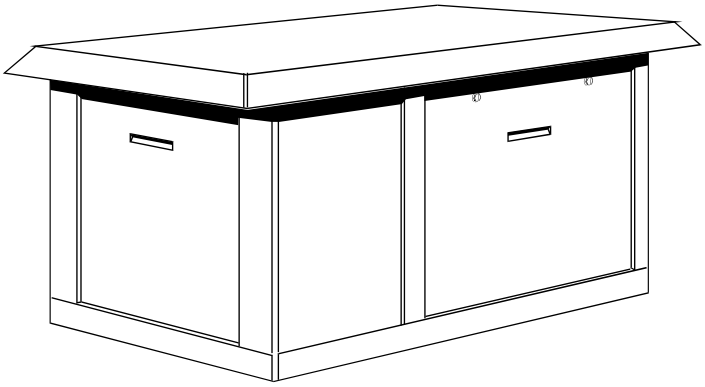
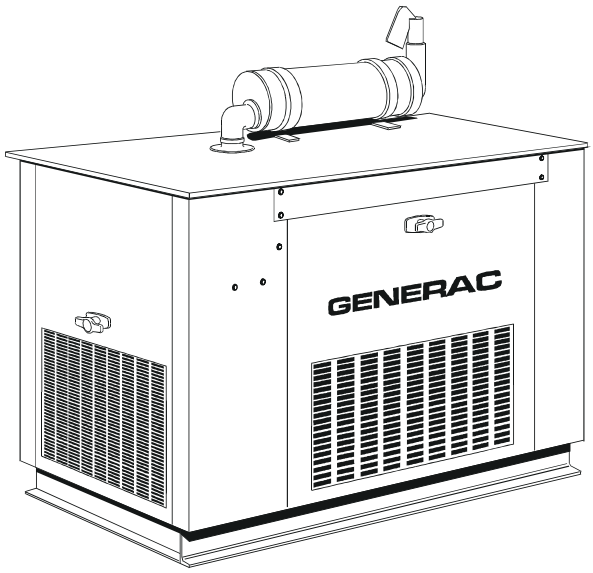
Part No. 79699

GUARDIAN™

by GENERAC® POWER SYSTEMS

INSTALLATION, START-UP AND ADJUSTMENT MANUAL





GENERAC®

POWER SYSTEMS, INC.

Revision 8 (5/13/99)

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INTRODUCTION

NOTE: Read the entire instructions before starting the installation.

Only qualified electricians or contractors should attempt such installations, which must comply strictly with applicable codes, standards and regulations.

Generac cannot possibly know of and advise the home standby trade of all conceivable procedures and methods by which installation of this equipment might be achieved. Neither can Generac know of possible hazards and/or results of each method or procedure. We have not undertaken any such wide evaluation.

INSTALLATION ASSISTANCE

1. For the Homeowner or Business Owner: You need to have a certified electrician or contractor to install this product. To arrange for proper installation, contact one of the following sources:
   - Generac Authorized Distributor or Dealer: Look for Generac in your local Yellow Pages under the classification "Generators – Electric."
   - Heating and A/C Contractors: Look in your local Yellow Pages under the classifications "Heating Contractors" or "Air Conditioning Contractors."
   - Call us direct at (414) 544-4811 between the hours of 8 a.m. and 5 p.m. CST. We will gladly assist you in finding a local qualified installer.
2. For the Installing Dealer/Contractor: This manual contains all the information required to properly install and start a Guardian Power Systems generator in most applications. If you do need more information, contact us directly at (414) 544-4811, between the hours of 8 a.m. and 5 p.m., CST.

STANDARDS INDEX

In the absence of pertinent standards, codes, regulations and laws, the published information listed below may be used as installation guide for this equipment.

1. NFPA No. 37, STATIONARY COMBUSTION ENGINES AND GAS TURBINES, available from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.
2. NFPA No. 76A, ESSENTIAL ELECTRICAL SYSTEMS FOR HEALTH CARE FACILITIES, available same as Item 1.
3. NFPA No. 54, NATIONAL FUEL GAS CODE, available same as Item 1.
4. NFPA No. 58, AMERICAN NATIONAL STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GAS, available same as Item 1.
5. NFPA No. 70, NFPA HANDBOOK OF NATIONAL ELECTRIC CODE, available same as Item 1.
6. Article X, NATIONAL BUILDING CODE, available from the American Insurance Association, 85 John Street, New York, N.Y. 10038.
7. AGRICULTURAL WIRING HANDBOOK, available from the Food and Energy Council, 909 University Avenue, Columbia, MO 65201.
8. ASAE EP-3634, INSTALLATION AND MAINTENANCE OF FARM STANDBY ELECTRICAL SYSTEMS, available from the American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.
9. NFPA No. 30, FLAMMABLE AND COMBUSTIBLE LIQUIDS CODE, available same as Item 1.

TABLE OF CONTENTS

UNPACKING

■ UNPACKING PRECAUTIONS

Handle shipping cartons and crates with care. Use care to avoid damage from dropping, bumping, collision, etc. Store and unpack cartons with the proper side up, as noted on the shipping carton.

■ INSPECTION

After unpacking, carefully inspect the generator and transfer switch for any damage that may have occurred during shipment. If loss or damage is noted at time of delivery, have the person(s) making delivery note all damage on the freight bill or affix his or her signature under the consignor's memo of loss or damage.

BEFORE INSTALLATION

Before installing this equipment, check the ratings of both the generator and the transfer switch. Read “Emergency Circuit Isolation Method” and “Total Circuit Isolation Method” in this section carefully.

The generator's rated wattage/amperage capacity must be adequate to handle all electrical loads that the unit will power. You may have to group the critical (essential) electrical loads together and wire them into a separate emergency distribution panel.

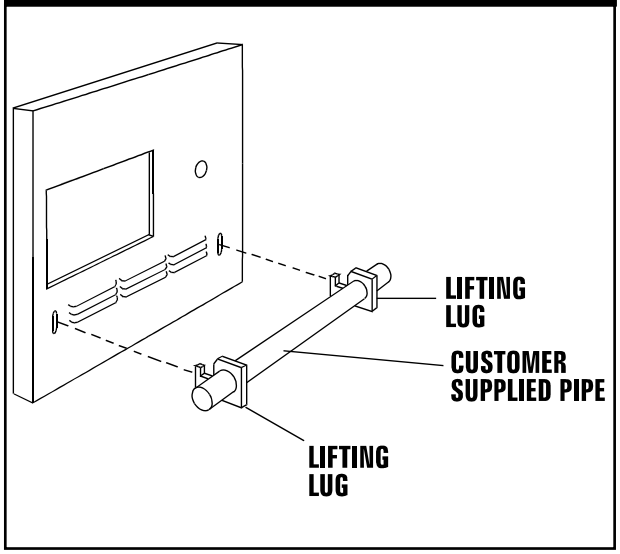
NOTE: In some areas, you may need to acquire electrical permits for installing an emergency system, building permits for installing gas lines, and permits for noise allowances. Check your local codes before installing the unit.

LIFTING THE GENERATOR

WARNING: IF LIFTING OR HOISTING EQUIPMENT IS USED, BE CAREFUL NOT TO TOUCH OVERHEAD POWER LINES. THE GENERATOR WEIGHS MORE THAN 300 POUNDS. PROPER TOOLS AND EQUIPMENT, AND QUALIFIED PERSONNEL SHOULD BE USED IN ALL PHASES OF HANDLING AND UNPACKING.

Lifting lugs (Figure 1) are available from a Generac distributor. To lift the unit, insert the lugs into the slots provided on the compartment side panels. You can use a pipe having sufficient strength and diameter with the lugs as shown.

Figure 1 — Lifting the Generator



ENGINE OIL RECOMMENDATIONS

Refer to the Owner's Manual of your particular generator for proper engine oil recommendations.

CAUTION: Any attempt to crank or start the engine before it has been properly serviced with the recommended oil will result in an engine failure. Both the engine crankcase and the oil makeup tank (if so equipped) must be properly filled with the recommended oil.

FUEL REQUIREMENTS

■ AIR-COOLED UNITS

Air-cooled models are factory tested and adjusted using natural gas as a fuel. You may, however, use liquid propane (LP) gas as a fuel, but it would require you to make minor adjustments at the gaseous fuel load block. See “Adjusting the Load Block.” With LP gas, use only the vapor withdrawal type system. This type of system uses the vapors formed above the liquid fuel in the storage tank.

■ LIQUID-COOLED UNITS

Liquid-cooled units are available with either natural gas or LP fuel systems by specific model numbers. Natural gas models are factory tested and adjusted on natural gas; LP models are tested and adjusted on LP. The regulators for both LP and natural gas are fixed and nonadjustable, therefore, converting from one fuel type to another does require a new regulator specific to that fuel.

Recommended fuels should have a Btu content of at least 1,000 Btus per cubic foot for natural gas, or at least 2,520 Btus per cubic foot for LP gas. Ask your fuel supplier for the Btu content of your fuel.

WARNING: GASEOUS FUELS SUCH AS NATURAL AND LIQUID PROPANE (LP) GAS ARE HIGHLY EXPLOSIVE. EVEN THE SLIGHTEST SPARK CAN IGNITE SUCH FUELS AND CAUSE AN EXPLOSION. NO LEAKAGE OF FUEL IS PERMITTED. NATURAL GAS, WHICH IS LIGHTER THAN AIR, TENDS TO SETTLE IN HIGH AREAS. LP GAS IS HEAVIER THAN AIR AND TENDS TO SETTLE IN LOW AREAS.

GENERATOR LOCATION

Install the generator set, in its protective enclosure, outdoors, where adequate cooling and ventilating air always is available. Consider these factors:

- Install the unit where air inlet and outlet openings will not become obstructed by leaves, grass, snow, etc. If prevailing winds will cause blowing or drifting, you may need to consider using a windbreak to protect the unit.
- Install the generator on high ground where water levels will not rise and endanger it.
- Allow sufficient room on all sides of the generator for maintenance and servicing. A good rule is to allow 3 feet of space on all sides.
- Where strong prevailing winds blow from one direction, face the generator air inlet openings into the prevailing winds.
- Install the generator as close as possible to the transfer switch. This reduces the length of wiring and conduit.
- Install the generator as close as possible to the fuel supply, to reduce the length of piping. HOWEVER, REMEMBER THAT LAWS OR CODES MAY REGULATE THE DISTANCE.

