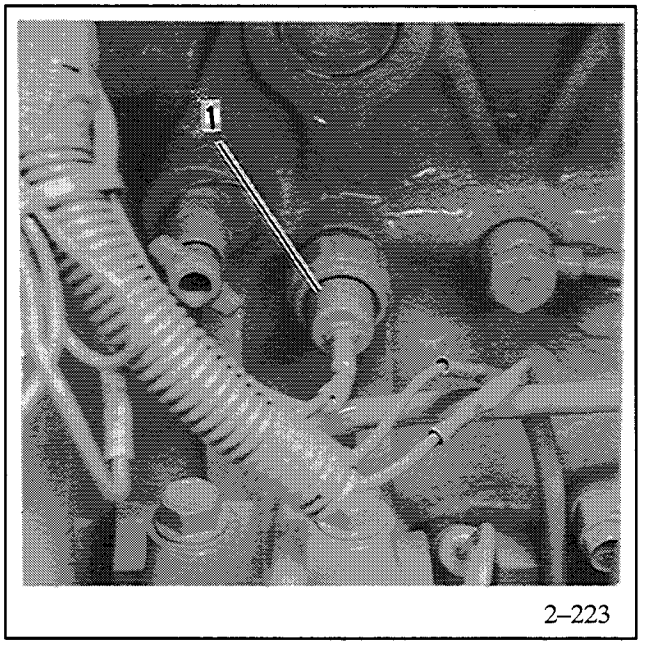
2. With fuel solenoid fully compressed, align linkage and check injection pump lever for travel. Fuel solenoid should fully compress and injection pump lever should be 1/16 in. (1.6 mm) before lever contacts (internal full open) stop.

3. If alignment is not correct, check linkage and mounting brackets. Loosen locknuts and adjust ball joint length in or out to attain proper alignment. Tighten locknuts.

Engine Safety Shutdown Switches

Low Oil Pressure (LOP) Shutdown

The Low Oil Pressure (LOP) shutdown feature protects the engine against internal damage if the oil pressure drops below 7.1 psi (49 kPa) due to oil pump fault or other engine malfunction. The LOP shutdown does not protect the set from damage due to operating with oil level below the safe range—IT IS NOT A LOW OIL LEVEL SHUTDOWN. The only protection against running out of oil is to check the oil level regularly and add oil as needed. Location of the LOP shutdown switch is shown in Figure 7-22.



1. LOP Switch

Figure 7-22. Low Oil Pressure (LOP) Shutdown Switch

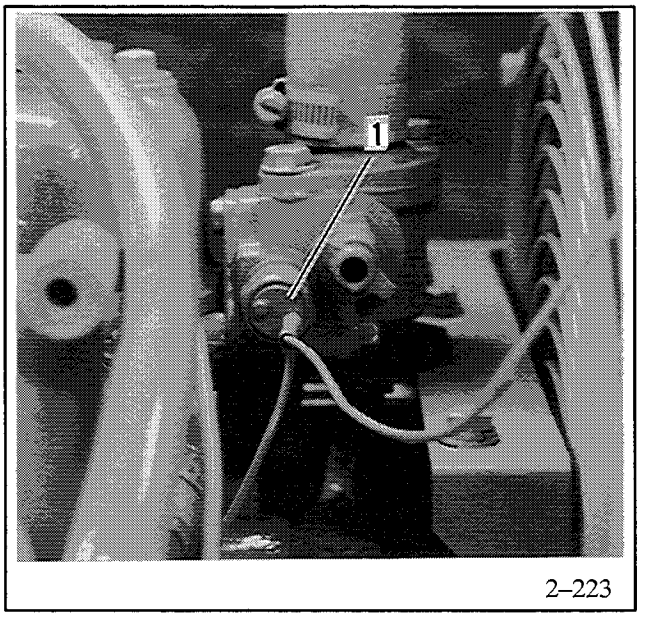
If unit shuts down, remove lead from LOP switch and insulate terminal on lead. Reset controller and attempt restart. A successful restart attempt indicates a faulty LOP shutdown switch.

NOTE

Verify proper engine oil pressure before performing test and/or replacing LOP shutdown switch.

High Engine Temperature (HET) Shutdown

The engine will automatically shut down after the engine temperature reaches 230° F (110° C). Fault shutdown time delay is dependent upon generator controller—refer to Section 2 Fault Shutdowns—Relay Controller or Fault Shutdowns—5 Light Controller for specific information on fault shutdown time delays. The engine cannot be restarted until the cause of the shutdown has been corrected (or the engine has cooled) and the controller is reset. Location of the shutdown switch is shown in Figure 7-23. Location of HET switch may be on opposite side of thermostat housing when a water temperature sender is installed.



1. High Engine Temperature (HET) Shutdown Switch

Figure 7-23. High Engine Temperature (HET) Shutdown Switch

NOTE

The High Engine Temperature (HET) shutdown is not a low coolant level switch. Engine coolant level must be maintained for the HET shutdown switch to function.

If unit shuts down, remove lead from HET switch and insulate terminal on lead. Reset controller and attempt restart. A successful restart attempt indicates a faulty HET shutdown switch.

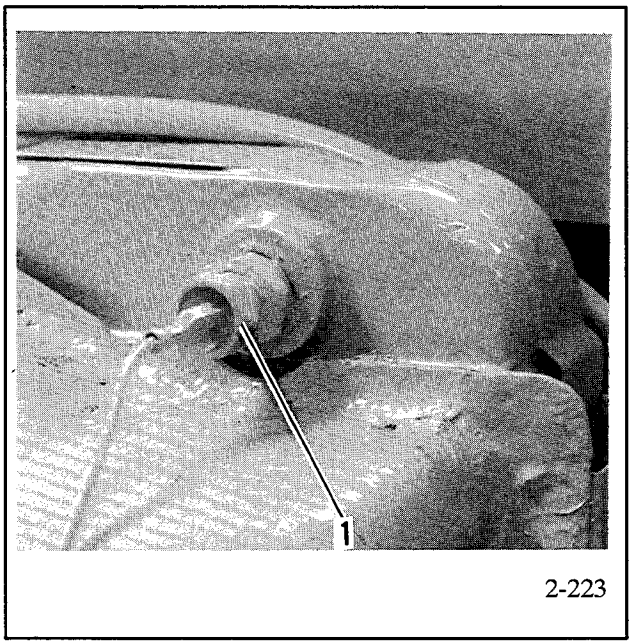
NOTE

Verify proper engine coolant level, water pump belt tension, and operating temperature of 175-195° F (77-91° C) before performing test and/or replacing HET shutdown switch.

Low Water Level (LWL) Shutdown Sensor

If the engine water (coolant) level falls below the safe range in the radiator the generator will automatically shut down. The generator set will not run until coolant is added to reach the specified level and the controller is reset. Location of the low coolant level shutdown sensor is shown in Figure 7-24. Refer to Section 2 Fault Shutdowns—Relay Controller or Fault Shutdowns 5 Light Controller for specific information on fault shutdown time delays.

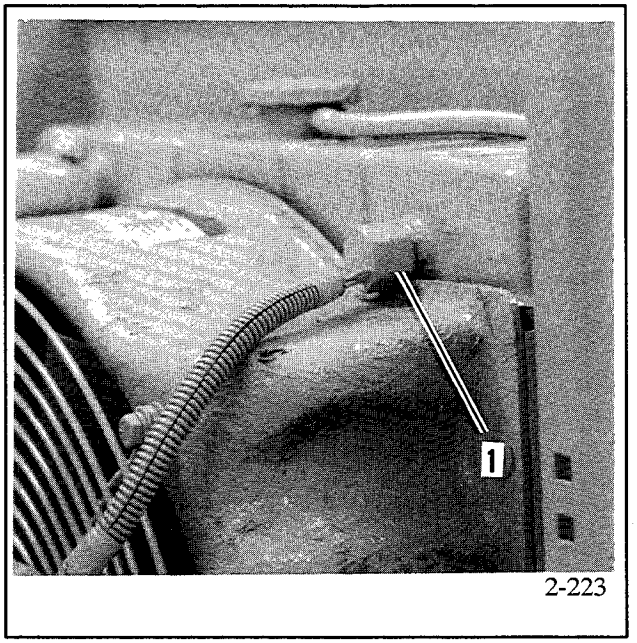
The relay controller models make use of a single terminal sensor which provides a low resistance connection to ground when water (coolant is not present at the tip. The sensor will provide a high resistance connection to ground when water (coolant) is present at the tip of the sensor.



1. LWL Sensor

Figure 7-24. Low Water Level (LWL) Shutdown Sensor (Relay Controller)

The 5-light microprocessor controller models make use of a three lead sensor. The red lead connects to battery positive and the black lead connects to battery negative when the unit is running. The blue lead provides a connection to ground when water (coolant) is not present at the tip. The sensor is *open* when water (coolant) is present at the tip of the sensor.



1. LWL Sensor

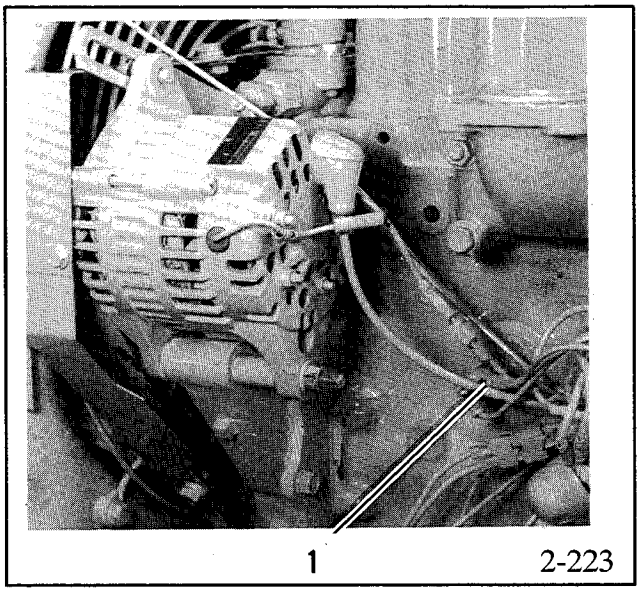
Figure 7-25. Low Water Level (LWL) Shutdown Sensor (5-Light Microprocessor Controller)

Prealarm Switches (Optional)

The pre-alarms or anticipatory alarms are only available as an option with generator sets equipped with the 5-light microprocessor controller and (optional) remote annunciator. The alarms will provide a visual alert of approaching shutdown conditions on the remote annunciator. The pre-alarm switches will NOT shut down the unit.

Anticipatory Low Water Temperature Switch

The anticipatory low water temperature switch (see Figure 7-26) closes when temperatures fall below 60° F (16° C) ±5° F (3° C). The switch opens when temperatures rise above 80° F (16° C) ±5° F (3° C). This switch warns of impending low water temperatures which indicate possible problems with cold weather starting. The causes for this switch to close include failure of the block heater or block heater power turned off. If remote annunciator lamp is ON and the switch is suspected to be defective, check function of switch with specifications given using controller water temperature gauge. Replace switch if not within specifications.

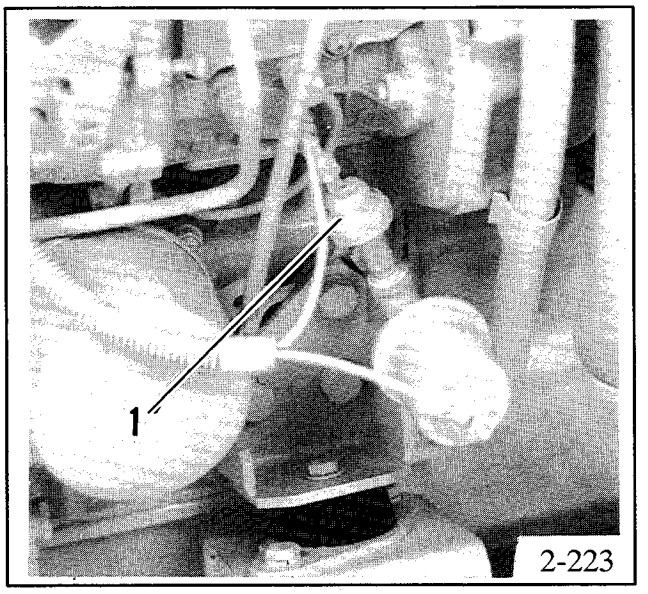


1. Anticipatory Low Water Temp Switch

Figure 7-26. Anticipatory Low Water Temperature Switch

Anticipatory Low Oil Pressure Switch

The anticipatory low oil pressure switch (see Figure 7-27) closes when oil pressure drops below 8 psi (55 kPa). This switch warns of impending low oil pressure which indicate possible lubrication problem. The causes for this switch to close include failure of the oil pump, inadequate oil level, improper oil viscosity, or oil change interval neglect. If remote annunciator lamp is ON and the switch is suspected to be defective, check function of switch with specifications given using controller oil pressure gauge or a separate mechanical oil pressure gauge. Replace switch if not within specifications.

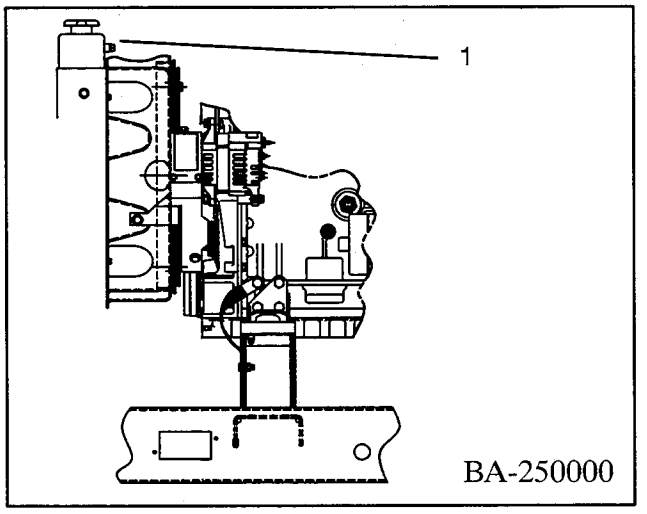


1. Anticipatory Low Oil Pressure Switch

Figure 7-27. Anticipatory Low Oil Pressure Switch

Anticipatory High Engine Temperature Switch

The anticipatory high engine temperature switch (see Figure 7-28) closes when temperatures rise above 218° F (103° C) ±7° F (4° C). This switch warns of impending high engine temperatures which indicate possible problems with engine overheating. The causes for this switch to close include thermostat failure, air inlet blockage, inadequate lubrication, cooling system blockage, improper engine timing, etc. If remote annunciator lamp is ON and the switch is suspected to be defective, check function of switch with specifications given using controller water temperature gauge. Replace switch if not within specifications.



1. Anticipatory High Engine Temp Switch

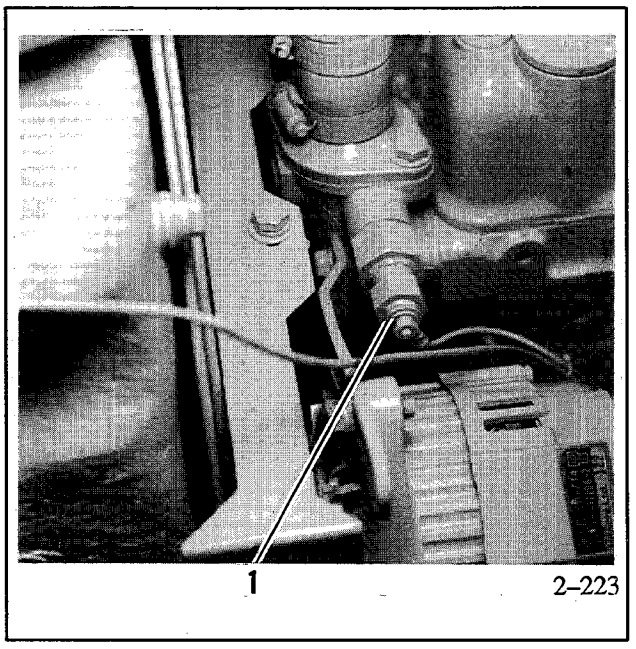
Figure 7-28. Anticipatory High Engine Temperature Switch

Meter Senders (Optional)

Some generators may be equipped with water temperature and oil pressure senders to activate controller-mounted meters.

Water Temperature Sender

To test the water temperature sender, connect one ohmmeter lead to the sender terminal and the other ohmmeter lead to ground. See Figure 7-29 for sender location and the chart below for sender resistance at different water temperatures. Start the generator set and check the sender resistance. As water temperature increases, a corresponding change in sender resistance should occur. Replace the sender if resistance readings vary greatly from those shown. Generally, a sender can be presumed good if the sender resistance value changes with temperature. A defective sender will either test open (no reading) or shorted (continuity).



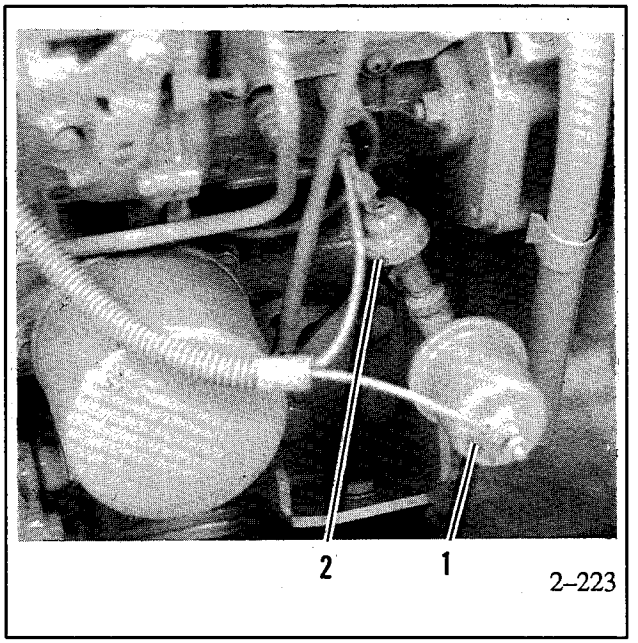
1. Water Temperature Sender

Figure 7-29. Water Temperature Sender Location

Temperature	Resistance ±10% (Ohms)
100°F (38°C)	450 ohms
160°F (71°C)	130 ohms
220°F (104°C)	47 ohms

Oil Pressure Sender

To test the oil pressure sender, connect one ohmmeter lead to the sender terminal and the other ohmmeter lead to ground. See Figure 7-30 for sender location and the chart below for resistance of the oil pressure sender at different pressure levels. Start the generator set and check the sender resistance. As oil pressure increases, a corresponding change in sender resistance should occur. Replace the sender if resistance readings vary greatly from those shown. Generally, a sender can be presumed good if the sender resistance value changes with pressure. A defective sender will either test open (no ohmmeter reading) or shorted (continuity).



