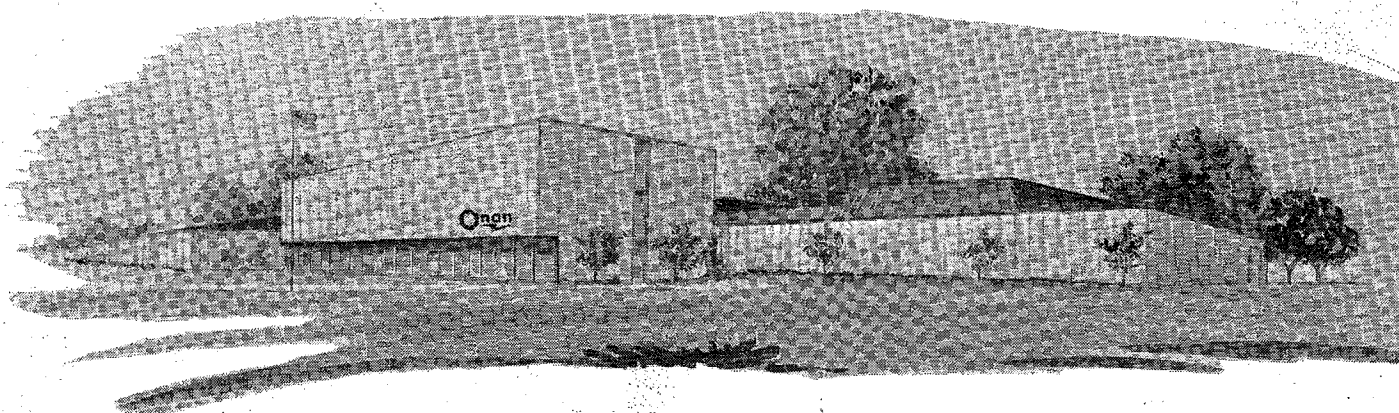


T-012

technical bulletin

APPLICATION OF ELECTRIC GENERATING SETS FOR RECREATIONAL VEHICLES



ONAN

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SAFETY PRECAUTIONS

The following symbols in this manual signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

WARNING Onan uses this symbol throughout this manual to warn of possible serious personal injury.

CAUTION This symbol refers to possible equipment damage.

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

- **Use Extreme Caution Near Gasoline. A constant potential explosive or fire hazard exists.**

Do not fill fuel tank near unit with engine running. Do not smoke or use open flame near the unit or the fuel tank.

Be sure all fuel supplies have a positive shutoff valve.

Fuel lines must be of steel piping, adequately secured and free of leaks. Use a flexible section of fuel line between generator set and stationary fuel line in the vehicle. This flexible section must be 100% NON-METALLIC to prevent electrical current from using it as a conductor.

Have a fire extinguisher nearby. Be sure extinguisher is properly maintained and be familiar with its proper 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.

- **Guard Against Electric Shock**

Remove electric power 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.

Jewelry is a good conductor of electricity and should be removed when working on electrical equipment.

Always use an appropriately sized, approved double-throw transfer switch with any standby generator set. **DO NOT PLUG PORTABLE OR STANDBY SETS DIRECTLY INTO A HOUSE RECEPTACLE TO PROVIDE EMERGENCY POWER.** It is possible for current to flow from generator into the utility line. This creates extreme hazards to anyone working on lines to restore power.

Use extreme caution when working on electrical components. High voltages cause injury or death.

Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician.

- **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 Toxic**

Provide an adequate exhaust system to properly expel discharged gases. Check exhaust system regularly for leaks. Ensure that exhaust manifolds are secure and not warped.

Be sure the unit is well ventilated.

- **Keep The Unit And Surrounding Area Clean**

Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

Do NOT store anything in the generator compartment such as oil or gas cans, oily rags, chains, wooden blocks, propane tanks, 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.

- **Protect Against Moving Parts**

Avoid moving parts of the unit. Loose jackets, shirts or sleeves should not be permitted because of the danger of becoming caught in moving parts.

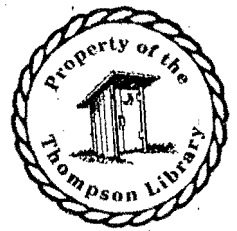
Make sure all nuts and bolts are secure. Keep power shields and guards in position.

If adjustments *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

Do not work on this equipment when mentally or physically fatigued.



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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.**

General

The requirements and recommendations throughout the bulletin are based on the:

1. National Electrical Code (Article 551).
2. ANSI/NFPA 501C.
3. Recommendations of Onan engineers, distributors, dealers and servicemen.
4. CSA Requirements (Bulletin #946).
5. UL Subject 1248. (ANSI A 198.1).

Besides requirements such as those of the National Electrical Code (NEC), Recreational Vehicle Institute, Inc., National Fire Protection Association, and CSA; follow all applicable state and local codes for mobile or recreational vehicles. All codes and recommendations are required of various Motor Home Manufacturers in conjunction with requirements for electric generating set installations listed above.

Due to various recreational vehicle chassis types and different installations, information given is quite general and must be adapted for particular installations. Refer to the appropriate operator's manual and installation guide for specific information on each generator set.

MODEL SELECTION

Size, weight, electrical characteristics, etc., are important when determining the correct Onan generator set for a given recreational vehicle application. However, read the entire bulletin covering cooling, fuel and wiring before making a final choice if the unit is expected to:

1. Deliver rated output when installed in compartment.
2. Start dependably.
3. Operate safely.
4. Be serviceable.

CONSIDERING LOAD APPLICATIONS

When determining the size of the generator set necessary for a given electrical load, consider the following points:

1. Total appliance loads to be used . . . refrigerator, water heater, water pump, etc. Note starting loads since they place higher demands than running loads. See Table 2.

Consider air conditioning loads separately since they are often the largest load in the recreational vehicle (see *Air Conditioning Loads*).

2. Loads which operate simultaneously.
3. Extra loads which might be added in the future.

AIR CONDITIONING LOADS

Probably the largest single load encountered for the electric generating set in a recreational vehicle installation is an air conditioner. Generator set sizing, more often than not, is dependent on the nature and characteristics of the air conditioner. Most air conditioners used are designed to operate from a commercial power source and can present problems to electric generating set. For this reason, care must be taken in selecting the set for air conditioning loads.