TRANSFER SWITCH MOUNTING

The transfer switch shipped with this generator is enclosed in a NEMA 1 enclosure. This type of enclosure is intended for indoor use only. Follow these rules:

- Install the transfer switch indoors on a firm, sturdy supporting structure.
- To prevent switch distortion, level the switch if necessary. This can be done by placing washers between the switch enclosure and mounting surface.
- Never install the switch where water or any corrosive substance might drip onto the enclosure.
- Protect the switch at all times against excessive moisture, dust, dirt, lint, construction grit and corrosive vapors.

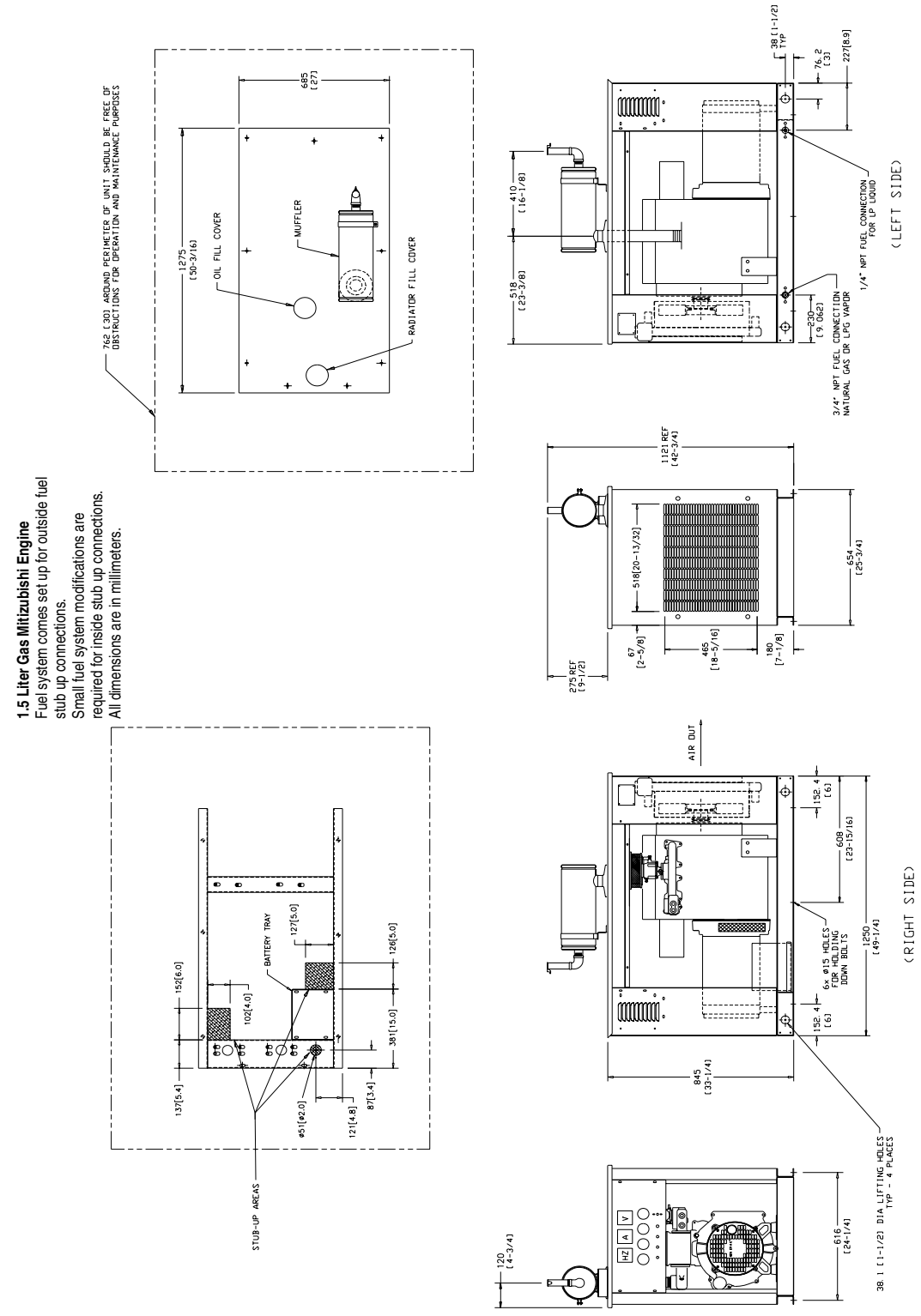
GENERATOR MOUNTING AND SUPPORT

Retain the generator compartment to a concrete slab with 1/4-inch masonry type anchor bolts. Be sure the bolts are long enough to retain the compartment. The slab should be at least 3 inches thick and should extend beyond the enclosure to a distance of at least 3 inches on all sides.

See Figure 2 (page 4) and Figure 3 (page 5) for generator and transfer switch major dimensions.

Figure 2 – Generator and Transfer Switch Mounting Dimensions

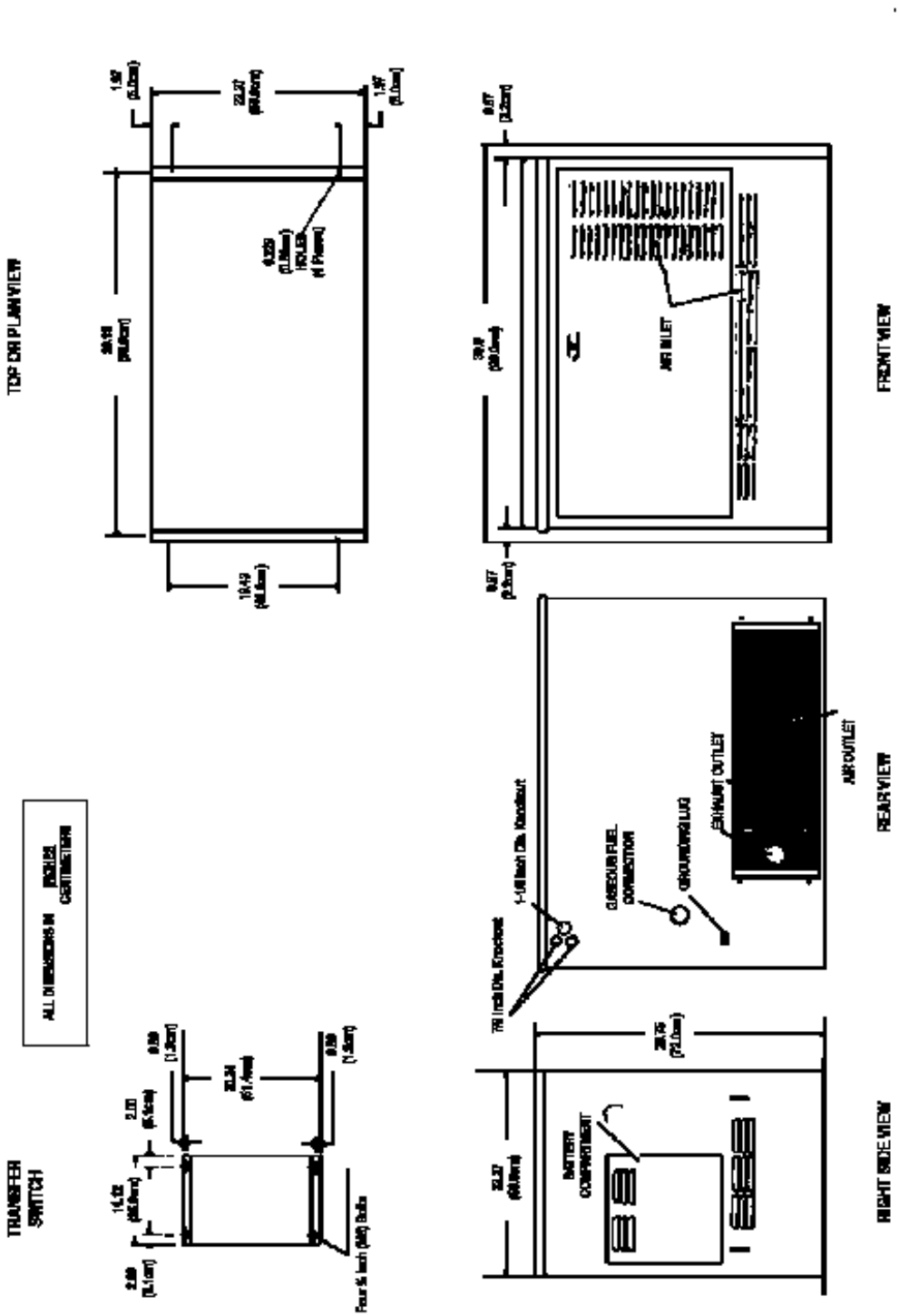
10 kW, 15 kW, 20 kW and 25 kW Liquid-cooled Power Systems



1.5 Liter Gas Mitizubishi Engine
Fuel system comes set up for outside fuel stub up connections.
Small fuel system modifications are required for inside stub up connections.
All dimensions are in millimeters.

Figure 3 – Generator and Transfer Switch Mounting Dimensions

5 kW, 8 kW Air-cooled Power System



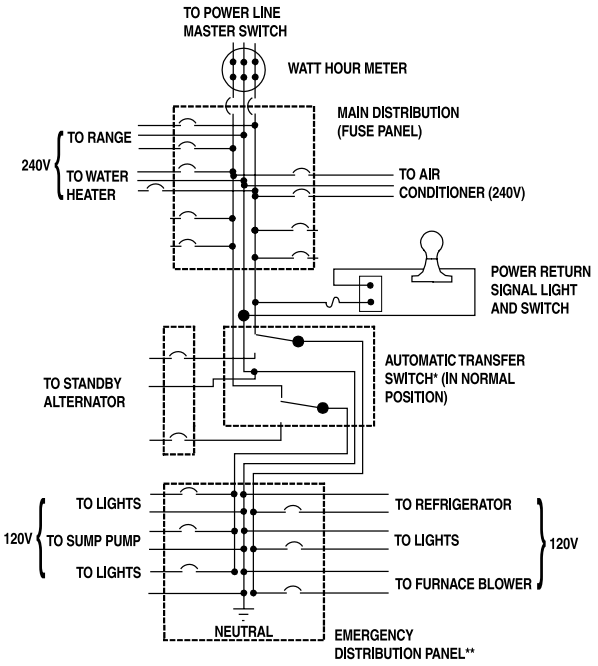
EMERGENCY CIRCUIT ISOLATION METHOD

One effective way of preventing the generator from being overloaded is to use the "Emergency Circuit Isolation Method" (Figure 4).