1. Oil Pressure Sender
2. Anticipatory Low Oil Pressure Switch

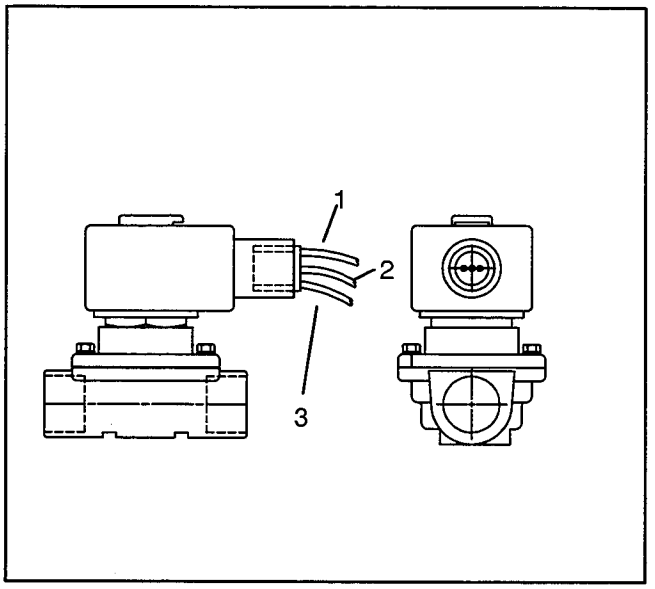
Figure 7-30. Oil Pressure Sender Location

Oil Pressure	Resistance (ohms)
0 psi/kPa	227-257
25 psi (172 kPa)	138-162
50 psi (345 kPa)	92-114
75 psi (517 kPa)	50-80
100 psi (690 kPa)	21-50

Water Solenoid
(Optional City Water Cooling)

If unit uses city water cooling, a water solenoid is incorporated in the system. See Figure 7-31. This water solenoid opens when the generator sets is running to provide cooling water. When the generator set is shut down, the water solenoid closes and shuts off the utility water supply. The water solenoid has two red leads and one green lead. The red leads connect to 12 Volt DC supply. The red leads can be connected to positive and negative either way as polarity is not a consideration. The green lead connects to the negative ground and is the safety ground.

Should failure of this valve be suspected, check for 12 Volts DC at red lead connected to the battery positive lead (70). If the water solenoid fails to open when 12 Volts DC is applied, replace the water solenoid.



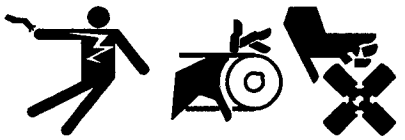
1. Red Lead (Battery + or – Connection)
2. Red Lead (Battery – or + Connection
3. Green Lead (Safety Ground Connection)

Figure 7-31. Water Solenoid

Section 8. Disassembly/Reassembly

Prior to disassembly, the generator set must be removed from the enclosure, if used. Disconnect battery (negative lead first), fuel line, exhaust system, remote switch, and load leads. In addition to the precautions included in the text, observe all safety precautions listed at the beginning of this manual during the disassembly/reassembly procedure.

⚠ WARNING

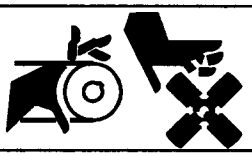


Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft bolt or rotor thru-bolt counterclockwise can loosen hardware and result in serious personal injury from hardware or pulley flying off engine while unit is running.

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Hazardous voltage can cause severe injury or death. Engine block heater can cause electrical shock. Remove engine block heater plug from electrical outlet before working on block heater electrical connections.

⚠ WARNING

Unbalanced weight.
Improper lift can cause severe injury, death, or equipment damage.
Do not use lifting eyes.
Use lifting bars thru holes in skid to lift set.

⚠ WARNING

Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on generator set until unit is allowed to cool.

NOTE

HARDWARE DAMAGE! Engine and generator may make use of both American Standard and metric hardware. Be sure to use the correct size tools to prevent rounding of bolt heads and nuts.

NOTE

Several models are covered in this manual and the procedure for disassembly/reassembly may vary due to product updates and assembly variations. Major differences are noted where appropriate. The model illustrated is a 6ROY.

Disassembly

1. Disconnect battery, negative lead first.
2. Remove nine screws securing junction box rear panel and remove panel. See Figure 8-1.

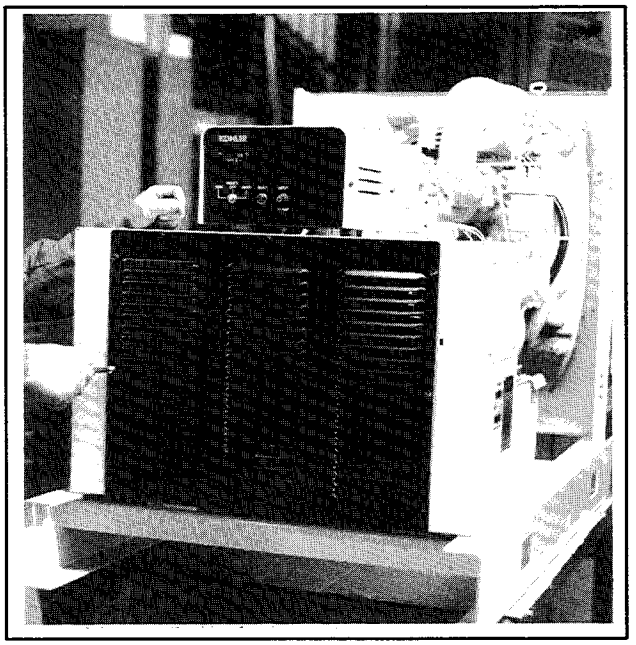


Figure 8-1. Removing Junction Box Rear Panel

3. Removal of the junction box panel will access the voltage regulator. See Figure 8-2.

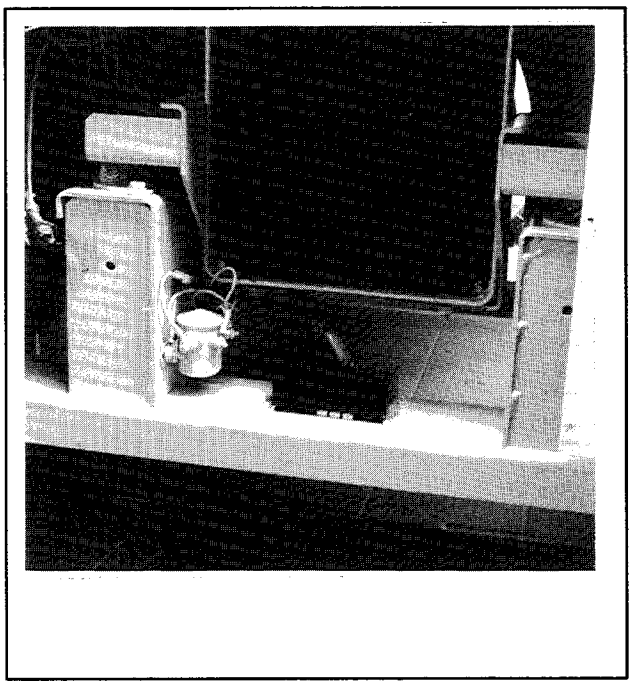


Figure 8-2. Voltage Regulator

4. Remove four mounting screws securing controller cover and remove cover. See Figure 8-3.

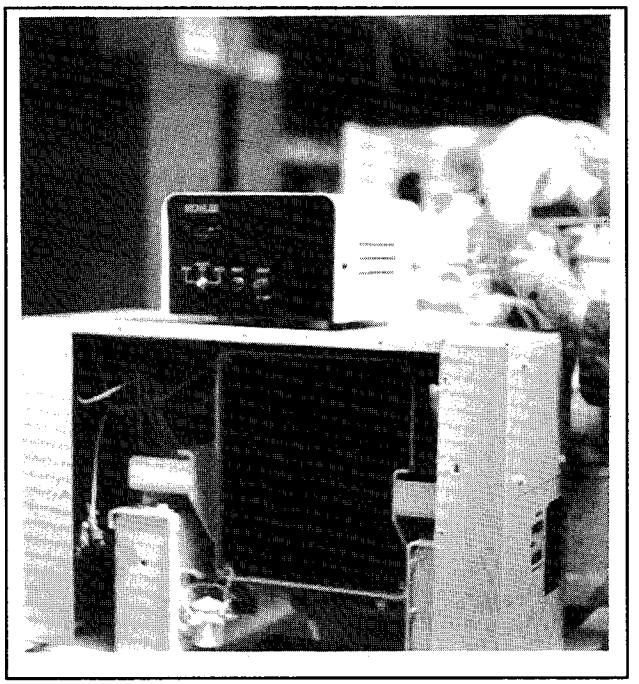


Figure 8-3. Removing Controller Cover

5. Remove four screws attaching end bracket panel and remove panel. See Figure 8-4.

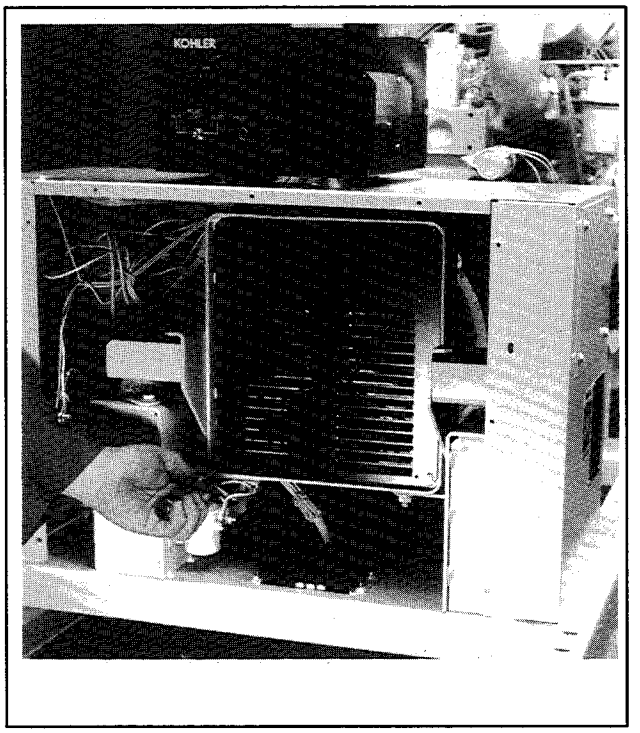


Figure 8-4. End Bracket Panel

6. Disconnect voltage regulator from wiring harness at six-pin in-line connector. See Figure 8-5. Remove all leads to starter solenoid. Mark leads, as necessary, for reassembly.

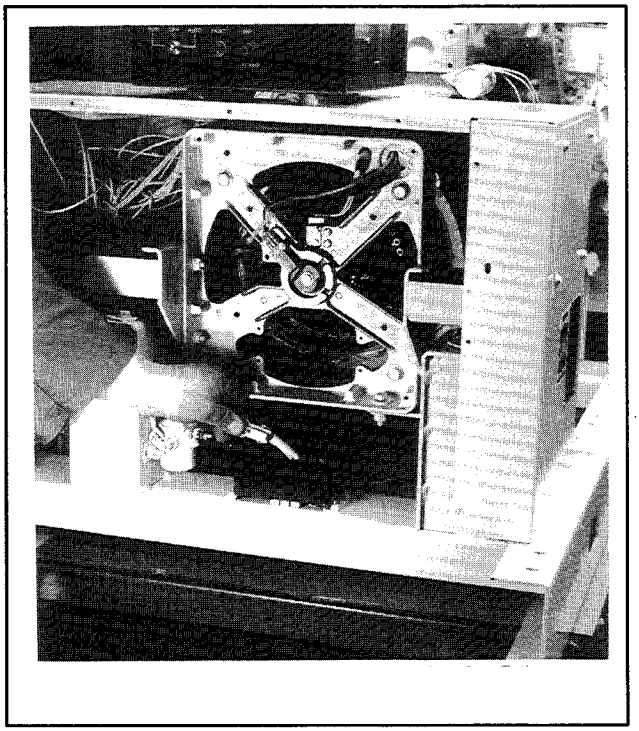


Figure 8-5. Disconnecting Voltage Regulator

7. Remove four screws and nuts attaching junction box to generator skid. See Figure 8-6.

8. Remove leads from magnetic pickup. Note order of leads: black, red, and white (top to bottom). See Figure 8-7.

9. Remove all stator leads. Mark leads, as necessary, for reassembly later. Disconnect stator leads 1, 2, 3, and 4 from leads V1, V2, and V4. Disconnect lead 33 at terminal block TB1. Disconnect lead 44 at in-line connector. Disconnect lead 55 at fuse connector.

   Disconnect brush lead FN at in-line connector and brush lead FP at terminal block TB1.

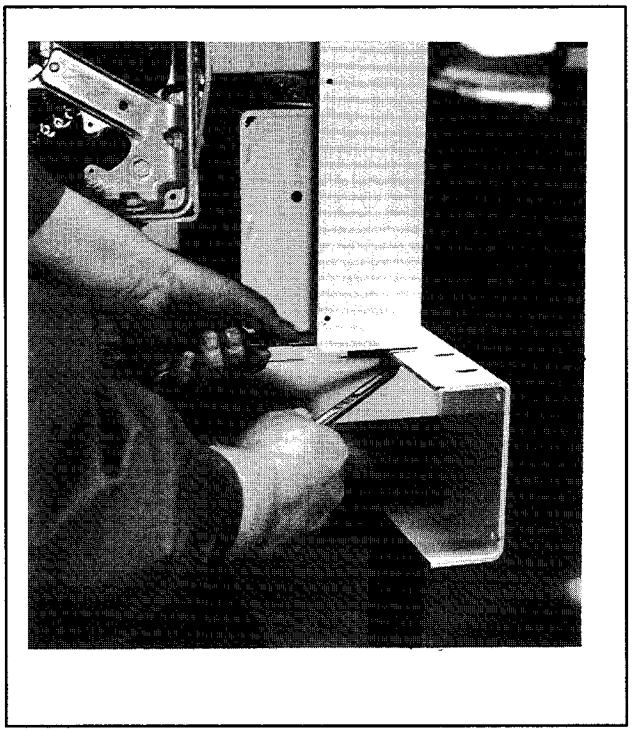


Figure 8-6. Removing Junction Box

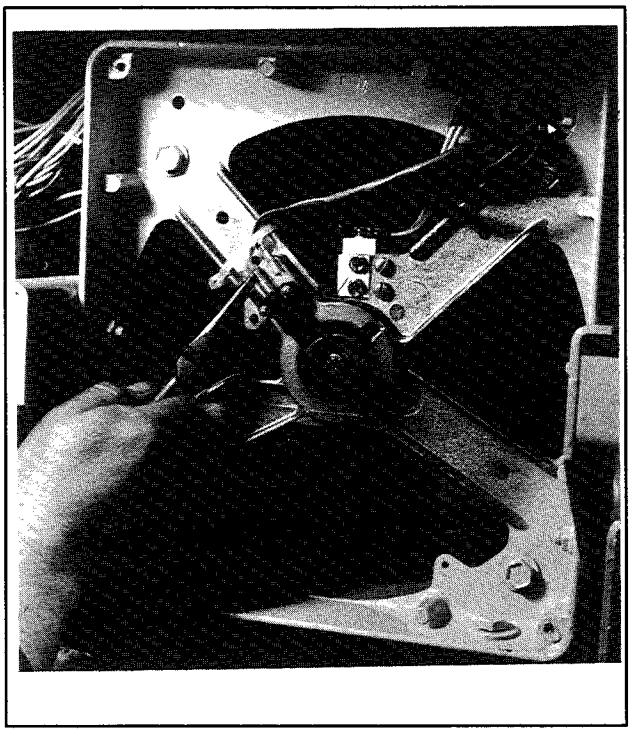


Figure 8-7. Magnetic Pick-up Leads

Remove leads from end bracket grommet, See Figure 8-8.

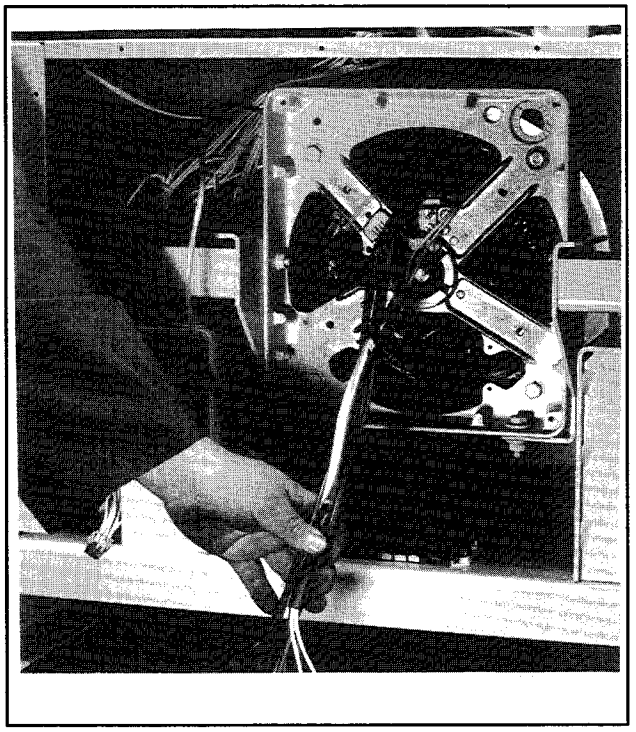


Figure 8-8. Stator Leads Disconnected

10. Move junction box and controller assembly from generator skid and place to the side of the generator set.

11. Place hoist hooks in end bracket ribs and slightly tension hoist chain. See Figure 8-9. Remove vibromount hardware which consists of a small flat washer under the bolt head and a large flat washer at the lock nut end. See Figure 8-10 .

NOTE

Hoist capacity should be rated at 1/2 ton or greater.

