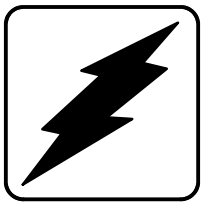
Operation

Industrial Generator Sets



Models:

10RY/RZ
12RY/RZ
17RY
18RY/RZ
22RY

Controllers:

Decision-Maker™ 1
Decision-Maker™ 3, 5-Light
Decision-Maker™ 1 Expanded

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

TP-5870 8/98

California Proposition 65

⚠ WARNING

Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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Appendix A. Glossary of Abbreviations A-1

A generator set, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or operated. The best way to prevent accidents is to be aware of potential dangers and act safely. Please read and follow the safety precautions and instructions below to prevent harm to yourself and others. This manual contains several types of safety precautions and instructions which are explained below. SAVE THESE INSTRUCTIONS.

⚠ DANGER

Danger indicates the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage.

⚠ WARNING

Warning indicates the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage.

⚠ CAUTION

Caution indicates the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage.

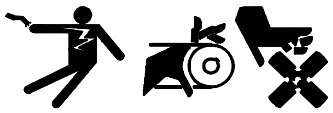
NOTICE

Notice communicates installation, operation, or maintenance information that is important but not hazard related.

Safety decals affixed to the generator set in prominent places advise the operator or service technician of potential hazards and how to act safely. The decals are reproduced in this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set. (Remove negative (–) lead first when disconnecting battery. Reconnect negative (–) lead last when reconnecting battery.)

Disabling generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: 1) Turn the generator set master switch to OFF position. 2) Disconnect power to battery charger. 3) Remove battery cables (remove negative (–) lead first). Reconnect negative (–) lead last when reconnecting battery. Follow these precautions to prevent starting of generator set by an automatic transfer switch or remote start/stop switch.

Battery

⚠ WARNING

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

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

⚠ WARNING

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

Locate battery in a well-ventilated area. Isolate battery charger from explosive fumes.

Battery acid. 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 near the battery. If battery acid is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery gases. 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 charging. Avoid touching terminals with tools, etc., to prevent burns and 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. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is charging. Always turn battery charger off before disconnecting battery connections. Remove negative (–) lead first when disconnecting battery. Reconnect negative (–) lead last when reconnecting battery.

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

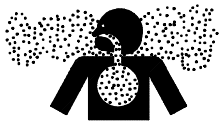
Do not smoke or permit flame or spark to occur near fuel or fuel system.

Servicing fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. Catch all fuel in a suitable container when removing fuel line or carburetor.

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

Exhaust System

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

Generator set operation. 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 a potentially occupied building. Avoid breathing exhaust fumes when working on or near the generator set. Carbon monoxide is particularly dangerous because it is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short period of time.

Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas which is present in exhaust gases. Carbon monoxide poisoning symptoms include but are not limited to the following:

- Light-headedness, dizziness
- Physical fatigue, weakness in joints and muscles
- Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision
- Stomachache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, affected persons should seek fresh air immediately. They should remain active. They should not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. If the condition of affected persons does not improve within minutes of breathing fresh air, they should seek medical attention.

Fuel System

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

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

Fuel system. Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling and storing 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 because spilled fuel may ignite on contact with hot parts or from spark. Do not smoke or permit flame or spark to occur near sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid breakage caused by vibration. Do not operate generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair systems before resuming generator set operation.

Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels:

Gasoline—Store gasoline only in approved red containers clearly marked GASOLINE.

Propane (LP)—Adequate ventilation is mandatory. Propane is heavier than air; install propane gas detectors low in room. Inspect detectors often.

Natural Gas—Adequate ventilation is mandatory. Natural gas rises; install natural gas detectors high in room. Inspect detectors often.

Fuel tanks. Explosive fuel vapors can cause severe injury or death. Gasoline and other volatile fuels stored in day tanks or subbase fuel tanks can cause an explosion. Store only diesel fuel in tanks.

Draining fuel system. Explosive fuel vapors can cause severe injury or death. Spilled fuel can cause an explosion. Use a container to catch fuel when draining fuel system. Wipe up all spilled fuel after draining system.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP vapor gas or natural gas fuel system for leakage using a soap-water solution with fuel system test pressurized to 6-8 ounces per square inch (10-14 inches water column). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP liquid withdrawal gas fuel system for leakage using a soap-water solution with fuel system test pressurized to at least 90 psi (621 kPa). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.

Never operate generator set without a muffler or with a faulty exhaust system.

Engine noise. Hazardous noise can cause loss of hearing. Generator sets not equipped with sound enclosures can produce noise levels greater than 105 dBA. Prolonged exposure to noise levels greater than 85 dBA can cause permanent hearing loss. Wear hearing protection when near an operating generator set.

Hazardous Voltage/ Electrical Shock

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

⚠ WARNING

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

If generator set is used for standby power, install an automatic transfer switch to prevent inadvertent interconnection of standby and normal sources of supply.

Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

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

Installing battery charger. Hazardous voltage can cause severe injury or death. Electrical shock may occur if battery charger is not electrically grounded. Connect battery charger enclosure to ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect to equipment grounding terminal or lead on battery charger. Perform battery charger installation as prescribed in equipment manual. Install battery charger in compliance with local codes and ordinances.

Connecting battery and battery charger. Hazardous voltage can cause severe injury or death. Reconnect battery correctly to avoid electrical shock and damage to battery charger and battery(ies). Have a qualified electrician install battery(ies).

Short circuits. Hazardous voltage/current 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 making adjustments or repairs. Remove wristwatch, rings, and jewelry before servicing equipment.

Testing voltage regulator. Hazardous voltage can cause severe injury or death. High voltage is present at the voltage regulator heat sink. Do not touch voltage regulator heat sink when testing voltage regulator or electrical shock will occur. *(PowerBoost™, PowerBoost™ III, and PowerBoost™ V voltage regulator models only.)*

Engine block heater. 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.

Electrical backfeed to utility. 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.

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lift can cause severe injury or death and/or equipment damage.

Do not use lifting eyes.
Lift generator set using lifting bars inserted through skid lifting holes.

Hot Parts

⚠ WARNING

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

Before removing pressure cap, stop generator set and allow it to cool. Then 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 it is allowed to cool.

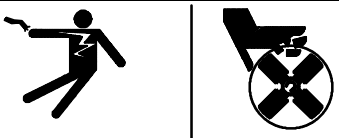
Servicing generator. Hot parts can cause severe injury or death. Avoid touching generator set field or exciter armature. Generator set field and exciter armature when shorted become hot enough to cause severe burns.

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

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

Moving Parts

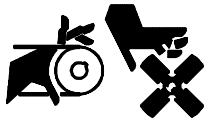
⚠ WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate generator set only with 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, and covers in place.

Tightening hardware. Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. Do not loosen crankshaft hardware or rotor thrubolt when making adjustments or servicing generator set. Rotate crankshaft manually in a clockwise direction only. Turning crankshaft bolt or rotor thrubolt counterclockwise can loosen hardware. Loose hardware can cause hardware or pulley to release from engine of generator set and can cause personal injury.

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

Notice

NOTICE

This generator set has been rewired from its nameplate voltage to:

246242

NOTICE

Voltage reconnection! Affix notice to generator set after reconnecting to a voltage different from the nameplate. Order voltage reconnection decal 246242 from authorized service distributors/dealers.

NOTICE

Hardware damage! Engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

NOTICE

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 identification.

NOTICE

Canadian installations only:
For standby service connect output of generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.

Notes

TP-5870 applies to Kohler liquid-cooled, gas-fueled standby generator sets in the 10-22 kW range. All generator sets are equipped with the PowerBoost™ voltage regulation system. At the time of print this manual applied to the 10/12/18RY/RZ and the 17/22RY.

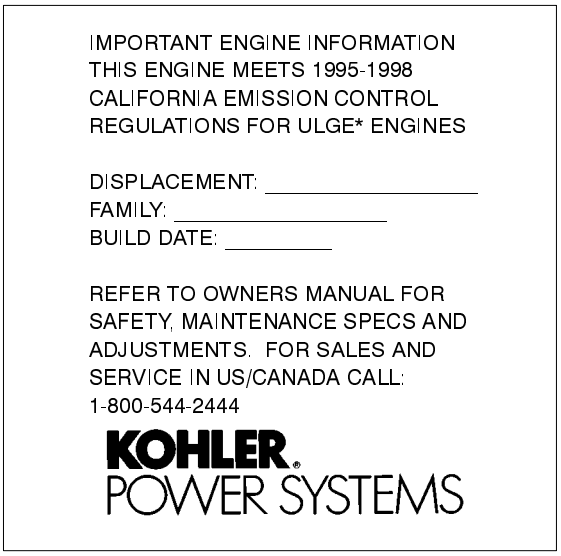
All information in this publication represents data available at time of print. Kohler Co. reserves the right to change this literature and the products represented without incurring obligation.

Read through this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with equipment for future reference.

Equipment service requirements are minimal but are very important to safe and efficient operation; therefore, inspect parts often and perform required service at the prescribed intervals. An authorized service distributor/dealer should perform required service to keep equipment in top condition.

California Emission Certification

If your engine/generator has this identification label, it is certified for operation in the state of California.



*Utility Lawn and Garden Equipment

This engine/generator is certified to operate on natural gas or propane fuel.

This engine certified with engine modifications.

Service Assistance

For sales and service in the U.S.A. and Canada check the yellow pages of the telephone directory under the heading GENERATORS—ELECTRIC for an authorized service distributor/dealer or call 1-800-544-2444.

For sales and service outside the U.S.A. and Canada, contact your local distributor.

For further information or questions, contact the company directly at:

KOHLER CO., Kohler, Wisconsin 53044 U.S.A.
Phone: 920-565-3381
Fax: 920-459-1646 (U.S.A. Sales)
920-459-1614 (International)

Kohler Power Systems, Asia Pacific Headquarters
7 Jurong Pier Road, Singapore 619159
Phone: (65)264-6422
Fax: (65)264-6455

To ensure supply of correct parts or information, make note of the following identification numbers in the spaces provided:

GENERATOR SET

MODEL, SPEC, and SERIAL numbers are found on the nameplate attached to the generator set.

Model No. _____

Specification No. _____

Serial No. _____

GENERATOR SET ACCESSORIES

An alternate nameplate inside the junction box identifies factory-installed generator set accessories.

Accessory Nos. _____

_____

_____

_____

_____

_____

_____

_____

_____

ENGINE

The engine serial number is found on the engine nameplate.

Engine Serial No. _____

1.1 Introduction

The spec sheets for each generator set provide specific generator and engine information. Refer to the respective spec sheet for data not supplied in this manual. Not all features and options are available on all models Consult the generator set service manual, installation manual, engine operation manual, and engine service manual for additional specifications.

1.2 Generator

The generator is equipped with Kohler's PowerBoost™ voltage regulation system which provides instant response to load changes.

PowerBoost™ is a unique system that ensures reliable motor starting and consistent voltage levels.

PowerBoost™ utilizes a voltage monitoring system that employs a winding independent of the field to monitor and stabilize voltage.