Essential electrical loads are grouped together and wired into a separate emergency distribution panel. Load circuits fed by the emergency distribution panel must be within the unit's rated wattage capacity. The following apply to this type of isolation system:

- The transfer switch is installed between the main and the emergency distribution panels as shown.
- The transfer switch must have an ampere rating equal to the ampere rating of the emergency circuit.

Figure 4 – Emergency Circuit Isolation Method



* Ampere rating must equal or exceed the ampere rating of the emergency distribution system.

** Ampere capacity not to exceed the alternator rating. Only these items will be powered by standby alternator. If the electrician sizes the load properly, the alternator cannot be overloaded.

All wiring must conform to the National Electrical Code and all state and local codes. Consult a qualified, licensed electrician.

The above illustration assumes the utility is supplying 120/240-volt, single-phase electrical service.

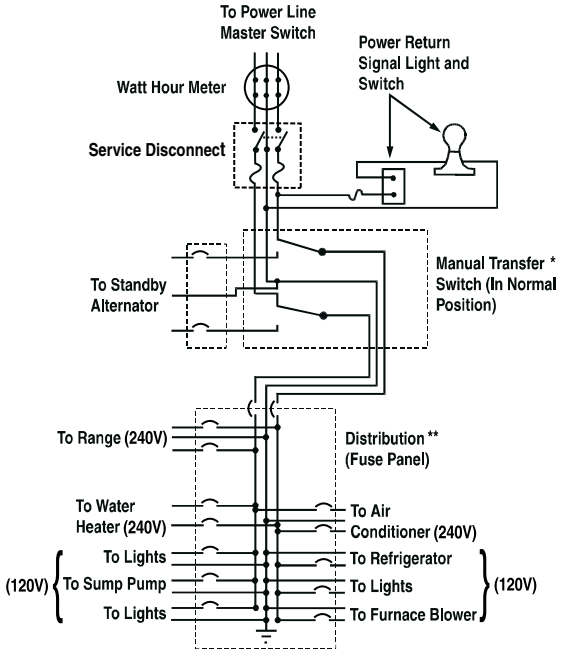
TOTAL CIRCUIT ISOLATION METHOD

If essential electrical loads cannot be grouped together and wired into an emergency distribution panel, you will have to select load circuits that the generator will power during a utility power outage.

Be careful to avoid overloading the generator. The following apply to the "Total Circuit Isolation Method" (Figure 5):

- The transfer switch is installed between the utility service entrance and the distribution panel.
- The transfer switch ampere rating must be equal to the main electrical service entrance rating.

Figure 5 – Total Circuit Isolation Method



* Ampere rating equal to or larger than main (normal) power source.

** Use caution with this system to prevent overload of the alternator during utility power failure. All load items in the distribution panel must be individually turned off. Only certain items can be turned back on during alternator operation. These items should be specified by your electrician so as not to overload the alternator.

All wiring must conform to the National Electrical Code, and all state and local codes. Consult a qualified, licensed electrician.

The above illustration assumes the utility is supplying 120/240-volt, single-phase electrical service.

GASEOUS FUEL SYSTEM

IMPORTANT: THE FOLLOWING INFORMATION PERTAINING TO GASEOUS FUEL SYSTEMS IS PROVIDED TO ASSIST GASEOUS FUEL TECHNICIANS IN PLANNING INSTALLATIONS. IN NO WAY SHOULD THIS INFORMATION BE INTERPRETED TO CONFLICT WITH APPLICABLE FUEL GAS CODES. CONSULT WITH YOUR LOCAL FUEL SUPPLIER OR FIRE MARSHALL IF QUESTIONS OR PROBLEMS ARISE.

Consider the following factors when planning to install the fuel supply system:

- Install a flexible length of line between the generator fuel connection and rigid piping. The flexible hose must be approved for use with gaseous fuels.
- Gas pressure at the generator's gaseous fuel connection should be a minimum of 11 inches of water and should not exceed 14 inches of water (1/2 psi).
- If you use liquid petroleum (LP) gas as fuel, use only a vapor withdrawal type system.

■ FUEL CONSUMPTION

See Figure 6 for fuel supply requirements. Ratings are at 100 percent load.

Figure 6 – Fuel Consumption Table

	NG FT^3/HR	LP FT^3/HR
5 kW	115	45
8 kW	165	65
10 kW	200	78
15 kW	277	110
20 kW	360	143
25 kW	441	175

■ FUEL PIPE SIZING

See Figure 7 for proper sizing of fuel supply piping. Insufficient fuel pipe size can cause hard starting, poor engine performance and inability to carry load.

Figure 7 – Fuel Systems NG and LP Vapor Pipe Sizing

Length of Pipe	Iron Pipe Size (IPS Inches)					
	½"	¾"	1"	1 ¼"	1 ½"	2"
15'	76	172	345	750	1220	2480
30'	52	120	241	535	850	1780
45'	43	99	199	435	700	1475
60'	38	86	173	380	610	1290
75'		77	155	345	545	1120
90'		70	141	310	490	1000
105		65	131	285	450	920
120			120	270	420	860
150			109	242	380	780
180			100	225	350	720
210			92	205	320	660
240				190	300	620
270				178	285	580
300				170	270	545
450				140	226	450
600				119	192	390

GENERATOR AC CONNECTION SYSTEM

The generator AC power winding is a dual winding type (Figure 8), which provides a three-wire AC connection system. Each single-stator AC power winding can supply 120 volts AC. Connecting the two windings in series results in a 240-volt AC output. Stator AC output leads 11 and 44 are the two “hot” leads; the junction of leads 22 and 33 form the neutral lead.

Figure 8 – Generator AC Connection System.

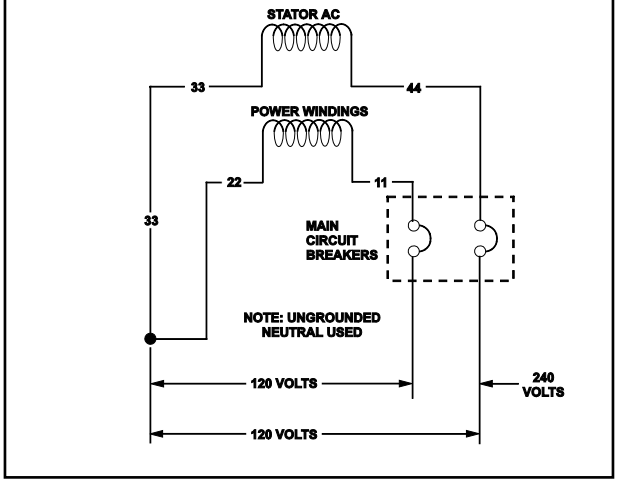
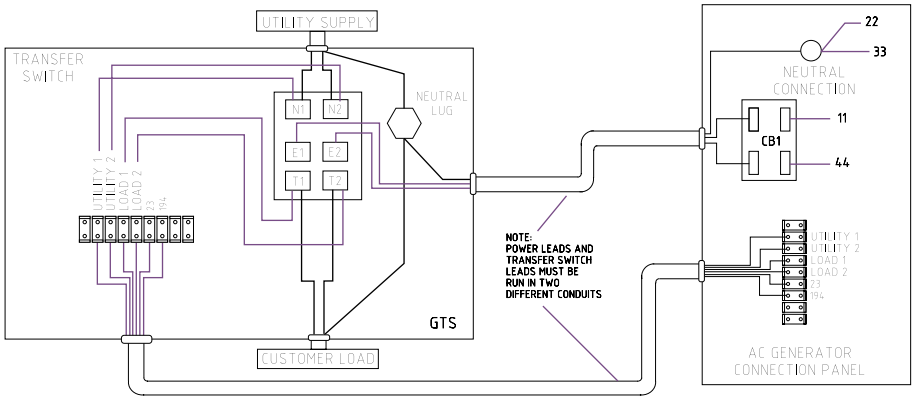


Figure 9 – Interconnection Diagram for Single-phase Power System (100A, V-type)



WIRING INTERCONNECTIONS

CAUTION: This generator uses an UNGROUNDED neutral line consisting of junction of stator leads 22 and 33. Figure 9 and Figure 10 are interconnection diagrams of home standby electrical systems. Power voltage leads and transfer switch "signal" leads must be run in separate conduit.

All wiring must be the proper size, properly supported, of approved insulative qualities, and protected by approved conduit. Use a length of flexible conduit between the generator and any rigid conduit.

NOTE: See also "Emergency Circuit Isolation Method" and "Total Circuit Isolation Method" on page 6.

Complete the following AC power lead connections for single-phase units (Figure 9):

1. Connect utility power supply leads to transfer switch terminals N1, N2 and switch's neutral lug.
2. Connect generator AC output leads from generator main circuit breaker (CB1) and the generator neutral lug to transfer switch terminals E1, E2 and the switch's neutral lug.
3. Connect circuit load leads to customer load and to transfer switch terminals T1, T2 and neutral.

Complete the following AC power lead connections for three-phase units (Figure 10):

1. Connect utility power supply leads to transfer switch terminals N1, N2, N3 and switch's neutral lug.
2. Connect generator AC output leads from generator main circuit breaker (CB1) and the generator neutral lug to transfer switch terminals E1, E2 , E3 and the switch's neutral lug.
3. Connect circuit load leads to customer load and to transfer switch terminals T1, T2, T3 and neutral.