Current draw from any air conditioner is high while starting and becomes less as the air conditioner's motor reaches synchronizing speed. The instant the air conditioner's compressor starts pumping refrigerant, the load on the motor and current draw increases again. After the inside temperature of the recreational vehicle lowers, motor load and motor current draw declines. The air conditioner operates for some time and probably stops. Restarting the air conditioner, probably the largest single starting test for the generator set, is more difficult because the internal temperature of the air conditioner has

TABLE 1. ELECTRIC GENERATING SETS

MODEL	ELECTRICAL CHARACTERISTICS					WEIGHT (Lb)
	WATTS	VOLTS	AMP	PHASE	WIRE	
3.0 AJ	3,000	120	25	1	2	160 (73 kg)
4.0 BFA	4,000	120	33.3	1	2	235 (106 kg)
5.0 BGA	5,000	120/240	41.6/20.8	1	3	282 (128 kg)
6.5 NH	6,500	120/240	54.2/27.1	1	3	305 (138 kg)

* - Can be two-wire connected for rated output at 120 volts or three-wire connected for 120/240 volts. Higher ampere rating shown is for 120 volts.

become much higher. With these points in mind, use the set selection procedure following.

1. Determine the running watts of each air conditioner from the nameplate. For operation in 100°F ambients, add 300 watts to the running watts. See Table 3.
2. Select the electric generating set from Table 4. It gives the available accessory load in watts of each set while starting various air conditioners in ambients up through 100°F.

Available accessory load will vary from installation to installation. Factors affecting this amount are altitude, carbon and lead buildup in engine, ambient temperature, compartment cooling system design, type of air conditioner and its starting time. Some can be compensated for by derating to assure the set and air conditioner operate properly. See steps 3 and 4.

3. Carbon and lead deposits in the set engine require a 10 percent derating if not removed after each 500 hours of operation.

NOTE: All air conditioner data included in this bulletin is based on air conditioners using capacitive start ONLY. Use of air conditioners with solid state starting aids when operating from engine generator set is not recommended.

A carburetor air preheater kit is available for cold weather operation—below 45°F (7°C), which helps prevent carburetor icing. Order Kit No. 140-1673.

TEMPERATURE AND ALTITUDE DERATION

Lower density air caused by higher altitudes and/or higher ambient temperatures can cause engine power loss and lower generator cooling capabilities for your gasoline fueled "RV" set.

One percent deration (Nominal) for every 10°F rise in ambient temperature above 85°F can be expected.

Four percent deration (Nominal) for every 1000 foot increase in altitude above 1000 feet can also be expected.

**TABLE 2.
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

TABLE 3. TYPICAL AIR CONDITIONER LOADS

BTU AIR CONDITIONER	ONE AIR CONDITIONER'S LOAD (Watts)
11,000	1800
12,000	2000
13,500	2200

TABLE 4. ELECTRIC GENERATING SET STARTING CAPACITIES (100°F Ambient) AND AVAILABLE ACCESSORY LOADS*

SERIES	Available Accessory Load (Watts) While Starting One Air Conditioner		Available Accessory Load (Watts) While Starting Two Air Conditioners**	
	One AC		Two AC	
	11,000 BTU	13,500 BTU	11,000 BTU	13,500 BTU
3.0 AJ	1900	1400	Not Recommended	
4.0 BFA	3500	3000	Not Recommended	
5.0 BGA	4000	3500	2400	2000
6.5 NH	5100	4900	4200	3000

* - Available accessory loads based on typical values for recreational vehicle air conditioners from Table 3 and set capacities.

- Add 500 watts to available accessory load after vehicle interior cools to 80°F.

** - Simultaneous starting.

Location

COMPARTMENT LOCATION

Compartment location is determined largely by:

1. Physical size.
2. Access opening.
3. Mounting support . . . most important of all.
4. Restrictions due to FMVSS-301 (applicable to vehicles under 10,000 lbs. gross weight).

Physical Size

The area in the vehicle for the electric generating set must be large enough for the compartment with minimum clearance between the generator set and compartment walls or ceiling (and acoustical material, if used) as specified by Onan in each individual installation guide.

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 (Figure 1). Channel, box or angle iron can be used for a compartment frame with a sheet metal cover. Compartment floor must be metal.

The compartment can be supported from above when the unit is below the level of the recreational vehicle main frame members. However, compartment structural design must be rugged enough to withstand severe forces in all directions.