1.3 Controller

The generator set is equipped with either a Decision-Maker™ 1 controller, Decision-Maker™ 1 Expanded controller or a Decision-Maker™ 3 controller. For a specific description of the controller, see Section 2, Operation. Controller features include the following:

1.3.1 Decision-Maker™ 1

- Fault shutdowns with common indicator:
  - Level, low coolant
  - Overcrank
  - Overspeed
  - Pressure, low oil
  - Temperature, high engine
- Running time meter
- Switches and standard features:
  - Cranking, cyclic
  - Start, remote two-wire
  - Master switch, run/off-reset/auto (engine start)

1.3.2 Decision-Maker™ 1 Expanded

- AC interlock to prevent starter reengagement with engine running
- Analog gauges, 2 in. (51 mm), 2% full-accuracy:
  - Pressure gauge, oil
  - Temperature gauge, engine water
  - Voltmeter, DC only
- Analog meters, 2.5 in. (63.5 mm):
  - AC ammeter, 2% full-scale accuracy
  - AC voltmeter, 2% full-scale accuracy
  - Frequency meter, 0.5% full-scale accuracy
- Fault shutdowns with common indicator:
  - Level, low coolant
  - Overcrank
  - Overspeed
  - Pressure, low oil
  - Temperature, high engine
- Running time meter
- Switches and standard features:
  - Cranking, cyclic
  - Start, remote two-wire
  - Master switch, run/off-reset/auto (engine start)
  - Meter selector switch for selecting line voltages and line amperages shown in metering

1.3.3 Decision-Maker™ 3

- Analog gauges, 2 in. (51 mm), 2% full-accuracy:
  - Pressure gauge, oil
  - Temperature gauge, engine water
  - Voltmeter, DC only
- Analog meters, 3.5 in. (89 mm):
  - AC ammeter, 2% full-scale accuracy
  - AC voltmeter, 2% full-scale accuracy
  - Frequency meter, 0.5% full-scale accuracy
- Fault shutdowns and status indicators:
  - Auxiliary (red)
  - Level, low coolant (uses auxiliary fault indicator)
  - Overcrank (red)
  - Overspeed (red)
  - Pressure, low oil (red)
  - Temperature, high engine (red)
  - Temperature, low water (red)*

  *Requires optional kit or user-provided device for lamp to function.
- Running time meter
- Switches and standard features:
  - Cranking, cyclic
  - Horn, alarm (with silence switch)
  - Rheostat, generator output voltage-adjusting (front panel mounted, ±5% of nominal voltage)
  - Start, remote two-wire
  - Switch, lamp test
  - Switch, meter range selector
  - Switch, run/off-reset/auto (engine start)
  - Timer, engine cool down (5-minute fixed)

Notes

2.1 Prestart Checklist

To ensure continued satisfactory operation, check the following items before each startup and at regular intervals. Refer to the engine service manual for specific service procedures.

Air Cleaner. Keep air cleaner element clean. Install element to keep unfiltered air from entering engine.

Battery. Ensure tight battery connections. Maintain full battery electrolyte level.

Coolant Level. Check level after the engine has cooled. Maintain coolant level at just below the overflow tube on the radiator filler neck. Open air-bleed petcocks, if equipped, when filling radiator. Close air-bleed petcock when coolant begins to flow from petcock. If equipped with a coolant recovery tank, maintain level in tank between 1/3 full (cold) and 2/3 full (hot). Use a coolant solution of 50% ethylene glycol and 50% clean, softened water to inhibit rust/corrosion.

A coolant solution of 50% ethylene glycol provides freezing protection of –34°F (–37°C) and overheating protection to 265°F (129°C). A coolant solution with less than 50% ethylene glycol may not provide adequate freezing and overheating protection. A coolant solution with more than 50% ethylene glycol can cause engine or component damage. Do not use alcohol or methanol antifreeze or mix them with the specified coolant. Consult the engine manufacturer's operation manual for engine coolant specifications.

Do not add coolant to a hot engine. Wait until engine has cooled. Adding coolant to a hot engine can cause the cylinder block or cylinder head to crack.

Do not energize block heater before filling cooling system. Before energizing block heater, run engine until it is warm and refill radiator to purge air from the system. Immerse heater element in coolant to prevent block heater failure.

Exhaust System. Keep exhaust outlet clear. Keep silencer and piping tight and in good condition.

Inspect exhaust system components for cracks and corrosion (exhaust manifold, exhaust line, flexible exhaust, clamps, silencer and outlet pipe).

- Check for corroded or broken metal parts and replace as needed.
- Check for loose, corroded, or missing clamps and hangers. Tighten or replace clamps and/or hangers as needed.
- Check that exhaust outlet is clear.

Fuel Level. Keep tank(s) full to ensure adequate fuel supply.

Lamp Test. Press the lamp test button (if equipped) to verify operation of all controller LEDs.

Oil Level. Maintain oil level at or near full but not over.

Operating Area. Check for obstructions that could block the flow of cooling air. Keep the air intake area clean. Do not leave rags, tools, or debris on or near the generator set.

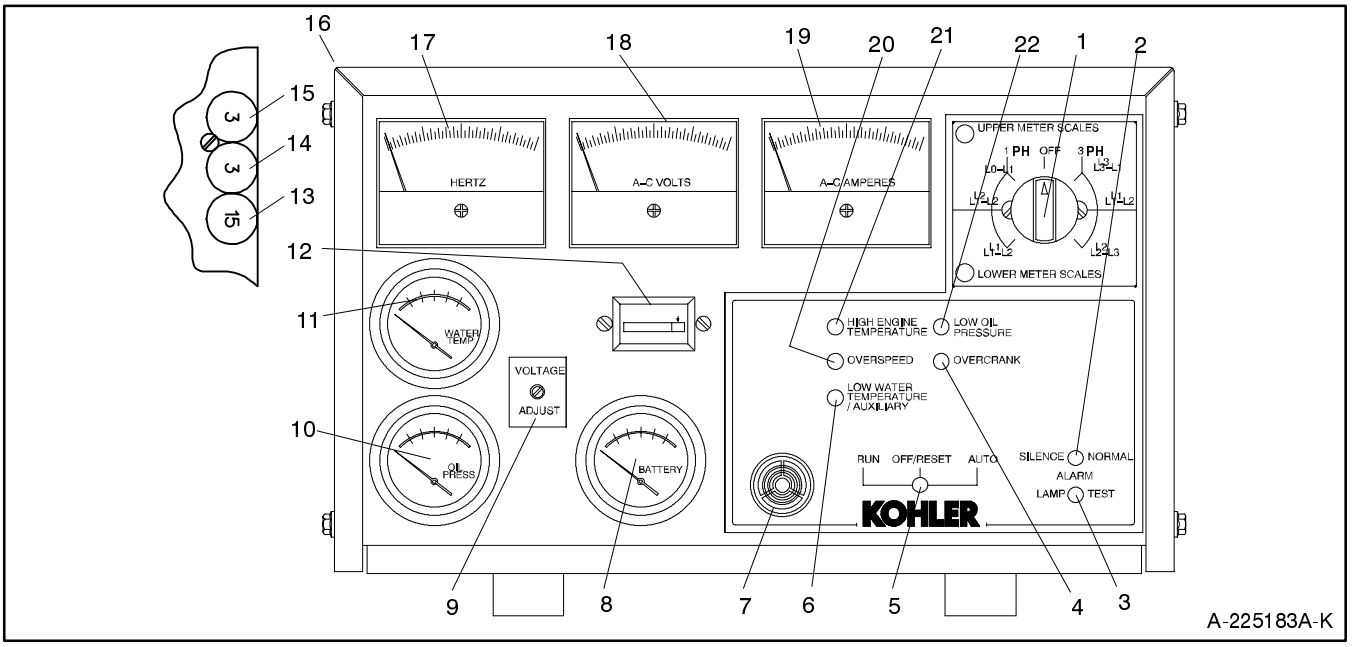
2.2 Exercising the Generator

Run the generator set under load once each week for one hour. Perform this exercise in the presence of an operator if the generator set does not have an automatic transfer switch with an exercise option.

Operator should perform all prestart checks before starting the exercise procedure. While the generator set is running, listen for a smooth-running engine and visually inspect the generator set to ensure there are no fluid or exhaust leaks.

Start the generator set according to the starting procedure in the controller section of this manual.

2.3 Decision-Maker™ 3 Controller Operation



1. Selector switch
2. Alarm silence switch
3. Lamp test
4. Overcrank
5. Generator master switch
6. Auxiliary light
7. Alarm horn
8. DC voltmeter
9. Voltage adjustment potentiometer
10. Oil pressure gauge
11. Engine water temperature gauge
12. Hourmeter
13. 15-amp engine and accessories fuse
14. 3-amp controller fuse
15. 3-amp remote annunciator fuse
16. Fuse location
17. Frequency meter
18. AC voltmeter
19. AC ammeter
20. Overspeed light
21. High engine temperature
22. Low oil pressure lamp

Figure 2-1. Decision-Maker™ 3 Controller Features

2.3.1 Decision-Maker™ 3 Controller Features

The Decision-Maker™ 3 controller features include the annunciator panel lamps, analog meters, switches and controls, fuses, and terminal strip. The following paragraphs cover each of these topics.

Lamps

Auxiliary Fault. Lamp flashes or lights when controller detects fault.

Flashing Lamp Conditions

- The auxiliary lamp flashes immediately if the controller senses no AC output while the generator set runs (except during the first 10 seconds after start-up). The flashing stops and the light goes out when the controller senses AC output. The controller requires no manual reset.
- The auxiliary lamp flashes if the battery power was reconnected or was low and then came back up again while the generator set master switch was in the RUN or AUTO position. A temporarily low battery condition where the battery is weak or undersized for the application is a possible cause. To clear this condition, place the generator set master switch in the OFF/RESET position.

Continuous On Lamp Conditions

- Upon activation of the emergency stop switch, if equipped the auxiliary lamp lights and generator set shuts down immediately.
- The auxiliary lamp lights if the optional emergency stop switch is reset while the generator set master switch is in the AUTO or RUN position. Place the generator set master switch in OFF/RESET position to clear this condition.
- The auxiliary lamp lights and engine shuts down 5 seconds after high oil temperature (P1-13) or auxiliary delay shutdown (P1-15) faults occur, if equipped. These conditions are inhibited during first 30 seconds after crank disconnect.
- The auxiliary lamp lights and engine shuts down immediately if an overvoltage condition occurs, if equipped with overvoltage shutdown kit.
- The auxiliary lamp lights and engine shuts down immediately if activated by any customer-supplied sensing devices connected to auxiliary immediate shutdown ports (P1-17 and P1-18).

Low Oil Pressure. Lamp illuminates if generator set shuts down because of low oil pressure. Shutdown occurs 5 seconds after engine reaches pressure shutdown range.

Overcrank. Lamp illuminates and cranking stops 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 illuminates after 15 seconds if starter or engine does not turn (locked rotor).
- Overcrank lamp flashes if speed sensor signal is absent longer than one second.

NOTE

The generator set controller's automatic restart function attempts to restart the generator set if the engine speed drops below 13 Hz (390 RPM). Continued decreased engine speed causes an overcrank fault condition.

Overspeed. Lamp illuminates if generator set shuts down because governed frequency on 50 and 60 Hz models exceeds 70 Hz (2100 RPM).

Analog Meters

AC Ammeter. Meter measures AC amperage from output leads. Use selector switch to choose output lead circuits.

AC Voltmeter. Meter measures AC voltage across output leads. Use selector switch to choose output lead circuits.

DC Voltmeter. Meter measures DC voltage of starting battery.

Frequency Meter. Meter measures frequency (Hz) of generator set output voltage.

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

Switches and Controls

Alarm Horn. Horn sounds if any fault or anticipatory condition exists. Place the generator set master switch in the AUTO position before silencing alarm horn. See Controller Resetting Procedure later in this section.

Alarm Silence. Switch disconnects alarm during service (place the generator set master switch in the AUTO position before silencing alarm horn). Restore alarm horn switches at all locations (controller, remote annunciator, and audio/visual alarm) to normal position after correcting fault shutdown to avoid reactivating alarm horn. See Controller Resetting Procedure later in this section.