Figure 10 – Interconnection Diagram for Three-phase Power System (100/200A Y-type)

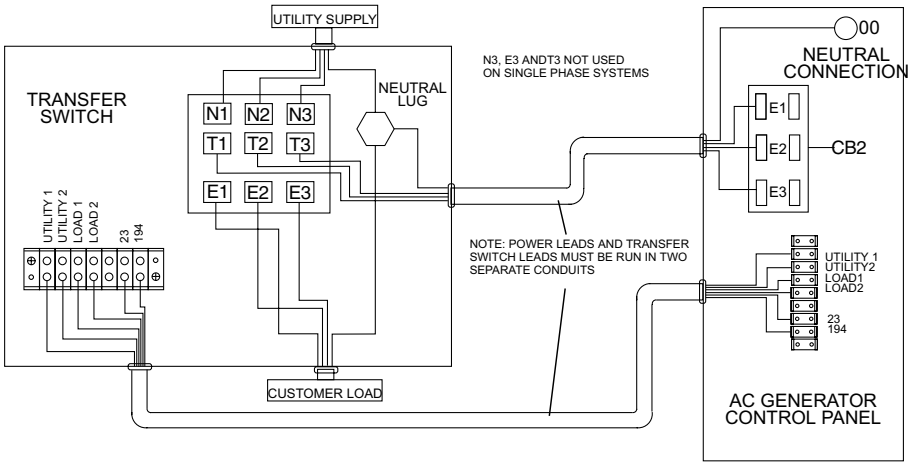
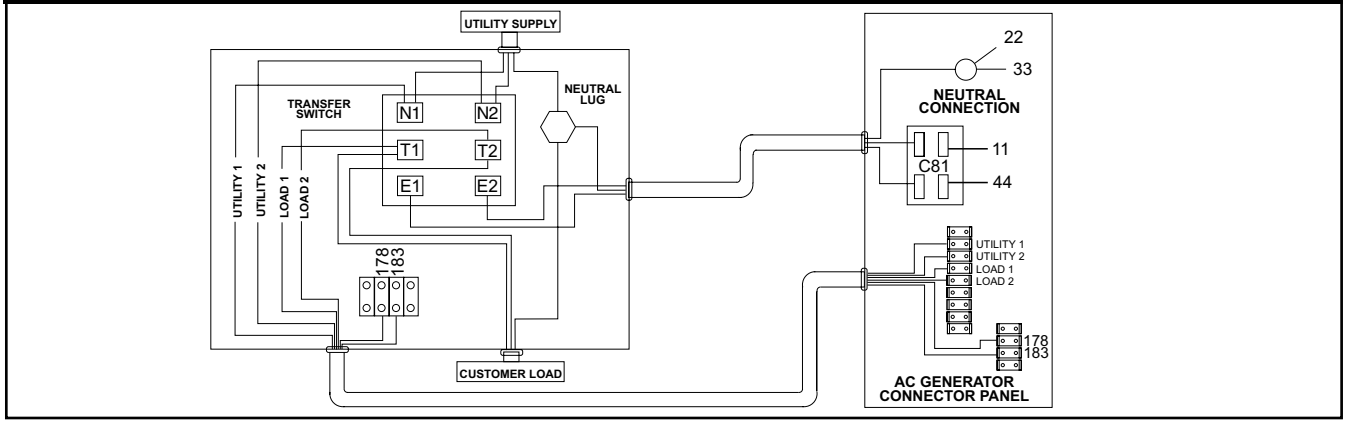


Figure 11 – Interconnection with GTS Transfer Switch (100A, Y-type)



PREPACKAGED GENERATORS AND GTS TRANSFER SWITCHES

Guardian generators with a liquid-cooled engine may be installed with either a prepackaged transfer switch or with a standard GTS-type automatic transfer switch (Figure 11). You can do this by connecting generator control console terminals 178 and 183 to identically numbered terminals in the GTS switch. Also, you must connect utility source power to generator terminals Utility 1 and Utility 2 and Load 1 and Load 2. Wires 23 and 194 are not connected.

When a prepackaged generator is installed with a standard GTS-type switch, solid-state circuit boards in the transfer switch control automatic operation. For automatic operating sequences, parameters and timing, refer to the appropriate GTS transfer switch manual.

Automatic operation for prepackaged generators installed with prepackaged transfer switches is controlled by a control module circuit board in the control panel. Refer to the "OPERATION" section of this manual.

CONTROL CIRCUIT INTERCONNECTIONS

These interconnections consist of "Utility" and "Load" leads, plus leads 23 and 194. These six leads must be routed in conduit that is separate from the generator AC power leads. Control lead functions may be briefly described as follows:

1. Utility 1 and Utility 2 (air-cooled); or N1A and N2 (liquid-cooled): Deliver utility source power to the generator's logic circuit board.
2. Load 1 and Load 2 (air-cooled); or T1 and T2 (liquid-cooled): Used to operate seven-day exerciser circuit on the generator's logic circuit board.
3. Leads 23 and 194 (both types): After the generator starts, the logic circuit board in control panel delivers a "transfer" signal via these two leads.
   - When logic circuit board action closes this circuit, it causes transfer switch main contacts to actuate and connect load circuits to generator output.
   - When utility source voltage is restored, logic board opens leads 23 and 194 circuit. Loads are then transferred back to utility circuit.

NOTE: Recommended size of control circuit leads (Utility 1 and 2, Load 1 and 2, 23 and 194) is No. 14 AWG stranded copper wire.

ADAPTING THREE-PHASE TRANSFER SWITCH

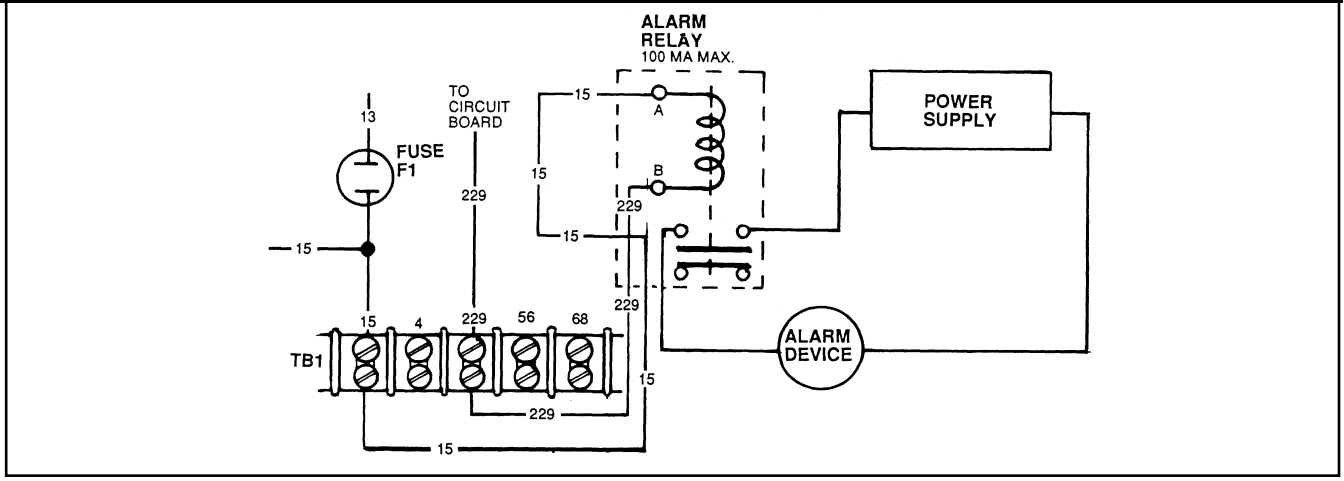
The generator you are installing may include a prepackaged transfer switch configured for three-phase loads. If you want to adapt this kind of transfer switch for single-phase loads, proceed as follows:

1. Discard the three-phase power monitor (PM) found inside the enclosure. You will not use it with a single-phase system.
2. Locate the eight-pin octal relay socket in the lower left corner of the transfer switch enclosure.
3. Move Wire N1A from Terminal 8 to Terminal 1 by cutting the lug off of N1A , stripping wire 5/16" from end, and inserting the wire under screw of Terminal 1.

NOTE: Moving N1A from Terminal 8 to Terminal 1 takes the three-phase voltage monitor out of the sensing circuit. Now, the control circuit board in the control module assembly (CMA) senses utility voltage.

4. Now, connect the control wires as follows:
   - Connect Utility Supply to lugs N1 and N2.
   - Connect the Customer Load lugs T1 and T2.
   - Connect the Standby Supply to lugs E1 and E2.

Figure 12 – Optional Alarm Relay Interconnections



OPTIONAL REMOTE ALARM RELAY

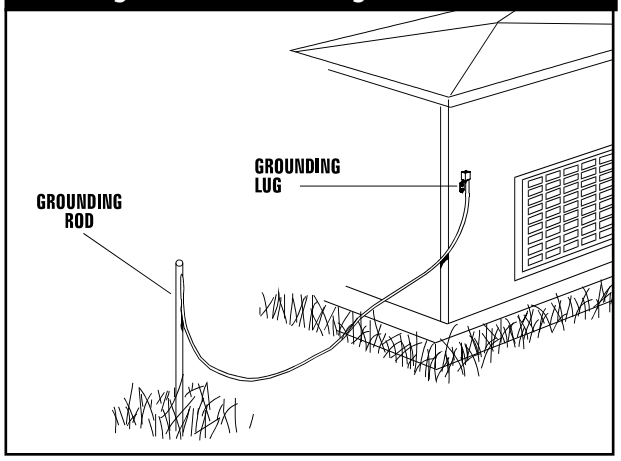
Terminal 229 on the control module assembly (CMA) for liquid-cooled home standby generators provides a convenient connection for an optional remote alarm relay. This connection does not have ample current capacity for direct connection of alarm devices. The connected alarm relay must not exceed about 100 milliamps current flow.

Notice in Figure 12 that the connected remote alarm device must have its own power supply, connected across the optional relay contacts. To operate the alarm relay, wire 15 is routed to terminal 15 of terminal board TB1, then to the alarm relay coil, back to terminal 229. The alarm relay is then energized by control logic circuit board action when an engine fault occurs. Remember, the current flow required to operate the alarm relay must not exceed 100 milliamps.

GROUNDING THE GENERATOR

Generally, connecting a No. 12 AWG stranded copper wire to the grounding lug (Figure 13) and to an earth-driven copper or brass grounding rod (electrode) will adequately ground the generator. However, local codes may vary widely. Consult with a local electrician for grounding requirements in your area.

Figure 13 – Grounding the Generator



BATTERY INSTALLATION

Refer to the *Owner's Manual* for the recommended battery for your home standby generator. Fill the battery with the proper electrolyte fluid and have the battery fully charged before installing it.