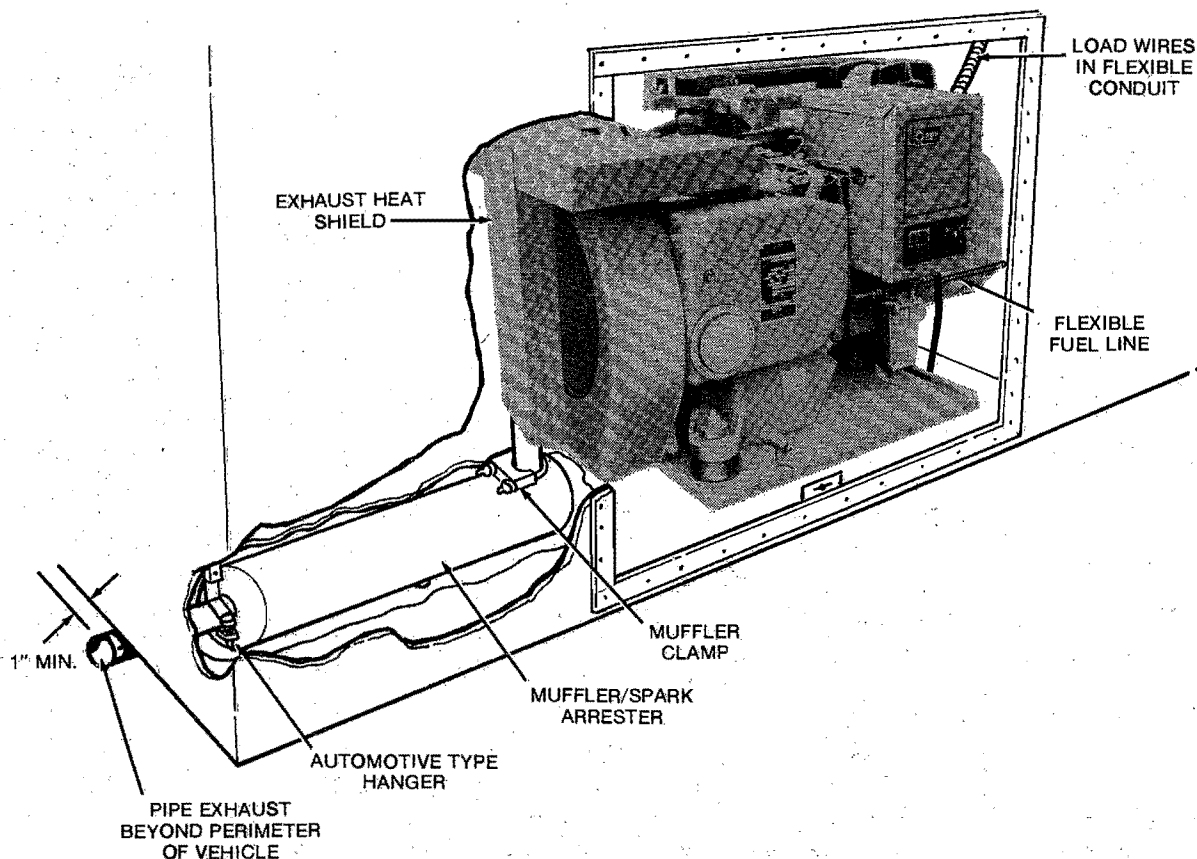


FIGURE 1. TYPICAL ELECTRIC GENERATOR SET INSTALLATION

COMPARTMENT

1. Install the generator set in its 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. Line the compartment or separate generator set from living quarters with a fire barrier of galvanized steel (22 gauge minimum) or other noncombustible material of equivalent quality and strength. The compartment must also be sealed (vapor tight) to prevent entrance of noxious fumes to the motor home interior. The compartment concept lends itself easily to sound or acoustical treatment.

WARNING

Do not use flammable material directly above or around the generator set compartment. Heat transferred through the sheet metal compartment structure or other material can be high enough to discolor, char or ignite fiberboard, seat cushions, etc.

3. Clearance between compartment walls or ceiling (and acoustical material, if used) and set should be as specified in individual *INSTALLATION* guide. For models with generator cooling inlets on the generator end, make sure adequate clearance (one inch minimum) is left for entrance of cooling air. Refer to individual installation guides for each set.
4. Compartment bottom must have minimal openings to reduce entrance of road dirt.
 - A sheet metal base plate is desirable. However, plywood of sufficient thickness for strength can be used if covered with sheet metal for protection.
 - Equip base with a oil drain hole to outside of compartment.

WARNING

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

- DO NOT use absorbent material on inside of compartment floor.
5. Compartment floor must be so constructed as to prevent accumulation of oil, fuel or water in any corner. Drainage must be accomplished through the use of a 1/2 inch diameter hole near each corner or other suitable means.
 6. 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

Before actual mounting of the generator set takes place, read the individual installation guide for that model. Also, consider the following mounting points:

1. Air cleaner should be easy to remove.
2. Battery or batteries must be accessible.
3. Oil fill, drain and oil dipstick should be easy to reach and service.
4. Sufficient clearance must be left around exhaust system. See *EXHAUST* section.

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.

Ventilation and Acoustics

The most important factors of ventilation for an air-cooled RV 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 2).

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.

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. While figures

TABLE 5. RV ELECTRIC SET AIR REQUIREMENTS*

RV SERIES	RPM	AIR DISCHARGE (Cu.Ft./Min.)	MIN. FREE AIR INLET, NO RESTRICTION (Sq. In.)	MIN. AIR OUTLET SIZE (Scroll Opening)
3.0 AJ	3600	325	50	5.38 x 7.75
4.0 BFA	1800	480	85	4.25 x 13.25
5.0 BGA	1800	480	100	4.25 x 13.25
6.5 NH	1800	570	120	4.0 x 9.69

* - NH "Power Drawer" model has a fixed air inlet and-outlet.

NOTE: Allow for airflow restrictions due to elbows in a duct, etc.

for air discharge are given in Table 5, special equipment is needed to measure it. Since the discharge area can't be changed, air inlet opening is critical. Table 5 also gives the total free inlet area recommended.

Restricted Air Openings

Expanded metal, screen or sheet metal with louvers or slots 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 example as a guide.

Example: Unrestricted air inlet requirements for a generator set is 140 square inches. The compartment door louvers provide 85 percent free inlet area per square foot. Divide 140 square inches by 0.85 (85 percent) to determine necessary inlet area.

$$\frac{140 \text{ sq. in.}}{0.85} = 165 \text{ sq. in.}$$

Air Inlet Location

If possible, always locate the air inlet on the side of the vehicle and as high as possible to minimize entrance of dirt and dust. With a rear air inlet, the generator set often has difficulty moving sufficient cooling air through the compartment, due to the vacuum created behind the vehicle during transit.

SUGGESTIONS FOR QUIETER OPERATION

Two general types of noise encountered with a generator set for recreational vehicles are airborne and structural vibration noise. Most structural vibration noises can be reduced by vibration isolators, skin dampers, in the form of lead-filled plastic or other

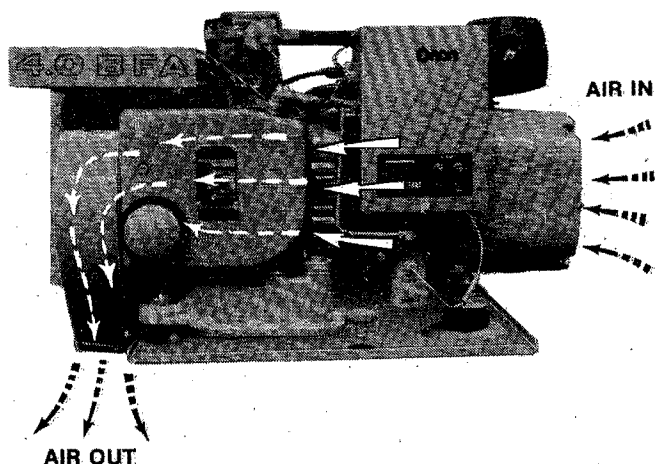


FIGURE 2. TYPICAL ONAN RV COOLING SYSTEM

high-density attachable materials, flexible fuel and electrical connections, etc. Compartment acoustical lining and special compartment design can usually reduce airborne noises.

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 pound 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 more superior.

WARNING Insulation must not reduce the minimum clearances required to meet ANSI 198.1 and CSA #946 temperature rise requirements for recreational vehicles.

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 as shown in Table 5.