Generator Master Switch (RUN/OFF-RESET/AUTO). Switch functions as controller reset and generator set operation switch. Refer to Starting, Stopping, and Controller Resetting Procedure later in this section.

Lamp Test. Switch tests the controller indicator lamps.

Selector Switch. Switch selects generator output circuits to measure. When switched to a position with two circuit labels, amperage is measured on the lead shown in the upper label and voltage is measured between the two leads shown in the lower label. AC ammeter and voltmeter do no function with switch in the OFF position.

Voltage Adjustment Potentiometer. Fine adjustment (±5%) for generator output voltage. See Wiring Diagrams, Voltage Reconnection.

Fuses and Terminal Strip

Fuses. See below for a description of controller circuit board fuses.

- **3-amp Remote Annunciator (F1).** Fuse protects remote annunciator circuit, A/V alarm, and isolated alarm kit, if equipped.
- **3-amp Controller.** Fuse protects controller circuit board, speed sensor, and lamp circuit board.
- **15-amp Engine and Accessory.** Fuse protects engine/starting circuitry and accessories.

Controller TB1 Terminal Strip (on Circuit Board). Connect customer supplied sensing devices and generator set accessories such as emergency stop switch, remote start stop/switch, audio/visual alarms, etc., to the TB1 terminal strip. Make crank mode selection (cyclic or continuous) on the TB1 terminal strip. Figure 2-2 shows the location of the TB1 terminal strip on the controller circuit board. Refer to appropriate wiring diagrams for additional information on connecting accessories to the TB1 terminal strip.

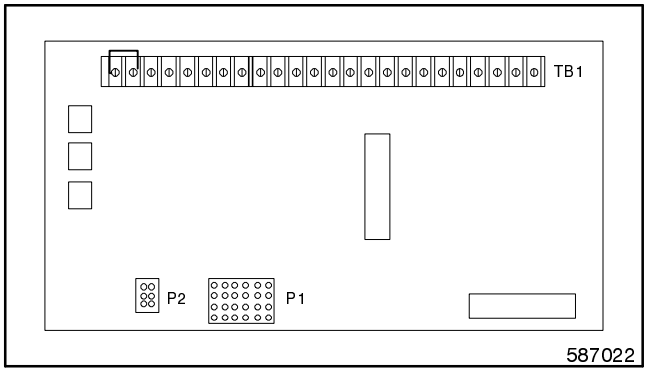


Figure 2-2. Controller TB1 Terminal Strip

2.3.2 Start/Stop Procedure

Local Starting

Place the generator set master switch in the RUN position to immediately start the generator set at the controller.

NOTE

The alarm horn sounds whenever the generator set master switch is not in the AUTO position.

NOTE

The transient start/stop function of the Decision-Maker™ 3 controller prevents accidental cranking of the rotating engine. If the generator set master switch is momentarily placed in the OFF/RESET position, then quickly returned to RUN, the genset slows to 249 rpm and then recranks before returning to rated speed.

NOTE

The Decision-Maker™ 3 controller's automatic restart function attempts to restart the generator set if the engine speed drops below 13 Hz (390 RPM). Continued decreased engine speed causes an overcrank fault condition.

Auto (Remote) Starting

Place the generator set master switch in the AUTO position for start-up by automatic transfer switch or remote start/stop switch (connected to controller terminals TB1-3 and TB1-4).

Crank Mode Selection

The Decision-Maker™ 3 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. Make the cranking mode (cyclic or continuous) selection on the controller circuit board terminal strip. For cyclic cranking, leave circuit board terminal TB1-9 open. Place a jumper between circuit board terminal TB1-2 (ground) and terminal TB1-9 for continuous cranking.

2.3.3 Stopping

Normal Stopping

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

NOTE

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

---

2. Place the generator set master switch in the OFF/RESET position. The engine stops.

NOTE

The generator set runs for a 5-minute cooldown cycle if engine stop is signaled by a remote switch or automatic transfer switch.

Emergency Stopping

Place the generator set master switch in the OFF/RESET position or activate remote emergency stop, if equipped for immediate shutdown. The controller AUXILIARY lamp lights and the generator set shuts down if the emergency stop switch is activated. The remote annunciator and/or audio-visual alarms, if equipped, signal an emergency stop.

NOTE

Use the emergency stop switch(s) for emergency shutdowns only. Use the generator set master switch to stop the generator set under normal operating conditions.

2.3.4 Circuit Protection

The line circuit breaker interrupts generator output in the event of an overload or short circuit in the wiring between the alternator and components. If the circuit breaker trips, reduce the load and switch the breaker back to the ON position. With the breaker in the OFF position, the generator set runs but produces no output voltage to the connected load.

NOTE

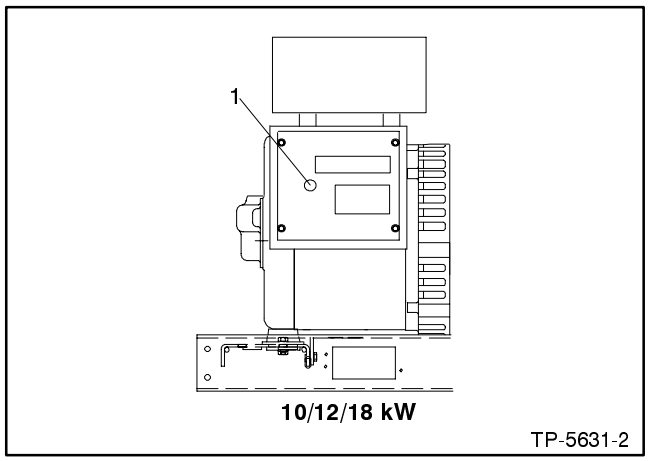
If the generator set circuit breaker trips repeatedly, see Section 4, Troubleshooting for possible causes.

Fuses F1 (3-amp), F2 (3-amp) and F3 (15-amp) on the controller circuit board protect the engine and controller circuitry. (See Fuses earlier in this section.) If the generator set will not crank or accessories will not work, and the battery/connections appear okay, check the controller circuit board fuses.

Fuses V7, V8, and V9 on the AC terminal block (TB2) protect the controller meters and lights. If the controller lights and meters are not functioning, check the condition of the V7, V8, and V9 fuses. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes.

Voltage Regulator Fuse

A 10-amp fuse protects the voltage regulator circuitry from damage because of overload or short circuits. If this fuse blows, the generator set shuts down. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes. See Figure 2-3 for the location of the voltage regulator fuse.



1. 10-amp fuse

Figure 2-3. Voltage Regulator Fuse Location

2.3.5 Fault Shutdowns

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

NOTE

Low oil pressure, low water temperature, and high water temperature do not function during the first 30 seconds after start-up. If the cause of the shutdown is not corrected, the generator set can be restarted (after controller reset) and runs approximately 30 seconds before shutting down again. See Resetting Fault Shutdown procedure.

Overcrank. Shutdown occurs after 45 seconds of continuous cranking. Shutdown occurs 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 set shuts down immediately when governed frequency exceeds 70 Hz (2100 rpm) on 50 and 60 Hz models.

Low Oil Pressure. Shutdown occurs 5 seconds after fault. Low oil pressure shutdown will not function during the first 30 seconds after start-up.

Overvoltage. The generator set shuts down and auxiliary lamp lights when voltage is 15% or more over nominal voltage for 2 seconds or more. Controllers come standard with overvoltage shutdown.

High Engine Temperature. Shutdown occurs 5 seconds after engine reaches temperature shutdown range.

Low Coolant Level. Shutdown occurs 5 seconds after engine coolant reaches shutdown level.

NOTE

Overvoltage can damage sensitive equipment in less than one second. Install separate overvoltage protection on on-line equipment requiring faster shutdowns.

2.3.6 Controller Resetting Procedure (following fault shutdown)

Use the following procedure to restart the generator set after a fault shutdown. Refer to Resetting Emergency Stop Switches in this section to reset the generator set after an emergency stop.

1. Place controller alarm horn switch in the SILENCE position. A/V annunciator alarm horn and lamp, if equipped are activated. Place A/V annunciator alarm switch in SILENCE position 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 lights 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. Place the generator set master switch in the OFF/RESET position and then in the RUN position to start generator set. A/V annunciator alarm horn sounds and lamp, if equipped, goes out.
5. Test operate generator set to verify that cause of shutdown has been corrected.
6. Reconnect generator set to load via line circuit breaker or automatic transfer switch.
7. Place generator set master switch in AUTO position for start-up by remote transfer switch or remote start/stop switch. Place A/V annunciator alarm switch, if equipped, in NORMAL position.

NOTE

Place generator set master switch in the AUTO position before silencing alarm horn.

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8. Place controller alarm horn switch in the NORMAL position.

2.3.7 Resetting Emergency Stop Switches

Use the following procedure to restart the generator set after shutdown by the remote emergency stop switch. Refer to the Controller Resetting procedure in this section to restart the generator set following a fault shutdown.

1. Determine cause of emergency stop and correct problem(s).
2. Replace glass piece in remote emergency stop switch, if equipped, to reset switch.

NOTE

The controller auxiliary lamp lights if the generator set master switch is in the RUN or AUTO position during the resetting procedure.

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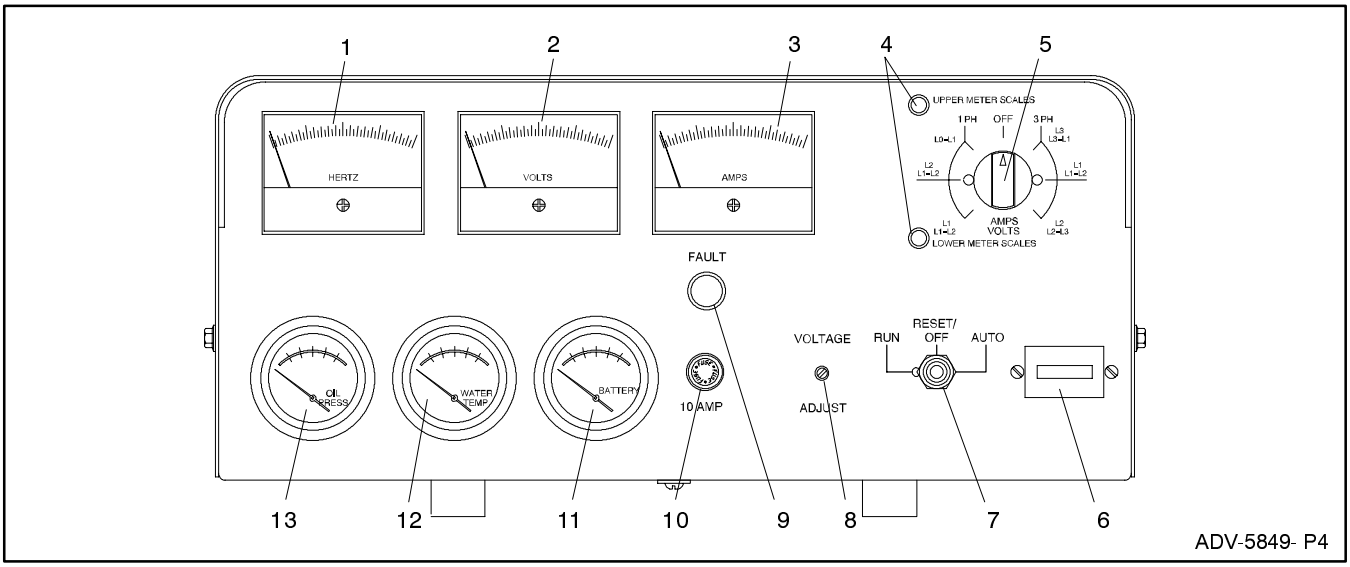
3. Toggle the generator set master switch to OFF/RESET and then to RUN or AUTO to restart generator set. The generator set does not crank until the resetting procedure is completed.

