

Onan

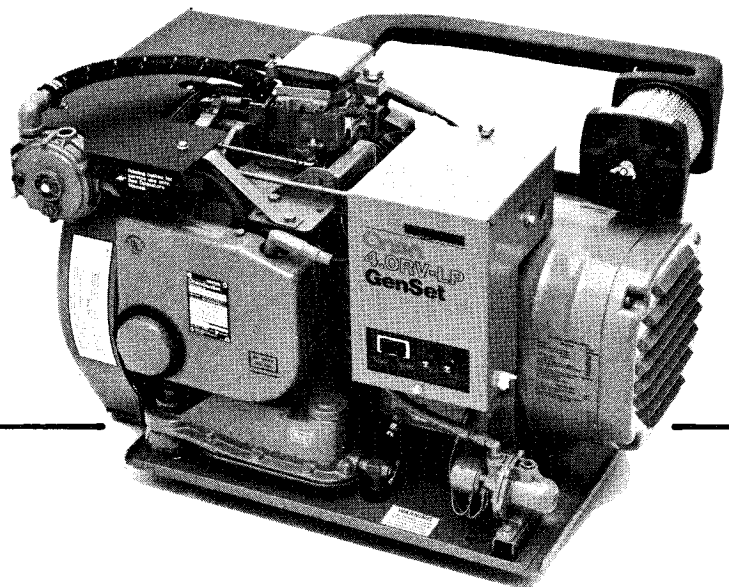
Installation Guide

4.0 kW

BGAL

**Spec 16013 Series
GenSet**

**Liquid LPG Fuel
RV Electric Generating Set**



965-0627
Revised 1-84
Printed in U.S.A.

Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and your equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER

This symbol warns of immediate hazards which will result in severe personal injury or death.

⚠ WARNING

This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.

⚠ CAUTION

This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.

FUEL AND FUMES ARE FLAMMABLE. Fire and explosion can result from improper practices.

- DO NOT fill fuel tanks while engine is running. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible, non-conductive line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Never sleep in the vehicle with the generator set running unless vehicle is equipped with an operating carbon monoxide detector.
- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Before starting work on the generator set, disconnect batteries. This will prevent accidental starting.

- Keep your hands away from moving parts.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing near moving parts, or jewelry while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

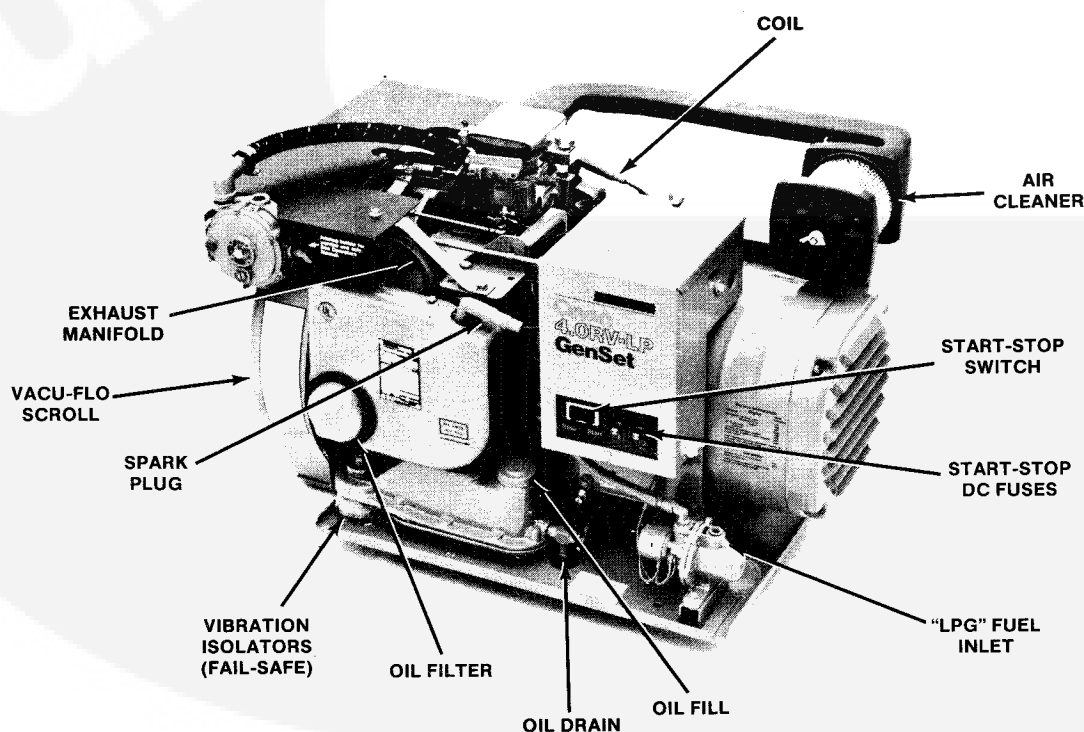
- Disconnect starting battery before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.

GENERAL SAFETY PRECAUTIONS

- Have a fire extinguisher nearby. Maintain extinguisher properly and become familiar with its use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.
- Hot coolants under pressure can cause severe personal injury. DO NOT open a radiator pressure cap while the engine is running. Stop the engine and carefully bleed the system pressure.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which presents a potential fire hazard.
- DO NOT store anything in the generator compartment such as oil or gas cans, oily rags, chains, wooden blocks, portable propane cylinders, etc. A fire could result or the generator set operation (cooling, noise and vibration) may be adversely affected. Keep the compartment floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

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TYPICAL BGAL FOR RECREATIONAL VEHICLES

Introduction

This manual covers detailed installation procedures for the UL Listed/CSA Certified Onan model 4.0BGAL-1R recreational vehicle electric generating sets. Each Onan RV electric generating set MUST be installed properly if it is to operate reliably, quietly and most important safely, even though the set itself meets or exceeds all Listing Requirements. Being Listed and Certified means this electric generating set meets or exceeds all requirements or ANSI/NFPA 501C-1977 Chapter 4 (Electrical Systems) and Chapter 5 (Fire and Life Safety) and ANSI A198.1 as well as UL Subject 1248 and CSA Electrical Bulletin #946. This model also complies with NFPA-58 and Canadian Gas Association Bulletin CAN 1-B149.2-78 for propane fueled appliances and equipment in Canada.

All Motor Home installations MUST comply with these specifications as well as Article S51, ANSI C1-1975/NFPA No. 70-1978 of the National Electrical Code. The Motor Home Manufacturer and/or the generator set installer MUST comply with above codes and any local codes which pertain to the generator set installation.

This manual provides detailed installation guidelines for this Onan model ONLY. For operation and maintenance procedures, refer to the individual Operator's manual which accompanies each set. The Operator's manual is #965-0127.

WARNING

*TO PREVENT FIRE OR ACCIDENT HAZARD . . .
THIS UNIT MUST BE INSTALLED ACCORDING
TO THE MANUFACTURER'S DETAILED IN-
STALLATION PROCEDURES OBSERVING ALL
MINIMUM CLEARANCES.*

*TO AVOID POSSIBLE PERSONAL INJURY OR
EQUIPMENT DAMAGE, ANY INSTALLATION
AND ALL SERVICE MUST BE PERFORMED BY
QUALIFIED PERSONNEL.*

The following list of Installation Codes and Safety recommendations pertain to the Installation and Operation of this liquid propane fueled (LPG) "RV" generator set. The address of each agency is also listed so that you may obtain a copy of each one for your own use.

AGENCY AND CODE	ADDRESS
1. NFPA 501C-1977	Recreation Vehicle Industry Association 14650 Lee Road Chantilly, VA 22021 Also available from National Fire Protection Association 470 Atlantic Avenue Boston, Massachusetts 02210
2. NFPA 58	National Fire Protection Association 470 Atlantic Avenue Boston, MA 02210
3. CSA Electrical Bulletin #946	Canadian Standards Association Housing and Construction Materials Section 178 Rexdale Blvd. Rexdale, Ontario, Canada M9W 1R3
4. Canadian Gas Association Bulletin CAN 1-B149.2-78	Canadian Gas Association 55 Scardale Road Don Mills Ontario, Canada M3B 2R3
5. UL Subject 1248	Underwriters Laboratories Inc 333 Pfingsten Road Northbrook, IL 60062

General Specifications

ENGINE

Onan opposed 2-cylinder, 4-cycle, air cooled, propane fueled engine rated 8.5 bhp at 1800-rpm. Remote start, negative ground, 12-volt, motorized alternator cranking.

ALTERNATOR

Onan-built, four-pole, revolving armature permanently aligned to engine. Generator produces 120 volts, 33.3 amps, 60 hertz, single phase AC, 4000 watt output.

CONTROL

Front mounted control featuring automatic electric fuel solenoid and filter, fused battery charging and Start Stop controls with remote start capability.

RV ELECTRIC GENERATING SET

Some general specifications are listed below for reference purposes.