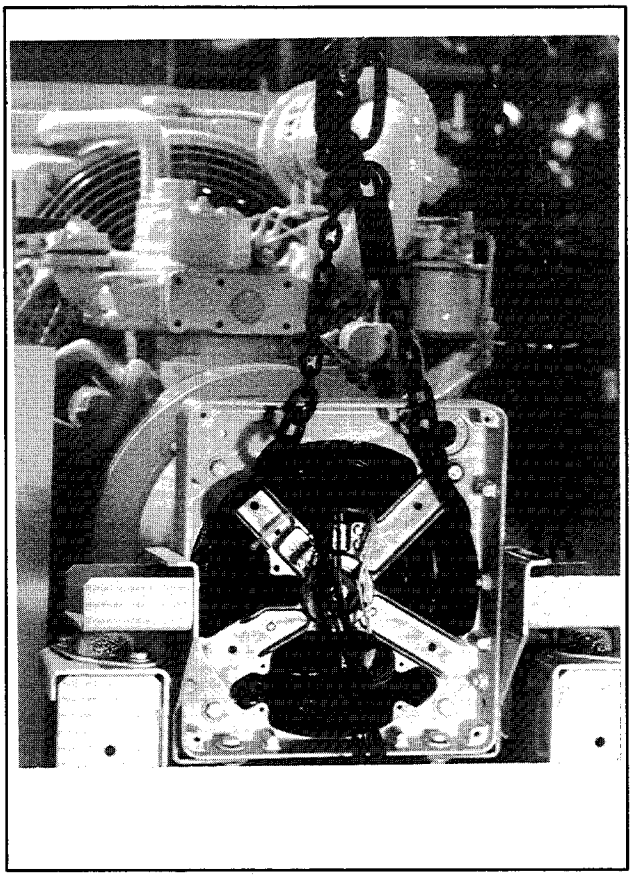


Figure 8-9. Hoisting Generator

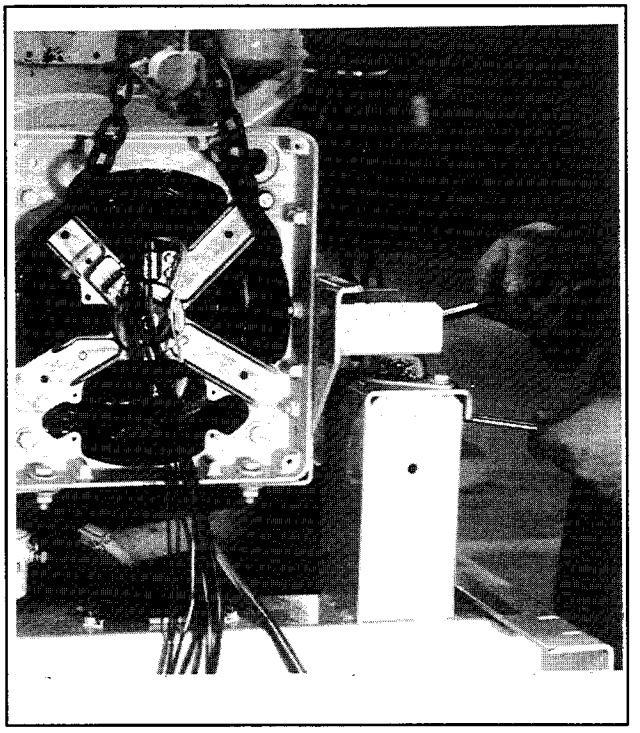
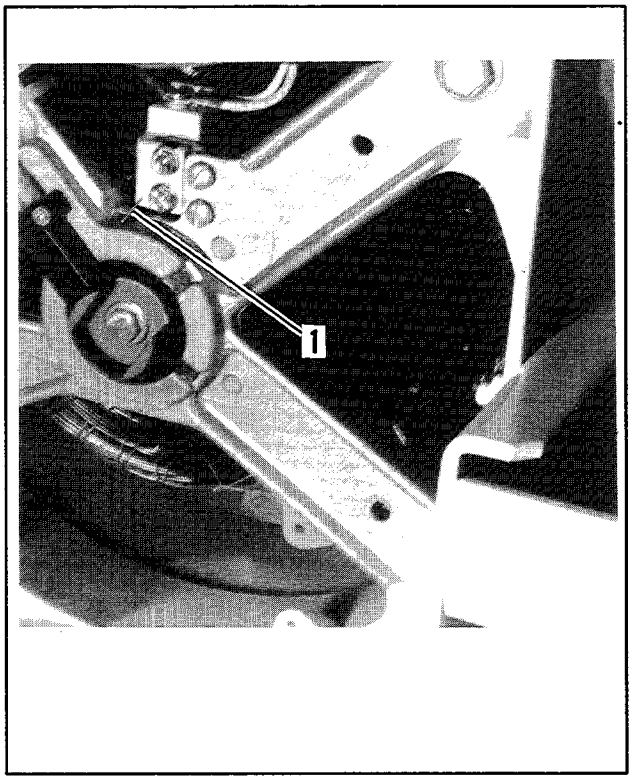


Figure 8-10. Removing Vibromounts

12. With vibromount hardware removed, use a hoist to raise generator end high enough to place a wood block under flywheel housing. Wood block should be rest on skid rails. Lower hoist so that generator rests on wood block. Remove hoist hooks.

13. Gently grasp brush leads and raise brushes from slip rings. Lock brushes in raised position by inserting a retaining wire (length of stiff wire or paper clip) in hole of brush holder. See Figure 8-11.



1. Brush Retainer

Figure 8-11. Inserting Brush Retainer

14. Remove four overbolts and hardened washers securing end bracket to generator adapter. See Figure 8-12.

15. With overbolts are removed, use a soft-faced hammer to remove end bracket from stator. Use light force blows in a rotating sequence to remove end bracket.

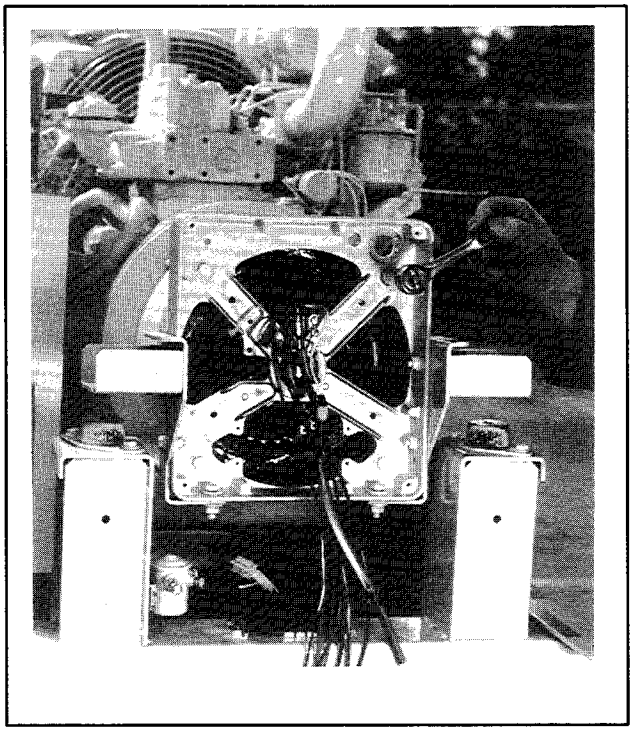


Figure 8-12. Removing Overbolts

16. Gently slide stator over rotor being careful to avoid damaging rotor and/or stator. See Figure 8-13.

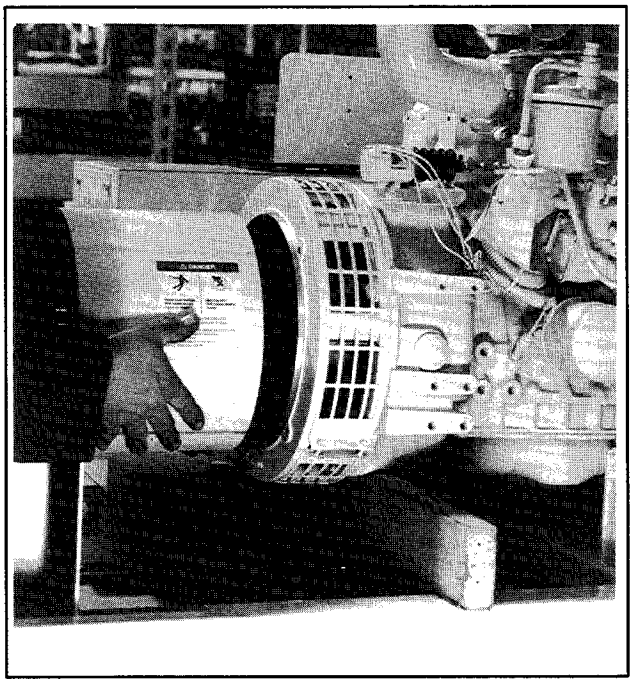


Figure 8-13. Removing Stator

NOTE

Due to the weight of stator, it is recommended that it be placed in a hoist sling during removal to prevent damage to stator and/or rotor.

17. Remove two screws and nuts securing fan guard on generator adapter. See Figure 8-14.

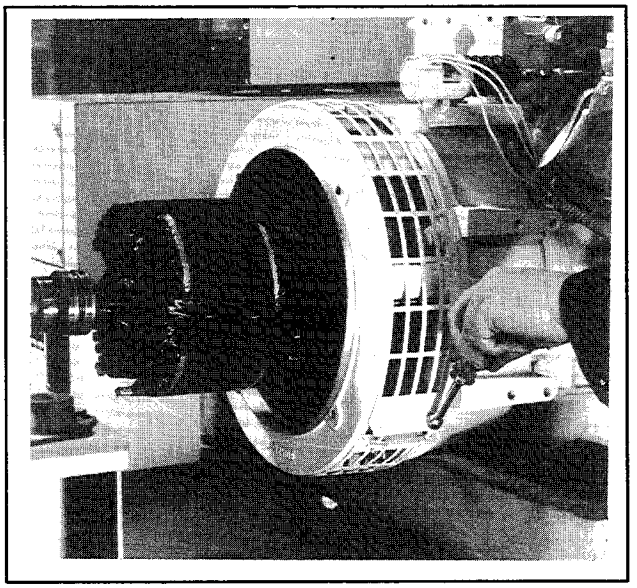


Figure 8-14. Removing Fan Guard

18. Remove four screws and flat washers attaching generator adapter to flywheel housing. See Figure 8-15.

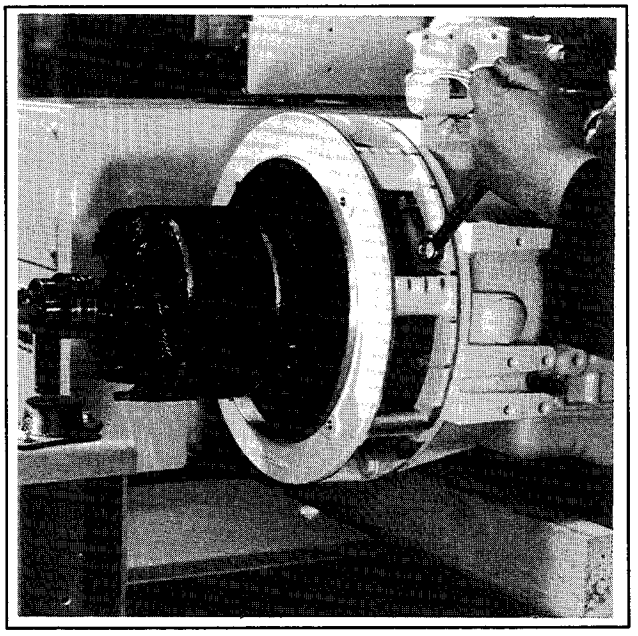


Figure 8-15. Removing Generator Adapter

19. Support rotor assembly with a hoist sling on rotor or place wood block(s) underneath rotor. **6ROY/RFOY and 10ROY/RFOY Models:** Remove eight screws and spacers attaching rotor/flex discs to flywheel. See Figure 8-16. **15ROY/RFOY Models:** Remove eight nuts and spacers attaching rotor/flex discs to flywheel.

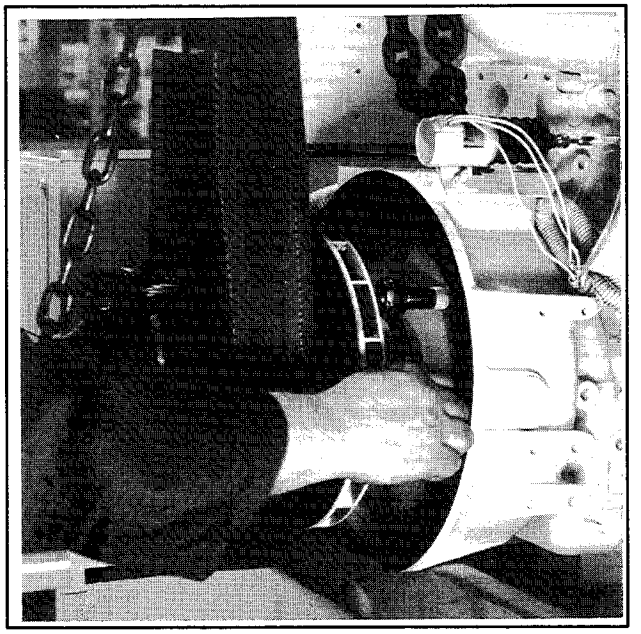


Figure 8-16. Removing Rotor

20. Remove eight screws to detach flex discs (2) from rotor. See Figure 8-17.

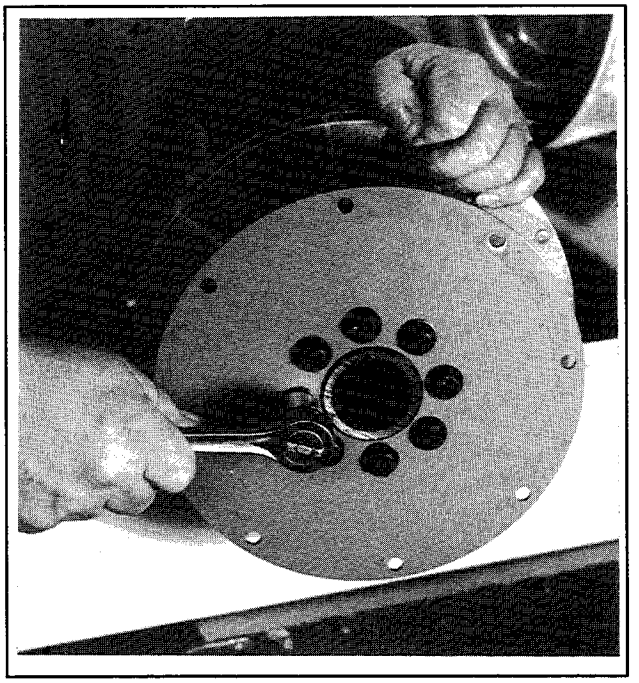


Figure 8-17. Removing Flex Discs (2)

21. Remove rotor fan by removing four screws and flat washers.

Reassembly

1. Attach rotor fan to rotor using four screws. Torque screws to 260 in. lbs. (24 Nm).

2. Install drive discs (2) to rotor using eight screws. Torque screws to 540 in. lbs. (61 Nm).

3. Support rotor assembly (if necessary) with a hoist sling on rotor or place wood blocks beneath rotor.

   6ROY/RFOY and 10ROY/RFOY Models: Secure rotor/drive discs (2) to flywheel with eight bolts and spacers. Torque bolts to 168 in. lbs. (19 Nm). See Figure 8-18.

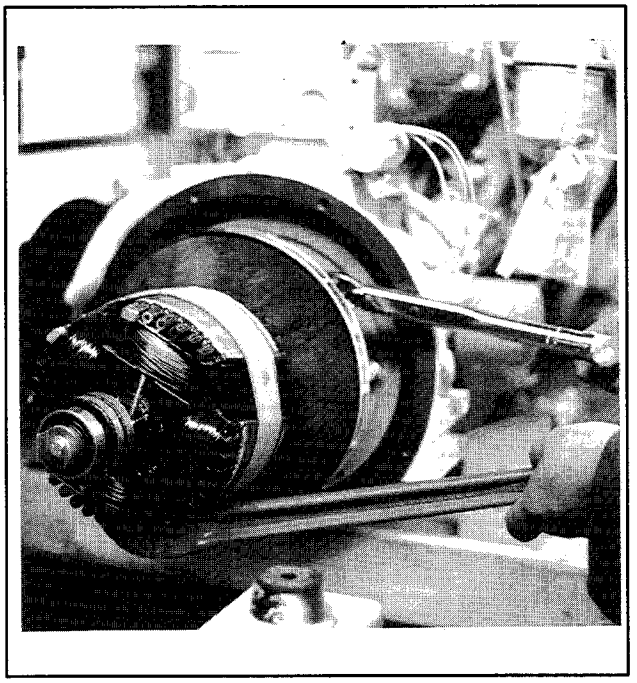


Figure 8-18. Attaching Rotor/Drive Discs

15ROY/RFOY Models: Secure drive discs (2) to flywheel with eight nuts and spacers. Torque nuts to 168 in. lbs. (19 Nm).

4. Install generator adapter to flywheel housing using four screws and flat washers. Torque screws to 324 in. lbs. (37 Nm) on 6ROY/RFOY and 10ROY/RFOY models. Torque screws to 300 in. lbs. (34 Nm) on 15ROY/RFOY models.

5. Install fan guard to generator adapter using two screws and nuts.

6. Using a hoist (if necessary) or wood blocks to support stator, gently slide stator over rotor and onto generator adapter lip. Stator leads should be to the top.

7. Run stator leads through upper or left-hand end bracket opening and then through grommet. Place end bracket assembly onto rotor bearing. Align end bracket on stator assembly and rotor bearing.

NOTE

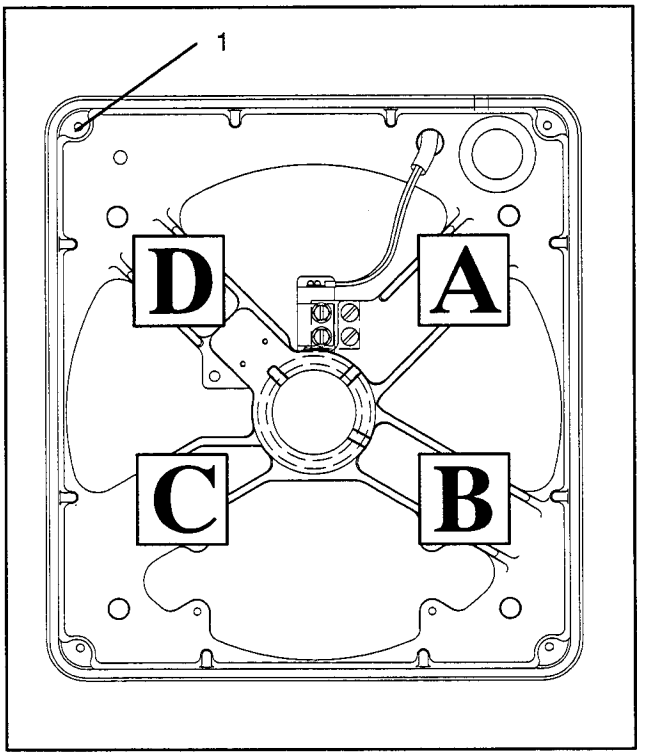
Do NOT attempt to install end bracket to rotor by tightening overbolts. Damage to end bracket and/or generator adapter may result.

NOTE

No lubricant should be used during assembly.

Check that stator shell notches (if used) are to the top and end bracket is properly aligned. Proper alignment of these components is critical for complete assembly of generator set.

Using a hard rubber or dead blow hammer alternately strike end bracket using medium force blows. Use the rotating sequence shown in Figure 8-19 to install end bracket.



1. Overbolt

Figure 8-19. Installing End Bracket

8. When end bracket is completely installed in stator assembly, install overbolts and hardened flat washers. Torque overbolts to 216 in. lbs. (24 Nm). See Figure 8-20.