Before installing and connecting the battery, complete the following steps:

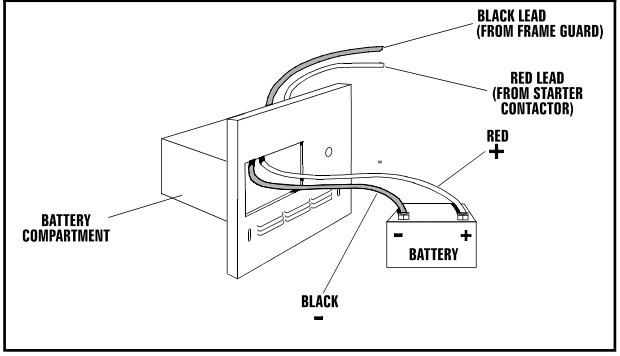
1. Set the generator's Manual/Off/Auto switch to OFF.
2. Turn off utility power supply to the transfer switch.

WARNING: IF THE MANUAL/OFF/AUTO SWITCH IS NOT SET TO ITS "OFF" POSITION, THE GENERATOR CAN CRANK AND START AS SOON AS BATTERY CABLES ARE CONNECTED. IF UTILITY POWER SUPPLY IS NOT TURNED OFF, SPARKING CAN OCCUR AT BATTERY POSTS AND CAUSE AN EXPLOSION.

Battery cables were factory connected at the generator (Figure 14). Connect cables to battery posts as follows:

1. Connect the red battery cable (from starter contactor) to the battery post indicated by a positive, POS or (+).
2. Connect the black battery cable (from frame ground) to the battery post indicated by a negative, NEG or (—).

Figure 14 – Battery Cable Connections

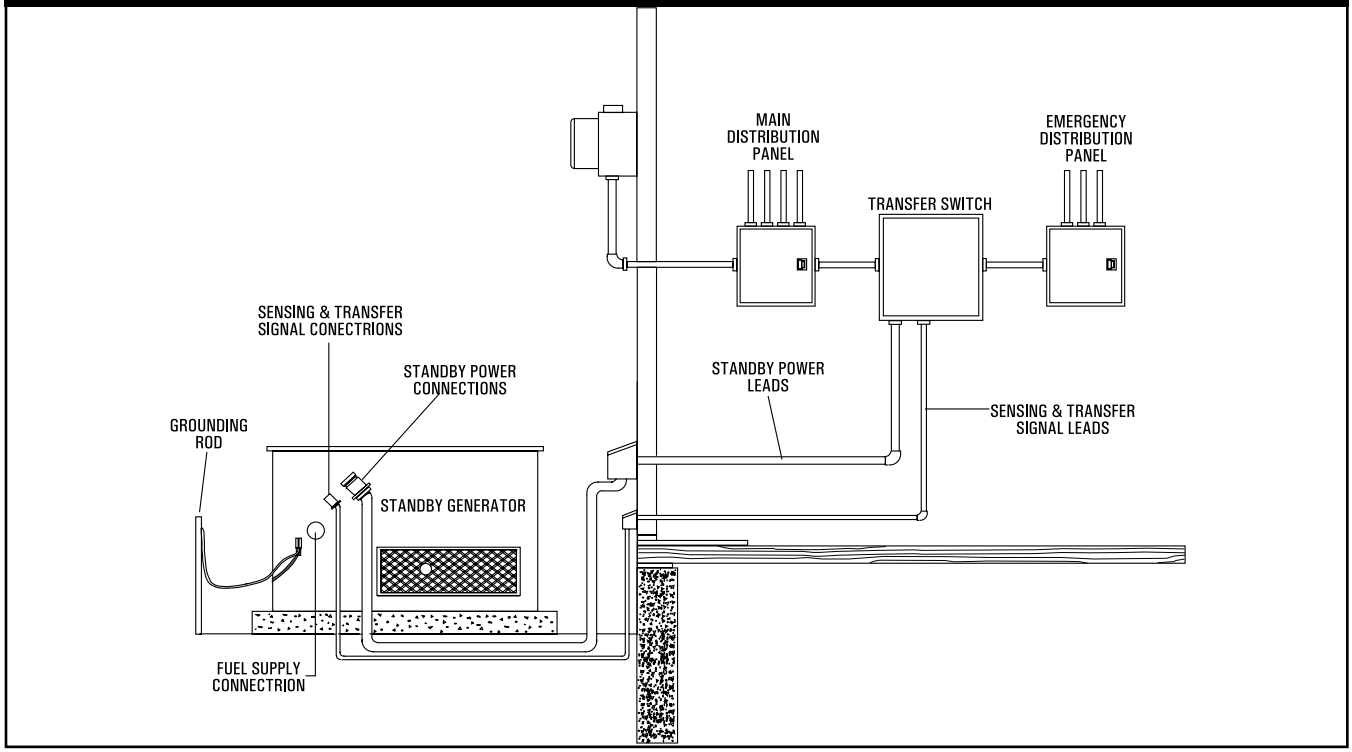


NOTE: With the battery installed and utility power source voltage available to the transfer switch, the battery receives a trickle charge while the engine is not running, to prevent self-discharge. The trickle charge feature cannot be used to recharge a discharged battery.

POST INSTALLATION INSPECTION

Before placing the home standby electrical system into service, inspect the entire installation carefully. Some areas may require that an inspection be performed by a building or electrical inspector.

Figure 15 – Typical Emergency Power System



The air-cooled generator set was factory tested and adjusted using natural gas as fuel. The liquid-cooled generator set was factory tested and adjusted using natural gas or liquid propane (LP) gas according to specifications. You should not be required to adjust the unit any further except under special circumstances.

WARNING: DO NOT MAKE ANY UNNECESSARY ADJUSTMENTS. FACTORY SETTINGS ARE CORRECT FOR MOST APPLICATIONS. HOWEVER, WHEN MAKING ADJUSTMENTS, BE CAREFUL TO AVOID OVERSPEEDING THE ENGINE.

CHECK TRANSFER SWITCH OPERATION

Refer to your *Home Standby Generator Owner's Manual* for manual operation procedures.

WARNING: DO NOT ATTEMPT MANUAL TRANSFER SWITCH OPERATION UNTIL ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES WILL RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

ELECTRICAL CHECKS

Complete electrical checks as follows:

1. Turn on the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).

DANGER: THE TRANSFER SWITCH IS NOW ELECTRICALLY "HOT." CONTACT WITH "HOT" PARTS WILL RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK. PROCEED WITH CAUTION.

2. Use an accurate AC voltmeter to check utility power source voltage across terminals N1 and N2. Nominal line-to-line voltage should be 240 volts AC.
3. Check utility power source voltage across terminals N1 and the transfer switch neutral lug; then across terminal N2 and neutral. Nominal line-to-neutral voltage should be 120 volts AC.
4. When certain that utility supply voltage is compatible with transfer switch and load circuit ratings, turn OFF the utility power supply to the transfer switch.
5. Set the generator's main circuit breaker to its OFF (or open) position. Initial tests will be conducted at no-load condition.
6. On the generator panel, set the Manual/Off/Auto switch to MANUAL. The engine should crank and start.
7. Let the engine warm up for about five minutes to allow internal temperatures to stabilize. Then, set the generator's main circuit breaker to its ON (or closed) position.

DANGER: PROCEED WITH CAUTION. GENERATOR POWER VOLTAGE IS NOW SUPPLIED TO THE TRANSFER SWITCH. CONTACT WITH LIVE TRANSFER SWITCH PARTS WILL RESULT IN DANGEROUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

8. Connect an accurate AC voltmeter and an AC frequency meter across transfer switch terminal lugs E1 and E2. Voltage should be 242-252 volts; frequency should read about 61-63 Hertz.
9. Connect the AC voltmeter test leads across terminal lug E1 and neutral; then across E2 and neutral. In both cases, voltage reading should be 121-126 volts AC.
10. Set the generator's main circuit breaker to its OFF (or open) position. Let the engine run at no-load for a few minutes to stabilize internal engine generator temperatures.
11. Set the generator's Manual/Off/Auto switch to OFF. The engine should shut down.

IMPORTANT: DO NOT PROCEED UNTIL YOU ARE CERTAIN THAT GENERATOR AC VOLTAGE AND FREQUENCY ARE CORRECT AND WITHIN THE STATED LIMITS. GENERALLY, IF BOTH AC FREQUENCY AND VOLTAGE ARE HIGH OR LOW, THE ENGINE GOVERNOR REQUIRES ADJUSTMENT. IF FREQUENCY IS CORRECT, BUT VOLTAGE IS HIGH OR LOW, THE GENERATOR'S VOLTAGE REGULATOR REQUIRES ADJUSTMENT.

BEFORE INITIAL START-UP

Before starting, complete the following:

1. Set the generator's Manual/Off/Auto switch to the OFF position.
2. Turn OFF the utility power supply to the transfer switch using the means provided (such as the utility main line circuit breaker).
3. Check the engine crankcase oil level and, if necessary, fill to the dipstick FULL mark with the recommended oil. Do not overfill above the FULL mark.
4. Check the fuel supply. Gaseous fuel lines must have been properly purged and leak tested in accordance with applicable fuel-gas codes. All fuel shutoff valves in the fuel supply lines must be open.

GENERATOR TESTS UNDER LOAD

To test the generator set with electrical loads applied, proceed as follows:

1. Set generator's main circuit breaker to its OFF (or open) position.
2. Set the generator's Manual/Off/Auto switch to OFF.
3. Turn OFF the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).

WARNING: DO NOT ATTEMPT MANUAL TRANSFER SWITCH OPERATION UNTIL ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES WILL RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

4. Manually set the transfer switch to the STANDBY position, i.e., load terminals connected to the generator's E1/E2 terminals. The transfer switch operating lever should be down.
5. Set the generator's Manual/Off/Auto switch to MANUAL. The engine should crank and start immediately.
6. Let the engine stabilize and warm up for a few minutes.
7. Set the generator's main circuit breaker to its ON (or closed) position. Loads are now powered by the standby generator.
8. Turn ON electrical loads. Apply an electrical load equal to the full rated wattage/amperage capacity of the installed generator.
9. Connect an accurate AC frequency meter across terminal lugs E1 and E2. Voltage should be greater than 230 volts; frequency should be greater than 58 Hertz.
10. Let the generator run at full rated load for 20-30 minutes. Listen for unusual noises, vibration or other indications of abnormal operation. Check for oil leaks, evidence of overheating, etc.
11. When testing under load is complete, turn OFF electrical loads.
12. Set the generator's main circuit breakers to their OFF (or open) positions.
13. Let the engine run at no-load for a few minutes.
14. Set the Manual/Off/Auto switch to OFF. The engine should shut down.