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

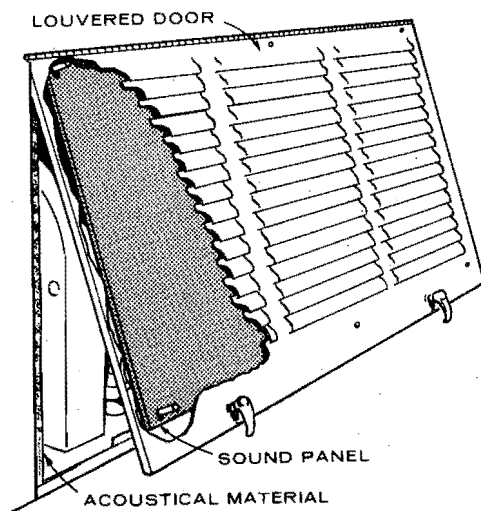


FIGURE 3. BAFFLE CONCEPT COMPARTMENT

Compartment Design

Compartments can be designed to prevent line-of-sight noise radiation. Four types of compartment designs are discussed:

1. Baffle concept.
2. Shelf concept.
3. Panel concept.
4. Z-duct concept.

The baffle concept is accomplished by mounting a panel on the inside of a louvered service door (Figure 3). The panel must be spaced to allow for free inlet airflow, yet not allow line-of-sight to the generator set. Often this compartment does not lend itself to effective noise reduction because the louvers in the door extend beyond the panel's edges.

Shelf-concept compartments are effective because they allow more acoustical material to be used on the air inlet. The incoming air goes past the unit and must make one 90-degree turn before entering the compartment proper (Figure 4). Available space above or beside the generator set determines the depth of the shelf. Depth of the shelf must not restrict airflow.

However, due to space limitations, the shelf-concept is seldom possible. For such instances the panel concept can be used (Figure 5). It requires very little room and prevents line-of-sight to the noise source.

One of the most effective compartment designs is the Z-duct concept. Incoming air must make at least one 90-degree turn (usually two) before it enters the compartment. See Figure 6. Depth of the duct must be determined to allow for inlet air and still allow for clearance between the generator set and the back

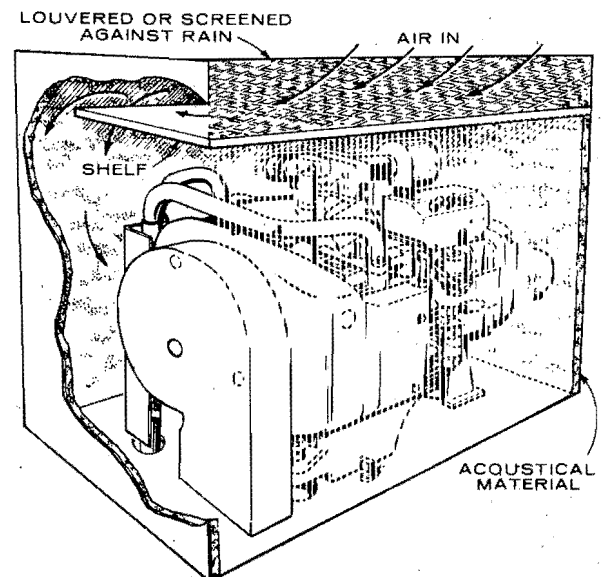


FIGURE 4. SHELF-CONCEPT COMPARTMENT

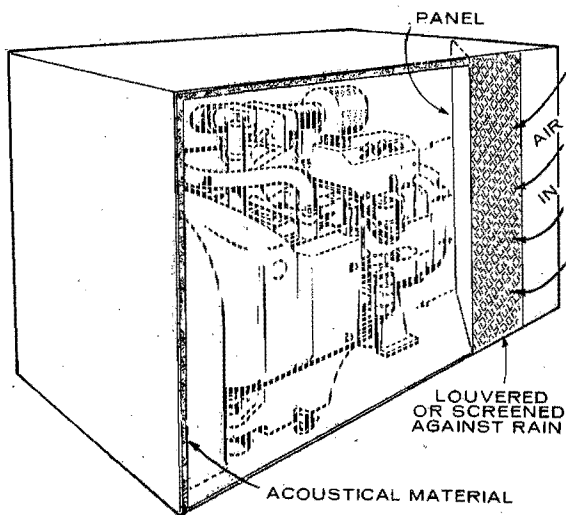


FIGURE 5. PANEL-CONCEPT COMPARTMENT

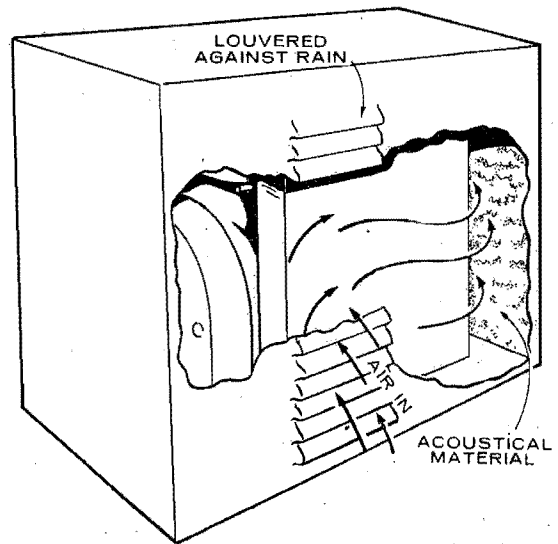


FIGURE 6. Z-DUCT CONCEPT COMPARTMENT

side of the duct and acoustical material, where applicable. Acoustical material lining inside the duct, if used, must not restrict airflow.

Air Outlet Duct

Noise of discharged air from the compartment can be

reduced by adding a duct (Figures 3 through 6) to direct the airflow under the vehicle. For most effective acoustical treatment, line the duct with acoustical material which is resistant to oil or gas absorption, and is fire resistant. Ducting or acoustical treatment material must not restrict discharge airflow from the set.

Fuel System

RECOMMENDED FUEL

Use clean, fresh, unleaded or regular grade gasoline. Do not use highly leaded premium fuels. Using unleaded gasoline results in reduced valve and carbon cleanout maintenance.

If the use of unleaded gasoline is desired, use regular gasoline for the first 25 hours to allow the rings to seat well for best performance. Then use unleaded gasoline thereafter.

If regular gasoline is used continually, carbon and lead deposits must be removed from the cylinder heads as required because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

Most Onan recreational vehicle gasoline generator sets have electric fuel pumps as standard. The other recreational vehicle models have mechanical fuel pumps. Choice of fuel pump type used is primarily for prevention of vapor lock.