9. Remove retainer wire from brush holder. Make sure brushes are centered on the slip rings. Improper positioning will cause brushes to wear.

10. Reinstall rotor actuator (if removed earlier) using one screw and flat washer. Torque screw to 96 in. lbs. (11 Nm). See Figure 8-21.

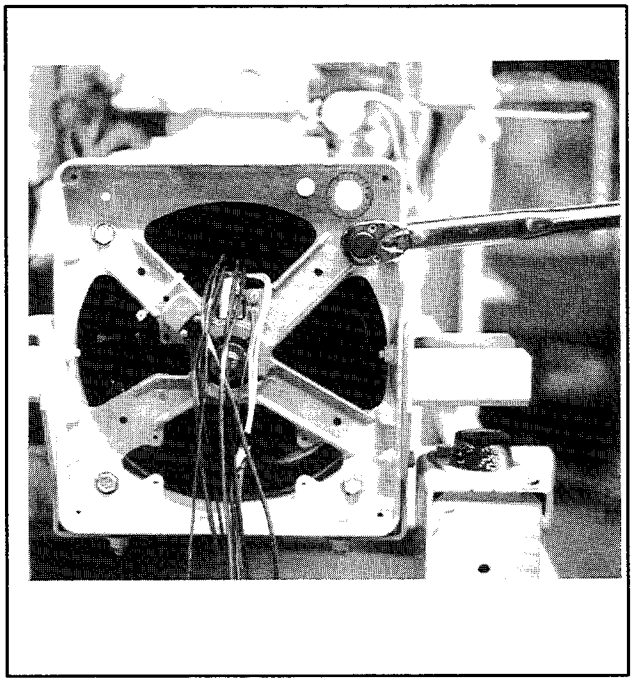


Figure 8-20. Installing Overbolts

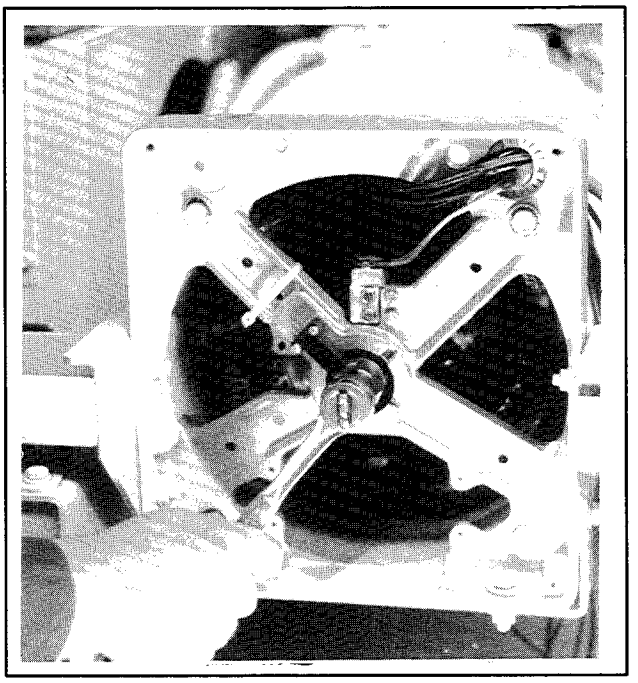


Figure 8-21. Installing Rotor Actuator

11. Check and adjust magnetic pick-up to actuator air gap. Actuator should be positioned so that raised portion is directly aligned with magnetic pick-up. See Figure 8-22. Air gap should be 0.030 in. (0.76 mm) ±0.010 in. (0.25 mm). Rotate actuator 180 degrees and recheck. Air gap should not be less than 0.020 in. (0.051 mm) at the closer end. To adjust, loosen the two magnetic pick-up mounting screws and slide magnetic pick-up (inward or outward) to obtain the proper specification. Tighten magnetic pick-up screws. See Figure 8-23.

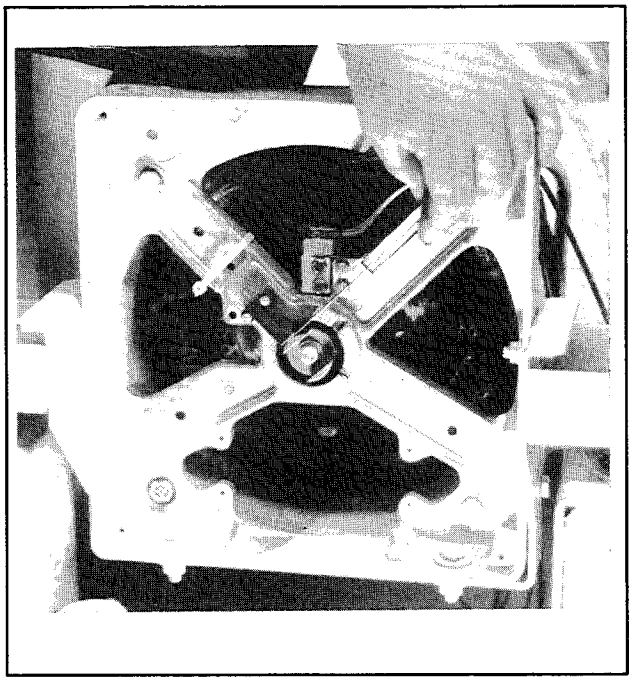


Figure 8-22. Checking Actuator Air Gap

12. Raise generator end with hoist, remove wood block, and lower until end bracket assembly rest on vibromounts. Install vibromount hardware as follows: place the small flat washer onto bolt and install into end bracket assembly first and then through vibromount. Place large flat washer on the bolt at the underside of vibromount bracket and secure with lock nut.

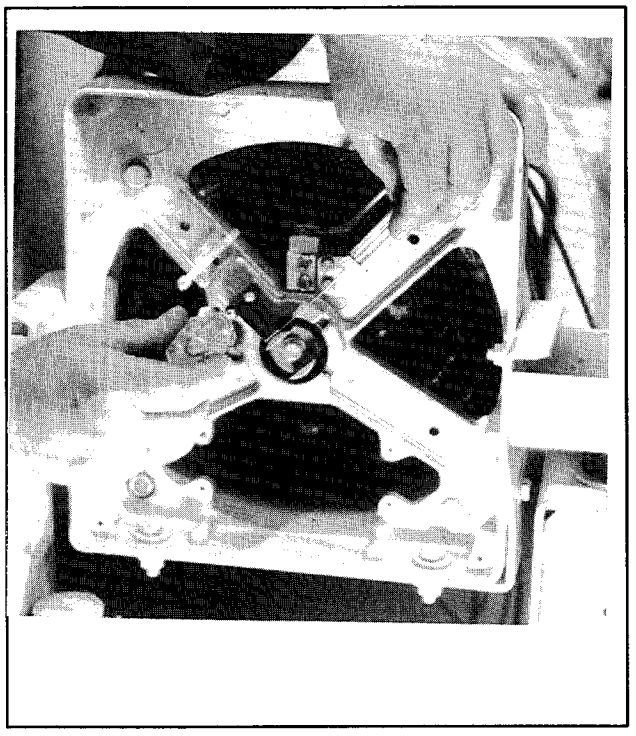


Figure 8-23. Adjusting Actuator Air Gap

13. Relocate junction box and controller assembly over end bracket and generator skid. Secure with four screws and nuts.

14. Reconnect generator leads. Reference the proper wiring diagram. See Section 9 Wiring Diagrams.

    Reconnect brush lead FP to terminal FP at terminal block TB1. Reconnect brush lead FN to lead FN at in-line connector.

    Reconnect lead 55 to fuse connector. Reconnect lead 44 to lead 44 at in-line connector. Reconnect lead 33 to terminal 67 at terminal block TB1.

    Reconnect stator leads 1, 2, 3, and 4 to leads V1, V2, and V4. Reconnection of stator leads 1, 2, 3, and 4 is dependant upon desired voltage configuration. Use notes taken during disassembly if no changes are required. Otherwise, reference Section 10 Generator Reconnection and Section 9 Wiring Diagrams for further information.

15. Reconnect magnetic pick-up leads. Black, red, and white to top (–), middle (+), and bottom (0) terminals respectively.

16. Reconnect leads to starter solenoid. Lead 14S to left-side large terminal. Leads 14P to right-side large terminal. Lead 71 to small terminal with diode connected.

    Reconnect voltage regulator six-pin in-line connector.

17. Install end bracket panel to end bracket using four screws.

18. Relocate controller cover and fasten using four screws.

19. Attach junction box panel using nine screws.

20. Reconnect all external connections (except battery). There include fuel line, exhaust system, remote switch, and load leads. Reconnect battery, negative lead last.

    Reinstall enclosure, if applicable.

Section 9. Wiring Diagrams

4-Lead Generator Sets

This reconnection procedure details voltage and voltage/frequency reconnection. If frequency changes are required, the governor and voltage regulator will need to be adjusted. See Component Testing & Adjustment for Governor adjustment.

To illustrate the proper reconnection of the generator set, the following information is provided. In all cases, the National Electrical code (NEC) should be followed.

The stator leads of the generator may be reconnected if a different output phase or voltage is desired. Refer to the following procedure and the connection schematics below. Follow all safety precautions at the front of this manual and in the text during this procedure.

NOTE

When a generator set is reconnected to a voltage different than nameplate voltage, notice should be placed on the unit indicating this change. A decal (part no. 246242) is available for this purpose from authorized service dealers/distributors.

⚠ WARNING

Hazardous voltage.

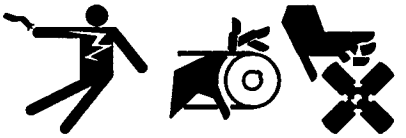
Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

4-Lead Reconnection Procedure

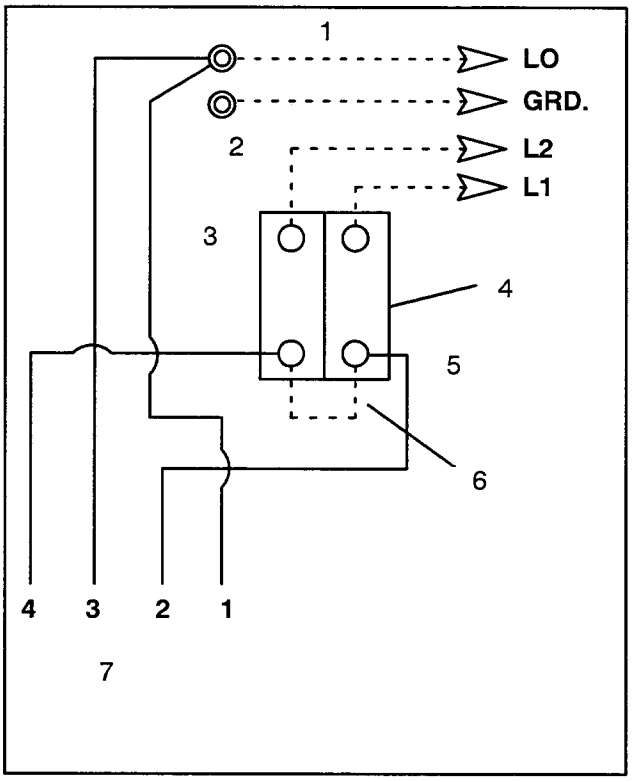
Contact the factory before attempting to convert the set from 60 to 50 Hz voltages and vise-versa. (Not all 4-lead alternators can be reconnected to 50/60 Hz voltages.) It is not necessary to reposition the meter scale lamp jumper on 5-light controllers following reconnection.

1. Move generator master switch to OFF/RESET position.
2. Disconnect engine starting battery, negative lead first.
3. Connect the generator to desired voltage as described in Step 4 (Single Voltage) or Step 5 (dual voltage).
4. Voltage Connection
   a. **Single Voltage Connection**.The jumper lead should be placed on the line side of the circuit breaker. See Figure 9-1. Both circuit breakers must have leads attached to the load side. It is recommended that the jumper lead be used for all straight 100-120 Volt systems to help balance the generator set load.

Leads	60Hz	50Hz
L0-L1	100-120 Volt	100-120 Volt
L0-L2	100-120 Volt	100-120 Volt

NOTE

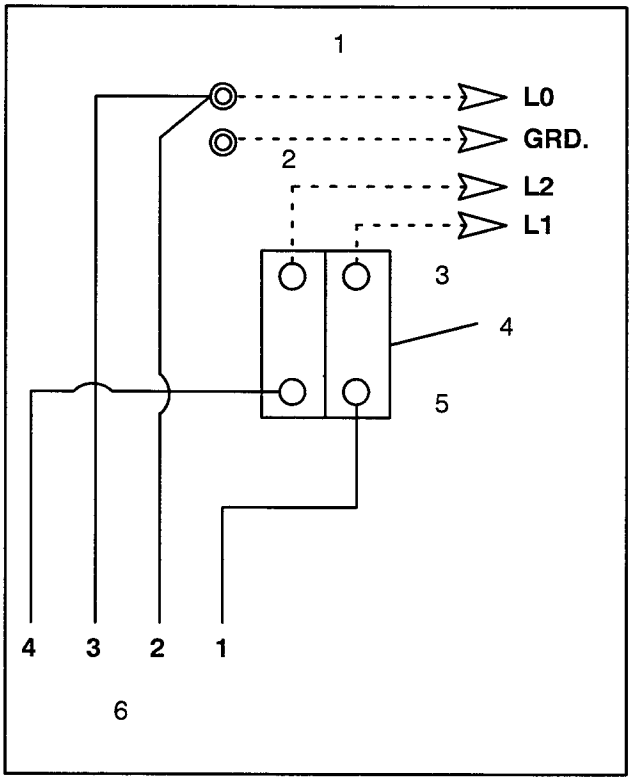
Line circuit breakers, transfer switch, and all other accessories must be properly sized for the voltage selected.



1. LO (Neutral)
2. Ground
3. Load Side
4. Circuit Breaker
5. Line Side
6. Jumper Lead
7. Stator Leads

Figure 9-1. 4-Lead Connection

b. **Dual Voltage Connections** In these systems, the jumper lead is not used. If the unit was originally wired for straight 100-120 Volt (60 Hz) or 100-120 Volt (50 Hz), be sure jumper lead is removed from circuit breaker line side. Leads L1 and L2 are different phases and must never be connected together. See Figure 9-2 for dual voltage connection.



1. LO (Neutral)
2. Ground
3. Load Side
4. Circuit Breaker
5. Line Side
6. Stator Leads

Figure 9-2. Dual Voltage Connection

Leads	Voltage at 50/60 Hz
L0-L1	100-120 Volt
L0-L2	100-120 Volt
L0-L2	100-120 Volt

NOTE

Voltage regulator adjustment may be required to achieve 50 Hz voltages listed. Refer to Voltage Adjustment Procedure.

5. Reconnect starting battery, negative lead last. Move controller master switch to the RUN position to start the generator set. Check voltmeter for proper voltage. Adjust voltage if necessary, with the voltage regulator. Refer to Voltage Adjustment Procedure. On 5-Light controllers, minor voltage adjustments may be done with the voltage adjusting rheostat.

NOTE

Line circuit breakers, transfer switch, and all other accessories must be properly sized for the voltage selected.

Voltage Adjustment Only (4-Lead)

1. STOP generator set by moving remote or generator master switch to OFF/RESET.
2. Disconnect engine starting battery, negative (–) lead first. Disconnect power to battery charger (if equipped).
3. Select desired voltage connection from Figure 9-1 and connect leads according to the diagram for the desired phase and voltage.

NOTE

Current transformers CT1, CT2, and CT3 should be positioned with dot or HI mark toward generator set. Current transformers are only used on generator sets equipped with 5-light controllers.

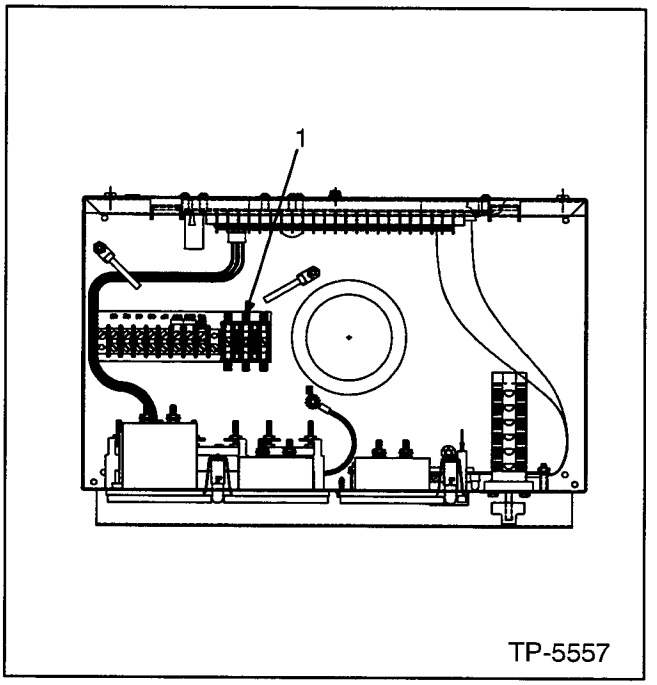
NOTE

Line circuit breakers, transfer switch, and all other accessories must be properly sized for the voltage selected.

4. If generator set is equipped with a 5-light controller, remove controller cover and reposition meter scale lamp jumper (see Figure 9-3), if necessary, to match meter scale lamps with desired voltage (as shown in Figure 9-4).
5. If generator set is equipped with the overvoltage kit (5-light controllers only), the J1 jumper must be removed. The overvoltage circuit board (if equipped) is located in the controller. See Figure 9-4 for J1 jumper location on overvoltage circuit board.
6. If the generator set is equipped with a 5 light controller, turn the meter phase selector switch to the proper position for the desired voltage connection (single-phase or three-phase).
7. Reconnect starting battery, negative lead last. Move generator master switch to the RUN position to start the generator set. Check voltmeter for proper voltage. (The 5-light controller is equipped with an AC voltmeter; if the set is equipped with a relay controller, connect a voltmeter across generator output leads.) Adjust voltage, if necessary, with the voltage adjustment on the controller (5-light only) and/or the voltage regulator.
8. STOP GENERATOR SET.