CHECKING AUTOMATIC OPERATION

To check the system for proper automatic operation, proceed as follows:

1. Check that the Manual/Off/Auto switch is set to OFF.
2. Manually set the transfer switch to the UTILITY position, i.e., load terminals connected to the utility power source side.
3. Turn ON the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).
4. Set the Manua/Off/Auto switch to AUTO. The system is now ready for automatic operation.
5. Turn OFF the utility power supply to the transfer switch.

With the Manual/Off/Auto switch at AUTO, the engine should crank and start when the utility source power is turned OFF. After starting, the transfer switch should connect load circuits to the standby side. Let the system go through its entire automatic sequence of operation.

With the generator running and loads powered by generator AC output, turn ON the utility power supply to the transfer switch. The following should occur:

- After about six seconds, the switch should transfer loads back to the utility power source.
- About one minute after retransfer, the engine should shut down.

GASEOUS FUEL LOAD BLOCK ADJUSTMENT

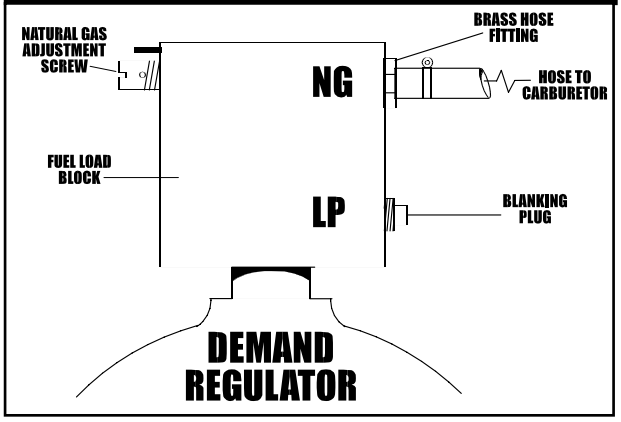
If you are installing an **air-cooled** home standby generator, you may need to adjust gaseous fuel load block.

■ RECONFIGURING THE FUEL SYSTEM

To reconfigure the fuel system, follow these steps:

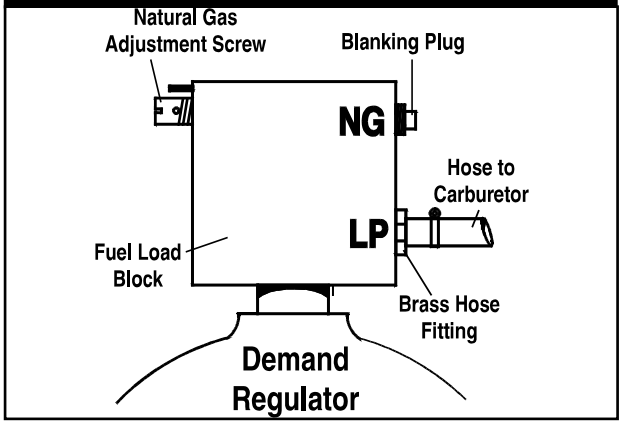
- Remove the carburetor fuel hose from the natural gas port of the fuel load block and the brass fitting (Figure 16).

Figure 16 – Natural Gas Setup



- Remove the blanking plug from the LP port of the load block (Figure 16).
- Refit the hose and fitting to the LP port and the blanking plug to the natural gas port (Figure 17).

Figure 17 – LP Gas Setup



■ ADJUSTING THE LOAD BLOCK

When the natural has system is being used, the load block is fitted with an adjustment screw that has been calibrated to provide maximum power. However, because of variations in the Btu content of natural gas across the country, it may be necessary to readjust the load block.

- Connect a frequency meter to the output of the generator.
- Start the unit and apply full load (33 amps at 240 volts – 66 amps at 120 volts AC).
- Allow the unit to stabilize; then, turn the adjustment screw slowly clockwise or counterclockwise and watch the frequency.
- When the highest frequency is reached, turn the adjustment screw counterclockwise 1/4 turn.
- The fuel system is now set.
- For LP gas operations, the hose and blanking plug must be reconfigured as shown in Figure 17. The unit is set to provide maximum power using LP gas..

ENGINE GOVERNOR ADJUSTMENT

If both AC frequency and voltage are correspondingly high or low, adjust the engine governor as follows:

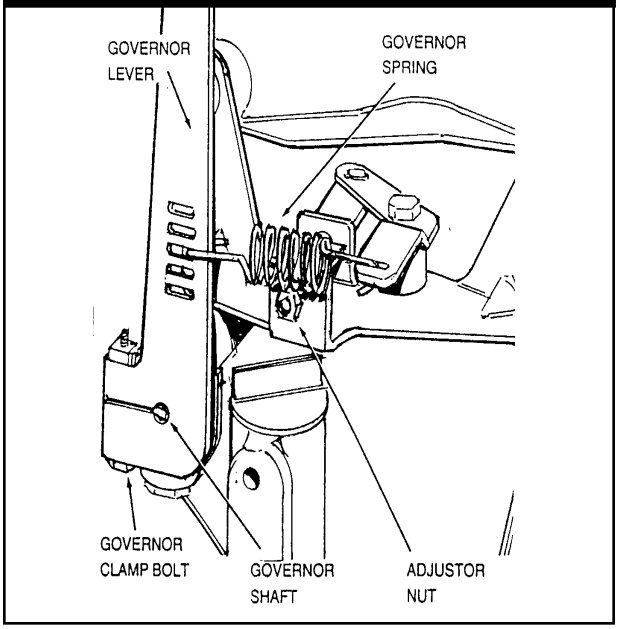
■ 5 KW UNITS

1. Loosen the GOVERNOR CLAMP BOLT (Figure 18).
2. Push the spring end of the GOVERNOR LEVER clockwise to the wide open throttle position of the lever.
   - Hold the GOVERNOR LEVER at wide open throttle and, with a pair of pliers, rotate the GOVERNOR SHAFT fully clockwise.
   - While holding the GOVERNOR SHAFT fully clockwise and the GOVERNOR LEVER at wide open throttle, tighten the GOVERNOR CLAMP BOLT to 70 inch-pounds (8 N-m).
3. Start the engine; let it stabilize and warm up at no-load.
4. Turn the ADJUSTER NUT to obtain a frequency reading of 62 Hertz.
5. Determine if the GOVERNOR SPRING is properly located in the slot of the GOVERNOR LEVER as follows:
   - If droop is excessive, move the GOVERNOR SPRING down one slot on the LEVER.

- For greater stability, move the GOVERNOR SPRING up one slot on the LEVER.

6. After repositioning the SPRING on a LEVER slot, recheck the frequency reading and, if necessary, readjust the ADJUSTER NUT to obtain 62 Hertz at no-load.
7. When frequency is correct at no-load, check the AC voltage reading. If voltage is incorrect, the voltage regulator may require adjustment.

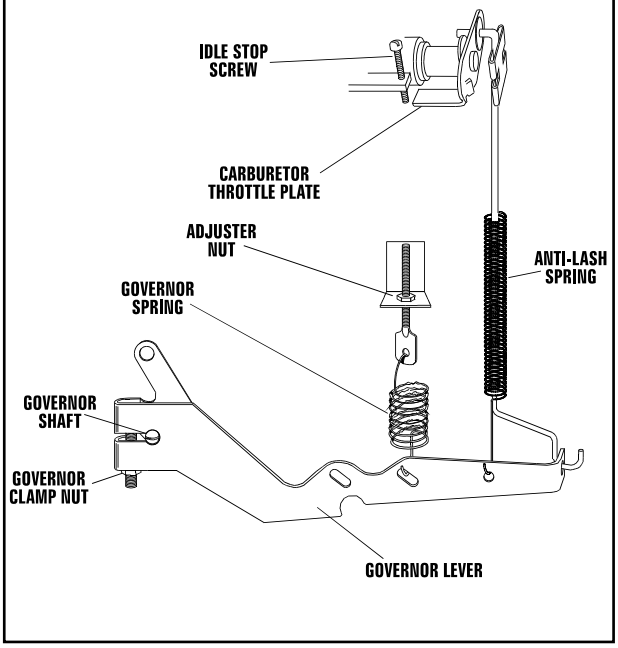
Figure 18 – 5 kW Air-cooled Engine Governor Adjustment



■ 8 KW UNITS

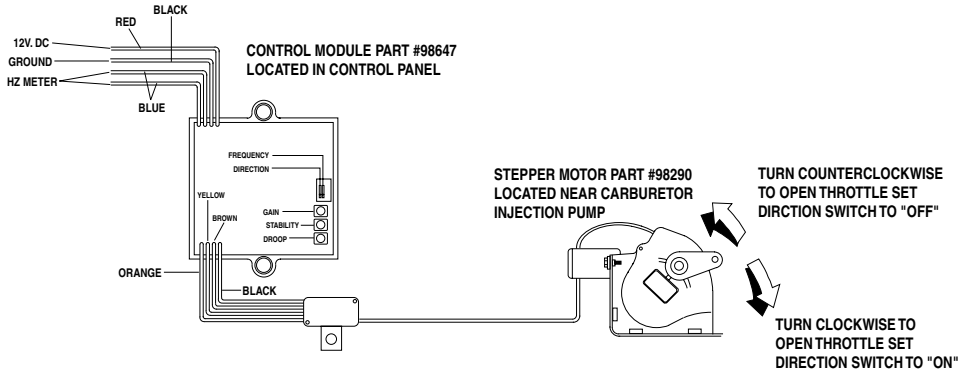
1. Carefully inspect the governor ANTI-LASH SPRING (Figure 19). Be sure it is not broken or disengaged.
2. Loosen the GOVERNOR CLAMP NUT. Then, push the spring end of the GOVERNOR LEVER all the way up (wide open throttle).
3. Hold the GOVERNOR LEVER at wide open throttle and insert the tip of a screwdriver into the slotted end of the GOVERNOR SHAFT.
   - Hold the GOVERNOR LEVER at wide open throttle and rotate the GOVERNOR SHAFT fully counterclockwise.
   - Hold the GOVERNOR SHAFT fully counterclockwise and tighten the GOVERNOR CLAMP NUT to 70 inch-pounds (8 N-m) torque.