SPECIFICATIONS

Height	18.89 in. (480 mm)
Length	30.40 in. (772 mm)
Width	18.00 in. (457 mm)
Weight	235 lbs. (107 kg)
Air Requirements	
Total (CFM)	Approx. 500 (14.15 m ³ /min)
Propane Fuel Inlet Connection Size	1/4" NPTF
Battery Voltage	12 Volts
Battery AMP-HR Minimum	74 (266.40 kC)
Battery Ground	Negative
RPM (At rated load 60 Hz)	1800

NOTE: Metric values are shown in parentheses.

Pre-Start Checks

This RV generator set is complete as received except for exhaust components and any other optional accessory items which are shipped loose with each set for installation later. After the initial installation is completed the following steps are necessary before actually starting the generator set for the first time.

1. Install the exhaust system.
2. Add oil to the engine.
3. Connect fuel line to engine from fuel supply tank.
4. Connect electrical leads to load circuits.
5. Connect the start stop remote switches (if used).
6. Connect battery leads between set and battery. Connect ground lead last.

Vehicle chassis (frame) ground and the battery and generator set ground should all be electrically connected to be at 0 ground potential. All Onan units are designed for negative ground application.

PROPANE FUEL SYSTEM

WARNING *Leaking propane will cause fumes which could EXPLODE. Check around all fuel system components and fuel line connections for loose or leaking joints. Make sure fuel*

lines are not rubbing against anything which could cause them to break. If all connections are OK in a "static condition", recheck all joints and connections using a soap and water mixture with set running.

ELECTRICAL

AC Output

AC leads (M1, M2,) terminate in generator set's junction box. These wires should be connected to distribution box with multi-strand wire enclosed in a flexible conduit. Check all wires (to and from the generator set) for fraying and loose connections. For information on load connections refer to ELECTRICAL LOADS AND CONNECTIONS section following.

Battery Connections

Battery positive (+) connects to start solenoid. Battery negative (-) connects to location on rear of generator. Check terminals on set for clean and tight connections.

WARNING *Do not smoke while servicing batteries. Lead acid batteries give off explosive gases while being charged*

WARNING

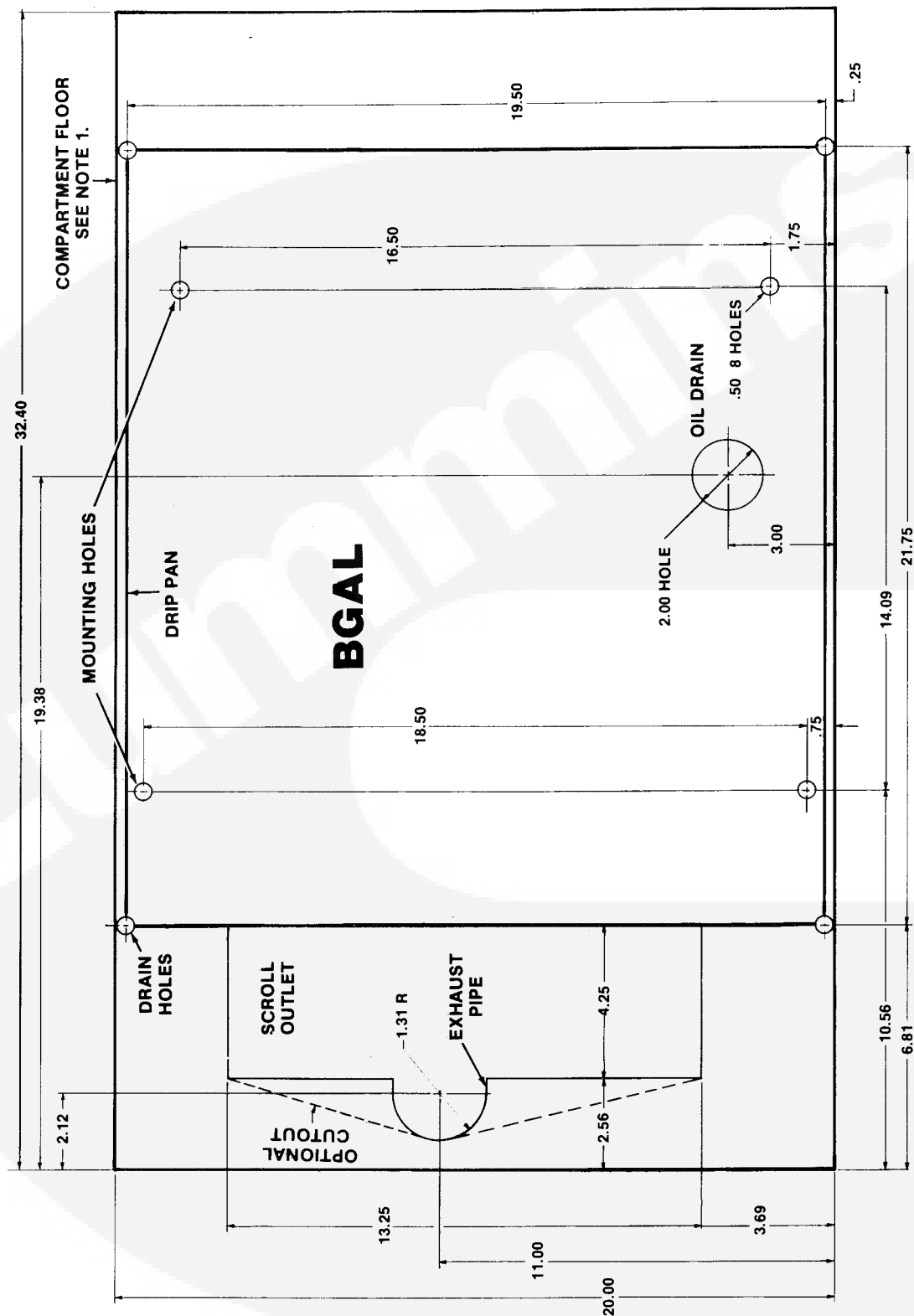
EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- Dizziness
- Nausea
- Headache
- Weakness and Sleepiness
- Throbbing in Temples
- Muscular Twitching
- Vomiting
- Inability to Think Coherently

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Never sleep in vehicle with the generator set running unless the vehicle interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.



1. DIMENSIONING INCLUDES ONE INCH MINIMUM CLEARANCE REQUIRED BETWEEN SET AND INSULATION OR COMPARTMENT WALLS.
2. IF COMPARTMENT IS LARGER THAN MINIMUM SHOWN ALLOW EXTRA SPACE AT EXHAUST SHIELD AND OIL FILL SIDES.
3. ALLOW A MINIMUM OF 1/2 INCH CLEARANCE BETWEEN CARBURETOR AIR INTAKE SYSTEM AND INSULATION OR COMPARTMENT CEILING. MINIMUM HEIGHT - 19.4 INCHES

FIGURE 1. TYPICAL INSTALLATION COMPARTMENT SIZE AND MINIMUM DIMENSIONS

Compartment Size and Location

COMPARTMENT SIZE AND LOCATION

Compartment location is determined largely by:

1. Physical size.
2. Access opening.
3. Mounting support—most important of all.

Physical Size

The area in the vehicle for the electric generating set must be large enough for the compartment, with specified minimum clearance between the electric generating set and compartment walls or ceiling (and acoustical material, if used). See Figure 1.

ACCESS OPENING

Plan the location for an access opening large enough to permit set removal. Compartment door should be designed for easy removal or for easy access for operator or service personnel.

MOUNTING SUPPORT

Because of compartment weight, the most desirable mounting location is between the main frame members of the recreational vehicle. However, this is seldom possible. Most common installations are on the side of the vehicle and most difficult to reinforce. One side of the compartment is fastened to the frame and the opposite side secured to the body. Compartment floor must be metal. Channel, box or angle iron can be used for a compartment frame with a sheet metal cover.

COMPARTMENT

1. Install the generator set in it's own compartment. Compartment area must be separated from the living quarters and any (gasoline or vehicle propane) fuel supply by a vapor-tight wall.
2. Insulate the compartment with 26-gauge galvanized steel or a material of comparable strength, durability and fire resistance.

WARNING

Do not use flammable material directly above or around the electric generating set compartment. Heat transferred through the sheet metal compartment structure or other material can be HOT enough to discolor, char or ignite fiberboard, seat cushions, etc. Use of asbestos or other noncombustible temperature insulating material in high temperature areas may be necessary.

3. See Figure 1 for minimum clearances and compartment size.

4. DO NOT use absorbent sound proofing material on compartment floor. The floor should have minimal openings to reduce entrance of road dirt. Compartment floor must be so constructed as to prevent accumulation of oil, fuel or water in any corner. Drainage can be accomplished through the use of 1/2" diameter hole near each corner or other suitable means

WARNING

Be sure hole is not directly above muffler to prevent fire hazard.

Equip base with an oil drain hole to outside of compartment. It is recommended that the recreational vehicle manufacturer provide a raised edge or collar around exhaust pipe outlet to prevent gasoline leakage onto exhaust system to meet requirements of CSA #946.