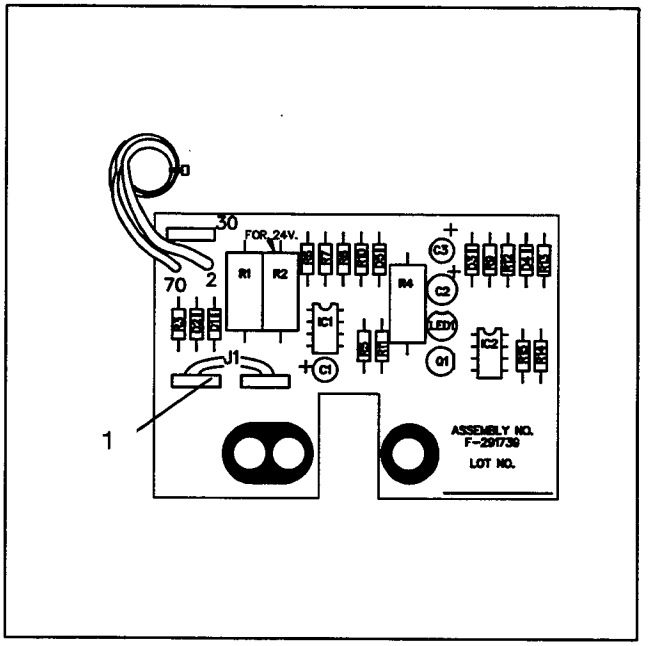
NOTE

When light flicker is evident reference Voltage/Frequency procedure.



1. Lamp Jumper

Figure 9-3. Meter Scale Lamp Jumper (5-Light Controller Only)



1. J1 Jumper

Figure 9-4. Overvoltage Circuit Board

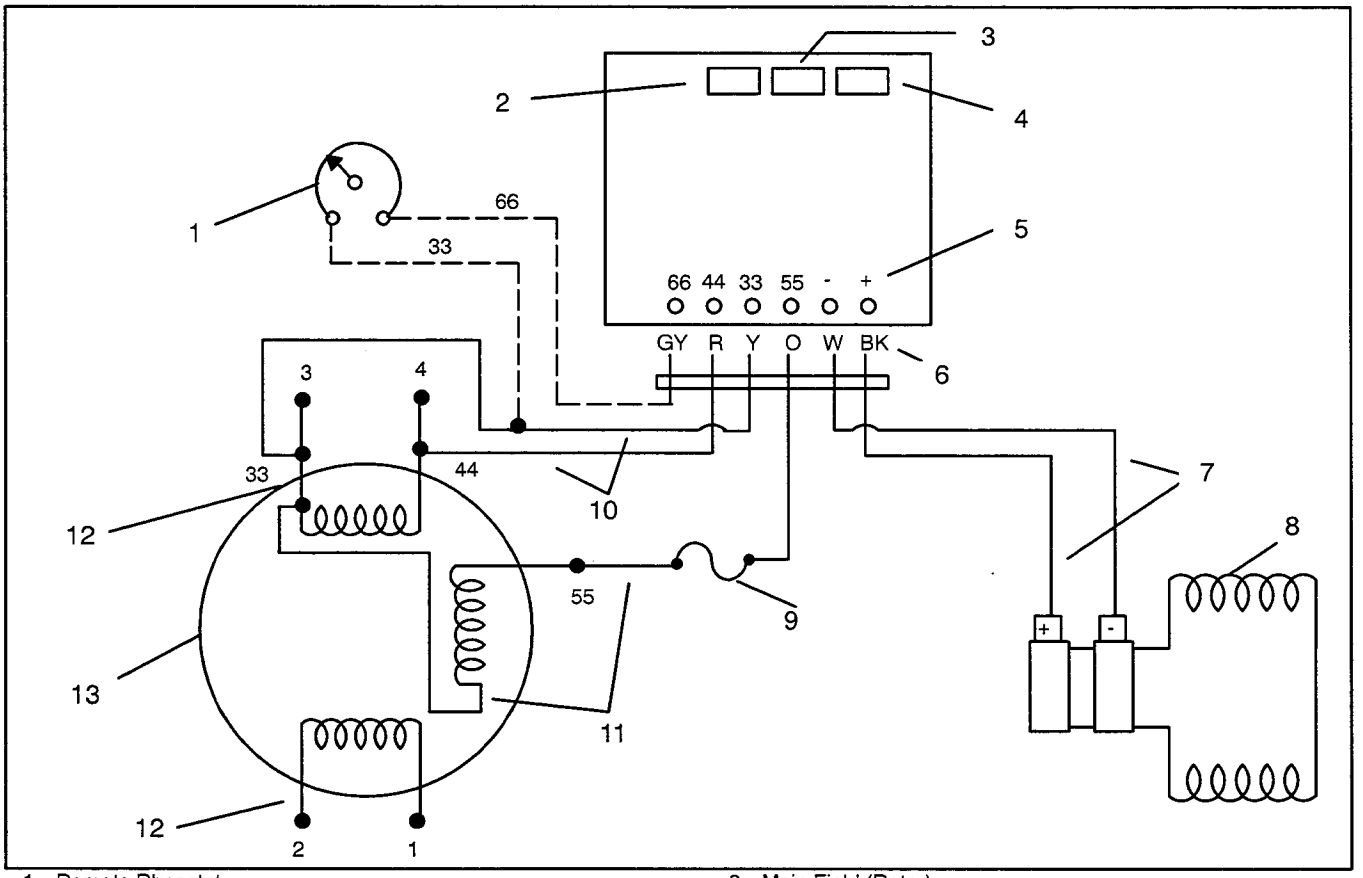
Voltage and Frequency Adjustment (4-Lead)

The PowerBoost™ IIIE voltage regulator monitors generator output to control current flow to the generator field. However, unlike earlier PowerBoost™ regulators, PowerBoost™ IIIE maintains generator output at specified voltage under load until the generator engine speed drops to a preset level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). At this point the regulator allows generator voltage and current to drop. The voltage/current drop enables the engine to pick up the load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, generator output also returns to normal. The voltage regulator is factory set for proper generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if regulator adjustment is necessary to achieve 50 Hz voltage, or if the regulator is replaced or has been tampered with, readjust according to the following procedure. Regulator components are identified in Figure 9-5 and described in the following paragraphs.

Voltage Adjustment Pot is used to fine adjust voltage.

Stabilizer Pot is used to fine adjust regulator circuitry to reduce light flicker.

Volts/Hz Pot adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.



1. Remote Rheostat
2. Voltage Adjustment Potentiometer
3. Stabilizer Potentiometer
4. Volts/Hz Potentiometer
5. Stator/Rotor Connections (for reference only)
6. Lead Color
7. DC-Output
8. Main Field (Rotor)
9. 10-Amp Fuse
10. Sensing Leads (33-44)
11. AC Power Input (Auxiliary) Lead (55)
12. Main Leads (1-2, 3-4)
13. Stator

Figure 9-5. PowerBoost™ IIIE Voltage Regulator

Voltage and Frequency Adjustment Procedure (4-Lead)

⚠ WARNING

Hazardous voltage.
Backfeed to utility system can cause property damage, severe injury, or death.

When generator is used for standby power, use of automatic transfer switch is recommended to prevent inadvertent interconnection of standby and normal sources of supply.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

1. STOP generator set by moving remote or generator master switch to OFF/RESET.
2. Disconnect engine starting battery, negative (–) lead first. Disconnect power to battery charger (if equipped).
3. Select desired voltage connection from Figure 9-1 and connect leads according to the diagram for the desired phase and voltage.

   NOTE

   Current transformers CT1, CT2, and CT3 should be positioned with dot or HI mark toward generator set. Current transformers are used only on generator sets equipped with 5-light controllers.

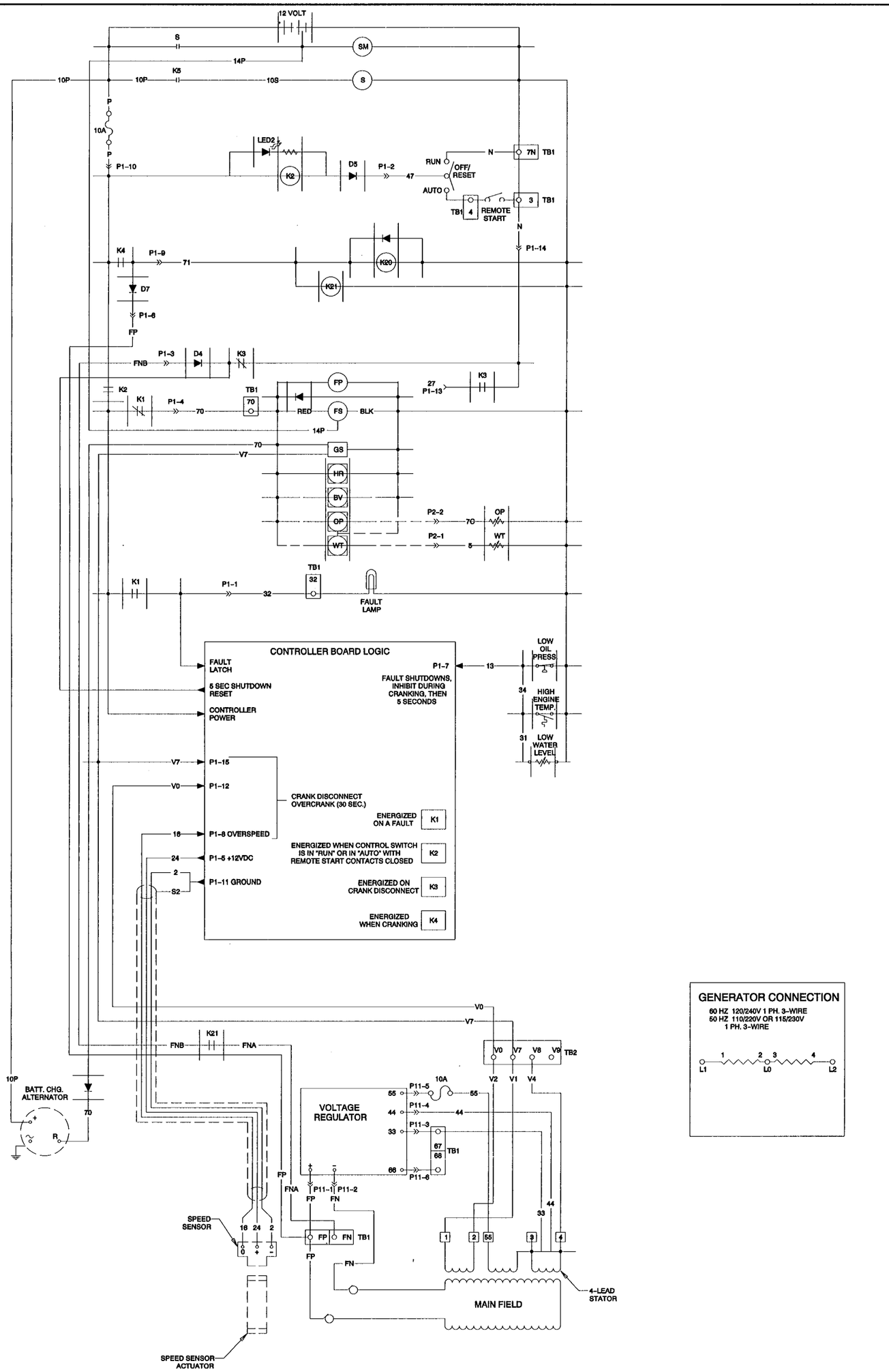
   NOTE

   Line circuit breakers, transfer switch, and all other accessories must be properly sized for the selected voltage.

4. If generator set is equipped with a 5-light controller, remove controller cover and reposition meter scale lamp jumper (see Figure 9-3), if necessary, to match meter scale lamps with desired voltage (as shown in Figure 9-4).
5. If generator set is equipped with the overvoltage kit (5-light controllers only), the J1 jumper must be removed. The overvoltage circuit board (if equipped) is located in the controller. See Figure 9-4 for J1 jumper location on overvoltage circuit board.
6. If the generator set is equipped with a 5 light controller, turn the meter phase selector switch to the proper position for the desired voltage connection (single-phase or three-phase).
7. With generator set off turn remote rheostat (if equipped) to mid-point. Turn voltage, Volts/Hz, and stability pots fully counterclockwise. Connect voltmeter to AC circuit or an electrical outlet.
8. Reconnect starting battery, negative lead last. Move generator master switch to the RUN position to start the generator set.
9. Rotate voltage adjustment pot clockwise to increase voltage or counterclockwise to decrease voltage until desired output voltage is achieved.
10. Rotate stability pot clockwise until minimum light flicker is obtained.
11. Readjust voltage adjustment pot if necessary.
12. **Mechanical Governor:**
    Adjust engine speed to desired cut-in frequency (factory setting 57.5-58 Hz. for 60 Hz. models or 47.5-48 Hz. for 50 Hz. models) as measured on frequency meter. See Section 3 Governor.
13. Rotate **Volts/Hz adjustment pot** clockwise until voltage level begins to drop (as measured on voltmeter). When set to these specifications,as load is applied the generator will attempt to maintain normal output until engine speed drops below the frequency set in step 5.
14. Remove jumper from governor circuit board -2.5 Hz/Freq. terminals.
15. **Mechanical Governor:**
    Readjust engine speed to normal (63 Hz./1890 rpm for 60 Hz. or 52.5 Hz./1575 rpm for 50 Hz.) See Section 3 Governor.
16. Readjust **stability pot** if necessary.
17. Use remote rheostat (if equipped) to make final voltage adjustments.
18. STOP GENERATOR SET.

Wiring Diagrams

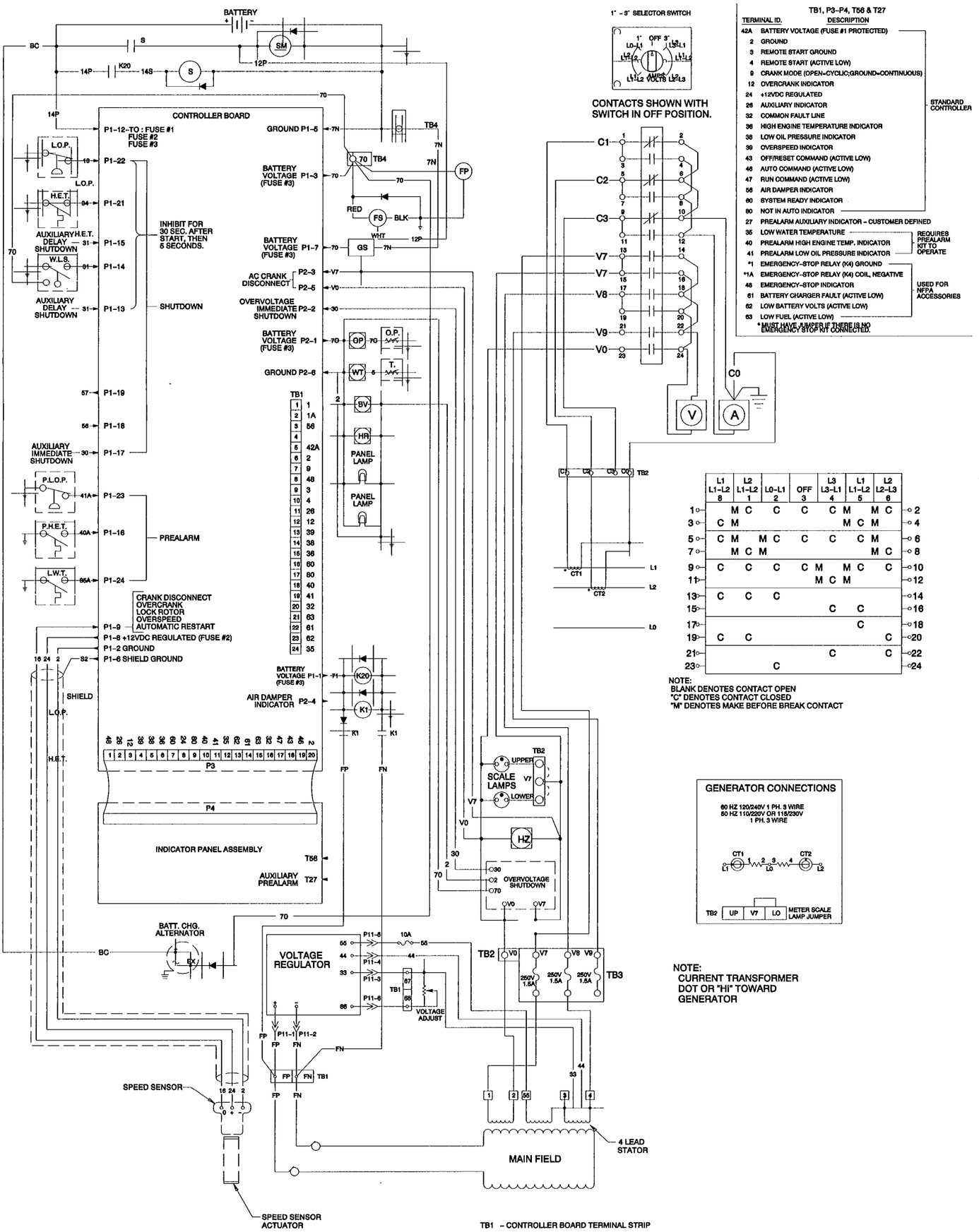
Description	Point to Point	Schematic	Wiring Diagram No.	Page No.
Relay Controller	X		225084-C	9-9
Relay Controller		X	ADV-5768-B	9-7
5-Light Microprocessor	X		225085-	9-10
5-Light Microprocessor		X	ADV-5770-A	9-8
Remote 5-Light Microprocessor	X		225141-A	9-11
Remote 5-Light Microprocessor		X	ADV-5770-A	9-8
Optional Equipment				
Accessories		X	256876-C P1	9-13
Remote Annunciator—10 Relay		X	256876-C P2	9-14
Remote Annunciator—14 Relay		X	255828-A P3	9-12