Figure 19 – 8 kW Air-cooled Engine Governor Adjustment



4. Start the engine; let it stabilize and warm up at no-load.
5. Turn the adjuster nut to obtain a frequency reading of 61-63 Hz at no-load.
6. When the frequency is correct, check the voltage reading across the transfer switch terminal lugs E1 and E2. The voltmeter should read between 244-252 volts.
7. When frequency is correct at no-load, check the AC voltage reading. If voltage is incorrect, the voltage regulator may require adjustment.

Figure 20 – Stepper Motor and Control Module



ELECTRONIC GOVERNOR ADJUSTMENT

The electronic governor for liquid-cooled emergency power systems is a stepper motor system. The system consists of a governor module mounted inside the generator control panel, a stepper motor mounted near the injection pump or carburetor, and interconnecting wires and connection boxes (Figure 20). You may be required to adjust the electronic governor when you install the system or when you replace the governor.

■ SETUP AND ADJUSTMENT PROCEDURE

Determine which direction the stepper motor must rotate to open the throttle to "full fuel." Adjust the rod length so the stepper motor is at its full rotation when the throttle is wide open. Then, tighten the jam nuts. Be sure the linkage moves freely and does not bind in any way.

■ CONTROL MODULE POTENTIOMETERS AND SWITCHES

The following is a description of the adjustment for the new electronic governor control module and stepper motor:

Potentiometer (pot) Settings on Control Manual

Set GAIN, DROOP and STABILITY pots to midpoint.

Switch Settings

- Set the frequency switch to either 50 Hz (ON) or 60 Hz (OFF).

Set Direction Switch

Determine which direction the stepper motor lever needs to be set to open the throttle. Some units are set to open at the clockwise position, and some are set to open at the counterclockwise position.

If the lever is set to open at the counterclockwise position, then the direction switch should be set in the "OFF" position. If the lever is set to open at the clockwise position, the direction should be set to the "ON" position.

When the switches and pots are set correctly, start the engine. Adjust the gain pot if necessary to stabilize engine speed.

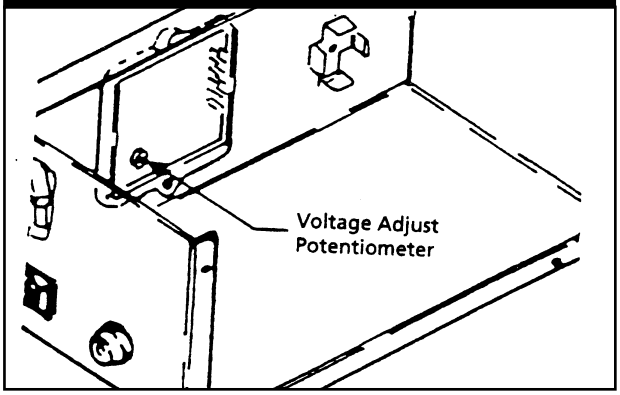
- Apply load to the system – 25-50 percent is best. If the system is unstable, reduce gain until it stabilizes.
- Adjust droop pot so that the engine speed recovers to the preselected speed (50 or 60 Hz based on unit).
- Observe performance of the system when loads are applied and removed.
- Increasing stability will decrease recovery time, but may result in damped oscillations (decreasing hertz around preset speed). Decreasing stability will soften the recovery and reduce the transient hertz.

Frequency and direction switches are integrated only at engine start. Changing switch settings while the engine is running will have no effect until the engine is stopped and restarted.

VOLTAGE REGULATOR ADJUSTMENT

With the frequency between 61-62 Hz, slowly turn the slotted potentiometer (Figure 21) until line voltage reads 244-252 volts.

Figure 21 – Voltage Adjustment Potentiometer



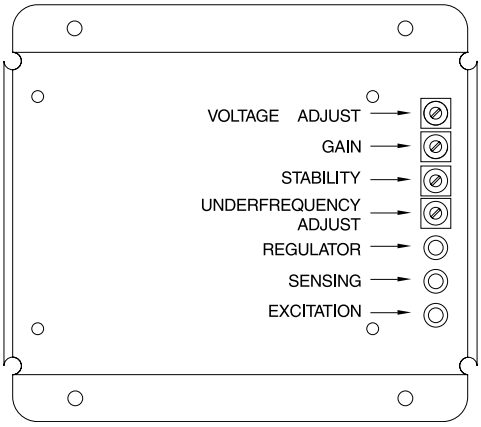
NOTE: The voltage regulator is housed in the generator's control panel. The regulator maintains a voltage in direct proportion to frequency at a 2-to-1 ratio. For example, at 62 Hz, line-to-neutral voltage will be 124 volts.

■ THREE-PHASE MODELS

1. Connect an accurate AC voltmeter and AC frequency meter to the generator's AC output leads.
2. On the regulator, set the potentiometers as follows (Figure 22):
   A. Turn the "Voltage Adjust" pot fully counterclockwise.
   B. Set "Gain" to its centered (mid) position.
   C. Set "Stability" to its centered (mid) position.
   D. Do NOT adjust "Under-frequency Adjust."
3. On the generator console, set the voltage adjust pot to its centered (mid) position.
4. Turn OFF all electrical loads. Start-up and initial adjustment will be done under a "no-load" condition.
5. Start the engine. Let it stabilize and warm up at no-load.
6. Check the reading on the frequency meter. If necessary, adjust the engine governor to obtain a frequency as close as possible to 60 Hz at no-load.
7. With the unit running at correct no-load frequency, observe the lamps (LEDs) on the voltage regulator. All lamps should be ON.
8. Turn the regulators "Voltage Adjust" pot to obtain a line-to-line voltage output of 208 or 240 VAC.
9. If the red "Regulator" lamp (LED) is flashing, turn the "Stability" pot either direction until the flashing stops.
10. Apply an electrical load and check engine speed recovery.
    A. Adjust the "Under-frequency Adjust" pot fully counterclockwise to unload the unit and reduce load while the engine recovers.
    B. For flat regulation (no voltage decrease as frequency drops), set the "Under-frequency Adjust" pot fully clockwise.
    C. To obtain a constant voltage reduction as frequency decreases, set the "Under-frequency Adjust" pot fully counterclockwise. Set point for this adjustment is 62 Hz (counterclockwise) to 52 Hz (clockwise).
11. With the electrical load still applied, check the "Regulator" lamp for flashing. If the lamp is flashing, adjust the "Stability" pot until the flashing stops.
12. If a better response is needed, adjust the "Gain" pot clockwise as needed. Then (if needed), correct for instability by adjusting the "Stability" pot.
13. Turn off electrical loads. Then, recheck the regulator lamps (LEDs) at no-load.

When all adjustments have been completed, let the engine run at no-load for a few minutes to stabilize internal engine-generator temperatures. Then, shut the generator down.

Figure 22 – Voltage Regulator 67680 (Three-phase Models)



SET WEEKLY EXERCISE CYCLE

The generator will start and exercise once every seven days. During this weekly exercise, the unit runs for about 20 minutes and shuts down. Transfer of loads to generator output does not occur during the exercise.

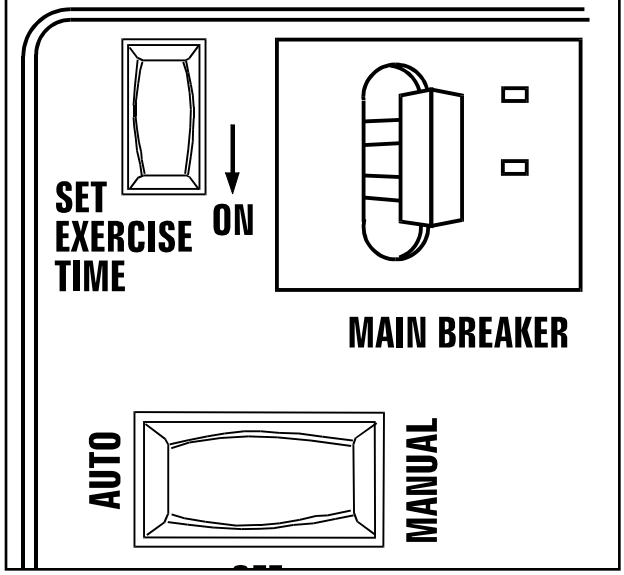
To select the day and time for exercising, proceed as follows:

1. Set the Manual/Off/Auto switch to OFF.
2. Set the generator's main circuit breaker to its OFF (or open) position.
3. On the control panel, locate the rocker switch identified with the words "Set Exercise" (Figure 23).
4. Hold the "Set Exercise" switch in the ON position for 20 to 30 seconds. The switch will spring back to its original position when released.
5. Wait about 30 seconds before setting the Manual/Off/Auto switch to AUTO.

CAUTION: If you switch the Manual/Off/Auto switch too soon, the engine may start. If engine does start, it will shut down automatically in about two (2) minutes.

6. Set the generator's main circuit breaker to its ON (or closed) position.
7. The generator is now programmed to start and exercise every seven days thereafter, on the day and time of day you pressed the switch.

Figure 23 – "Set Exercise" Switch on Control Panel



8. Place a sign on the generator control panel and the transfer switch that indicates the day and time the generator will be exercising.

USING THE MANUAL/OFF/AUTO SWITCH

■ "MANUAL" (OR "START") POSITION (Figure 23)

- Set the switch to MANUAL (or START) to crank and start the engine.
- Transfer to standby power will not occur after any manual start unless utility is not available.

■ "AUTO" POSITION

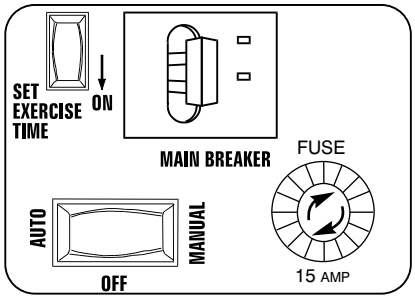
- This position provides fully automatic system operation.
- Selecting this switch position allows the system to automatically start and exercise the engine every seven days.