MOUNTING

Read the entire manual before mounting the generator set. Additional allowances should be made to allow easy access to the oil fill, drain and oil dip stick as well as the air cleaner element for service purposes.

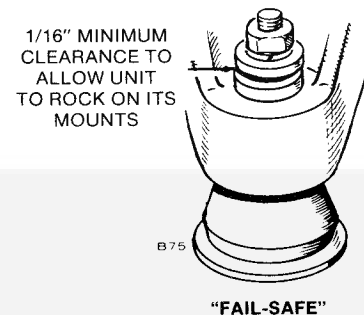


FIGURE 2. VIBRATION ISOLATORS

VIBRATION ISOLATORS

Rubber vibration isolators are furnished with all Onan recreational vehicle models.

CAUTION

Use only the vibration isolators provided with the electric generating set, as they are designed to support unit's weight.

1. Onan mounts are a "through bolt" type which prevent the set from breaking loose if they are damaged.
2. Vibration isolators of the type shown (with snubbing washers) in Figure 2 must be installed properly to minimize vibration. Leave 1/16-inch minimum clearance between the snubbing washers as shown in Figure 2.

Ventilation and Acoustics

The most important factors of ventilation for an air-cooled mobile electric generating set are sufficient incoming cooling air and exhausting heated air. Before considering the installation problems, knowledge of how an Onan unit cools itself is needed.

VACU-FLO® COOLING

All Onan electric generating sets for recreational vehicles use Vacu-Flo® cooling, a centrifugal fan in a scroll housing on the engine end (Figure 3).

1. It draws air from the generator end of the compartment, through the generator and over the cooling surfaces of the engine, then discharges the heated air out through the Vacu-Flo® discharge opening.
2. All standard sets for recreational vehicles have the Vacu-Flo® scroll positioned downward. Be sure nothing obstructs or restricts discharged airflow.

WARNING *Never use discharged cooling air for heating since it can contain poisonous gases.*

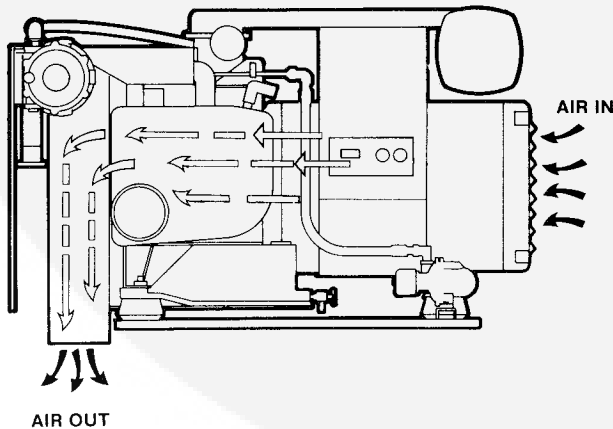


FIGURE 3. TYPICAL ONAN VACU-FLO COOLING SYSTEM

Allow for ducts or obstructions of airflow. Position of the air openings must permit airflow while the unit is running to purge the compartment of heated air. But on shutdown, the openings must allow for convection cooling of the compartment for heated air to escape.

AIR REQUIREMENTS

Cooling air requirements for Onan electric generating sets vary with type and size. Special equipment is needed to measure it. Since the discharge area can't be changed, air inlet opening is *critical!* The 4.0 kW BGAL running at 1800 rpm requires a minimum free air inlet area of 85 square inches with no restrictions and the air discharge is 480 cubic feet per minute.

The Onan UL tested air cleaner element is specifically designed to meet the combustion air requirements of the 4.0BGAL. This element should be replaced each 200 hours of operation and more often in extremely dusty conditions.

RESTRICTED AIR OPENINGS

Sheet metal with louvers can be used over inlet areas. However, some provide only 60 percent free inlet area per square foot. Even the most efficient grille only provides about 90 percent free inlet area per square foot. The free inlet area of the material can be obtained from the manufacturer. Calculate the inlet area needed using the following information as a guide. See Figure 4.

Unrestricted air inlet requirements for this set is 85 square inches. The 85 square inches should be divided by the percent (%) of free air of the proposed louver to determine necessary surface area for this set.

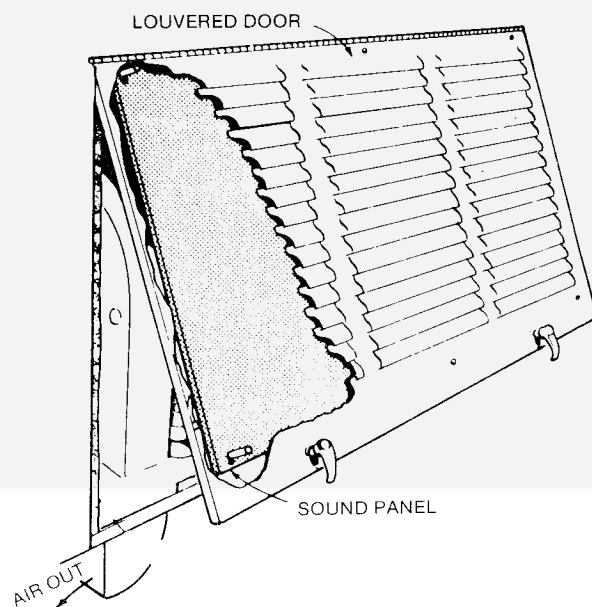


FIGURE 4. TYPICAL LOUVERED DOOR AIR INLET

COMPARTMENT ACOUSTICAL LINING

1. Be sure all joints and corners of the compartment are vapor tight to coach interior before lining with acoustical material.

Lining the compartment does little if opening, cracks, door and joints are not sealed. Also make sure compartment door edge is sealed to eliminate noise-air leaks around the door perimeter.

2. Cover the sound reflective surfaces, back, top and sides (not compartment base) with fiberglass or other noncombustible acoustical material. It should be no less than one inch thick and approximately two pounds per square foot in density. Be sure adhesive used is also noncombustible. Test acoustical material and adhesive for heat effects before using.
3. Rather than using one single material of two pounds per square foot density, a combination of

materials can reduce noise even more. For example, a sheet of lead or viscoelastic material of one-half to one pound per square foot density and a layer of one inch acoustical material of two pound per square foot density, respectively, is far superior.

4. To prevent line of sight noise, a sound panel (baffle) may be added behind louvered air inlet. The panel must be spaced to allow for minimum free air inlet of 85 square inches. See Figure 4.

WARNING *Separate installation area or compartment from living quarters by a vapor-tight wall to prevent entrance of noxious fumes to interior.*

WARNING *Insulation must not reduce the minimum clearances as specified in Figure 1 to meet ANSI 198.1 and CSA #946 temperature rise air requirements for recreational vehicles.*

Propane (LPG) Fuel System

GENERAL INFORMATION

Generator set operation using LP gas is very sensitive to altitude, temperature and BTU content of the LP gas. Variation in any one of these factors directly affects the performance of the generator set. Because of this, minor adjustment of the carburetor may be necessary.

Difficult starting is usually caused by slow cranking because of a weak battery. Cold temperatures (below 32°F -0°C) increase the load on the cranking battery at cranking speed. Low cranking speed in turn prevents proper intake vacuum for starting.

WARNING *LP gas, propane and butane are extremely flammable substances which MUST be handled with extreme care. Do NOT operate the generator set in an enclosed area. Do NOT smoke. All bulk tank(s) are pressurized but require vaporization to operate appliances or use as a vehicle engine fuel source. Keep a type ABC fire extinguisher handy.*

WARNING *Leakage of propane in or around the compartment is a serious fire hazard. The ventilation system should provide a constant flow of air to expel any accumulation of fuel vapor while the vehicle is in transit. Compartments must be vapor tight to the interior to keep fumes from within the vehicle.*

For operation below 32°F (0°C), Onan recommends the use of Commercial propane or HD-5 grade Liquid propane gas. Other grades of propane (LPG) that contain more than 2.5% butane may NOT vaporize in colder ambient temperatures.

PROPANE FUEL CONSUMPTION

It should be noted that under varying electrical loads, fuel consumption of engines for recreational vehicle generator sets varies accordingly. Average fuel consumption at various loads is shown in the table below.

PROPANE FUEL CONSUMPTION

Model	Load	Propane Consumption Gal/hr)
4.0BGAL	1/4	0.63
	1/2	0.80
	3/4	0.99
	Full Load	1.30

LPG FUEL FILTER AND SOLENOID VALVE

Onan liquid LPG generator sets contain a filter cartridge and magnet within the fuel solenoid valve to protect the solenoid valve and regulator valves from dirt and metallic particles. LPG fuel that has not been properly stored and transported may contain a large portion of contaminants. Always purchase propane from a reputable dealer. If the fuel filter becomes plugged, the generator set will operate erratically at heavier loads and/or in colder weather due to high fuel demand and lower tank pressure to push liquid propane through the filter in the fuel solenoid valve. Fuel solenoid valve and filter is shown in Figure 5. The "normally closed" propane fuel solenoid valve will open when the set is cranking or running. If the generator set stops for any reason the solenoid valve will close and remain closed.