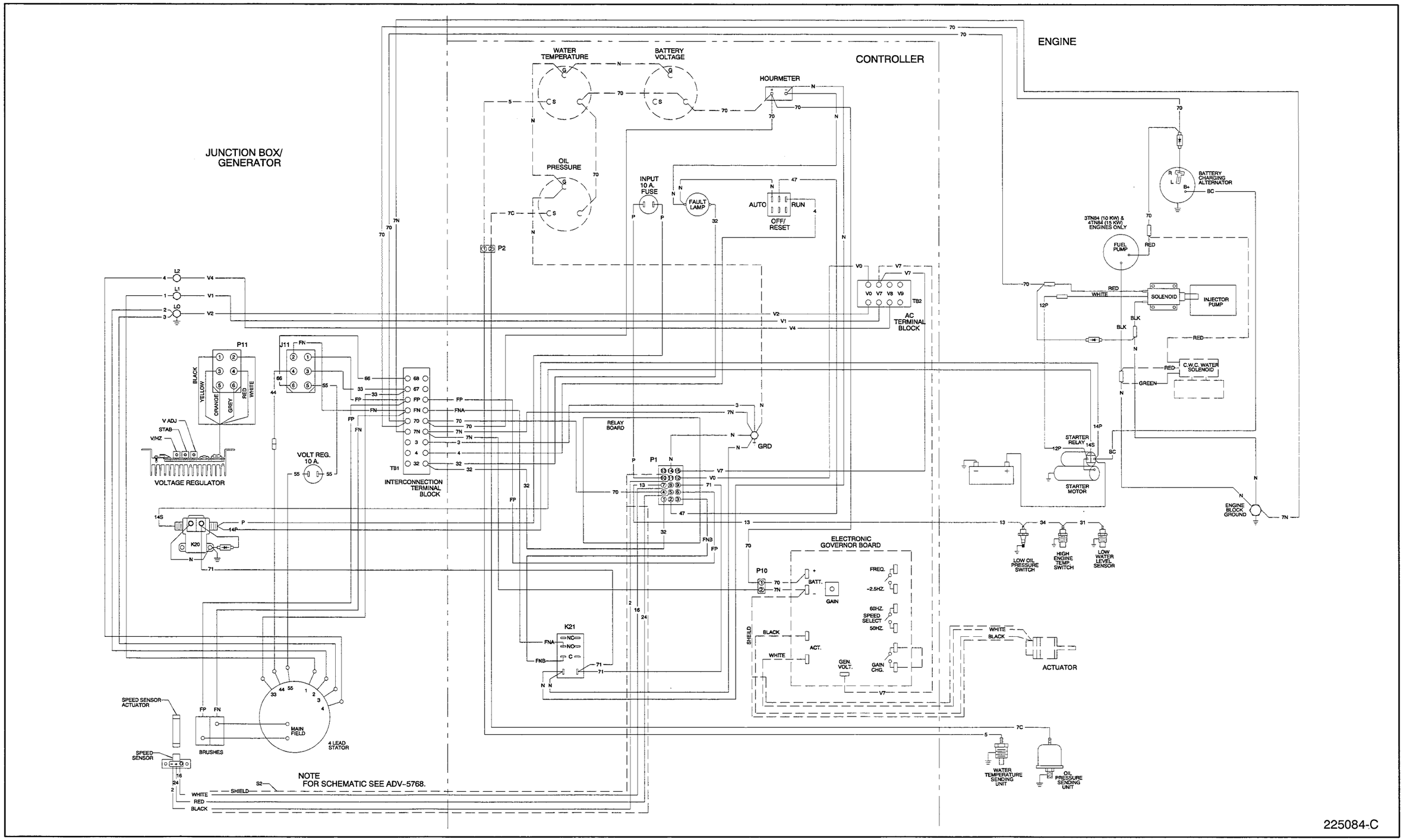


TB1 – INTERCONNECTION TERMINAL BLOCK
TB2 – AC TERMINAL BLOCK
SM – STARTER MOTOR
GS – GOVERNOR SYSTEM
FS – FUEL SOLENOID
FP – FUEL PUMP
HR – HOUR METER
BV – BATTERY VOLTS
WT – WATER TEMPERATURE
OP – OIL PRESSURE
K1 – FAULT SHUTDOWN RELAY
K2 – ENGINE RUN RELAY
K3 – CRANK DISCONNECT/FLASHING CONTROL RELAY
K4 – CRANK DISCONNECT RELAY
K20 – STARTER RELAY/SOLENOID
K21 – CRANKING/FLASHING RELAY
~ – BATTERY CHARGING ALTERNATOR
S – STARTER RELAY

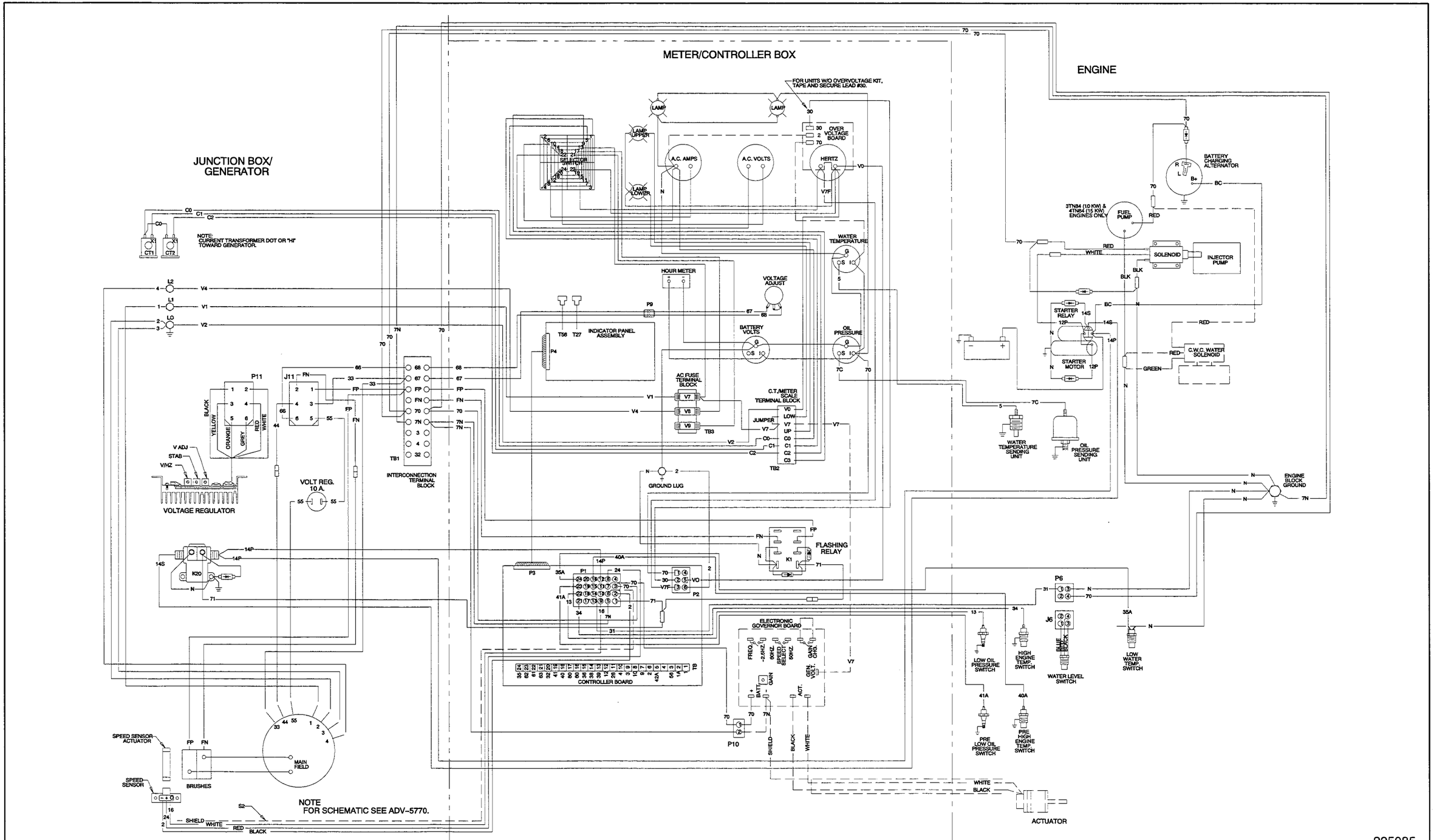
Schematic Diagram, Relay Controller

ADV-5768-B

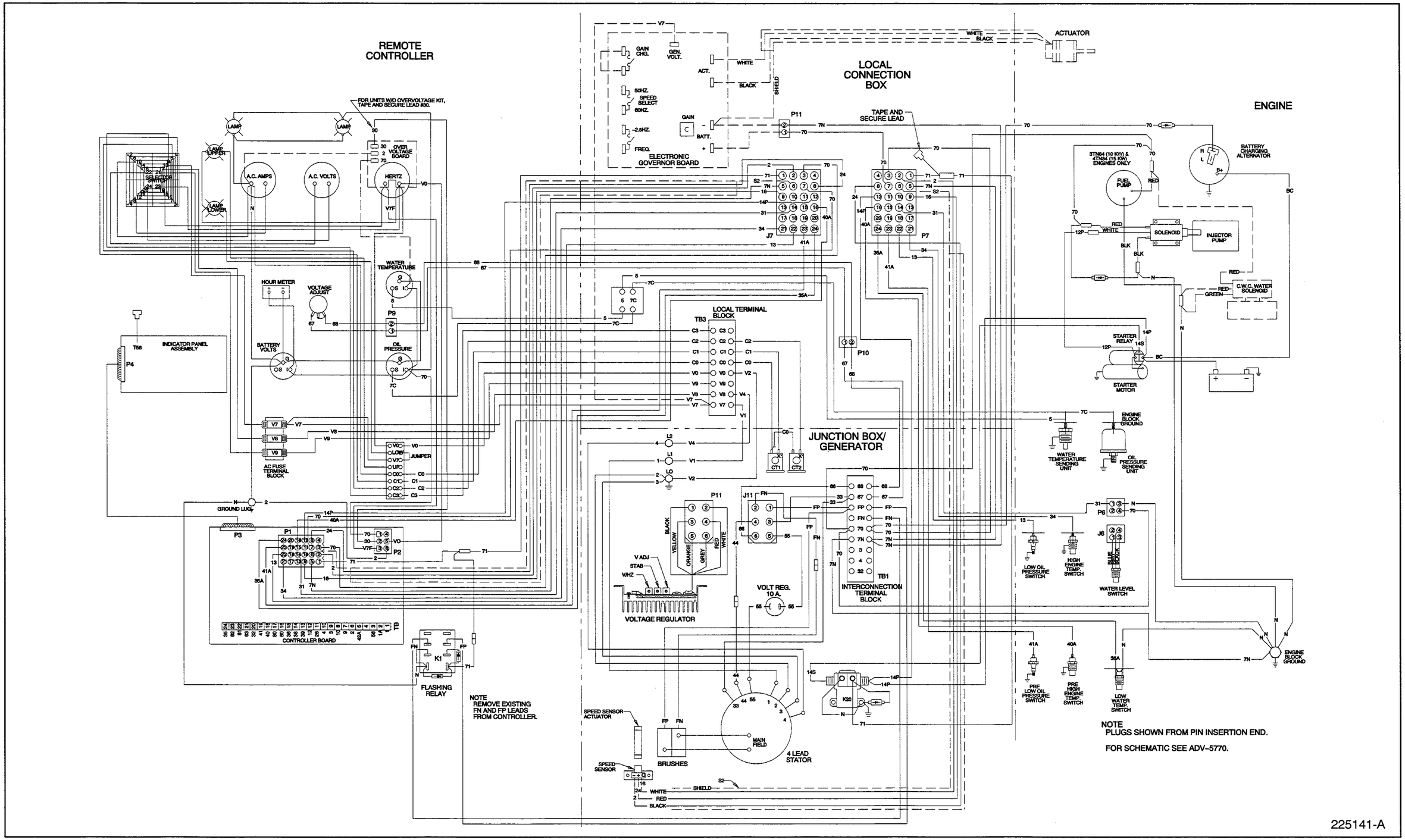

BATTERY
CONTROLLER BOARD
P1-12-TO : FUSE #1
FUSE #2
FUSE #3
GROUND P1-5
BATTERY VOLTAGE P1-3 (FUSE #3)
BATTERY VOLTAGE P1-7 (FUSE #3)
AC CRANK DISCONNECT P2-3
P2-5
OVERVOLTAGE IMMEDIATE SHUTDOWN P2-2
BATTERY VOLTAGE P2-1 (FUSE #3)
GROUND P2-6
BATTERY VOLTAGE P1-1 (FUSE #3)
AIR DAMPER INDICATOR P2-4
P1-22
P1-21
P1-15
P1-14
P1-13
P1-19
P1-18
P1-17
P1-23
P1-16
P1-24
P1-9
P1-8 +12VDC REGULATED (FUSE #2)
P1-2 GROUND
P1-6 SHIELD GROUND
INHIBIT FOR 30 SEC. AFTER START, THEN 6 SECONDS.
SHUTDOWN
PREALARM
CRANK DISCONNECT
OVERCRANK
LOCK ROTOR
OVERSPEED
AUTOMATIC RESTART
L.O.P.
H.E.T.
AUXILIARY H.E.T. DELAY SHUTDOWN
W.L.S.
AUXILIARY DELAY SHUTDOWN
AUXILIARY IMMEDIATE SHUTDOWN
P.L.O.P.
P.H.E.T.
L.W.T.
SHIELD
P3
P4
INDICATOR PANEL ASSEMBLY
T56
AUXILIARY PREALARM T27
TB1
PANEL LAMP
PANEL LAMP
O.P.
T.
BATT. CHG. ALTERNATOR
VOLTAGE REGULATOR
P11-5
P11-4
P11-3
P11-6
P11-1
P11-2
10A
VOLTAGE ADJUST
SPEED SENSOR
SPEED SENSOR ACTUATOR
MAIN FIELD
4 LEAD STATOR
TB4
TB2
TB3
SCALE LAMPS
UPPER
LOWER
OVERVOLTAGE SHUTDOWN
HZ
250V 1.5A
250V 1.5A
1- -3 SELECTOR SWITCH
CONTACTS SHOWN WITH SWITCH IN OFF POSITION.
C1
C2
C3
V7
V7
V8
V9
V0
C0
V
A
CT1
CT2
L1
L2
L0
TB1, P3-P4, T56 & T27
TERMINAL ID.
DESCRIPTION
42A BATTERY VOLTAGE (FUSE #1 PROTECTED)
2 GROUND
3 REMOTE START GROUND
4 REMOTE START (ACTIVE LOW)
9 CRANK MODE (OPEN=CYCLIC;GROUND=CONTINUOUS)
12 OVERCRANK INDICATOR
24 +12VDC REGULATED
26 AUXILIARY INDICATOR
32 COMMON FAULT LINE
36 HIGH ENGINE TEMPERATURE INDICATOR
38 LOW OIL PRESSURE INDICATOR
39 OVERSPEED INDICATOR
43 OFF/RESET COMMAND (ACTIVE LOW)
46 AUTO COMMAND (ACTIVE LOW)
47 RUN COMMAND (ACTIVE LOW)
56 AIR DAMPER INDICATOR
60 SYSTEM READY INDICATOR
80 NOT IN AUTO INDICATOR
27 PREALARM AUXILIARY INDICATOR - CUSTOMER DEFINED
35 LOW WATER TEMPERATURE
40 PREALARM HIGH ENGINE TEMP. INDICATOR
41 PREALARM LOW OIL PRESSURE INDICATOR
*1 EMERGENCY-STOP RELAY (K4) GROUND
*1A EMERGENCY-STOP RELAY (K4) COIL, NEGATIVE
48 EMERGENCY-STOP INDICATOR
61 BATTERY CHARGER FAULT (ACTIVE LOW)
62 LOW BATTERY VOLTS (ACTIVE LOW)
63 LOW FUEL (ACTIVE LOW)
* MUST HAVE JUMPER IF THERE IS NO EMERGENCY STOP KIT CONNECTED.
STANDARD CONTROLLER
REQUIRES PREALARM KIT TO OPERATE
USED FOR NFPA ACCESSORIES
L1 L1-L2 8
L2 L1-L2 1
L0-L1 2
OFF 3
L3 L3-L1 4
L1 L1-L2 5
L2 L2-L3 6
NOTE:
BLANK DENOTES CONTACT OPEN
"C" DENOTES CONTACT CLOSED
"M" DENOTES MAKE BEFORE BREAK CONTACT
GENERATOR CONNECTIONS
60 HZ 120/240V 1 PH. 3 WIRE
50 HZ 110/220V OR 115/230V
1 PH. 3 WIRE
TB2 UP V7 LO METER SCALE LAMP JUMPER
NOTE:
CURRENT TRANSFORMER
DOT OR "HI" TOWARD
GENERATOR
TB1 - CONTROLLER BOARD TERMINAL STRIP
TB2 - CT/METER SCALE - TERMINAL BLOCK
TB3 - AC FUSE - TERMINAL BLOCK
TB4 - INTERCONNECTION TERMINAL BLOCK
SM - STARTER MOTOR
K20 - STARTER SWITCH
K1 - FLASHING RELAY
GS - GOVERNOR SYSTEM
FS - FUEL SOLENOID
FP - FUEL PUMP
HR - HOUR METER
BV - BATTERY VOLTS
WT - WATER TEMPERATURE
WLS - WATER LEVEL SWITCH
LOP - LOW OIL PRESSURE
HET - HIGH ENGINE TEMPERATURE
OP - OIL PRESSURE
CT - CURRENT TRANSFORMER
HZ - HERTZ (ENGINE)
V - VOLTMETER
A - AMMETER
~ - BATTERY CHARGING ALTERNATOR



Point to Point Wiring, Relay Controller



Point to Point Wiring, 5-Light Microprocessor Controller



225141-A

Point To Point Wiring, Remote 5-light Microprocessor

WIRING HARNESS
TO CONTROLLER BOARD

REMOTE ANNUNCIATOR
DRY CONTACT BOX
MOUNTED AT GEN

42 2 39 12 36 38 26 60 80 41 48 61 62 63 35 40

INPUT

42A 2 K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12 K13 K14

N N N N N N N N N N N N N N

NO C NO C NO C NO C NO C NO C NO C NO C NO C NO C NO C NO C NO C NO C

K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12 K13 K14

39 N 12 36 38 26 60 80 41 48 61 62 63 35 40

N

42B P

P

FBA–1

ANNUNCIATOR
FUSE BLOCK
10 AMP

TRANSFER SWITCH

AUXILLARY CONTACTS MOUNTED ON TRANSFER SWITCH CONTACTOR ASSEMBLY.

DO NOT APPLY ANY VOLTAGE TO THESE CONTACTS.

10 NO 59
11
12 NC N
13 58

REMOTE ANNUNCIATOR

42B 63 35 41 40 39 48 38 36 12 26 62 61 58 59 60 80 N

OPTIONAL DECISION MONITOR CONNECTIONS

CUSTOMER SUPPLIED WIRES

#N & #42B WIRE REQUIRE
100 FT. – 18–20 GA.
500 FT. – 14 GA.
1000 FT. – 10 GA.

SIGNAL WIRES
18–20 GA. TO 1000 FT.