■ "OFF" POSITION

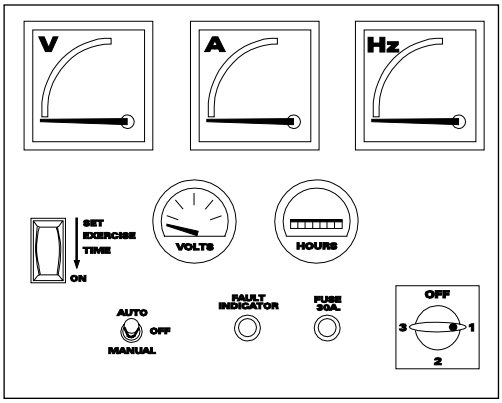
- This position shuts down the engine.
- This position prevents automatic operation.

Figure 24 – Generator Control Panels

Air-cooled Control Panel



Liquid-cooled Control Panel



WARNING: WITH SWITCH SET TO "AUTO," THE ENGINE MAY CRANK AND START AT ANY TIME WITHOUT WARNING. SUCH AUTOMATIC STARTING NORMALLY OCCURS WHEN UTILITY POWER SOURCE VOLTAGE DROPS BELOW A PRESET LEVEL. TO PREVENT POSSIBLE INJURY THAT MIGHT BE CAUSED BY SUCH SUDDEN STARTS, ALWAYS SET THE SWITCH TO "OFF" BEFORE WORKING ON OR AROUND THE GENERATOR OR TRANSFER SWITCH. THEN, PLACE A "DO NOT OPERATE" TAG ON THE GENERATOR PANEL AND ON THE TRANSFER SWITCH.

TO SELECT AUTOMATIC OPERATION

1. Make sure the transfer switch main contacts are set to their UTILITY position, i.e., load connected to utility power source side.
2. Be sure normal utility power source voltage is available to transfer switch terminal lugs N1 and N2.
3. Set the generator's Manual/Off/Auto switch to AUTO.
4. Set the generator's main circuit breaker to its ON (or closed) position.

With the preceding steps completed, the generator will start automatically when utility source voltage drops below a preset level. After the unit starts, loads are transferred to the standby power source. Refer to "Sequence of Automatic Operation."

MANUAL OPERATION

To start the generator and set the transfer switch manually, refer to the *Owner's Manual* of your generator or the manual of your particular transfer switch.

DANGER: DO NOT ATTEMPT TO ACTIVATE THE TRANSFER SWITCH MANUALLY UNTIL AFTER ALL POWER VOLTAGE SUPPLIES TO THE SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

■ TRANSFER BACK TO UTILITY POWER SOURCE

When utility power has been restored, you will want to transfer back to that source and shut down the generator. This can be accomplished as follows:

1. Set the generator's main circuit breaker to its OFF (or open) position.
2. Let the engine run for a minute or two at no-load to stabilize the internal temperatures.
3. Set the generator's Manual/Off/Auto switch to OFF. The engine should shut down.
4. Check that utility power supply to transfer switch is turned OFF.

DANGER: DO NOT ATTEMPT TO ACTIVATE THE TRANSFER SWITCH MANUALLY UNTIL AFTER ALL POWER VOLTAGE SUPPLIES TO THE SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

5. Manually set the transfer switch main contacts back to UTILITY position, i.e., loads connected to utility power supply. Refer to the *Owner's Manual* of your generator for transfer switch operation.
6. Turn ON the utility power supply to the transfer switch, using the means provided.
7. Set the system to automatic operation as outlined in "To Select Automatic Operation."

SEQUENCE OF AUTOMATIC OPERATION

■ AIR-COOLED STANDBY SYSTEMS

The actual sequence of operation is controlled by sensors and timers on control logic circuit board, as follows:

A. Utility Voltage Dropout Sensor
- This sensor monitors utility source voltage.
- If utility source voltage drops below about 60 percent of the nominal supply voltage, the sensor energizes a six-second timer.
- If the utility source voltage drops below 60 percent of nominal supply for more than six seconds, the engine cranks and starts.

B. Engine Warm-up Time Delay
- This mechanism lets the engine warm up for about 15 seconds before the load is transferred to a standby source.

C. Standby Voltage Sensor
- This sensor monitors generator AC output voltage. When the voltage has reached 50 percent of the nominal rated voltage, transfer to standby can occur.

D. Utility Voltage Pickup Sensor
- This sensor monitors utility power supply voltage. When that voltage is restored above 80 percent of the nominal source voltage, a retransfer time delay starts timing.

E. Retransfer Time Delay
- This timer runs for about six seconds.
- At end of a six-second delay, circuit board action de-energizes transfer relay in the transfer switch.
- Retransfer to utility power source then occurs.

F. Engine Cool-down Timer
- When the load is transferred back to utility power source, the engine cool-down timer starts timing.
- The timer will run for about one minute, and the generator will then shut down.

Engine Starting:

The control module assembly (CMA) board reads frequency signals from the stator battery charge windings and relates them to "engine speed" or rpm. When AC frequency reaches about 30 Hz, cranking is terminated and an engine warmup timer goes ON, running for about 15 seconds.

■ LIQUID-COOLED STANDBY SYSTEMS

The generator control panel houses a control logic circuit board. This board constantly monitors utility power source voltage. Should that voltage drop below a preset level, circuit board action will signal the engine to crank and start. After the engine starts, the circuit board signals the transfer switch to activate and connect load circuits to the standby power supply (load terminal lugs T1/T2 connect to terminal lugs E1/E2).

When utility source voltage is restored above a preset level, generator circuit board action signals the transfer switch to transfer loads back to that power supply. After retransfer, the engine is signalled to shut down.

NOTE: Automatic operating sequences outlined in this section apply only to those home standby generators (Option "P" control panel) that have been installed along with a prepackaged transfer switch. This is mentioned because you can install a GTS-type automatic transfer switch if you prefer. The standard GTS-type switch incorporates a solid-state "intelligence circuit" of its own. For more information, refer to the *Owner's Manual* of your GTS switch.

The Manual/Off/Auto Switch:

This switch on the generator control console must be set to AUTO for normal automatic operation.

When the Manual/Off/Auto switch is set to MANUAL (or to START on some models), the generator engine cranks and starts as if utility source voltage had dropped out. The MANUAL position is actually a test of the circuit board's automatic operating functions.

When the Manual/Off/Auto switch is set to OFF, the circuit board's 12-volt DC power supply is turned off, and you cannot start the engine automatically or manually. That is, setting the switch to OFF means you have turned off power to the circuit board.

When Utility Power is Available: When utility source voltage is available to transfer switch terminal lugs N1/N2/N3, a voltage signal is delivered to a sensing transformer in the control module assembly (CMA). As long as the CMA board senses that utility source voltage is greater than about 60 percent of the nominal supply voltage, the circuit board takes no action.

NOTE: When a single-phase V-type or Y-type transfer switch is used, AC voltage that the transformer reduces is delivered to the CMA circuit board as sensing voltage. However, three-phase transfer switches are equipped with a three-phase power monitor that senses the voltage on all three legs of the AC power circuit (N1, N2 and N3). If voltage in any one (or more) of the three legs drops below a preset level, power monitor contacts open the sensing circuit to the sensing transformer and CMA circuit board. The drop out setting of the three-phase power monitor is adjustable.

Utility Source Voltage Dropout on Single-phase Systems: The CMA circuit board in the generator console constantly monitors utility power source voltage, via the Utility 1 and Utility 2 terminals and a step-down transformer. Should that source voltage drop below about 60 percent of the nominal source voltage, a six-second delay timer begins running. At the end of six seconds, a run relay on the CMA circuit board energizes to initiate engine cranking and start-up.

Utility Source Voltage Dropout on Three-phase Systems: A three-phase power monitor in the prepackaged transfer switch monitors voltage in all three legs of the three-phase utility circuit (N1, N2, N3). Normally open contacts in the three-phase power monitor are closed as long as the voltage of all three legs remains high. Should the voltage in any of the three-phase legs drop low, the power monitor de-energizes. Its normally open contacts then open, cutting off sensing voltage to the CMA board. A six-second timer on the circuit board then starts running, and after six seconds, the CMA board's crank-and-run relay energizes to crank and start the engine.

Engine Cranking: The engine will crank for about seven to nine seconds, followed by a seven to nine second rest (no-crank) period. Then it will crank again for seven to nine seconds and rest for seven to nine seconds and so on until 90 seconds have passed. If the engine has not started in the 90-second limit, the generator console's fault indicator lamps goes ON.

The six-second timer is required to prevent false starts that might otherwise be caused by transient dips of utility source voltage.

Engine Starting: The CMA board reads frequency signals from the AC power windings as “engine speed” or rpm. When AC frequency reaches about 30 Hz, cranking is terminated and an engine warmup timer goes ON, running for about 15 seconds.

Transfer to Standby Source: After the engine warm up timer has finished running, a “standby voltage sensor” on the CMA board checks the generator AC output voltage. If the AC output voltage is greater than about 50 percent of the system's rated AC voltage, the transfer relay (in the prepackaged transfer switch) then energizes and electrical loads are transferred to generator output. Electrical loads are now powered by the standby power supply.

Transfer Back to Utility – Single-phase Systems: The CMA board continues to look for an acceptable utility source voltage. When utility voltage is restored above 80 percent of the rated system voltage, circuit board action causes a “retransfer time delay” to start running. That time delay will run for about six seconds. After six seconds, the transfer relay opens to ground. The transfer relay then de-energizes which transfers loads back to utility power.

Transfer Back to Utility – Three-phase Systems: A three-phase power monitor in the prepackaged transfer switch (three-phase switches only) monitors voltage in all three legs of utility circuit (N1, N2, N3). When utility voltage is restored in all three legs of the circuit, the power monitor energizes. Its normally open contacts close, and utility sensing voltage is again delivered to the CMA board. The circuit board's “retransfer time delay” then starts running for about six seconds, after which the relay de-energizes, transferring loads back to utility power. Loads are now powered by utility power supply.

Generator Shutdown: After loads are transferred back to utility, an “engine cool-down timer” starts running. After one minute, the run relay is de-energized, and the engine shuts down.

The CMA board continues to monitor utility source voltage as long as the Manual/Off/Auto switch is set to AUTO.

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