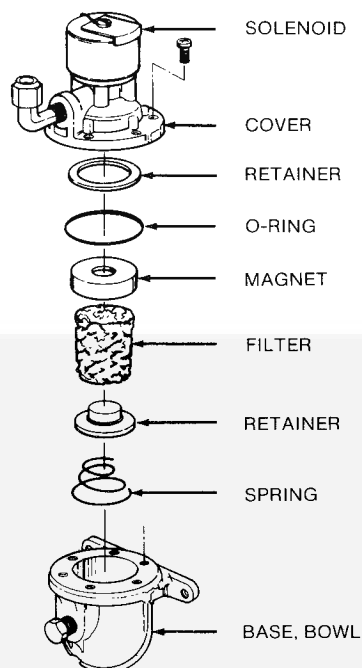


FIGURE 5. FUEL SOLENOID VALVE AND FILTER

PROPANE FUEL LINES AND SUPPLY TANK(s)

Figure 6 shows the flow diagram for the LPG liquid propane fuel system components used on this RV generating set.

WARNING *The installer must review all codes that apply to his installation. Paragraph 3-5.1 (Gas Piping Systems) of NFPA pamphlet 501C, deals specifically with propane fuel lines but*

does not necessarily cover all applicable codes and regulations. This pamphlet may be obtained from the address listed in the beginning of this manual.

IMPORTANT SAFETY CONSIDERATIONS WHEN WORKING WITH PROPANE (LPG)

- Always close the LPG tank shutoff valve when the engine is left unattended between use.
- Be sure LPG tank shutoff valve is closed before disconnecting tank from system.
- Ignition switch must be in OFF position prior to disconnecting any electrical wires.
- Check fuel system regularly for leaks. Use soap to locate leaks and recheck with soap after repairing leaks.
- LPG is heavier than air and settles in low places.

FUEL LINES

1. Install all propane fuel lines so they are accessible and protected from damage.
2. Use metal scraps without sharp edges to secure fuel lines.
3. Keep fuel lines away from hot engine or exhaust areas.
4. Do NOT run fuel lines in conjunction with electrical wiring.

Most propane (LPG) liquid withdrawal generator set installations are designed to share the vehicle propane fuel supply tank(s). The vehicle propane fuel supply tank MUST have a dip tube to ensure liquid withdrawal.

An excess flow valve MUST be mounted internal to the propane fuel supply tank(s) per NFPA 501C, Paragraph 3-4.4. This excess flow valve and propane fuel lines MUST be sized so the excess flow valve will

close with a completely severed (broken) propane fuel line. For operation at the lowest ambient temperature, a valve that is rated at 2.6 GPM (flow rate) and 6.5 PSI DIFFERENTIAL pressure is recommended. Consult the NATURAL LP GAS ASSOCIATION, Bulletin 113-78 for the limitations of excess flow valves.

A manual shut-off valve MUST be mounted on the propane fuel supply tank. This supply tank valve MUST be fully open when operating the generator set to ensure the excess flow valve will close with a severed (broken) propane fuel line.

A hydrostatic pressure relief valve MUST be installed between the propane fuel supply tank manual shut-off valve and the propane fuel solenoid valve and filter assembly.

This relief valve protects the propane fuel line from pressure build up if both the supply tank manual shut-off valve and the fuel solenoid valve are closed at the same time.

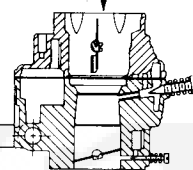
TESTING FUEL SYSTEM FOR LEAKS

The completed propane fuel system installation MUST be checked and tested for leaks before the generator set is operated. The fuel solenoid MUST be energized from a separate 12 volt DC source before testing the fuel system for leaks. The test MUST conform to procedures listed in NFPA-58, Paragraph 318, or UL recommended test procedure as follows:

After assembly and PRIOR to initial operation, all fuel system connections, hose, valves, regulators and fittings shall be tested and proven free of any leaks using a soap and water or equivalent solution while the system is under a gas or air pressure of NOT less than 90 PSI (0.62 mPa).

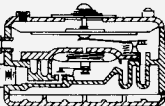
Other approved methods of detecting leaks may be used if appropriate. Tests shall NOT be made with a flame.

CARBURETOR
Venturi type with both a "Main" and "Idle" jet adjustments.



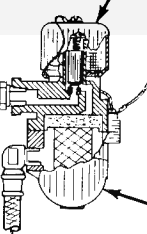
REGULATOR

Two stage design that will ONLY flow fuel when carburetor provides suction to fuel outlet.



SOLENOID VALVE

A "Normally Closed" valve which allows fuel flow ONLY when engine is cranking or running. This valve also back flows to prevent hydrostatic pressure build up in vaporizer and regulator.



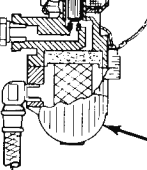
VAPORIZER

Changes propane fuel from a liquid state to a gas using exhaust manifold heat on generator set.



FUEL FILTER

Protects engine and fuel system components from contaminants. An internal magnet stops all magnetic particles that may collect on fuel lock solenoid plunger and foul its action or plug fuel filter.



Customer Supplied and Installed Hardware
Customer Must Satisfy UL1248 NFPA 58, CSA946,
CAN1-B149.2-78 and Any Local Codes That Apply.

PRESSURE RELIEF VALVE

Locate in vapor space internal to fuel tank. (Relief pressure between 274 and 375 PSI depending on tank specified and expected ambient).

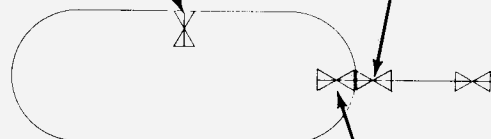
MANUAL SHUTOFF VALVE
Must Be Mounted on Tank

HYDROSTATIC RELIEF VALVE

Must be located after manual shutoff valve. Relief pressure between 400 and 500 PSIG MUST be properly vented.

FUEL TANK (Generator Set and Other Vehicle Appliances)
Must conform to ASME or dot and CTC standards. (Working pressure between 240 and 375 psi depending on tank selected).

INTERNAL EXCESS FLOW VALVE
Must Close with Complete Line Breakage. Consult National LP Gas Association Publication 113-78 For Limitations.



Pipings, Hoses and Fittings
Must be Approved For LPG Fuel
System Use.

FIGURE 6. FLOW DIAGRAM OF LPG "LIQUID" FUEL SYSTEM COMPONENTS

FS-1465

Exhaust System

Plan each individual exhaust system carefully. A proper installation is not only gas tight, but usually quieter, too. Be sure to check all applicable recreational vehicle standards, local codes and regulations.

IMPORTANT: Certain states (particularly California) have state ordinances pertaining to the type and usage of exhaust muffler/spark arresters on internal combustion engines or engine driven equipment when used in a recreational vehicle such as electric generating sets. Be sure your installation meets all Federal, State and local codes pertaining to your unit. Failure to provide and maintain a spark arrester may be in violation of the law.

WARNING

Plan the exhaust system carefully. Exhaust gases are deadly!

CAUTION

Do not connect the electric generating set exhaust to the vehicle exhaust system. Water vapor from one engine can damage the other engine.

1. Where the exhaust system passes through the base or floor, leave adequate clearance as protection against exhaust pipe damage from vibration (Figure 7). The metal around the hole should be turned up or some type of collar used to prevent oil from draining onto hot exhaust parts.
2. The exhaust system must be no closer than 1-1/2 inches from any combustible material, or be so

located, insulated or shielded so it does not raise the temperature of any combustible material by more than 117° F (65°C) above the ambient air inlet temperature.

3. The exhaust system must extend a minimum of one inch beyond the perimeter of the vehicle. If the generator set tailpipe is on the same side of the coach as the compartment, it should terminate aft of the air intake to prevent recirculation of exhaust fumes.

WARNING

Do not terminate poisonous carbon monoxide exhaust gas under vehicle. Direct exhaust gases away from window and door openings. Keep all openings above or to the rear of exhaust pipes closed when generator is operating.

4. Do NOT mount the exhaust pipe directly below the gasoline filler spout.
5. Use automotive type tail pipe hangers for hanging the exhaust system from vehicle undercarriage.
6. Position the clean-out plug within 45° of an imaginary line drawn vertically through the muffler (See "Muffler - Front View", below).

CAUTION

If tail pipe deflector is used, be sure it is large enough to prevent excessive back pressure.