NOTE: IF ADDITIONAL LOAD IS ADDED
RESIZE N & 42B AS REQUIRED

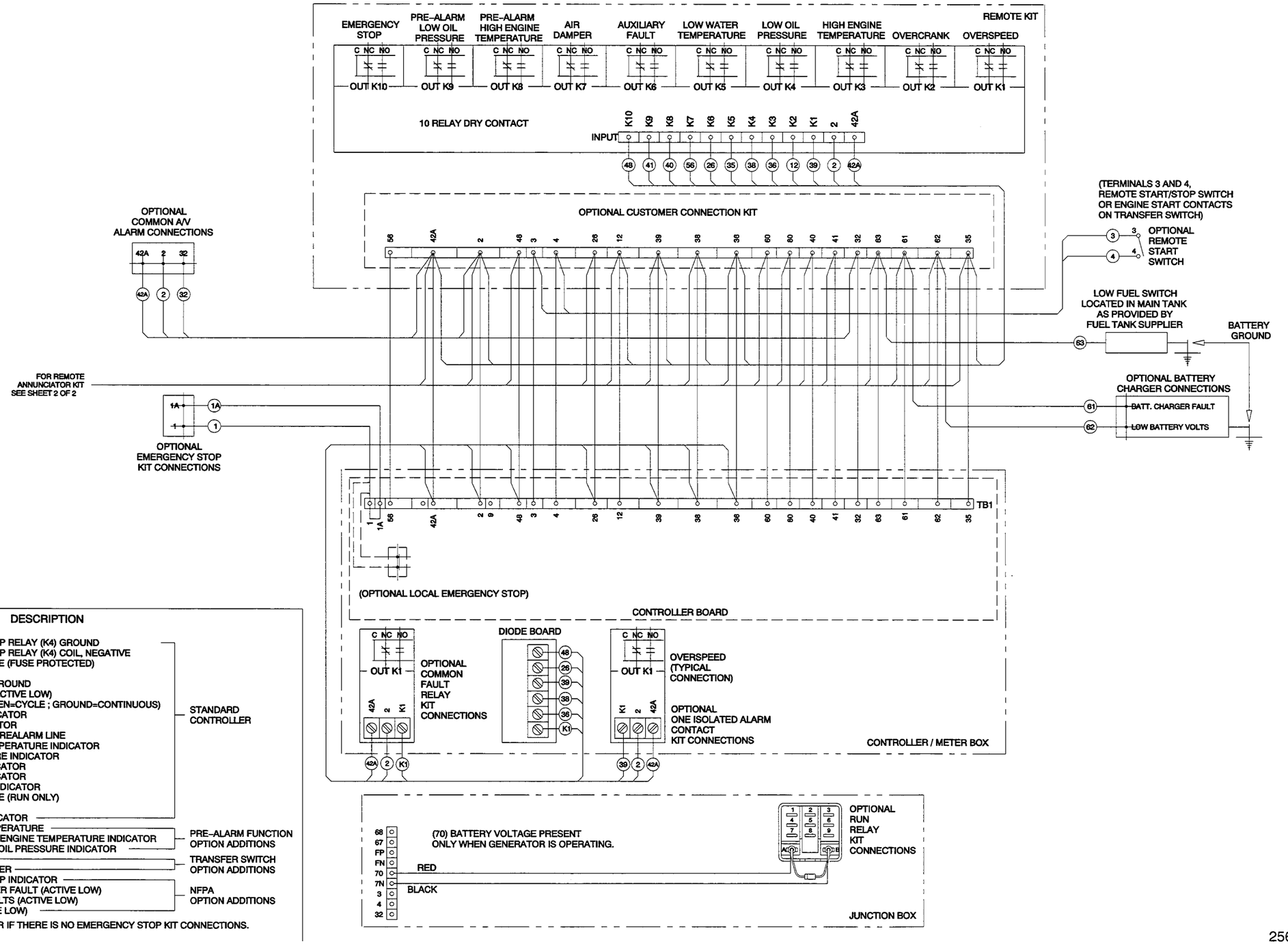
P

N

NOTE:
CONTRACTOR TO HARDWIRE "P" TO BATTERY POSITIVE ENGINE CONNECTION, AND "N" TO BATTERY NEGATIVE ENGINE CONNECTION. USE WIRE HARNESS PROVIDED AND CUT & TERMINATE AS REQUIRED.

255828-A P3

Remote Annunciator—14 Relay



TERMINAL ID.	DESCRIPTION	
*1	EMERGENCY–STOP RELAY (K4) GROUND	STANDARD CONTROLLER
*1A	EMERGENCY–STOP RELAY (K4) COIL, NEGATIVE	
42A	BATTERY VOLTAGE (FUSE PROTECTED)	
2	GROUND	
3	REMOTE START GROUND	
4	REMOTE START (ACTIVE LOW)	
9	CRANK MODE (OPEN=CYCLE ; GROUND=CONTINUOUS)	
12	OVERCRANK INDICATOR	
26	AUXILIARY INDICATOR	
32	COMMON FAULT/PREALARM LINE	
36	HIGH ENGINE TEMPERATURE INDICATOR	
38	LOW OIL PRESSURE INDICATOR	
39	OVERSPEED INDICATOR	
56	AIR DAMPER INDICATOR	
60	SYSTEM READY INDICATOR	
70	BATTERY VOLTAGE (RUN ONLY)	
7N	GROUND	
80	NOT IN AUTO INDICATOR	
35	LOW WATER TEMPERATURE	PRE–ALARM FUNCTION OPTION ADDITIONS
40	PRE–ALARM HIGH ENGINE TEMPERATURE INDICATOR	
41	PRE–ALARM LOW OIL PRESSURE INDICATOR	
58	LINE POWER	TRANSFER SWITCH OPTION ADDITIONS
59	GENERATOR POWER	
48	EMERGENCY–STOP INDICATOR	NFPA OPTION ADDITIONS
61	BATTERY CHARGER FAULT (ACTIVE LOW)	
62	LOW BATTERY VOLTS (ACTIVE LOW)	
63	LOW FUEL (ACTIVE LOW)	

* MUST HAVE JUMPER IF THERE IS NO EMERGENCY STOP KIT CONNECTIONS.

256876-C P1

Schematic Diagram, Remote Annunciator—10 Relay

WIRING HARNESS
FROM SHEET 1 OF 2.

REMOTE ANNUNCIATOR
DRY CONTACT BOX
MTG AT GEN

40 — 40
35 — 35
63 — 63
62 — 62
61 — 61

42 2 39 12 36 38 26 60 80 41 48

INPUT

42A 2 K1 K2 K3 K4 K5 K6 K7 K8 K9 K10

OUT K1 OUT K2 OUT K3 OUT K4 OUT K5 OUT K6 OUT K7 OUT K8 OUT K9 OUT K10

NO NC C

N

39 N 12 36 38 26 60 80 41 48 N

42B — P

FBA–1

ANNUNCIATOR
FUSE BLOCK
10 AMP

P

N

NOTE:
CONTRACTOR TO HARDWIRE "P" TO BATTERY POSITIVE ENGINE CONNECTION, AND "N" TO BATTERY NEGATIVE ENGINE CONNECTION. USE WIRE HARNESS PROVIDED AND CUT & TERMINATE AS REQUIRED.

TRANSFER SWITCH

AUXILLARY CONTACTS MOUNTED ON TRANSFER SWITCH CONTACTOR ASSEMBLY.

DO NOT APPLY ANY VOLTAGE TO THESE CONTACTS.

10 NO 59
11
12 N
NC 13 58

REMOTE ANNUNCIATOR

42B 63 35 41 40 39 48 38 36 12 28 62 61 58 59 60 80 N

OPTIONAL DECISION MONITOR CONNECTIONS

CUSTOMER SUPPLIED WIRES

#N & #42B WIRE REQUIRE
100 FT. – 18–20 GA.
500 FT. – 14 GA.
1000 FT. – 10 GA.

SIGNAL WIRES
18–20 GA. TO 1000 FT.

NOTE: IF ADDITIONAL LOAD IS ADDED
RESIZE N & 42B AS REQUIRED

256876-C P2

Schematic Diagram, Remote Annunciator—10 Relay

Section 10. Specifications

6ROY/6RFOY

General

		6ROY		6RFOY
Dimensions—L x W x H			53.5 x 29 x 35.8	
in. (mm)			(1359 x 737 x 909)	
Weight—lbs. (kg)		674 (306)		674 (306)
Air Requirements (Radiator model)				
Combustion—cfm (cmm)		30 (0.85)		24 (0.68)
Cooling—cfm (cmm)		1815 (51)		1512 (43)
Fuel Consumption			**Diesel-gph (Lph)**	
Load	25%	50%	75%	100%
6ROY	0.15 (0.6)	0.31 (1.2)	0.46 (1.7)	0.61 (2.3)
6RFOY	0.13 (0.5)	0.26 (1.0)	0.38 (1.4)	0.51 (1.9)

Engine

Some general engine specifications are listed below. Refer to the appropriate service section and the engine service manual for specific service details.

Manufacturer	Yanmar
Model	3TN75E-RK
Cycle	4
Number Cylinders	3
Combustion System	Direct Injection
Compression Ratio	17.6:1
Displacement—cu.in. (cc)	61 (994)
Rated Horsepower	12.7 (1800 rpm), 10.6 (1500 rpm)
RPM	1800 (60 Hz), 1500 (50 Hz)
Bore—in. (mm)	2.953 (75)
Stroke—in. (mm)	2.953 (75)
Valve Material	Heat Resistant Steel
Valve Clearance—in. (mm)	
Intake	0.008 (0.2)
Exhaust	0.008 (0.2)
Cylinder Block Material	Cast Iron
Cylinder Head Tightening Torque—ft. lbs (Nm)	Step 1: 24-26 (3.4-3.6)
	Step 2: 49-52 (6.8-7.2)
Cylinder Head Material	Cast Iron

Engine-continued

Piston Rings	2 Compression/1 Oil
Crankshaft Material	Carbon Steel
Main Bearings, Number & Type	4, Replaceable Sleeves
Governor	Mechanical
Lubrication System	Full Pressure
Oil Capacity (with filter)—qts. (L)	3.6 (3.4)
Oil Type (API)	CC or CD
Oil Pressure—psi (kPa)	43-57 (294-392)
Direction of Rotation (from Generator End)	Counterclockwise
Fuel Type	Diesel-ASTM D975 No. 2-D
	(Cetane No. > 45)
Aspiration	Natural Aspiration
Fuel Injection Pressure—psi (kPa)	2844 (19609)
Battery Voltage	12
Battery Ground	Negative
Battery Recommendation (min.)	500 Cold Cranking Amps.
Battery Charging	Belt-Driven Alternator
Starter Motor	12-Volt, Positive Engagement
Cooling System	Water-Cooled
Cooling System Capacity—gal. (L)	2 (7.6)
Recommended Coolant	50% ethylene glycol
	50% clean, softened water
Engine Firing Order	1-3-2
Timing (B.T.D.C.)	16° + 1°
Fan Belt Tension (Deflection)—in. (mm)	0.4-0.6 (10-5)
Air Cleaner	Dry Paper Element

Generator

	6ROY	6RFOY
Rated kW	6	5
Frequency—Hz	60	50
RPM	1800	1500
Rated Voltage	100-120/	100-120/
	200-240	200-240
Excitation Method	Static Excited	Static Excited
Coupling Type	Flexible Disc	
Magnetic Pick-up Air Gap	0.030 in. (0.76 mm) ±0.010 in. (0.25 mm)	

Generator-continued	6ROY	6RFOY
Rotor Resistance (ohms)*	5.1	5.1
Stator Resistance (ohms)*		
Leads:		
1-2, 3-4	0.17	0.17
33-44	0.17	0.17
55-33	2.2	2.2
Stator Output Voltages with Separately Excited Rotor Using 12 Volt Battery	80-100	60-80
Rotor Field Voltage/Current Readings at Rated Output Voltage (Hot)		
No Load	16/2.6 (63 Hz.)	19/3.0 (53 Hz.)
Full Load	36/5.1 (60 Hz.)	38/5.4 (50 Hz.)
Voltage Regulator Type	PowerBoost™ IIIE	PowerBoost™ IIIE
Number of Output Leads	4	4
Insulation (Rotor and Stator)	Class F, Epoxy Varnish Vacuum Impregnated	
Winding Material	Copper	
Bearing, Quantity and Type	1, Replaceable Ball	
Circuit Protection		
Controller	See Section 2, Circuit Protection	
Generator	Optional Line Circuit Breaker (Size Dependent on Voltage)	
Voltage Regulator	Replaceable 10 Amp Fuse	

* Most ohmmeters will not give accurate readings when measuring less than 1 (one) ohm. The rotor/stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

DERATION: The kilowatts of the generator set will decrease 4% for each 1000 feet (305 meters) above sea level and 1% for each 10°F (5.5°C) increase in ambient temperature above 85°F (29°C). Ambient temperature is measured at air cleaner inlet.

Model Series	Voltage Code	Voltage	Standby Amps	Phase	Hz.	Power Factor	Continuous Standby Ratings Kw/kVA	Prime Rating kW/kVA
6ROY	61	120/240	25	1	60	1.0	6/6	4.5/4.5
6RFOY	61	100/200	25	1	50	1.0	5/5	4.5/4.5
6RFOY	61	110/220	23	1	50	1.0	5/5	4.5/4.5
6RFOY	61	115/230	22	1	50	1.0	5/5	4.5/4.5
6RFOY	61	120/240	21	1	50	1.0	5/5	4.5/4.5

10ROY/10RFOY

General

		10ROY		10RFOY
Dimensions—L x W x H in. (mm)			53.5 x 29 x 35.8 (1359 x 737 x 909)	
Weight—lbs. (kg)		758 (344)		758 (344)
Air Requirements (Radiator model)				
Combustion—cfm (cmm)		39 (1.1)		32 (0.9)
Cooling—cfm (cmm)		1815 (51)		1512 (43)
Fuel Consumption			**Diesel-gph (Lph)**	
Load	25%	50%	75%	100%
10ROY	0.3 (1.1)	0.6 (2.3)	0.8 (3)	1.1 (4.2)
10RFOY	0.2 (0.8)	0.5 (1.9)	0.7 (2.6)	0.9 (3.4)

Engine

Some general engine specifications are listed below. Refer to the appropriate service section and the engine service manual for specific service details.

Manufacturer	Yanmar
Model	3TN75E-RK
Cycle	4
Number Cylinders	3
Combustion System	Direct Injection
Compression Ratio	17.79:1
Displacement—cu.in. (cc)	87 (1430)
Rated Horsepower	19 (1800 rpm), 14 (1500 rpm)
RPM	1800 (60 Hz), 1500 (50 Hz)
Bore—in. (mm)	3.307 (84)
Stroke—in. (mm)	3.386 (86)
Valve Material	Heat Resistant Steel
Valve Clearance—in. (mm)	
Intake	0.008 (0.2)
Exhaust	0.008 (0.2)
Cylinder Block Material	Cast Iron
Cylinder Head Tightening—ft. lbs (Nm)	Step1: 25-31 (3.5-4.3)
	Step 2: 54-61.5 (7.5-8.5)
Cylinder Head Material	Cast Iron
Piston Rings	2 Compression/1 Oil
Crankshaft Material	Carbon Steel
Main Bearings, Number & Type	4, Replaceable Sleeves
Governor	Mechanical

Engine-continued

Lubrication System	Full Pressure
Oil Capacity (with filter)—qts. (L)	5 (4.7)
Oil Type (API)	CC or CD
Oil Pressure—psi (kPa)	43-57 (294-392)
Direction of Rotation (from Generator End)	Counterclockwise
Fuel Type	Diesel-ASTM D975 No. 2-D
	(Cetane No. > 45)
Aspiration	Natural Aspiration
Fuel Injection Pressure—psi (kPa)	2844 (19609)
Battery Voltage	12
Battery Ground	Negative
Battery Recommendation (min.)	500 Cold Cranking Amps.
Battery Charging	Belt-Driven Alternator
Starter Motor	12-Volt, Positive Engagement
Cooling System	Water-Cooled
Cooling System Capacity—gal. (L)	2 (7.6)
Recommended Coolant	50% ethylene glycol
	50% clean, softened water
Engine Firing Order	1-3-2
Timing (B.T.D.C.)	16° + 1°
Air Cleaner	Dry Paper Element

Generator

	10ROY	10RFOY
Rated kW	10	8
Frequency—Hz	60	50
RPM	1800	1500
Rated Voltage	100-120/	100-120/
	200-240	200-240
Excitation Method	Static Excited	Static Excited
Coupling Type	Flexible Disc	
Magnetic Pick-up Air Gap	0.030 in. (0.76 mm) ±0.010 in. (0.25 mm)	

Generator-continued	10ROY	10RFOY
Rotor Resistance (ohms)*	3.5-4.3	3.5-4.3
Stator Resistance (ohms)*		
Leads:		
1-2, 3-4	0.13	0.13
33-44	0.13	0.13
55-33	1.3	1.3
Stator Output Voltages with Separately Excited Rotor Using 12 Volt Battery	80-100	68-88
Rotor Field Voltage/Current Readings at Rated Output Voltage (Hot)		
No Load	16/3.4 (63 Hz.)	17/4.0 (53 Hz.)
Full Load	38/7.1 (60 Hz.)	41/7.2 (50 Hz.)
Voltage Regulator Type	PowerBoost™ IIIE	PowerBoost™ IIIE
Number of Output Leads	4	4
Insulation (Rotor and Stator)	Class F, Epoxy Varnish Vacuum Impregnated	
Winding Material	Copper	
Bearing, Quantity and Type	1, Replaceable Ball	
Circuit Protection		
Controller	See Section 2, Circuit Protection	
Generator	Optional Line Circuit Breaker (Size Dependent on Voltage)	
Voltage Regulator	Replaceable 10 Amp Fuse	

* Most ohmmeters will not give accurate readings when measuring less than 1 (one) ohm. The rotor/stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

DERATION: The kilowatts of the generator set will decrease 4% for each 1000 feet (305 meters) above sea level and 1% for each 10°F (5.5°C) increase in ambient temperature above 85°F (29°C). Ambient temperature is measured at air cleaner inlet.

Model Series	Voltage Code	Voltage	Standby Amps	Phase	Hz.	Power Factor	Continuous Standby Ratings Kw/kVA	Prime Rating kW/kVA
10ROY	61	120/240	42	1	60	1.0	10/10	9/9
10RFOY	61	100/200	42	1	50	1.0	8/8	7.5/7.5
10RFOY	61	110/220	36	1	50	1.0	8/8	7.5/7.5
10RFOY	61	115/230	35	1	50	1.0	8/8	7.5/7.5
10RFOY	61	120/240	35	1	50	1.0	8/8	7.5/7.5

15ROY/15RFOY

General

		15ROY		15RFOY
Dimensions—L x W x H in. (mm)			63 x 29 x 35.8 (1600 x 737 x 909)	
Weight—lbs. (kg)		872 (395)		872 (395)
Air Requirements (Radiator model)				
Combustion—cfm (cmm)		52 (1.5)		43 (1.2)
Cooling—cfm (cmm)		1815 (51)		1512 (43)
Fuel Consumption			**Diesel-gph (Lph)**	
Load	25%	50%	75%	100%
10ROY	0.6 (2.3)	0.8 (3)	1.1 (4.2)	1.4 (5.3)
10RFOY	0.5 (1.9)	0.7 (2.6)	0.9 (3.4)	1.2 (4.5)

Engine

Some general engine specifications are listed below. Refer to the appropriate service section and the engine service manual for specific service details.