2.4 Decision-Maker™ 1 Expanded Controller Operation



1. Frequency meter
2. AC voltmeter
3. AC ammeter
4. Scale lamps (upper/lower)
5. Selector switch
6. Hourmeter
7. Generator master switch
8. Voltage adjustment
9. Fault lamp
10. 10-amp fuse
11. DC voltmeter
12. Water temperature gauge
13. Oil pressure gauge

Figure 2-4. Decision-Maker™ 1 Expanded Controller

2.4.1 Controller Features

The following paragraphs cover the Decision-Maker™ 1 Expanded controller features.

Fault Lamp

Fault Lamp. Lamp illuminates during engine shutdown if engine shuts down because of high engine temperature, low water level, low oil pressure, overcrank, or overspeed faults. See Fault Shutdowns following for additional shutdown information.

Analog Meters/Gauges

AC Ammeter. Meter measures AC output amperage. Use selector switch to choose phase currents.

AC Voltmeter. Meter measures AC output voltage. Use selector switch to choose output lead circuits.

DC Voltmeter. Meter measures DC voltage of starting battery(ies).

Frequency Meter. Meter measures frequency (Hz) of generator output.

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

Oil Pressure Gauge. Gauge measures engine oil pressure.

Scale Lamps (Upper/Lower). Lamps indicate which AC voltmeter and/or ammeter scales to read.

Water Temperature Gauge. Gauge measures engine coolant temperature.

Switches and Controls

Generator Master Switch (RUN/RESET-OFF/AUTO). Switch functions as controller reset and generator operation switch. Refer to Starting, Stopping, and Controller Resetting Procedure later in this section.

Selector Switch. Operator selects what voltage, current, and frequency to view on the voltmeter, ammeter, and frequency meter. AC ammeter and voltmeter do not register with switch in the OFF position.

Voltage Adjustment. Fine adjustment (±5%) of generator output voltage.

Fuse

10-Amp Fuse. Fuse protects controller circuitry.

2.4.2 Starting

The generator set master switch controls the starting of the generator set.

Local Starting

Move the generator master switch to the RUN position to immediately start the generator set.

Auto (Automatic) Starting

Move the generator master switch to the AUTO position to allow startup by remote start/stop switch (connected to controller terminals 3 and 4).

NOTE

The controller provides up to 30 seconds of continuous cranking before overcrank shutdown fault occurs.

2.4.3 Stopping

NOTE

Run the generator at no load for 5 minutes prior to stopping to ensure adequate cooling of the generator set. See Local Starting.

Normal Stopping

1. Disconnect load from generator set and allow generator set to run without load for 5 minutes.
2. Move generator master switch to the RESET/OFF position. Engine stops.

2.4.4 Fault Shutdowns

The generator set shuts down automatically under the following fault conditions and cannot restart until correction of the fault condition. The shutdown switches automatically reset after correction of the problem or the generator set cools (if overheating was the problem).

NOTE

The fault lamp does not stay lit after the generator set shuts down on a fault condition.

Overspeed. Generator set shuts down immediately when governed frequency on 50 and 60 Hz models exceeds 70 Hz.

Overcrank. Shutdown occurs after 30 seconds of cyclic cranking. The factory sets the circuit board for three attempts of 8 seconds each (8 on, 3 off, 8 on, 3 off, etc.).

Low Oil Pressure. Shutdown occurs 5 seconds after fault. Low oil pressure shutdown does not function during the first 5 seconds after start up.

NOTE

Low oil pressure shutdown does not protect against low oil level. Check oil level at engine.

High Engine Temperature. Shutdown occurs 5 seconds after fault. High engine temperature does not function during first 5 seconds after start-up.

Low Coolant Level. Shutdown occurs 5 seconds after fault. Low coolant level shutdown does not function during first 5 seconds after start-up.

2.4.5 Circuit Protection

Line Circuit Breaker

The line circuit breaker (if equipped) interrupts generator output in the event of an overload or short circuit in the wiring between the alternator and components. If the circuit breaker trips, reduce the load and switch the breaker back to the ON position. With the breaker in the OFF position, the generator set runs but produces no output voltage to the connected load.

NOTE

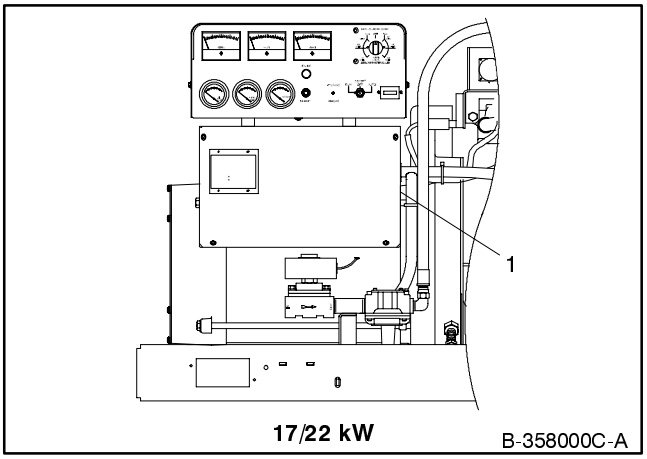
If the generator set circuit breaker trips repeatedly, see Section 4—Troubleshooting for possible causes.

Controller Fuse

A replaceable 10-amp fuse protects the controller circuitry. See Figure 2-4 for fuse location. Check the controller fuse if the generator set will not crank and the battery and/or connections appear correct. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes.

Voltage Regulator Fuse

A replaceable 10-amp fuse protects the voltage regulator circuitry on single phase models. The generator set shuts down if this fuse blows. Typically with this condition, the generator set starts and then shuts down in 8 seconds. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes. See Figure 2-7 for location of the voltage regulator fuse.



1. 10-amp fuse

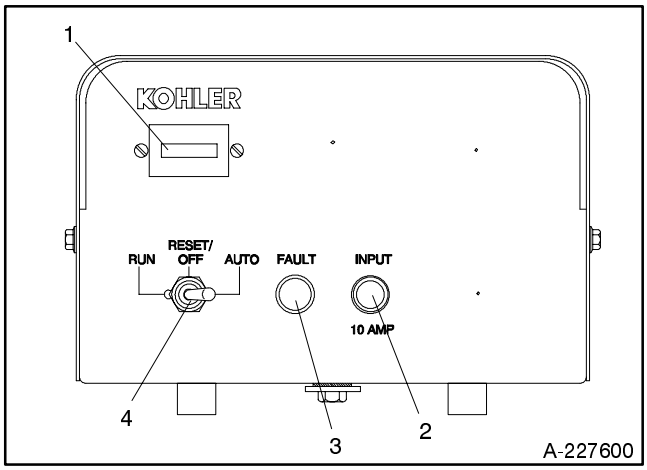
Figure 2-5. Voltage Regulator Fuse Location

2.4.6 Controller Resetting Procedure (Following Fault Shutdown)

Use the following procedure to restart the generator set after a fault shutdown.

1. Disconnect generator set from load by opening the line circuit breaker or automatic transfer switch.
2. Correct cause of fault shutdown. See Safety Precautions section of this manual before proceeding.
3. Start generator set by moving the generator master switch to OFF/RESET and then to the RUN position.
4. Test operate generator set to verify that the cause of the shutdown has been corrected.
5. Reconnect generator to load by closing the line circuit breaker.
6. Move generator master switch to AUTO position for start-up.

2.5 Decision-Maker™ 1 Controller Operation



1. Hourmeter
2. Controller fuse
3. Fault lamp
4. Generator master switch
5. AC circuit breaker (not shown)

Figure 2-6. Decision-Maker™ 1 Controller Features

For generator sets equipped with a Decision-Maker™ 1 controller, refer to Figure 2-6 and the following descriptions to identify controller components.

Fault Lamp. Lamp lights to indicate a fault condition. Generator set shuts down on Overcrank, Overspeed, and Low Oil Pressure faults. See Fault Shutdowns following. (Fault lamp will not stay lit after generator set shuts down. Fault lamp lights as fault occurs.)

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

Generator Master Switch (RUN/RESET-OFF/AUTO). Switch functions as controller reset and generator set operation switch. Refer to Starting, Stopping, and Controller Resetting procedure in this section.

Controller Fuse. Fuse (10-amp) protects controller circuitry.

2.5.1 Starting

Place the controller or remote Start/Stop switch in the RUN position for immediate engine start-up. If the engine fails to start after three 8-second cranking attempts, the generator set stops cranking because of overcrank fault shutdown. Wait for the engine to come to a complete stop before attempting restart. Place generator master switch in the RESET/OFF position and then return generator master switch to the RUN position.

NOTE

Do not crank engine continuously for more than 30 seconds at a time. Allow a 60-second cooldown period between cranking attempts if the engine does not start. If the generator set does not start after three attempts, see Section 4—Troubleshooting for possible causes.

2.5.2 Stopping

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

NOTE

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

2. Place controller or remote start/stop switch in the OFF/RESET position. The generator set shuts down.

2.5.3 Fault Shutdowns (Decision-Maker™ 1 controller)

The generator set shuts down automatically under the following fault conditions and cannot be restarted until the fault condition is corrected. The shutdown switches automatically reset when the problem is corrected or the generator set cools (if overheating was the fault).

Overcrank. Shutdown occurs after 30 seconds of cyclic cranking. The factory sets the circuit board for three attempts of 8 seconds each (8 on, 3 off, 8 on, 3 off, etc.).

Overspeed. Generator set shuts down immediately if governed frequency exceeds 70 Hz on 50 and 60 Hz models.

Low Oil Pressure. Shutdown occurs approximately 8 seconds after fault. Fault occurs when engine oil pressure drops below specified limit.

NOTE

Low oil pressure shutdown does not protect against low oil level. Check for oil level at engine.

NOTE

If the cause of a low oil pressure shutdown is not corrected, the generator set can be restarted (after controller reset) and runs approximately 8 seconds before shutting down again. See Resetting Fault Shutdown procedure following.

2.5.4 Circuit Protection

Line circuit breaker

The line circuit breaker interrupts generator output in the event of an overload or short circuit in the wiring between the alternator and components. If the circuit breaker trips, reduce the load and switch the breaker back to the ON position. With the breaker in the OFF position, the generator set runs but produces no output voltage to the connected load..

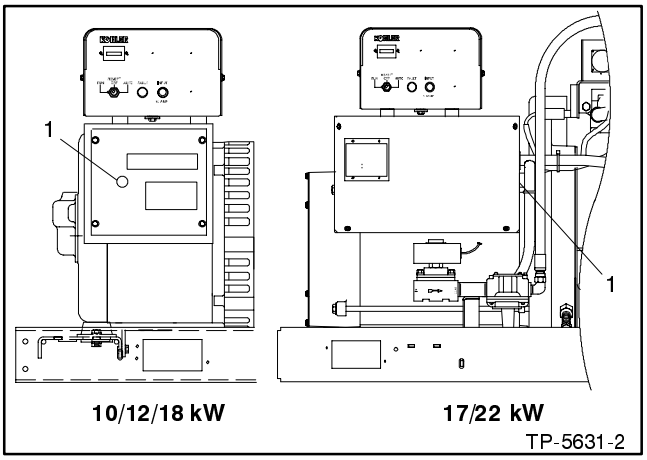
NOTE

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

A replaceable 10-amp fuse protects the controller circuitry. See Figure 2-6 for fuse location. Check the controller fuse if the generator set will not crank and the battery and/or connections appear correct. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes.