WARNING

Leakage of gasoline in or around the compartment is a definite 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.

Gaseous Fuel

This fuel does have some advantages over gasoline, but Onan does not use (on AC RV models) and does not recommend gaseous fuel operation for the following reasons:

1. Complex installation—requires special lines, solenoid valve, strainer, regulators, gauges, etc.
2. High installation costs.
3. Usually limited bulk fuel availability.
4. Set capacity limited by physical size of tanks.
5. Lower engine power.
6. Poor and erratic low temperature starting and operation.

FUEL CONSUMPTION

It should be noted that under varying electrical loads, engines for recreational vehicle generator sets can use up to the fuel consumption figures shown in Table 6 for rated output.

TABLE 6. FUEL CONSUMPTION

RV UNIT	GALLONS/HOUR (Rated Load)
3.0 AJ	0.81
4.0 BFA	0.88
5.0 BGA	0.90
6.5 NH	1.30

If the vehicle fuel tank is shared, design the fuel tank withdrawal system to insure the set cannot use the entire supply.

FUEL LINES AND FUEL FILTERS

Fuel Lines

1. Most electric generating set installations are designed to share the vehicle fuel supply tank with the vehicle engine. All connections to vehicle fuel system must be in accordance with chassis (vehicle) manufacturers' detailed installation instructions.
2. Install an approved flexible non-metallic and non-organic fuel line between the vehicle fuel system and the engine to absorb vibration.
3. Use of seamless steel tubing and flared connections are recommended for long runs between the fuel tank and the flexible connector to the generator set.
4. Run fuel lines at the top level of tank to a point as close to the engine as possible to reduce danger of fuel siphoning out of tank if the line should break.
5. Keep fuel lines away from hot engine or exhaust areas. This reduces chance of vapor lock.
6. Flexible line must be long enough to allow for 4 inches of set movement to prevent binding, stretching or breaking because of set movement.
7. Install lines so they are accessible and protected from damage.
8. Use metal straps without sharp edges to secure the fuel lines.
9. Do not run fuel line in conjunction with electrical wiring.

Fuel Filters

Onan electric generating sets with electric fuel pumps have phenolic or screen filters within the fuel pump itself. Additional filters in the fuel line are unnecessary unless unusual operating conditions exist.

Operating the generator set from a tee in the main fuel line can cause erratic operation when vehicle is operated at highway speeds. The set's fuel pump has neither the capacity nor the power to overcome the draw of vehicle engine fuel pump.

GASOLINE EVAPORATIVE CONTROL SYSTEMS

With the increasing emphasis on pollution controls, certain states are now requiring strict evaporative controls on vehicle gasoline supply systems. Manufacturers of RV chassis and vehicles in general have complied to new regulations for these areas by using special design gas tanks, filler tubes, filler gas caps and interconnecting vapor tubing from the vehicle gas tank through a special canister to the vehicle engine.

Because these systems are designed to operate in a critical pressure range, it is very important during connection of an electric generating set and building of the motor home, etc., the vehicle manufacturer's fuel supply design not be altered. The filler tube, fill limiter vent, canister, vapor lines and gas fill cap should not be changed, removed or replaced unless receiving recommendations and approval from the vehicle manufacturer. If not, serious vehicle engine and generator set operating conditions could result.

WARNING

ENGINE EXHAUST GAS (CARBON MONOXIDE) IS DEADLY!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Exhaust System

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

WARNING

Plan the exhaust system carefully. Exhaust gases are deadly!

CAUTION

Do not connect the generator 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. The metal around the hole should be turned up or some type of collar used to prevent gas or 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 after the generator set has run at full load for one hour. Clearance varies for each set. Refer to individual installation guides.
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 and reduced output.

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 set is operating.

4. Exhaust pipe must terminate a minimum of three feet from the vehicle gasoline filler spout (more distance if required by local codes).
5. Use the largest possible radius elbows on the exhaust lines and as few elbows as possible. If not, the system might create high back pressure.
6. Use automotive type tail pipe hangers for hanging the exhaust system from vehicle undercarriage.

CAUTION

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

7. Clean spark arrester muffler every 100 hours of operation. Remove 1/8" pipe plug in bottom of muffler and run set under load for 5 minutes. Then replace pipe plug. Check exhaust system (visually and audibly) for leaks daily (at least every 8 hours of running time).

EXHAUST SYSTEM MODIFICATIONS

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

Modifications of exhaust system (other than shortening of down pipe) 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.

EXHAUST SPARK ARRESTERS

Exhaust spark arresters are necessary when operating in some parks and campgrounds. Two basic types are used in the recreational vehicle industry. One is the spin-out type spark arrester, the other is a screen type spark arrester. All require periodic clean-out (every 50 to 100 operating hours) to maintain maximum efficiency. Onan supplied spark arresters are the spin-out type integral with the muffler.

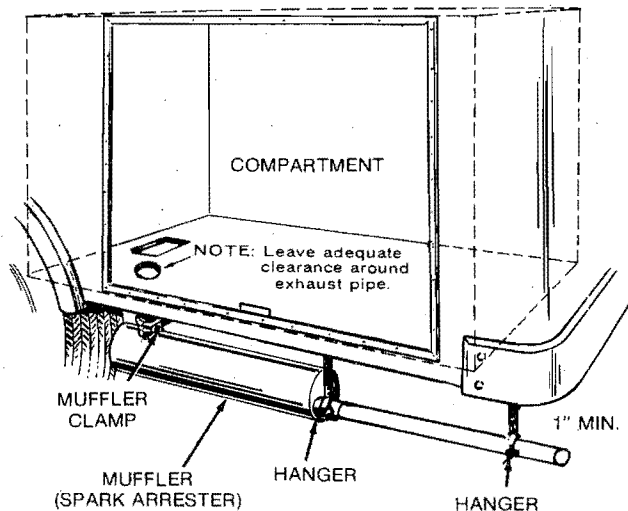


FIGURE 7. TYPICAL EXHAUST SYSTEM INSTALLATION

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.

Spin-Out Type Spark Arrester

This type removes carbon particles by centrifugal force, catching the particles in a holding chamber. Removing a pipe plug from the arrester and operating the generator set (at a convenient time and place) cleans out the deposits. It is important to note this

arrester does not plug up when the holding chamber is full and does not cause harmful, high exhaust back pressure. When full, particles pass through the arrester.