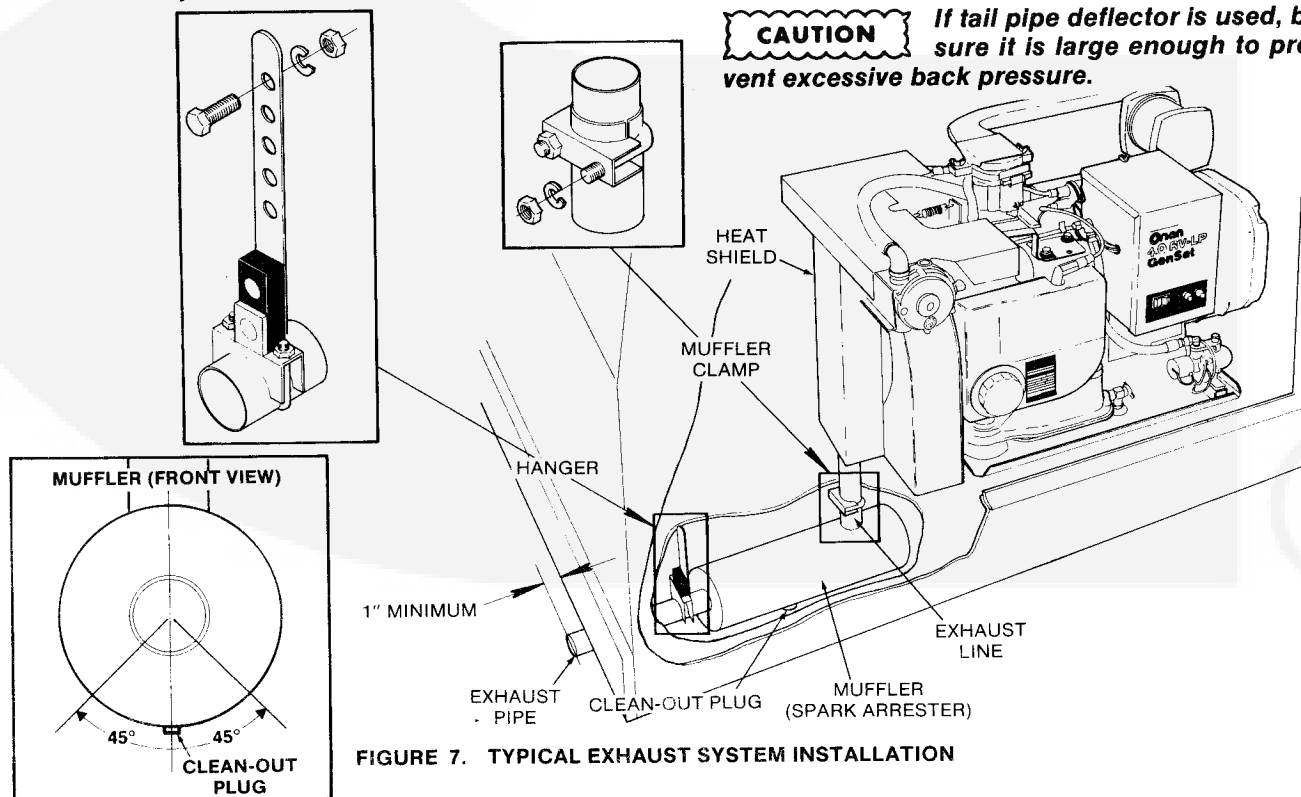


FIGURE 7. TYPICAL EXHAUST SYSTEM INSTALLATION

EXHAUST SPARK ARRESTER/MUFFLER

Exhaust spark arresters are necessary for SAFE OPERATION. All require periodic clean-out (every 5 to 100 operating hours) to maintain maximum efficiency. Some state and federal parks require them. To clean spark arrester remove 1/8" pipe plug in bottom of muffler. Run set under load for 5 minutes. Replace plug. Inspect exhaust system (visually and audibly) for leaks daily (at least every 8 hours of running time).

WARNING All exhaust shielding supplied with unit **MUST** be properly installed to prevent overheating of compartment wall or the possibility of fire.

WARNING Do NOT operate generator set if exhaust system is damaged or excessively noisy. Have it inspected and repaired immediately by an authorized Onan service center.

ASSEMBLY INSTRUCTIONS FOR INSTALLATION OF EXHAUST ACCESSORY

These exhaust shields and components **MUST** be properly installed to maintain the generator compartment temperature rise requirements within the limits of ANSI A 198.1 and CSA Electrical Bulletin #946 regulations and for proper operation of the generator set. The exhaust system must NOT raise the temperature of any combustible material by more than 117°F (65°C) above the ambient air inlet temperature. Proceed as follows:

1. After set is completely installed in generator set compartment, install the exhaust down pipe and asbestos gasket using 5/16-18 x 1-1/4 inch grade 5 bolts, lockwashers and nut supplied. Be sure to install asbestos gasket between exhaust manifold flanges to prevent leaks.

WARNING Be sure to install asbestos gaskets between exhaust manifold flanges to prevent leaks. Inhalation of exhaust gases might result in serious personal injury or death.

2. Install downpipe shield in place by engaging tab (on inside of shield) over the clamp screw (already positioned on downpipe). Downpipe must be positioned so that clamp screw is toward outside of down tube as shown in Figure 8.

CAUTION Do NOT clamp tab on shield between (under) clamp and down tube; tab may break off due to vibration.

3. Install and tighten top 1/4-20 x 1/2 inch locking head bolt through exhaust shield as shown in Figure 8.

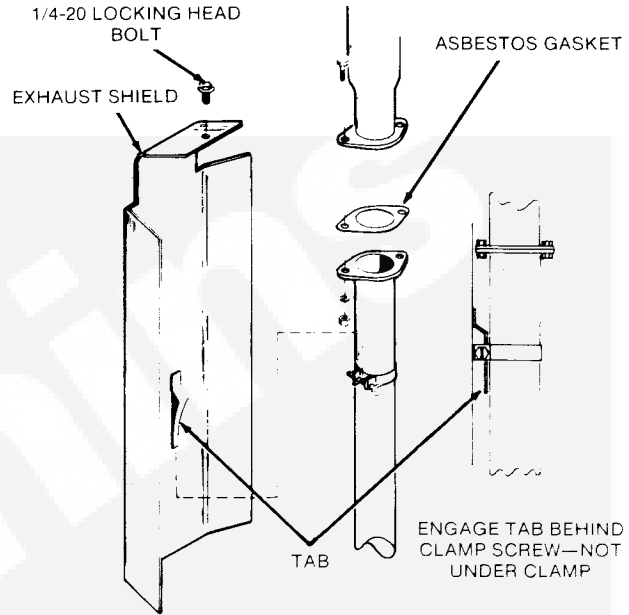


FIGURE 8. EXHAUST SHIELD TAB ENGAGEMENT

4. Recheck and tighten any loose bolts. If downpipe shield is loose, adjust steel clamp higher up on downpipe as shown in Figure 8. With tab properly engaged, tighten securely.

CAUTION Do not connect the electric generating set exhaust to the vehicle exhaust system. Water vapor from one engine can damage the other engine.

WARNING All exhaust shielding supplied with unit **MUST** be properly installed to prevent overheating of compartment walls or the possibility of fire.

5. Install and connect an approved spark arresting muffler to the downpipe on underside of compartment floor using shock-mounted hanger bracket and 1-5/8 inch automotive U-bolt type clamps ONLY. See Figure 8. Select the appropriate muffler required from Table 1 for the chassis involved.

Use only the UL/CSA approved mufflers listed in Table 1. Failure to use one of these mufflers will void the UL/CSA approval. Liability for damage or injury and warranty expenses due to use of unapproved mufflers becomes the responsibility of the person installing substitute muffler.

CAUTION Muffler and tailpipe hanger brackets should be mounted directly above the component being supported and NOT at an angle to prevent excessive vibration transfer to vehicle.

**TABLE 1. UL/CSA APPROVED
SPARK ARRESTER MUFFLERS**

ONAN PART NO.	MUFFLER STYLE
155-1258	End Inlet - Opposite End Outlet
155-1485	End Inlet - Same End Outlet
155-1520	Center Inlet - End Outlet

6. An exhaust tailpipe is NOT supplied because of variation in length requirements between Motor Home Manufacturers. After muffler is installed and prior to installing exhaust tailpipe, refer to the following recommendations for additional tips and safety considerations.

WARNING Do NOT use flexible exhaust tailpipe since it may break due to road shock and vibration.

WARNING Do NOT terminate exhaust system under the vehicle. Direct exhaust gases away from any window, door or compartment openings. Do NOT operate the generator set WITHOUT an exhaust tailpipe.

- Use 1-3/8 inch I.D. 18 gauge rigid steel tubing for tailpipe. Terminate exhaust to the rear of generator compartment air intake to prevent recirculation of exhaust gases. The tailpipe must extend at least one inch beyond the perimeter of the vehicle. Direct tailpipe down and away from vehicle.

- Install exhaust tailpipe at least 1-1/2 inches away from any combustible material or fuel tank location. Use suitable shielding if tailpipe routing is within 1-1/2 inches of combustible materials.
- Route the exhaust tailpipe as far as possible from any fuel tank. Do not terminate tailpipe near any fuel tank fill spout.
- Use 1-1/2 inch U-bolt type automotive muffler clamps and shock mounted hangers for supporting the exhaust system.