Voltage Regulator Fuse

A replaceable 10-amp fuse protects the voltage regulator circuitry. The generator set shuts down if this fuse is blown. Typically with this condition, the generator set starts and then shuts down in 8 seconds. Replace fuse. If fuse blows again, see Section 4—Troubleshooting for possible causes. See Figure 2-7 for location of the voltage regulator fuse.



1. 10-amp fuse

Figure 2-7. Voltage Regulator Fuse Location

2.5.5 Controller Resetting Procedure (following fault shutdown)

Use the following procedure to restart the generator set after a fault shutdown. Reset the controller and correct the fault before restarting the generator set.

NOTE

If the fault is not corrected, the generator set will start and then shut down in 8 seconds.

1. Place the generator set master switch in the OFF/RESET position. See Safety Precautions before proceeding.
2. Disconnect generator set from load by opening the line circuit breaker or automatic transfer switch.
3. Correct cause of fault shutdown. Refer to Section 4—Troubleshooting for possible causes of fault shutdown.
4. Place the generator set master switch in RUN or AUTO position for start-up.

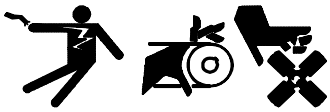
The generator set alternator does not require regular or scheduled service under normal operating conditions. The prestart checklist lists the main areas of the generator set that require attention.

If generator set operates under dusty or dirty conditions, use DRY compressed air to blow dust out of the generator. Do this with the generator set running and direct the stream of air through the openings in the generator end bracket.

Perform generator set engine service at the intervals specified by the engine manufacturer in the engine service literature. Contact an authorized service distributor/dealer to obtain service literature for specific models.

Some generator sets may be equipped with an emission certified engine. Emission certified engines are fitted with carburetors that have no possible adjustments.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set. (Remove negative (–) lead first when disconnecting battery. Reconnect negative (–) lead last when reconnecting battery.)

Disabling generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: 1) Turn the generator set master switch to OFF position. 2) Disconnect power to battery charger. 3) Remove battery cables (remove negative (--) lead first). Reconnect negative (–) lead last when reconnecting battery. Follow these precautions to prevent starting of generator set by an automatic transfer switch or remote start/stop switch.

⚠ WARNING

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

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

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

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

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

3.1 Service Schedule

System—Component	Procedure					Frequency
● Follow procedures and frequencies indicated in the engine manufacturer's maintenance manual. If not indicated, follow this service schedule. Some items may not pertain to specific generator sets. X Action R Replace as necessary	Visually Inspect	Check	Change	Clean	Test	W=Weekly M=Monthly Q=Quarterly S=Six Months Y=Yearly No.=Hours
FUEL						
Flexible lines and connections	X		R			W
Main tank supply level		X				W
Fuel piping	X					Y
LUBRICATION						
Oil level	●	●				W
Crankcase breather	●		●			Q
Change oil			●			50 or Y
Replace filter(s)†			●			50 or Y
COOLING						
Air cleaner to room/enclosure		X				W
Block heater operation		X				W
Coolant level	●	●				W
Flexible hoses and connectors Check connections for leaks. Replace hoses that are cracked, frayed, or feel spongy.	X	X				W
Water pump(s)	●					W
Fan and alternator belts	●	●	R			M
Coolant temperature protection level					●	S
Air ducts, louvers		X		X		Y
Coolant			●			Y
Louver motors and controls	X			X	X	Y
Radiator exterior				●		Y
EXHAUST LINE						
Drain condensate trap		X				W
Leakage	X	X				W
Insulation, fire hazards	X					Q
Flexible connector(s)	X					S
Excessive back pressure					X	Y
Hangers and supports	X					Y
DC ELECTRICAL SYSTEM						
Battery charger operation, charge rate	X					M
Battery electrolyte level		X				M
Battery specific gravity, charge state					X	M
Recharge after engine start		X				M
Remove corrosion, clean and dry battery and rack	X			X		M
Clean and tighten battery terminals	X	X				Q
Tighten DC electrical connections		X				S

† Service more frequently if operated in dusty areas

Service Schedule (continued)

System—Component	Procedure					Frequency
● Follow procedures and frequencies indicated in the engine manufacturer's maintenance manual. If not indicated, follow this service schedule. Some items may not pertain to specific generator sets. X Action R Replace as necessary	Visually Inspect	Check	Change	Clean	Test	W=Weekly M=Monthly Q=Quarterly S=Six Months Y=Yearly No.=Hours
AC ELECTRICAL SYSTEM						
Controller lamp test	X				R	W
General Inspection	X					W
Circuit breakers, fuses‡	X	X		X	X	M
Wire abrasions where subject to motion	X	X				Q
Safety and alarm operation***		X			X	S
Tighten control and power wiring connections***		X				Y
Wire-cable insulation breakdown	X				X	3 Y or 500
ENGINE AND MOUNTING						
General inspection	●					W
Air cleaner service		●	●			S
Carburetor adjustment		●				S
Ignition components	●			●		Y
Valve clearance		●				3 Y or 500
Bolt torque		●			●	3 Y or 500
REMOTE CONTROL SYSTEM, ETC.						
Compartment condition	X			X		W
Remote control					X	M
Run generator set					X	M
GENERATOR						
General inspection	X					W
Rotor and stator	X			X		Y
Bearing condition	X	X	R			Y
Voltage regulator	X	X		X		Y
Measure and record resistance readings of windings with insulation tester (Megger, with SCR assembly or rectifier disconnected)					X	3-5 Y
Blow dust out of generator†	X			●		2 Y or 300
GENERAL CONDITION OF EQUIPMENT Any condition of vibration, leakage, noise, temperature, or deterioration	X	X		X		W
Ensure that system is set for automatic operation	X					W
Interior of equipment room or outdoor weather housing	X			X		W

† Service more frequently if operated in dusty areas

‡ Do not break manufacturer's seals or internally inspect these devices

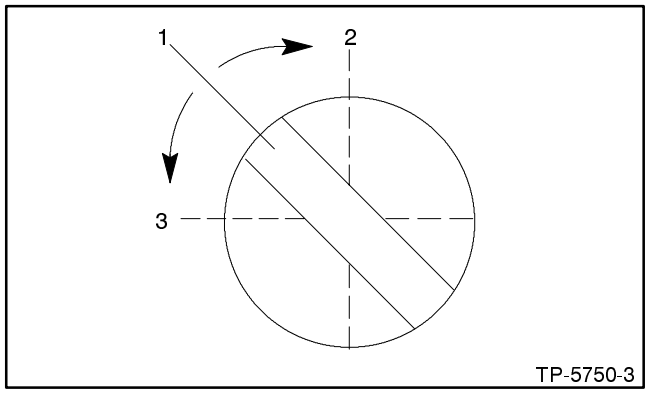
*** See Generator Set Service Manual for procedure

3.2 Carburetor Adjustments (LP/Natural Gas)

Some generator sets may be equipped with an emission certified engine. Emission certified engines may be fitted with carburetors that have no adjustments.

Contact an authorized service distributor/dealer about carburetor adjustments for altitude performance on emission certified engines.

To adjust the carburetor on non-emission certified generator sets, run the generator set at a minimum of half-load. Rotate engine fuel mixture screw clockwise or counterclockwise until the engine runs smoothly. See Figure 3-1. Apply varying loads and adjust carburetor again, if necessary, to achieve smooth engine performance at all loads.



1. Fuel adjusting screw
2. Lean
3. Rich

Figure 3-1. Fuel Mixture Adjustment (typical)

3.3 LP Liquid Withdrawal Fuel System

With the LP liquid withdrawal system, LP fuel in liquid form is directed under pressure from the tank to a vaporizer. The vaporizer converts the fuel from a liquid to a gaseous state and then the LP vapor is drawn off to the carburetor. The system also includes a fuel valve which shuts off the fuel flow when the engine is stopped. Contact an authorized service distributor/dealer for LP liquid withdrawal availability.

NOTE

NFPA fire codes prohibit LP liquid in many structures or buildings. Consult NFPA, local, and state codes before piping LP liquid into any structure or building. The generator set vaporizer may have to be relocated outside of the structure or building.

3.4 Electronic Governor

The governor control system consists of an electronic isochronous governor, an electro-mechanical actuator, and a magnetic pickup. The magnetic pickup supplies electrical pulses to the isochronous governor (control unit) each time one of the ring gear teeth passes the pickup. The control unit then compares the frequency of these pulses to a preset reference and provides a signal to the actuator which, in turn, controls the carburetor throttle and hence the engine speed.

3.5 Exhaust System

Remove combustible materials from exhaust location. Combustible materials include building materials as well as natural surroundings. Keep dry field grass, foliage, and combustible landscaping material whether or not seasonal a safe distance from the exhaust system.

Inspect exhaust system components for cracks and corrosion (exhaust manifold, exhaust line, flexible exhaust, clamps, silencer and outlet pipe).

- Check for corroded or broken metal parts and replace as needed.
- Check for loose, corroded, or missing clamps and hangers. Tighten or replace clamps and/or hangers as needed.
- Check that exhaust outlet is clear.

3.6 Battery

Use a 12-volt battery with a rating as listed on the generator set specification sheet. The generator set uses a negative ground electrical system. See the Wiring Diagrams for battery connections.

3.6.1 Battery Charging Systems

The generator set is equipped with a belt-driven battery charging alternator to keep the engine starting battery fully charged. The alternator requires no maintenance other than maintaining belt tension. See the Engine Operation manual for alternator belt tension adjustment.

A generator set not used on a regular basis requires an external battery charger to keep the starting battery fully charged.

NOTE

Reverse battery connections prevent the generator set from starting and can possibly damage the circuit board.

⚠ WARNING

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

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

⚠ WARNING

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

Locate battery in a well-ventilated area. Isolate battery charger from explosive fumes.

Battery acid. 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 near the battery. If battery acid is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery gases. 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 charging. Avoid touching terminals with tools, etc., to prevent burns and 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. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is charging. Always turn battery charger off before disconnecting battery connections. Remove negative (–) lead first when disconnecting battery. Reconnect negative (–) lead last when reconnecting battery.

3.6.2 Cleaning

Keep all electrical connections dry and tight. Disconnect cable from battery and brush away corrosion with a wire brush. Clean battery and cables with a solution of baking soda and water. Do not allow cleaning solution to enter battery cells. Flush battery and cables with clean water and wipe with a dry cloth. Coat battery connections with petroleum jelly or other nonconductive grease after reconnecting the battery cables.

3.6.3 Checking Electrolyte Level

It is not possible to check the electrolyte level of a maintenance-free battery. Check the electrolyte level of batteries with filler caps monthly. Remove filler caps and verify that electrolyte level reaches bottom of filler holes. Refill as necessary with distilled or clean tap water. DO NOT add fresh electrolyte! Tighten all filler caps.

3.6.4 Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell. While holding the hydrometer vertically, read the number on the glass bulb at the top of the electrolyte level or the number adjacent to the pointer. If the hydrometer used does not have a correction table, use the table in Figure 3-3. Determine specific gravity and electrolyte temperature of battery cells. Locate temperature in Figure 3-3 and adjust specific gravity by amount shown. The battery is fully charged if the specific gravity is 1.260 at an electrolyte temperature of 80°F (26.7°C). The difference between specific gravities of each cell should not exceed ±0.01. Charge the battery if the specific gravity is below 1.215 at an electrolyte temperature of 80°F (26.7°C).

Some battery testers have four or five beads in the test tube. Draw electrolyte into the tube as performed with the battery hydrometer described previously. Use the manufacturer's instructions. Figure 3-2 interprets typical test results.