Screen Type Spark Arrester

This arrester has a screen which traps carbon particles as they pass through. The screen is removed, cleaned or replaced after it has filled. A disadvantage of this type is the screen plugs as it collects the particles and gradually increases exhaust back pressure. Back pressure causes a loss of engine power and can cause burned or damaged valves if pressure is high enough. It is very important this type be cleaned as recommended.

WARNING

On all listed models with exhaust shielding supplied with unit, shielding **MUST** be properly installed to prevent overheating of compartment walls or the possibility of fire. Refer to appropriate installation guide for each model for details.

WARNING

Onan does **NOT** recommend the use of screen type spark arresters. A screen type spark arrester, if not properly maintained, may plug up, creating exhaust back pressure and higher temperatures which increases the risks of fire and carbon monoxide asphyxiation.

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. Use tight fitting grommets or other suitable means.

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 generator set conductors must be able to carry at least 115 percent of the generator nameplate current (amperes). Neutral conductors must be the same size as the conductors of the outside legs.

Supply conductors from the electric generating set to the junction box on the compartment wall must be installed in flexible conduit.

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. Protect all external outlets.

RECOMMENDED TRANSFER MECHANISMS

An economical manual, positive-off transfer mechanism is a receptacle for the generator set in the compartment. An approved power cable connected from the load, plugs into this receptacle or the park utility power receptacle. This ensures both sources are NOT connected simultaneously.

An alternative to the receptacle is a manual, positive-off type transfer switch. The positive-off switch allows residual voltages of inductive loads (motors, etc.) to decay before switching to the other power source.

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."

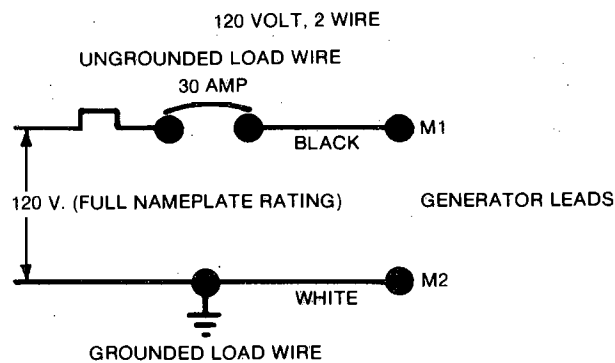
LOAD CONNECTIONS

Generator set load wires M1, M2, M3 and M4 terminate within the junction box. Connect and join wires within junction box in an approved manner for desired voltage code. See Figure 7A.

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.

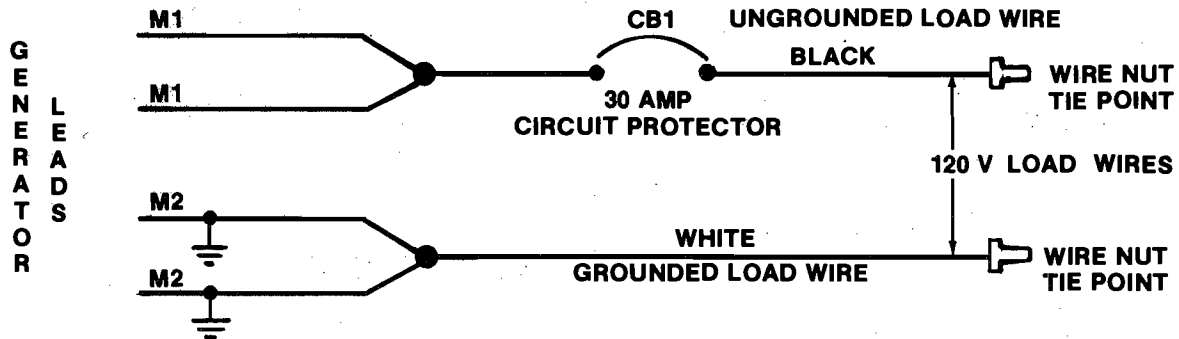
The operation of a typical transfer device is shown in Figure 8. In addition to the transfer device, an over current protection device (circuit breaker or fuse) shall be provided between the transfer device and the AC circuit in the motor home. The generator set field has inherent overload protection 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 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."



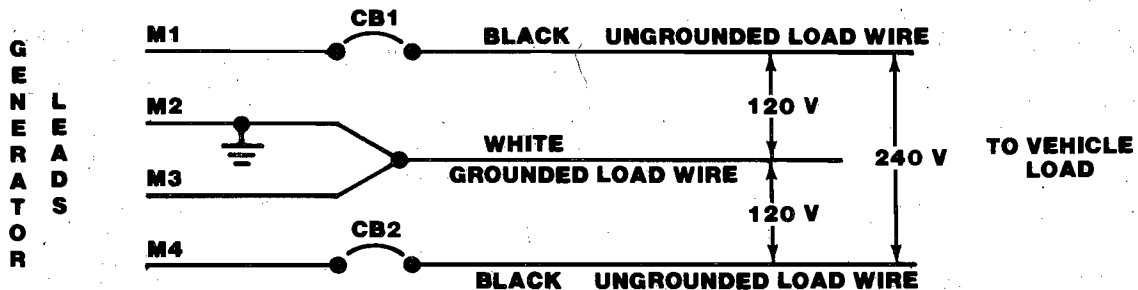
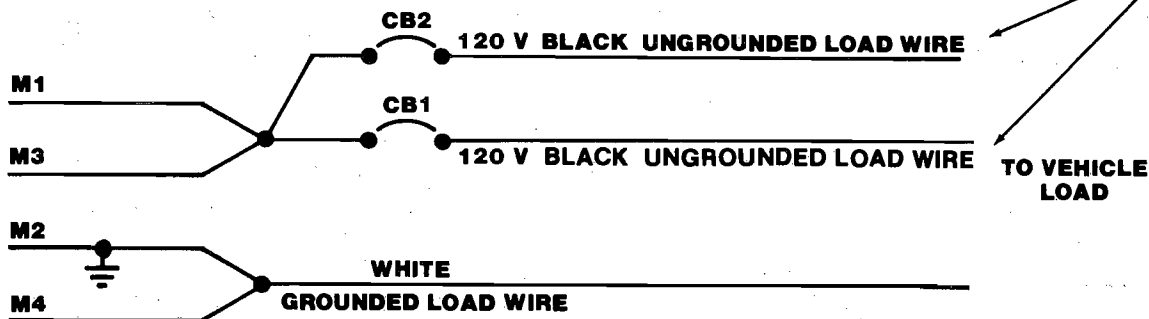
3.0AJ SINGLE-PHASE, "IR" 120 VOLT CONNECTIONS