CAUTION The ONLY acceptable means of fastening the exhaust tailpipe to muffler is approved SAE 1-1/2 inch U-bolt type automotive muffler clamps.

7. Run the generator set for five minutes and check entire exhaust system (visually and audibly) for leaks or excessive noise.
8. Clean spark arrester muffler every 100 hours of operation. Remove 1/8 inch pipe plug in bottom of muffler and run set for five minutes. Then replace pipe plug. Inspect exhaust system (visually and audibly) for leaks daily (at least every eight hours of running time).

EXHAUST SYSTEM MODIFICATIONS

If exhaust downpipe needs to be shortened, slots must be cut in downpipe after pipe is cut.

Modifications of exhaust system (other than shortening of downpipe) will void the UL/CSA approval and warranty. Liability for damage or injury and warranty expenses due to any changes become the responsibility of the person making such changes.

Electrical Loads and Connections

All of the following description pertains to alternating current Onan electric generating sets for recreational vehicles.

1. All wiring must meet applicable local electrical codes. Have a qualified electrician install and inspect the wiring.
2. Wires must be adequate size, properly insulated and supported in an approved manner.
3. Mount switches and controls securely to prevent damage from vibration and road shocks. All switches must be vibration-proof to prevent accidental opening or closing while the vehicle is in motion.
4. Install an approved junction box for feeder conductors from the electric generating set. It must have a blank cover and be inside compartment (not on set).

WARNING *To prevent noxious gases from entering vehicle interior, seal any openings made in the set's compartment for conduit, wiring, etc.*

WIRE TYPES

Use multistrand wire which meets all applicable codes as feeder conductors, from electric generating set to compartment junction box. Many installers use multistrand wire throughout the vehicle to reduce the danger of breakage from vibration.

The conductors of the electric generating set shall have an ampacity not less than 115 percent of the nameplate current rating of the generator. Neutral conductors shall be the same size as the conductors of the outside legs.

Install generator load conductors in a flexible metallic conduit. Conduit must be connected either to the junction box on the compartment wall or to a panel board mounted on the outside of the compartment wall.

CAUTION *Do not use solid metal conductors in compartment. They may develop metal fatigue from set movement and eventually break.*

WARNING *Because of fire hazard, do not tie electrical wiring to fuel line.*

DISCONNECT SWITCH

The feeder conductors from the set compartment must terminate in a double-pole, double-throw positive off switch device for 120 volt operation before the vehicle distribution panel. This assures the outside power source cannot be connected simultaneously with the electric generating set. For 120/240 volt operation, a 3-pole, double-throw, positive off, switching device must be used. Neutral must be switched.

WARNING *Use only approved power supply assemblies. Never remove grounding pin from power supply assembly. Incorrect or no ground may cause the recreational vehicle to be electrically "hot."*

STARTING CONTROLS

Remote control Onan electric generating sets are designated by an "R" in the model number and allow the operator to start the set inside the vehicle. See operator's manual for more specific information.

LOAD CONNECTIONS

Generator set load wires M1 and M2 terminate within the junction box. Connect and join wires within junction box in an approved manner. See Figure 9.

On motor homes which have provisions for using outside AC utility power (separate from the electric generating set) the neutral as well as the "Hot" lead MUST be completely isolated from the motor home when load or power is switched.

The operation of a typical transfer device is shown in Figure 10. In addition to the transfer device, an over current protection device (circuit breaker or fuse) shall be provided between the transfer device and the AC circuit in the motor home. The generator set field has inherent overload protection when any overload is applied; frequency will sag which causes output voltage to drop and in turn the generator set field drops to zero voltage. A ground fault circuit interrupter should be installed in the wiring system to protect all branch circuits.

⚠ WARNING *Electrical shock can result in severe personal injury or death. Properly-applied and -maintained ground fault interrupters can afford additional protection against the hazard of electrical shock. Equip the recreational vehicle with adequate ground fault protection devices to meet the National Electrical Code NFPA 70, 551-7 (C).*

POWER REQUIREMENTS FOR APPLIANCES

Appliance or Tool	Approximate Running Wattage
Refrigerator	600-1000
Electric broom	200-500
Coffee percolator	550-700
Electric frying pan	1000-1350
Hair dryer	350-500
Electric stove (per element)	350-1000
Electric iron	500-1200
Radio	50-200
Electric water heater	1000-1500
Space heater	1000-1500
Electric blanket	50-200
Television	200-600
Electric drill	250-750
Battery charger	Up to 800
Electric water pump	500-600
Air Conditioner	1400-2200
Converter	300-350
Microwave oven	700-1500

Appliance or Tool	Approximate Running Wattage
Refrigerator	600-1000
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Coffee percolator	550-700
Electric frying pan	1000-1350
Hair dryer	350-500
Electric stove (per element)	350-1000
Electric iron	500-1200
Radio	50-200
Electric water heater	1000-1500
Space heater	1000-1500
Electric blanket	50-200
Television	200-600
Electric drill	250-750
Battery charger	Up to 800
Electric water pump	500-600
Air Conditioner	1400-2200
Converter	300-350
Microwave oven	700-1500

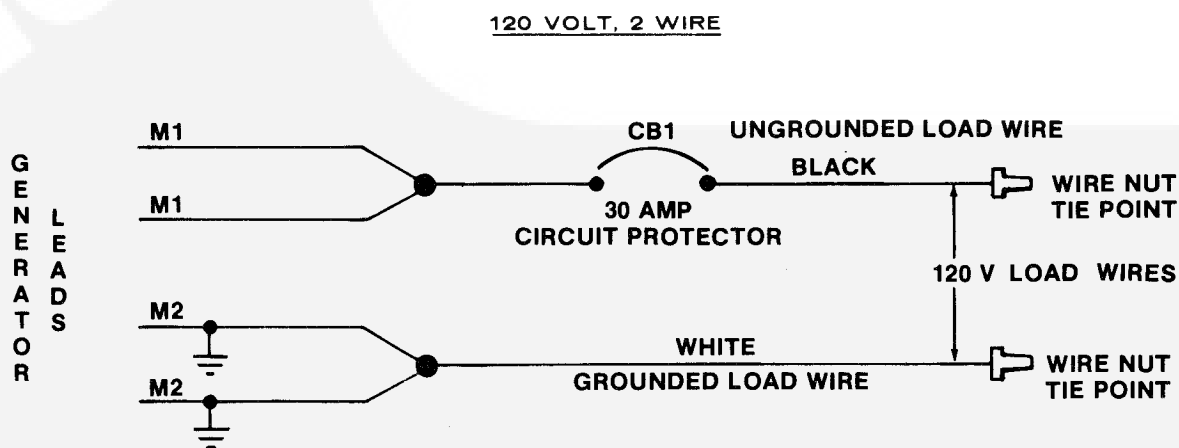
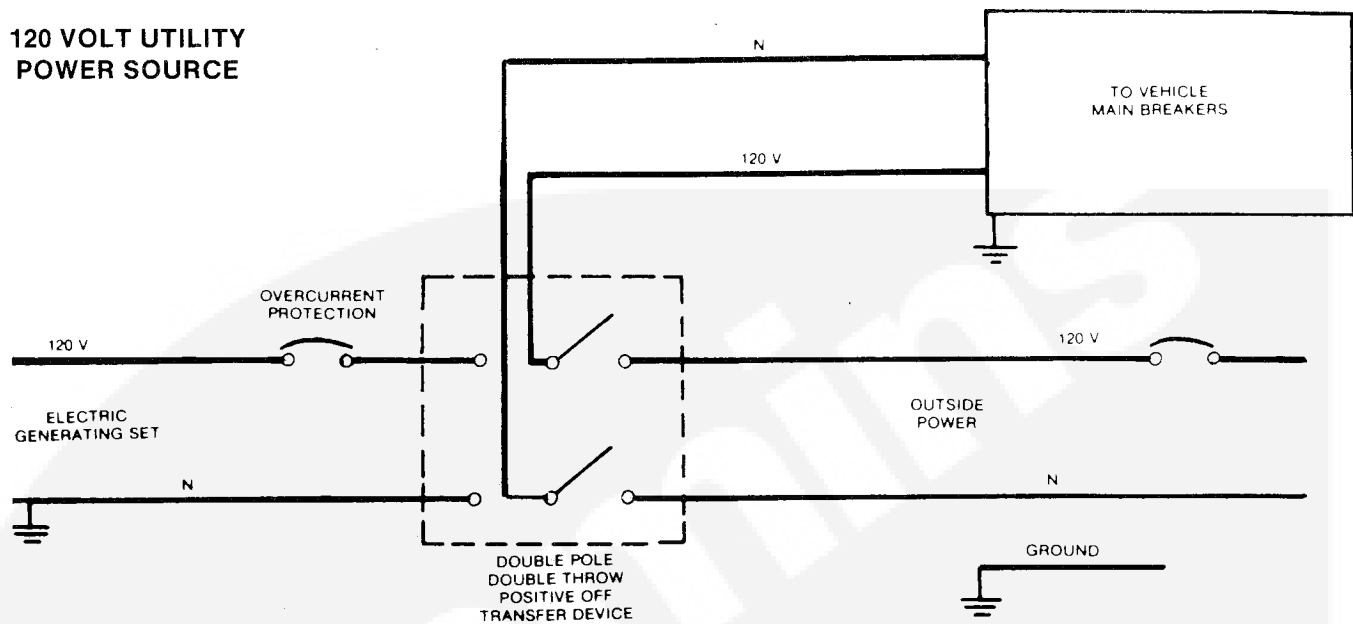