Manufacturer	Yanmar
Model	4TN84E-RK
Cycle	4
Number Cylinders	4
Combustion System	Direct Injection
Compression Ratio	17.79:1
Displacement—cu.in. (cc)	116 (1910)
Rated Horsepower	27 (1800 rpm), 23 (1500 rpm)
RPM	1800 (60 Hz), 1500 (50 Hz)
Bore—in. (mm)	3.307 (84)
Stroke—in. (mm)	3.386 (86)
Valve Material	Heat Resistant Steel
Valve Clearance—in. (mm)	
Intake	0.008 (0.2)
Exhaust	0.008 (0.2)
Cylinder Block Material	Cast Iron
Cylinder Head Tightening Torque—ft. lbs (Nm)	Step1: 25-31 (3.5-4.3)
	Step 2: 54-61.5 (7.5-8.5)
Cylinder Head Material	Cast Iron
Piston Rings	2 Compression/1 Oil
Crankshaft Material	Carbon Steel
Main Bearings, Number & Type	4, Replaceable Sleeves
Governor	Mechanical

Engine-continued

Lubrication System	Full Pressure
Oil Capacity (with filter)—qts. (L)	6.1 (5.8)
Oil Type (API)	CC or CD
Oil Pressure—psi (kPa)	43-57 (294-392)
Direction of Rotation (from Generator End)	Counterclockwise
Fuel Type	Diesel-ASTM D975 No. 2-D
	(Cetane No. > 45)
Aspiration	Natural Aspiration
Fuel Injection Pressure—psi (kPa)	2844 (19609)
Battery Voltage	12
Battery Ground	Negative
Battery Recommendation (min.)	500 Cold Cranking Amps.
Battery Charging	Belt-Driven Alternator
Starter Motor	12-Volt, Positive Engagement
Cooling System	Water-Cooled
Cooling System Capacity—gal. (L)	4.7 (17.8)
Recommended Coolant	50% ethylene glycol
	50% clean, softened water
Engine Firing Order	1-3-2
Timing (B.T.D.C.)	16° + 1°
Air Cleaner	Dry Paper Element

Generator

	15ROY	15RFOY
Rated kW	15	12.5
Frequency—Hz	60	50
RPM	1800	1500
Rated Voltage	100-120/	100-120/
	200-240	200-240
Excitation Method	Static Excited	Static Excited
Coupling Type	Flexible Disc	
Magnetic Pick-up Air Gap	0.030 in. (0.76 mm) ±0.010 in. (0.25 mm)	

Generator-continued	15ROY	15RFOY
Rotor Resistance (ohms)*	2.5-3.1	2.5-3.1
Stator Resistance (ohms)*		
Leads:		
1-2, 3-4	0.07	0.07
33-44	0.07	0.07
55-33	1.1	1.1
Stator Output Voltages with Separately Excited Rotor Using 12 Volt Battery	80-100	63-83
Rotor Field Voltage/Current Readings at Rated Output Voltage (Hot)		
No Load	16/4.5 (63 Hz.)	18/5.2 (53 Hz.)
Full Load	36/8.6 (60 Hz.)	38/9.1 (50 Hz.)
Voltage Regulator Type	PowerBoost™ IIIE	PowerBoost™ IIIE
Number of Output Leads	4	4
Insulation (Rotor and Stator)	Class F, Epoxy Varnish Vacuum Impregnated	
Winding Material	Copper	
Bearing, Quantity and Type	1, Replaceable Ball	
Circuit Protection		
Controller	See Section 2, Circuit Protection	
Generator	Optional Line Circuit Breaker (Size Dependent on Voltage)	
Voltage Regulator	Replaceable 10 Amp Fuse	

* Most ohmmeters will not give accurate readings when measuring less than 1 (one) ohm. The rotor/stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

DERATION: The kilowatts of the generator set will decrease 4% for each 1000 feet (305 meters) above sea level and 1% for each 10°F (5.5°C) increase in ambient temperature above 85°F (29°C). Ambient temperature is measured at air cleaner inlet.

Model Series	Voltage Code	Voltage	Standby Amps	Phase	Hz.	Power Factor	Continuous Standby Ratings Kw/kVA	Prime Rating kW/kVA
15ROY	61	120/240	63	1	60	1.0	15/15	13.5/13.5
15RFOY	61	100/200	63	1	60	1.0	12.5/12.5	11/11
15RFOY	61	110/220	57	1	50	1.0	12.5/12.5	11/11
15RFOY	61	115/230	54	1	50	1.0	12.5/12.5	11/11
15RFOY	61	120/240	52	1	50	1.0	12.5/12.5	11/11

Installation

Distance Between Generator Set and Battery	Cable Size (AWG) At 0°F(-18°C)	At 32°F(0°C)	At 75°F(24°C)
40 Feet (12.2 m)	00	0	1
30 Feet (9.1 m)	0	1	2
25 Feet (7.6 m)	1	2	4
20 Feet (6.1 m)	2	2	6
15 Feet (4.6 m)	2	4	6
10 Feet (3 m)	4	6	8
5 Feet (1.5 m)	6	6	8
2.5 Feet (.8 m)	8	8	8

Battery Cable Size

Torque Specifications

Generator

	6ROY/6RFOY	10ROY/10RFOY	15ROY/15RFOY
Overbolt torque in. lbs. (Nm)	216 (24)	216 (24)	216 (24)
Fan to rotor boly torque in. lbs. (Nm)	260 (29)	260 (29)	260 (29)
Drive disc to rotor bolt torque in. lbs. (Nm)	540 (61)	540 (61)	540 (61)
Drive disc to flywheel bolt torque in. lbs. (Nm)	168 (19)	168 (19)	–
Drive disc to flywheel nut torque in. lbs. (Nm)	–	–	168 (19)
Generator adapter to flywheel housing bolt torque in. lbs. (Nm)	324 (37)	324 (37)	300 (34)
Magnetic pickup actuator to rotor bolt torque in. lbs. (Nm)	96 (11)	96 (11)	96(11)

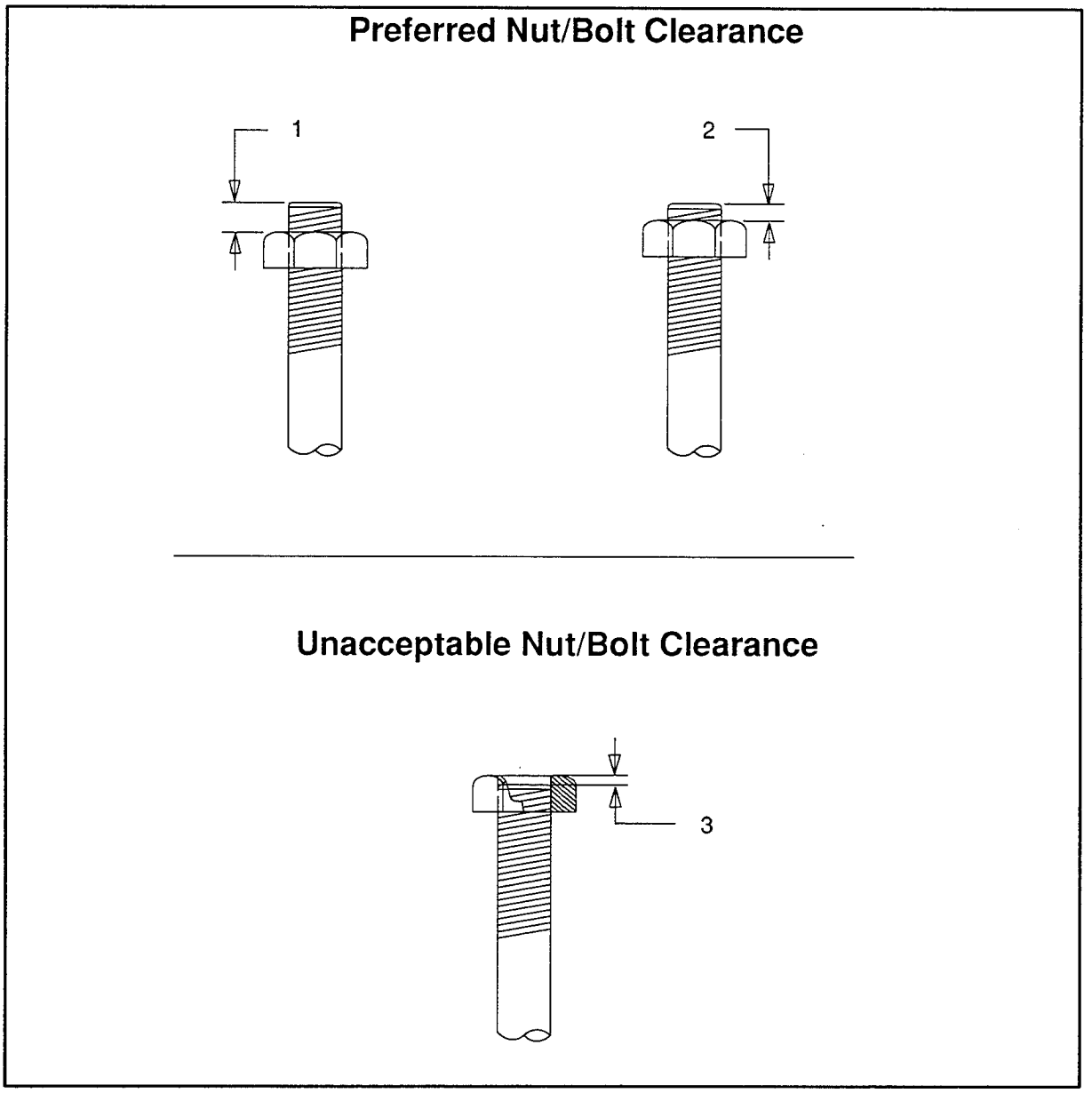
General Fastener Assembly Guidelines

Starting late 1991 common hardware will not be specified on Engineering assembly drawings. As a result, this practice will also be found in many Parts Catalogs and Service Manuals. To help identify proper fastening techniques, use this information in cases where the unit is unassembled and no documentation or reference for reassembly has been made.

When bolt/screw length is not given, use Figure 10-1 for recommendations. As a general rule, a minimum length of one thread beyond the nut and a maximum length of 1/2 the bolt/screw diameter beyond the nut is the preferred method. Figure 10-2.

Split lock washers will no longer be used as a locking device. For hardware up to 1/2 in. dia., a whiz nut (serrated flange) will be incorporated. The locking method utilized above 1/2 in. dia. will be SAE flat washers and preloading (torque) of the bolt/screw. Reference *General Torque Specifications* following for situations when no torque spec. is given with the instructions.

For cases where hardware size (diameter and threads per inch) is given but no indication of type of additional hardware (washers, nuts) is shown in Figure 10-2.



1. 1/2" Bolt Diameter
2. Min. 1 Full Thread Beyond Top of Nut
3. Below Top of Nut

Figure 10-1. Acceptable Bolt Lengths

Steps for common hardware application:

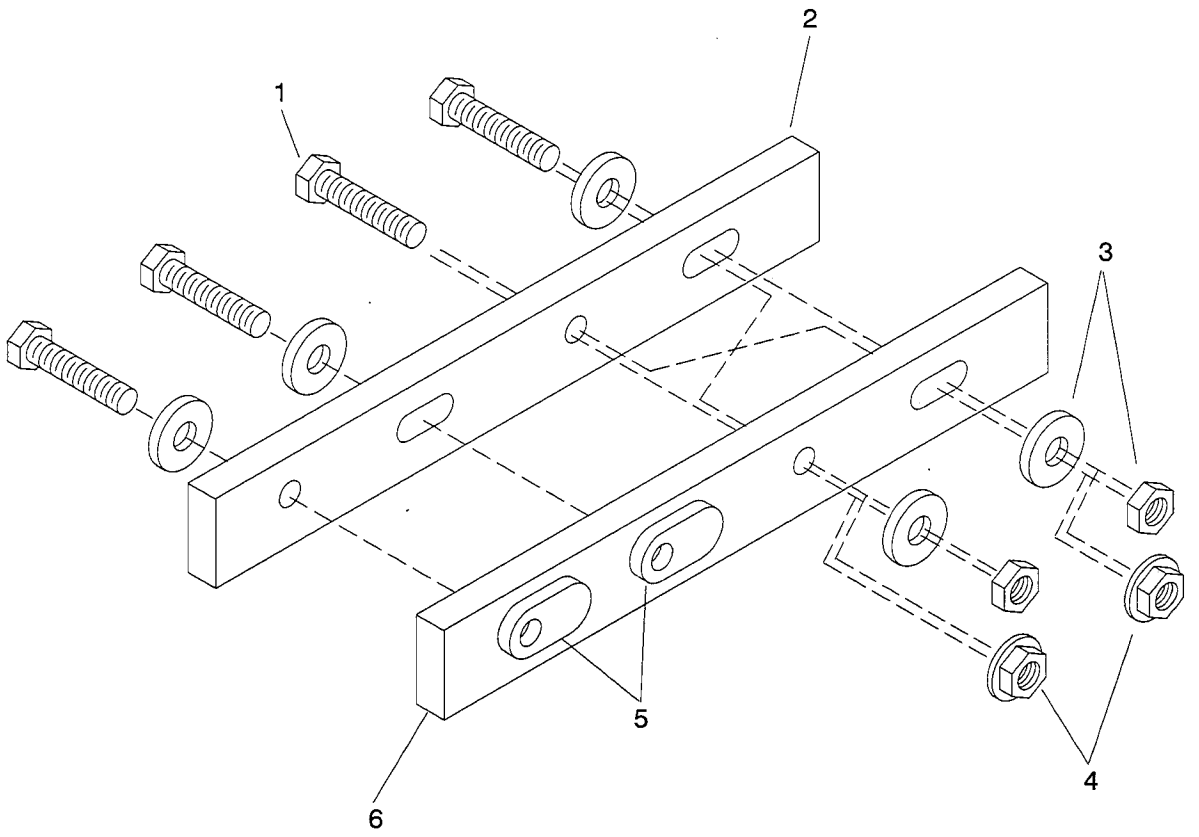
1. Determine entry hole type: round, or slotted.
2. Determine exit hole type: fixed female thread (weld nut), round, or slotted.

a. For non-weld nut exit holes (round and slotted), determine if hardware is greater than 1/2 inch in diameter, or up to 1/2 inch in diameter. Hardware that is greater than 1/2 inch in diameter takes a standard nut and SAE washer. Hardware up to 1/2 inch in diameter can take a properly torqued whiz nut. See diagram below.

3. Follow these SAE washer rules:

   a. Always use a washer between hardware and a slot.
   b. Always use a washer under a nut.
   c. Use a washer under a bolt when the female thread us fixed (weld nut).

4. Refer to the diagram below, which depicts the preceding hardware configuration possibilities.



1. Cap screw
2. Entry hole types
3. Standard nut and SAE washer
4. Wiz nut: up to 1/2" dia. hardware
5. Weld nuts: above 1/2" dia. hardware
6. Exit hole types

Figure 10-2. Acceptable Hardware Combinations

General Torque Specifications

Use the following specifications for SAE fasteners when no torque values are given elsewhere in this manual for a specified bolt. The values given are based on new plated threads. Increase values by 20% if non-plated threads are used.

		Assembled in Cast Iron or Steel			Assembled in Aluminum
Size	**Measurement**	**Grade 2**	**Grade 5**	**Grade 8**	**Grade 2 or 5**
8-32	in. lbs. (Nm)	16 (1.8)	20 (2.3)	–	16 (1.8)
10-24	in. lbs. (Nm)	26 (2.9)	32 (3.6)	–	26 (2.9)
10-32	in. lbs. (Nm)	26 (2.9)	32 (3.6)	–	26 (2.9)
1/4-20	in. lbs. (Nm)	60 (6.8)	96 (10.8)	132 (14.9)	60 (6.8)
1/4-28	in. lbs. (Nm)	72 (8.1)	108 (12.2)	144 (16.3)	72 (8.1)
5/16-18	in. lbs. (Nm)	120 (13.6)	192 (21.7)	264 (29.8)	120 (13.6)
5/16-24	in. lbs. (Nm)	132 (14.9)	204 (23.1)	288 (32.5)	132 (14.9)
3/8-16	ft. lbs. (Nm)	18 (24)	28 (38)	39 (53)	18 (24)
3/8-24	ft. lbs. (Nm)	20 (27)	31 (42)	44 (60)	20 (27)
7/16-14	ft. lbs. (Nm)	29 (39)	44 (60)	63 (85)	
7/16-20	ft. lbs. (Nm)	32 (43)	50 (68)	70 (95)	
1/2-13	ft. lbs. (Nm)	44 (60)	68 (92)	96 (130)	
1/2-20	ft. lbs. (Nm)	49 (66)	76 (103)	108 (146)	
9/16-12	ft. lbs. (Nm)	60 (81)	98 (133)	138 (187)	
9/16-18	ft. lbs. (Nm)	67 (91)	109 (148)	154 (209)	
5/8-11	ft. lbs. (Nm)	83 (113)	135 (183)	191 (259)	
5/8-18	ft. lbs. (Nm)	94 (128)	153 (208)	216 (293)	
3/4-10	ft. lbs. (Nm)	147 (199)	240 (325)	338 (458)	
3/4-16	ft. lbs. (Nm)	164 (222)	268 (363)	378 (513)	
1-8	ft. lbs. (Nm)	191 (259)	532 (721)	818(1109)	
1-12	ft. lbs. (Nm)	209 (283)	582 (789)	895(1214)	
1-12	ft. lbs. (Nm)	209 (283)	582 (789)	895(1214)	

Use the following specifications for metric fasteners when no torque values are given elsewhere in this manual for a specified bolt. These values on based on new plated threads. Increase values by 20% if non-plated threads are used. Screws threaded into aluminum must have two diameters of threads engaged and may require 30% or more reduction in the torque.

	5.8	6.8	10.9	Fasteners Assembled Into Alum.
	Torque	Torque	Torque	Torque
Size (mm)	ft-lb (Nm)	ft-lb (Nm)	ft-lb (Nm)	ft-lb (Nm)
6 x 1.00	5 (7)	6 (9)	9 (12)	5 (7)
8 x 1.25	14 (19)	14 (20)	20 (37)	14 (19)
8 x 1.00	16 (21)	17 (24)	23 (31)	16 (21)
10 x 1.50	25 (35)	27 (37)	38 (51)	25 (35)
10 x 1.25	29 (39)	34 (46)	45 (61)	29 (39)
12 x 1.75	42 (57)	45 (61)	65 (89)	
12 x 1.50	48 (65)	55 (75)	78 (106)	
14 x 2.00	64 (86)	69 (94)	101 (137)	
14 x 1.50	74 (100)	81 (110)	116 (157)	
16 x 2.00	98 (133)	104 (141)	150 (204)	
16 x 1.50	104 (141)	116 (157)	168 (228)	
18 x 2.50	133 (181)	145 (196)	208 (283)	
18 x 1.50	145 (196)	156 (212)	226 (306)	

TP-5555 3/94

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