120 VOLT, 2 WIRE



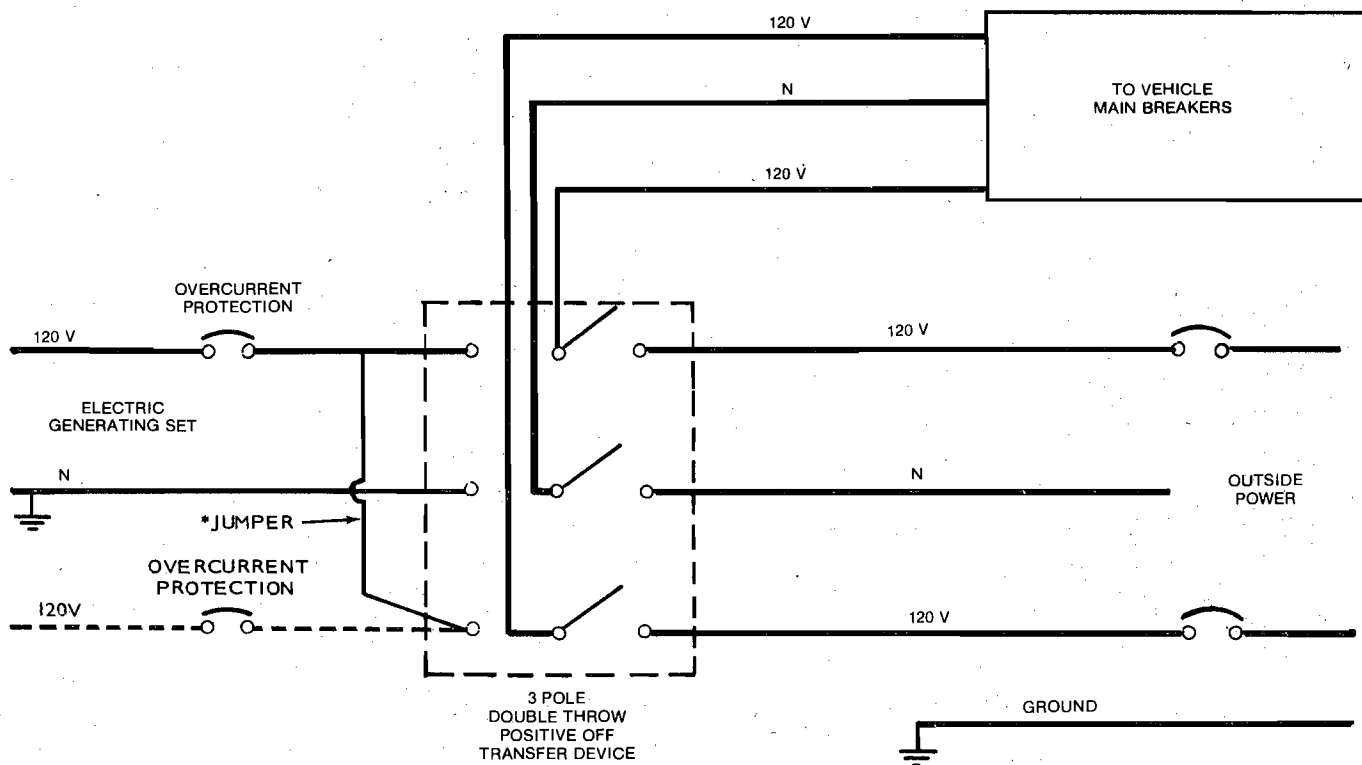
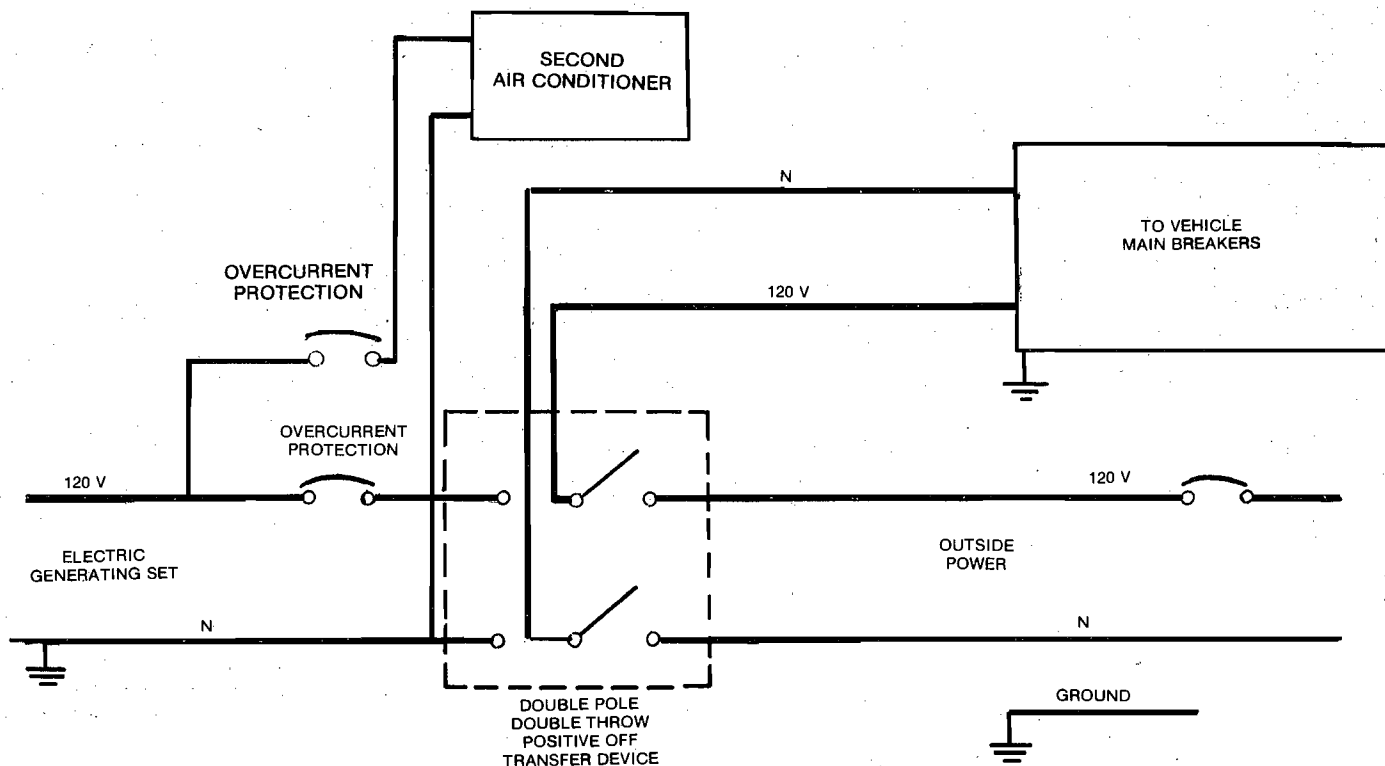
4.0 BFA SINGLE-PHASE "IR" 120 VOLT LOAD WIRE CONNECTIONS