FIGURE 9. SINGLE-PHASE, "1R" VOLTAGE CODE GENERATOR CONNECTIONS

120 VOLT UTILITY POWER SOURCE



120/240 VOLT UTILITY POWER SOURCE

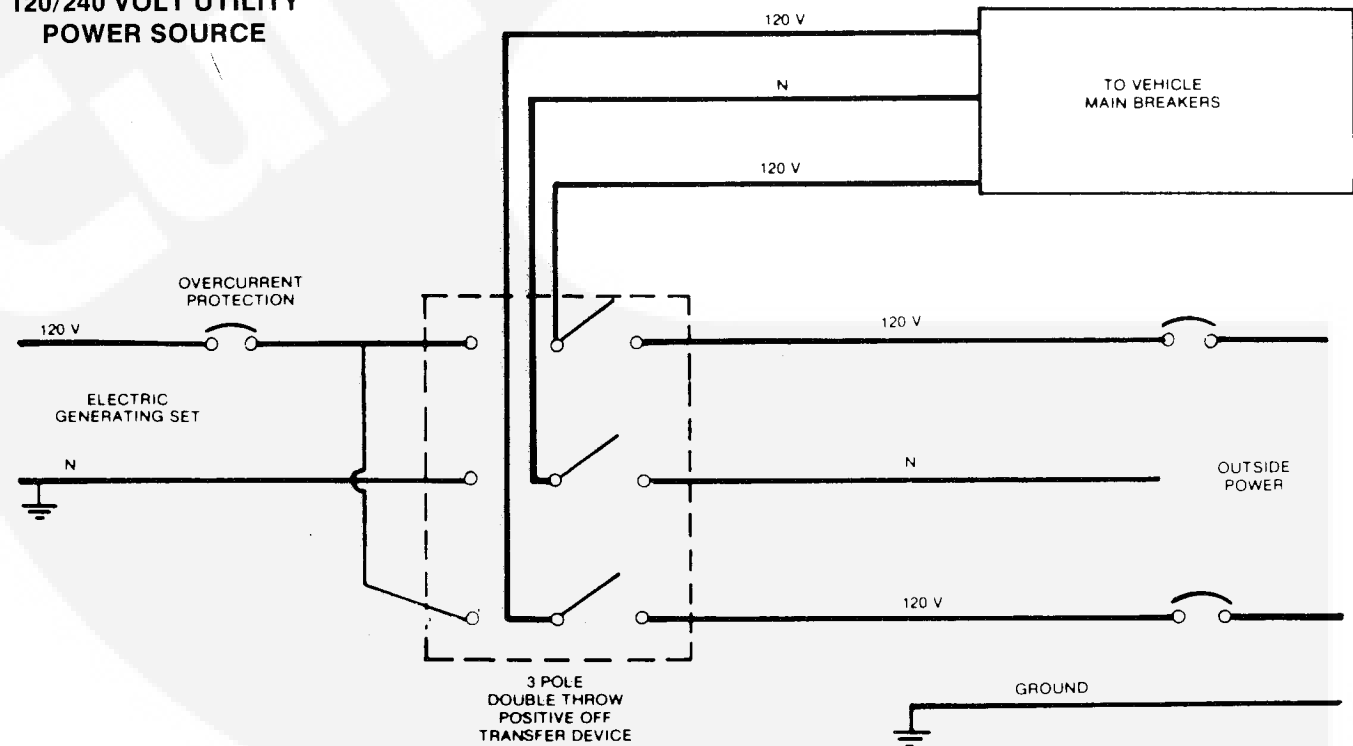


FIGURE 10. SCHEMATIC OF TRANSFER DEVICE AND OVERLOAD PROTECTION

Batteries

BATTERY CARE

To increase battery life, the operator can perform a number of routine checks and some preventive maintenance.

1. Keep the battery case clean and dry.
2. Make sure the battery cable connections are clean and tight. Use a terminal puller when removing cables for any reason.
3. Coat the battery terminals with a mineral grease or petroleum jelly to reduce corrosion and oxidation.
4. Identify each battery cable to be positive or negative before making any connection. Always connect the ground (negative) cable last.
5. Maintain the electrolyte level by adding water (drinking quality or better) as needed for filling to split level marker. (The water ingredient of the electrolyte evaporates, but the sulphuric acid ingredient remains. Therefore, add water, not electrolyte.)
6. Avoid overcharging when recharging. Stop the boost charge when the specific gravity is 1.260 and the electrolyte is 80°F (26.7°C).

WARNING *Do not smoke while servicing batteries. Lead acid batteries give off explosive gases while being charged.*

BATTERIES AND BATTERY CABLES

In order for the electric generating set to crank efficiently under various operating conditions, the battery and battery cables must be correctly chosen and installed. Before selecting a battery, be sure the installation area is compatible and properly designed. The compartment for the battery must provide:

1. Rigid mounting support.
2. A location where accidental acid spills or leaks won't damage set, battery cables, etc.
3. Provide a minimum of 1.7 square inches at top and 1.7 square inches at bottom of battery for ventilation purposes.
4. Battery cable entry points should be sealed (vapor tight) if they enter or pass through living area.

WARNING *Mount the battery in a separate compartment from the set or any spark-producing device to prevent fire or explosion.*

CAUTION *Never disconnect the battery with either engine running and never crank both engines simultaneously.*

BATTERY CABLES

For reliable starting, voltage drop from the battery terminals to the exciter cranking windings of the generator should not exceed 0.12 volts per 100 amperes of break-away current *while cranking*. Measure voltage at battery terminals and at start solenoid terminals *while cranking*. Disconnect spark plug wire during test. The battery cables in Table 2 will meet this condition if the grounding system is adequate. Connect the battery negative to ground with the same size cable as used for battery positive.

Be sure the frame connection (major frame member if possible) is sufficient to minimize resistance. Try to avoid a connection at a weld or mechanical joint.

For short distances, one negative battery cable can be used between set and battery rather than separate cables to chassis ground.

The 4.0BGAL draws 75-100 amperes of cranking current.

The break-away current is 300 to 400 amperes.

The charging current varies from 1-2 amperes depending on battery condition (state of charge).

For additional information on installation contact your Onan Service Representative or request *Technical Bulletin T-012* from Onan.

Onan recommends using a separate battery for operation of the generator set in addition to the regular vehicle starting battery.

TABLE 2. RECOMMENDED BATTERY CABLES FOR RELIABLE COLD WEATHER STARTING

*CABLE LENGTH IN FEET (metres)	CABLE SIZE
0-10 (0-3)	2
11-15 (3-4.5)	0
16-20 (4.5-6)	000

* - Distance from battery to set.

WARNING *Do not disconnect battery cables from battery while generator set is cranking or running; sparks may cause an explosion.*

Table 3. Minimum 12 Volt Battery Size*

Above 32° F (0° C)	Below 32° F (0° C)
360 Cold Cranking Amps (Approximately 70 Amp/Hr)	500 Cold Cranking Amps (Approximately 95 Amp/Hr)

* - Larger capacity batteries may be required if battery is also used to power other coach accessories.

Remote Accessories

INSTALLING STANDARD OR DELUXE REMOTE START CONTROLS

The standard control includes a start-stop switch and indicator lamp. The deluxe control contains these items plus a running time meter and a battery condition meter. Install as follows:

1. Select control location. Using Figure 11 or 12 as a guide, drill screw holes and cut hole to accommodate remote switch in dash panel.
2. Following national local electrical codes and using #18 or larger insulated wires of predetermined length, connect remote control to generator set. Ensure that leads from remote control connect to corresponding terminals on generator set. Refer to Figure 13 for wiring connections.

CAUTION Do not route DC wires for remote control through conduit containing AC load wiring. Induced voltages may cause erratic operation.

3. Insert remote control in hole cutout and secure with woodscrews supplied with switch.

WARNING Seal all holes that might allow noxious gases to enter motor home.

CAUTION Ensure that leads from remote switch connect with corresponding terminals on generator set.

For sets without remote connector plug, connect terminals 1, 2, and 3 to corresponding terminals on generator set terminal block. Connect terminal #5 (if used) to B+ (on terminal block) or to battery connection on start solenoid. This connection should be protected with a 5 amp fuse. Connect terminal #6 to positive terminal on ignition coil and protect with a 5 amp fuse.

4. When wiring is complete, check for proper operation by starting and stopping set at the set control and by the remote start switch.