Number of Floating Beads	Battery Condition
5	Overcharged
4	Fully charged
3	Good charge
1 or 2	Low charge
0	Dead battery

Figure 3-2. Bead-Type Test Interpretation

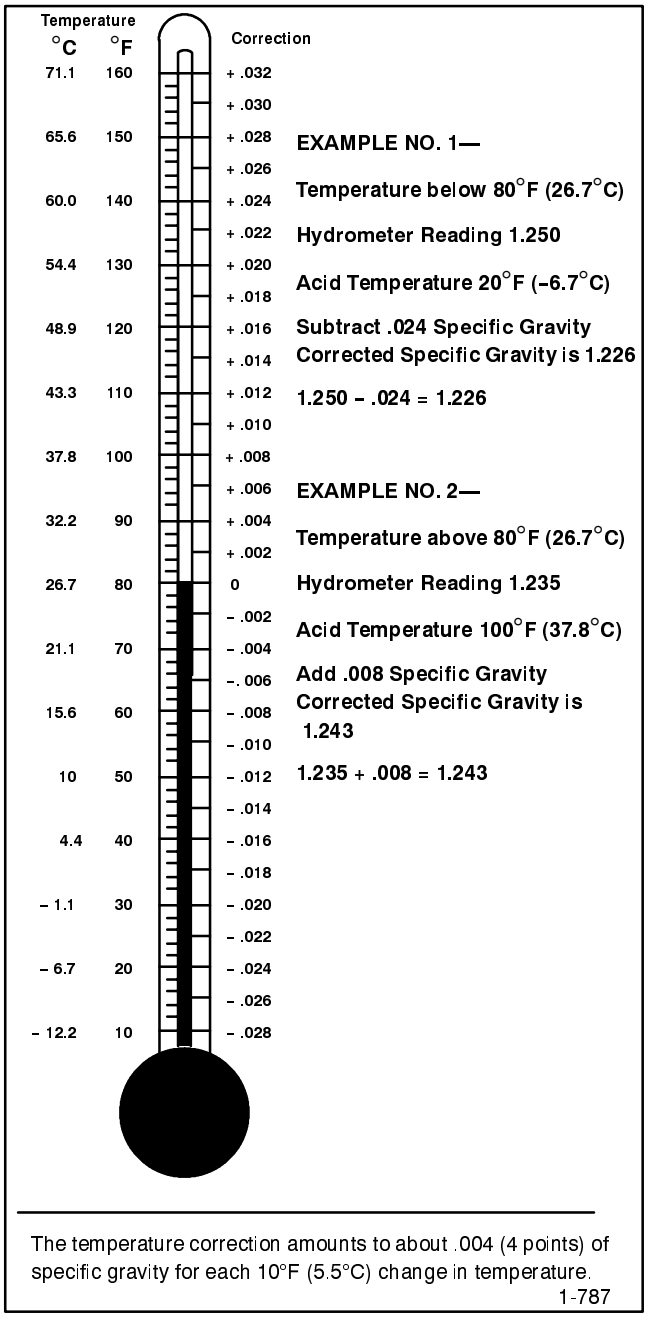


Figure 3-3. Specific Gravity Temperature Correction

3.7 Generator Service

Have an authorized service distributor/dealer perform all generator set service. Under normal conditions, regular generator service is not required. For operation under dusty and dirty conditions, use dry compressed air to blow dust out of the generator. Do this with the generator set operating and direct the stream of air in through the cooling slots at the end of the generator.

3.8 Storage Procedure

Perform the following steps for a generator set out of service for three months or longer.

3.8.1 Engine oil

1. Operate generator set for 5 minutes.
2. Stop the generator set.
3. While the engine is still warm, drain the engine lubrication oil from the crankcase.
4. Refill the engine crankcase with an oil having a viscosity appropriate for the particular climate.
5. Run the generator set for a few minutes to distribute the clean oil.
6. Stop the generator set.

3.8.2 Fuel (gaseous-fueled engines)

1. With the generator set running, shut off the gas supply.
2. Run generator set until the engine stops from lack of fuel.

3.8.3 Coolant

1. Check engine coolant protection.
2. Add coolant, if required.

3.8.4 Lubricate Cylinders

1. Remove the spark plugs.
2. Pour approximately one tablespoon of engine oil into each spark plug hole.
3. Crank the engine two or three revolutions to lubricate the cylinders.
4. Reinstall spark plugs.

3.8.5 Exterior Preparation

1. Clean exterior surface of generator set.
2. Seal all openings in the engine with non-absorbent adhesive tape.
3. Mask off all areas to be used for electrical contact.
4. Spread a light film of oil over unpainted metallic surfaces to prevent rust and corrosion.

Notes

General Troubleshooting Chart (Sheet 1 of 2)

When troubles occur, do not overlook simple causes which might seem too obvious to be considered. A starting problem, for example, could be attributed to an empty fuel tank. As a general aid to diagnosing common problems, refer to the Troubleshooting Table below. If the trouble cannot be corrected through routine servicing, contact an authorized service distributor/dealer for assistance.

Problem	Possible Cause	Corrective Action
Generator set does not crank	Weak or dead battery	Recharge or replace; check battery charger operation. Check battery charging circuit (circuit breaker, module, and wiring), if equipped.
	Reversed or poor battery connections	Check connections
	Fuse blown in controller	Replace fuse
	Defective starter/starter solenoid	Test function
	Defective start/stop switch (master switch)	Test function
	Generator master switch in OFF position (attempting start-up from remote switch)*	Move master switch to AUTO position
Generator set cranks but does not start, starts hard, lacks power, or operates erratically	Incorrect fuel	Replace fuel
	No fuel	Add fuel; check fuel control circuit
	Clogged fuel filter (gasoline models only)	Replace fuel filter
	Air cleaner clogged	Clean and/or replace
	Weak or dead battery	Recharge or replace
	Defective fuel pump (gasoline models only)	Check fuel pump for function
	Defective fuel valve or (gas models only)	Check fuel valve for function
	Defective antidiesel solenoid (gasoline models only)	Check antidiesel solenoid for function
	Defective carburetor choke (gasoline models only)	Check function of carburetor choke
	Defective fuel regulator (gas models only)	Check function of fuel regulator
	Faulty ground (–) connection	Clean and tighten ground connections
	Faulty spark plugs	Replace (and regap) spark plugs
	Defective ignition system	Check ignition coil, module, and wiring
	Loose spark plug wire connection	Check spark plugs wires
	Insufficient fuel pressure (gas models only)	Check fuel pressure
	Engine malfunction	Troubleshoot engine
	Defective cold weather starting aid	Check cold weather starting device
	Low oil pressure shutdown switch	Check oil level, oil pressure, and check switch for function
	Carburetor adjustment incorrect	Adjust carburetor
	Carbon buildup on cylinder head	Service cylinder head
	Incorrect engine timing (signal)	Check air gap of ignition pickup

*** Decision-Maker™ 3 controller only**

General Troubleshooting Chart (Sheet 2 of 2)

Problem	Possible Cause	Corrective Action
No AC output	AC circuit breaker in OFF position	Place circuit breaker in ON position
	AC circuit breaker tripping because of overload	Reduce load on generator set
	AC circuit breaker tripping because of short circuit	Correct cause of short circuit
	Voltage regulator fuse blown	Replace fuse
	Internal generator problem	Contact distributor
Low output or excessive drop in voltage	Generator set overloaded	Reduce load
	Engine speed too low	Check governor
	Faulty/misadjusted voltage regulator	Check voltage regulator adjustment and/or test voltage regulator
	Internal generator problem	Contact distributor
High output voltage (or high frequency)	Loose voltage regulator connections	Check connections
	Governor misadjusted (high frequency)	Check governor
	Faulty voltage regulator	Check voltage regulator adjustment and/or test voltage regulator
	Internal generator problem	Contact distributor
Generator set stops suddenly	Low oil pressure shutdown	Check oil level, oil pressure, and switch for function
	Out of fuel	Add fuel
	Overcrank shutdown*	Reset controller. If overcrank fault reoccurs, troubleshoot generator and/or controller
	Fuse blown in controller	Replace fuse. If fuse blows again, troubleshoot controller
	Engine malfunction	Troubleshoot engine
	Overspeed shutdown*	Reset controller. If generator set overspeeds again, troubleshoot generator and controller
	Overvoltage shutdown, if equipped*	Troubleshoot generator and controller
	Generator master switch in OFF/RESET position *	Move switch to correct position (RUN or AUTO)
	Emergency stop switch activated (local or remote)*	Check reason for emergency shutdown; reset switch
*** Decision-Maker™ 3 controller only**		

Voltage Reconnection Procedure

The reconnection procedure explains voltage reconnections only. If frequency changes are required, the governor and voltage regulator need adjustment. See the generator set service manual for information regarding frequency adjustment.

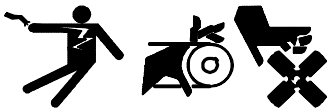
To illustrate the reconnection of 4-lead or 12-lead generator sets, the following information is provided. In all cases, follow the National Electrical Code (NEC) guidelines.

Reconnect the stator leads of the generator set if a different output phase or voltage is desired. Refer to the following procedure and the connection schematics. Follow all safety precautions at the front of this manual and in the text while performing this procedure.

NOTE

Order voltage reconnection decal 246242 from an authorized service distributor/dealer and affix decal to generator set after reconnecting to a voltage different than the nameplate.

⚠ WARNING

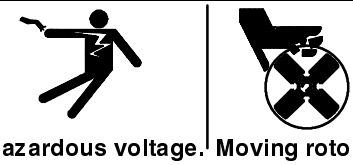


Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set. (Remove negative (–) lead first when disconnecting battery. Reconnect negative (–) lead last when reconnecting battery.)

Disabling generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: 1) Turn the generator set master switch to OFF position. 2) Disconnect power to battery charger. 3) Remove battery cables (remove negative (--) lead first). Reconnect negative (–) lead last when reconnecting battery. Follow these precautions to prevent starting of generator set by an automatic transfer switch or remote start/stop switch.

⚠ WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

Short circuits. Hazardous voltage/current 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 making adjustments or repairs. Remove wristwatch, rings, and jewelry before servicing equipment.

5.1 Four-Lead (Single-Phase) Generator Sets

NOTE

Current transformers (CTs) are used only on generator sets equipped with controllers with meters.

Position current transformers CT1, CT2, and CT3 with dot or HI side toward generator set.

See Figure 5-1 for four-lead reconnectable (single-phase) generator set options.

	60 Hz	50 Hz
100-120 volt	X	
100-120/200-240 volt	X	X
200-240 volt		X

Figure 5-1. Four-Lead, Single-Phase Generator Set Voltage Connection Options

NOTE

Decision-Maker™ 3 and Decision-Maker™ 1 Expanded controllers only: Make fine adjustment ±5% using voltage adjustment potentiometer on the controller front panel.

100-120 Volt Configurations

The load side terminals of the circuit breaker are not to be connected together when using a factory two-pole circuit breaker, see Figure 5-2. If the installation requires a 100-120 volt, 2-wire system, use a single-pole circuit breaker. See Figure 5-3. When connecting stator phase leads together, size output lead (L1) accordingly. Use a jumper lead on the line side of the circuit breaker to balance the load of the generator set. After connection adjust the voltage regulator to obtain desired voltage.