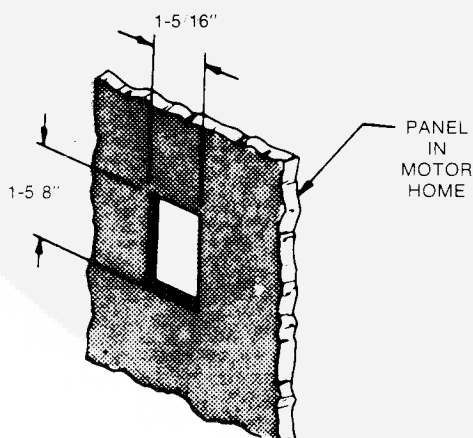


FIGURE 11. MOTOR HOME CUTOUT FOR STANDARD CONTROL PANEL

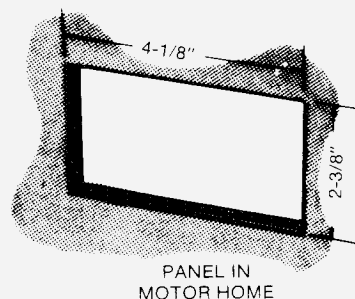


FIGURE 12. MOTOR HOME CUTOUT FOR PANEL DELUXE CONTROL

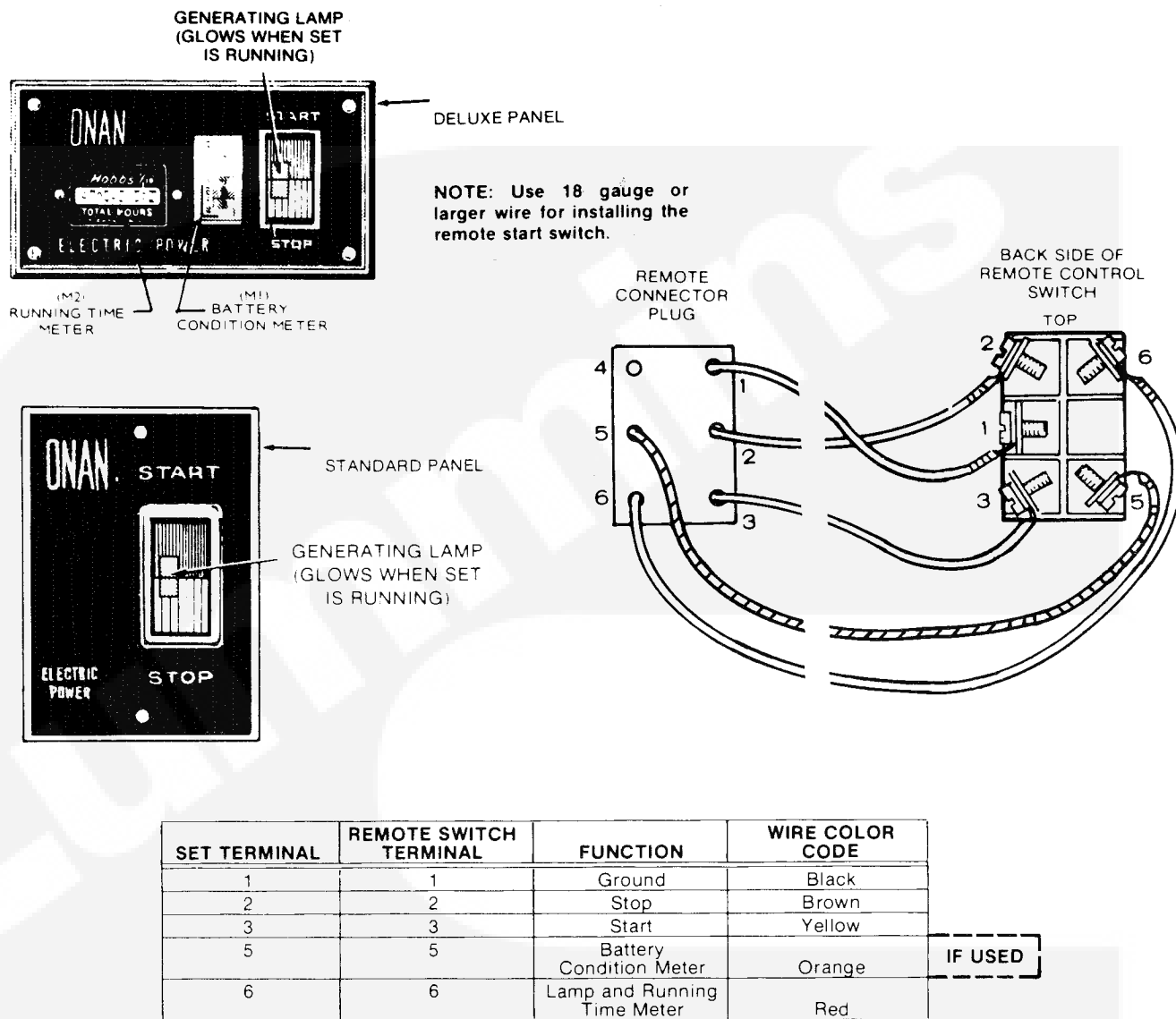
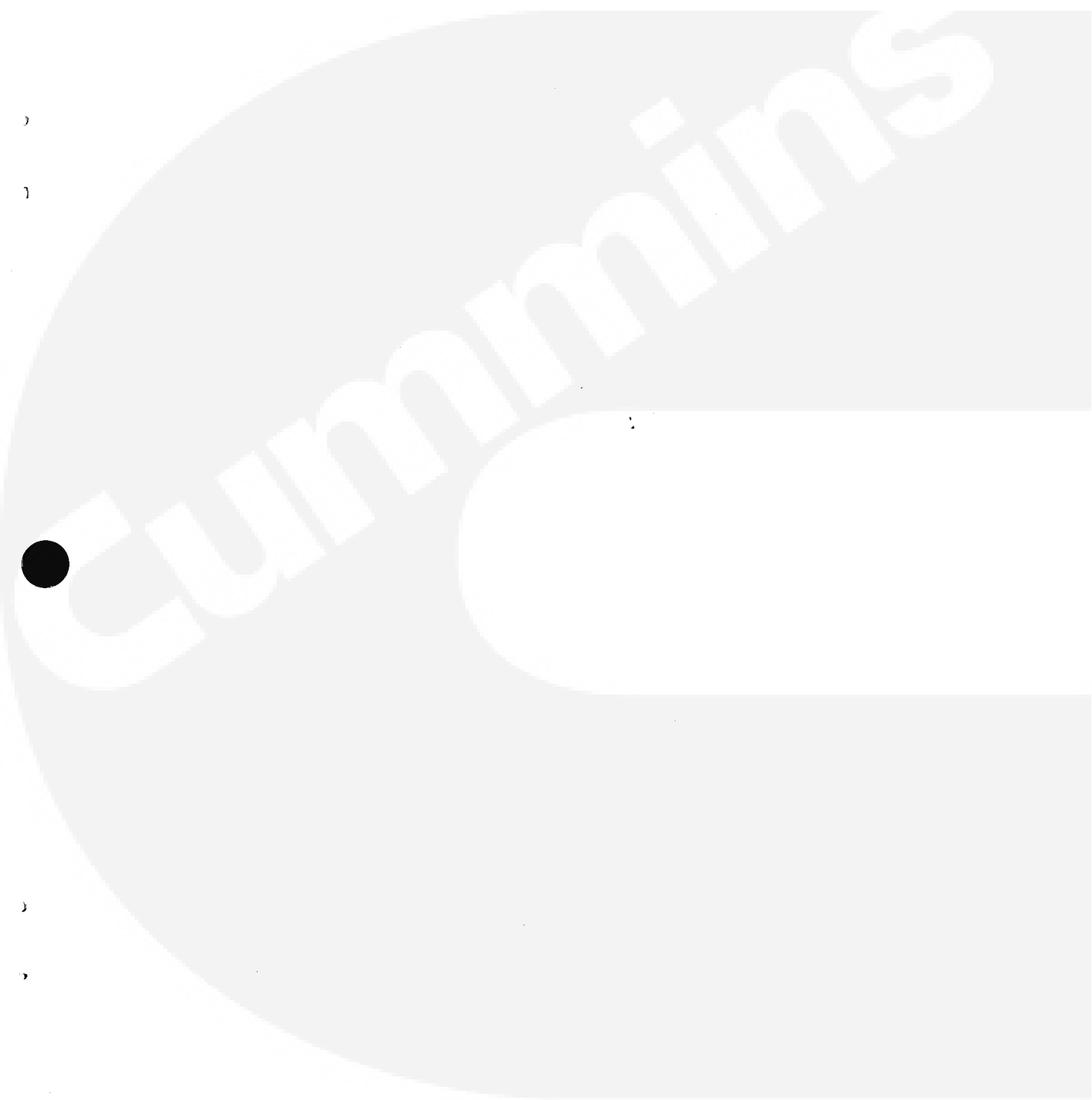


FIGURE 13. WIRING CONNECTIONS FOR REMOTE CONTROLS







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