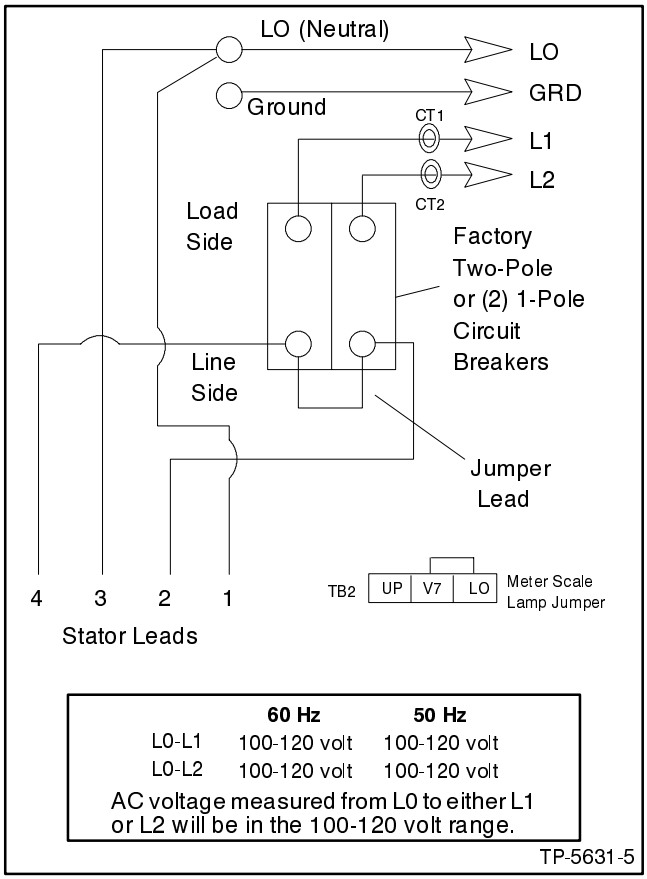


Figure 5-2. 100-120 volt, 3-wire

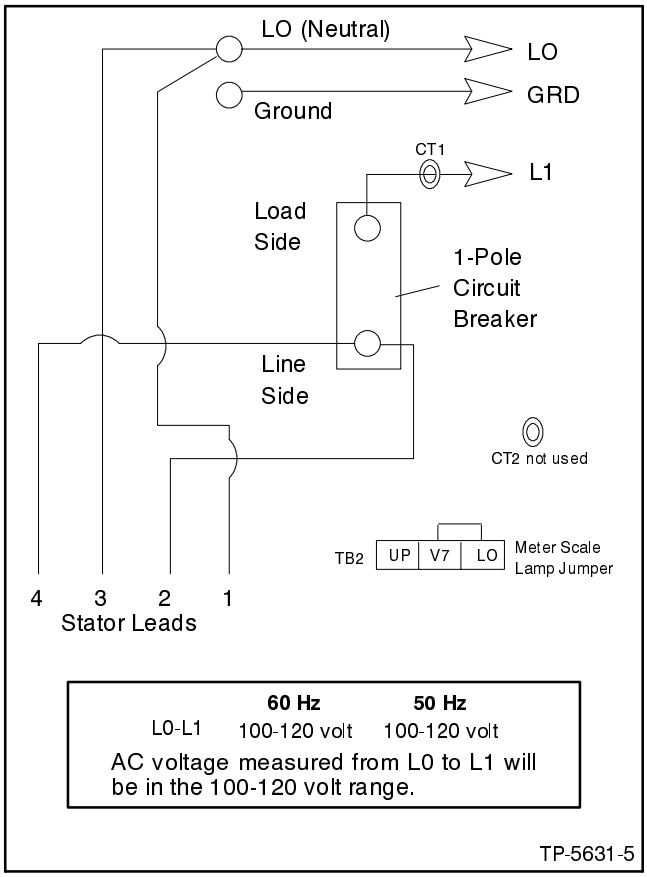


Figure 5-3. 100-120 volt, 2-wire

100-120/200-240 Volt

Jumper lead not used. If the generator set was originally wired for straight 100-120 volt 3-wire, be sure to remove jumper lead. See Figure 5-4 for location of jumper lead. Leads L1 and L2 are of different phases. Never connect Leads L1 and L2 together. After connection adjust the voltage regulator to obtain desired voltage.

NOTE

Use a circuit breaker manufacturer's two-pole circuit breaker. Two single-pole circuit breakers do not conform to NEC requirements when supplying a 200-240 volt load. This is true even if they are mechanically attached together.

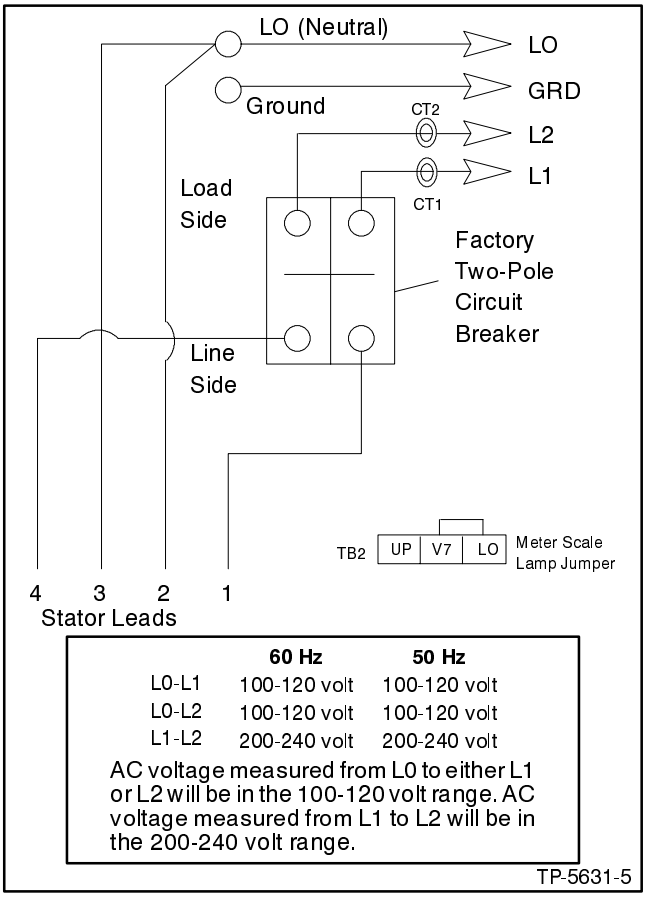


Figure 5-4. 100-120/200-240 volt, 3-wire configurations

200-240 Volt

Jumper lead not used. If the generator set was originally wired for straight 100-120 volt, 3 wire, be sure to remove jumper lead. See Figure 5-5 for location of jumper lead. After connection adjust the voltage regulator to obtain desired voltage.

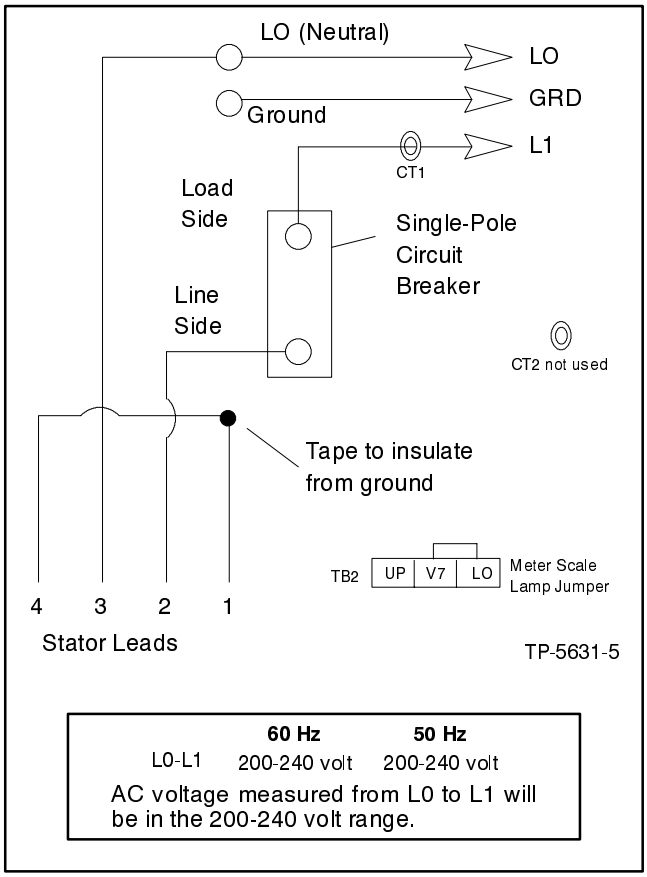


Figure 5-5. 200-240 volt, 2-wire configurations

5.2 12-Lead (Three-Phase) Generator Sets

NOTE

Current transformers (CTs) are used only on generator sets equipped with controllers with meters.

Position current transformers CT1, CT2, and CT3 with dot or HI side toward generator set.

Three-phase, 12-lead generator sets are reconnectable to the voltages and phases shown in Figure 5-6. If the generator set is reconnected to obtain a different output voltage, voltage regulator voltage adjustments may be necessary to obtain desired voltage.

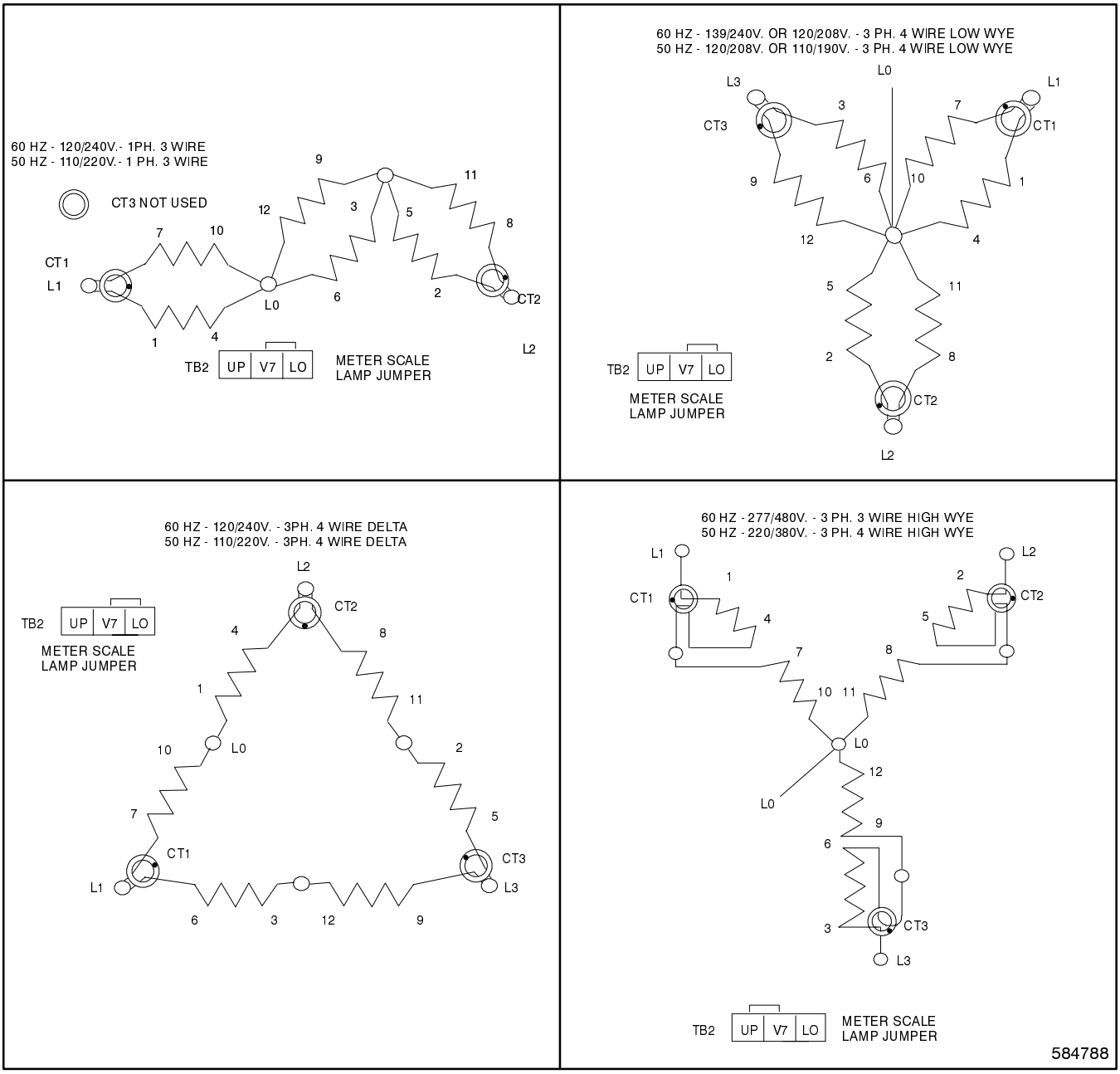


Figure 5-6. Generator Reconnection

5.3 Reconnection Procedure (Decision-Maker™ 3 Controller only)

1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
3. Select desired voltage connection from Figure 5-6. Route leads through current transformers and connect according to the diagram for desired phase and voltage.

NOTE

Position current transformers CT1 and CT2 (single-phase) or CT1, CT2, and CT3 (three-phase) with dot or HI mark toward generator set. Current transformers are only used on generator sets equipped with metered controllers.

NOTE

Equipment Damage! Verify that transfer switch, line circuit breakers, and any other accessories using line voltage are sized for the voltage selected.

NOTE

See generator service manual for information on changing generator frequency.

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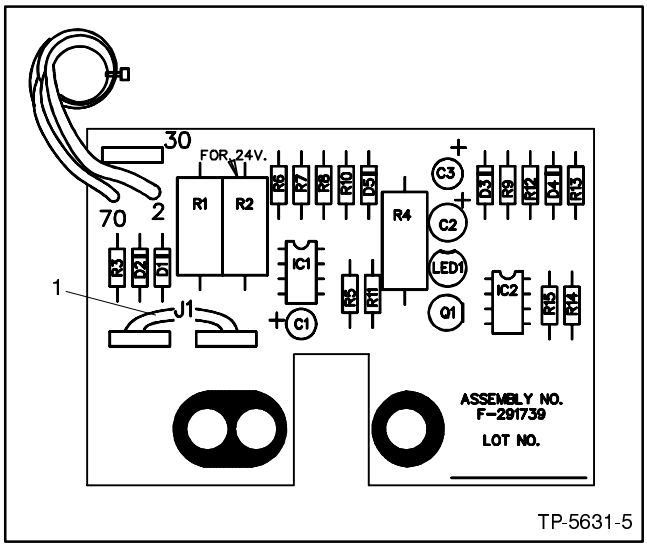
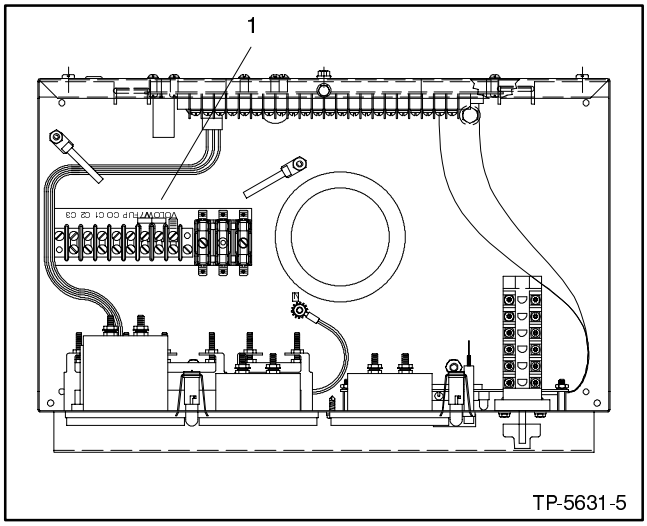
4. If controller is equipped with meters, remove controller cover and reposition meter scale lamp jumper, if necessary, to match meter scale lamps with desired voltage. See Figure 5-8.
5. The jumper J1 must be in place on the overvoltage circuit board if the generator set is connected for 139/240 or 277/480 volts (3-phase, 4-wire, 60 Hz) if the generator set is equipped with the overvoltage kit.

   For all other voltages, remove J1 jumper from the overvoltage circuit board. See Figure 5-7 for J1 jumper location on the overvoltage circuit board.
6. If the controller is equipped with meters, turn the phase selector switch to the L1-L2 position (1-phase or 3-phase depending on generator connection). If the controller is not equipped with meters, connect a voltmeter across leads L1 and L2.
7. Reconnect generator set engine starting battery, negative (–) lead last.
8. Place the generator master switch in the RUN position to start the generator set.
9. Check voltmeter for correct voltage. Adjust voltage if necessary with the voltage adjustment potentiometer on the controller front panel. See Figure 5-9.
10. Stop generator set after adjustment procedure.



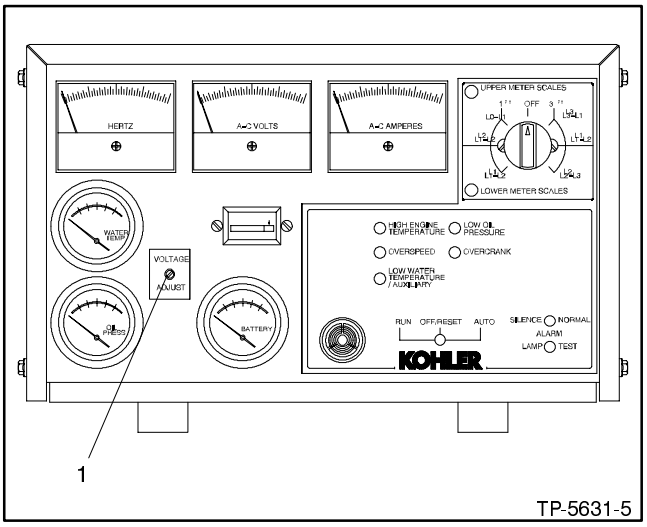
1. J1 jumper

Figure 5-7. Overvoltage Circuit Board



1. Lamp jumper

Figure 5-8. Meter Scale Lamp Jumper



1. Voltage adjustment potentiometer

Figure 5-9. Voltage Adjustment (typical)

5.4 Reconnection Procedure (Decision-Maker™ 1 Expanded Controller only)

1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
3. Select desired voltage connection from Figure 5-6. Route leads through current transformers and connect according to the diagram for desired phase and voltage.

NOTE

Position current transformers CT1 and CT2 (single-phase) or CT1, CT2, and CT3 (three-phase) with dot or HI mark toward generator set. Generator sets equipped with metered controllers use current transformers.

NOTE

Equipment Damage! Verify that transfer switch, line circuit breakers, and any other accessories using line voltage are sized for the voltage selected.

NOTE

See generator service manual for information on changing generator frequency.

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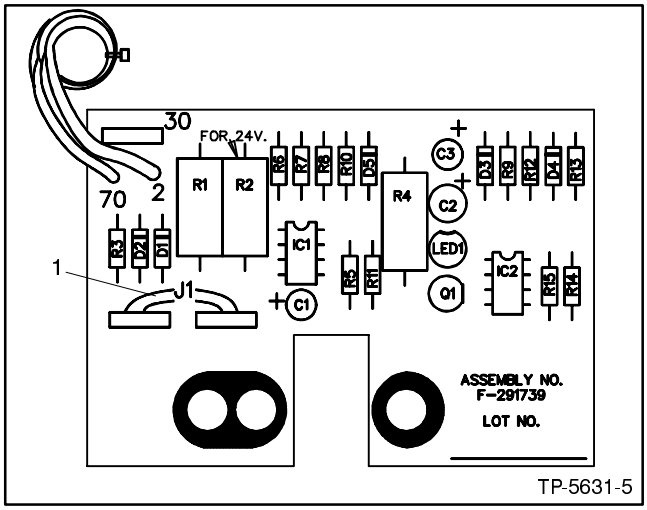
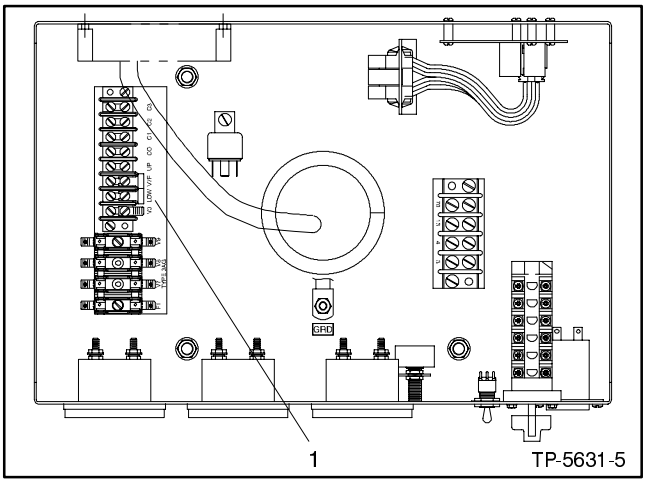
4. Remove controller cover and reposition meter scale lamp jumper, if necessary, to match meter scale lamps with desired voltage. See Figure 5-8.
5. The jumper J1 must be in place on the overvoltage circuit board if the generator set is connected for 139/240 or 277/480 volts (3-phase, 4-wire, 60 Hz) if the generator set is equipped with the overvoltage kit.

   For all other voltages, remove J1 jumper from the overvoltage circuit board. See Figure 5-7 for J1 jumper location on the overvoltage circuit board.
6. Turn the phase selector switch to the L1-L2 position (1-phase or 3-phase depending on generator connection) or connect a voltmeter across leads L1 and L2.
7. Reconnect generator set engine starting battery, negative (–) lead last.
8. Place the generator master switch in the RUN position to start the generator set.
9. Check voltmeter for correct voltage. Adjust voltage if necessary with the voltage adjustment potentiometer on the controller front panel. See Figure 5-9.
10. Stop generator set after adjustment procedure.



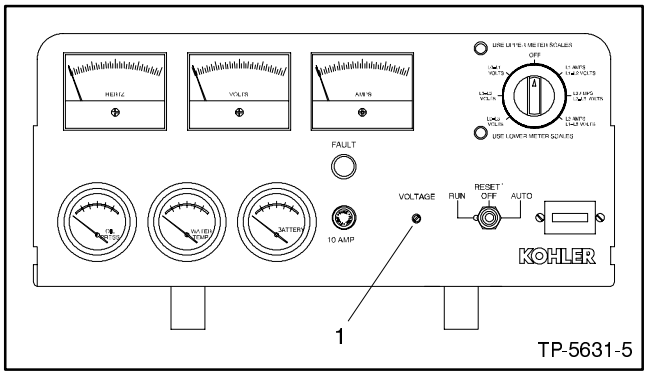
1. J1 jumper

Figure 5-10. Overvoltage Circuit Board



1. Lamp jumper

Figure 5-11. Meter Scale Lamp Jumper



1. Voltage adjustment potentiometer

Figure 5-12. Voltage Adjustment (typical)

Notes

Appendix A. 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
AISI	American Iron and Steel Institute
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
aux.	auxiliary
AWG	American Wire Gauge
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective pressure
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
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch, cubic inches
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.	et cetera (and so forth)
ext.	external
°F	Fahrenheit degree
fl. oz.	fluid ounce, fluid ounces
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
ga.	gauge (meters, wire size)
gal./ gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust (or engine) temperature
Hg	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour
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
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
megger	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
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available or not applicable
NBS	National 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 minute
RTV	room temperature vulcanization
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

Notes

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