JOIN BOTH BLACK LEADS HERE FOR FULL RATING SINGLE CIRCUIT 120 VOLT OUTPUT



5.0 BGA AND 6.5 NH SINGLE-PHASE "3CR" 120/240 LOAD WIRE CONNECTIONS

FIGURE 7A. RECONNECTION DIAGRAM



*FOR 120/240 OPERATION (5.0 & 6.5 kW ONLY) DO NOT USE JUMPER. CONNECT OVERCURRENT PROTECTION AS SHOWN IN DASHED LINE. SEE RECONNECTION DIAGRAM IN FIGURE 7A.

FIGURE 8. SCHEMATIC OF TRANSFER DEVICE AND OVERLOAD PROTECTION

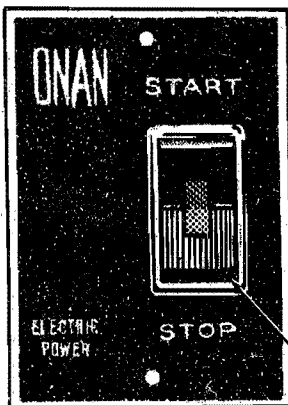
STARTING CONTROLS

Remote control Onan electric sets are designated by an "R" in the model number and provide the operator to start the set inside the vehicle, etc. Sets with the designation "E" are electric start at the set only. See the appropriate operator's manual for more specific information.

Onan has available remote start-stop controls for all RV electric generating sets. An Onan remote control switch shown in Figure 9 includes a start-stop switch with an amber indicator lamp (lights when set is running). A deluxe remote control includes a start-stop switch with an amber indicator lamp (lights when set is running), a running time meter and a battery condition meter. See Figure 10.

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.

FRONT SIDE OF
REMOTE CONTROL
SWITCH

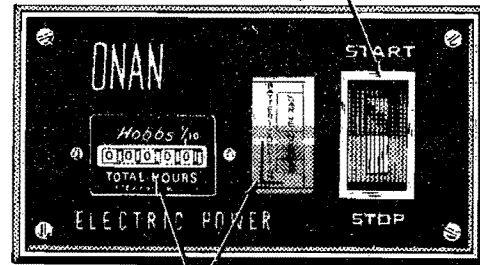


NOTE: Use 18 gauge or larger wire for installing the remote start switch.

STOP-START SWITCH (DPDT)
(Amber light glows when
generator set is running)

FIGURE 9. OPTIONAL REMOTE CONTROL SWITCH

STOP-START SWITCH (DPDT)
(Amber light glows when
generator set is running)



RUNNING TIME
METER BATTERY CONDITION
METER

FIGURE 10. OPTIONAL DELUXE REMOTE CONTROL

FINAL CHECK-OUT PROCEDURE (60 to 80 F ambient)

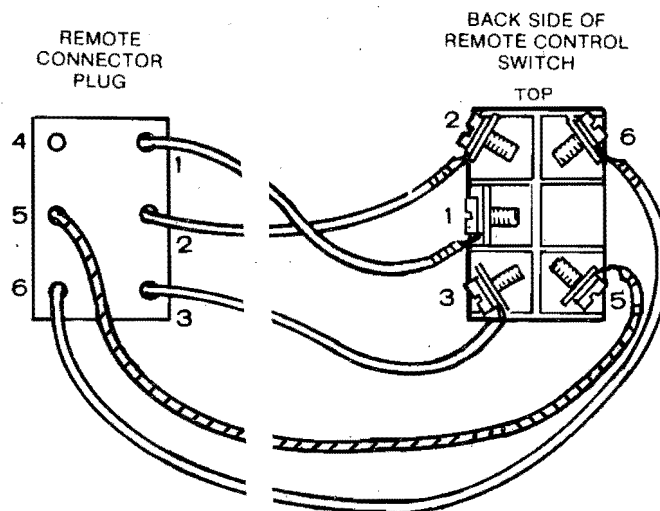
Before the generator set is operated, remove the spark plug wires so the set will not start when cranked. Connect a voltmeter to the battery terminals, and to the battery side of the start solenoid and set frame.

Crank the engine and measure the voltage at the battery. Then measure the voltage from the start solenoid to the set frame. Do not allow more than five seconds between these readings (use double-pole, double-throw switch).

Subtract voltage at set from measured battery voltage during the cranking. The difference should not exceed 0.6 volt. If it does, check all connections. A separate ground cable may have to be used (same size as battery cable).

Alternate Test

Remove the spark plug wires, crank the engine and measure the cranking speed. Connect a separate ground cable from the battery to the set's frame. Crank the engine and again measure the speed. If cranking speed increased more than ten percent, check connections and consider a permanent ground cable if it seems necessary.



SET TERMINAL	REMOTE SWITCH TERMINAL	FUNCTION	WIRE COLOR CODE	
1	1	Ground	Black	
2	2	Stop	Brown	
3	3	Start	Yellow	
5	5	Battery Condition Meter	Orange	IF USED
6	6	Lamp and Running Time Meter	Red	

FIGURE 11. WIRING CONNECTIONS FOR 300-0985 AND 300-0986 REMOTE CONTROLS

Batteries

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 2 square inches at top and 2 square inches at bottom of battery for ventilation purposes.
4. Battery cable entry points must be sealed (vapor tight) if they enter or pass through living area.

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

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 1 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.

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

TABLE 7. 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.

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.

Battery Selection

Determine battery size by the amount of "surge" power required to start the generating set. Select a battery that is at least as large as that specified by Onan.

Locate battery as close as possible to starter and charging system. Keep the battery well charged and clean. Keep terminals clean and free of corrosion.

TABLE 8. 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)

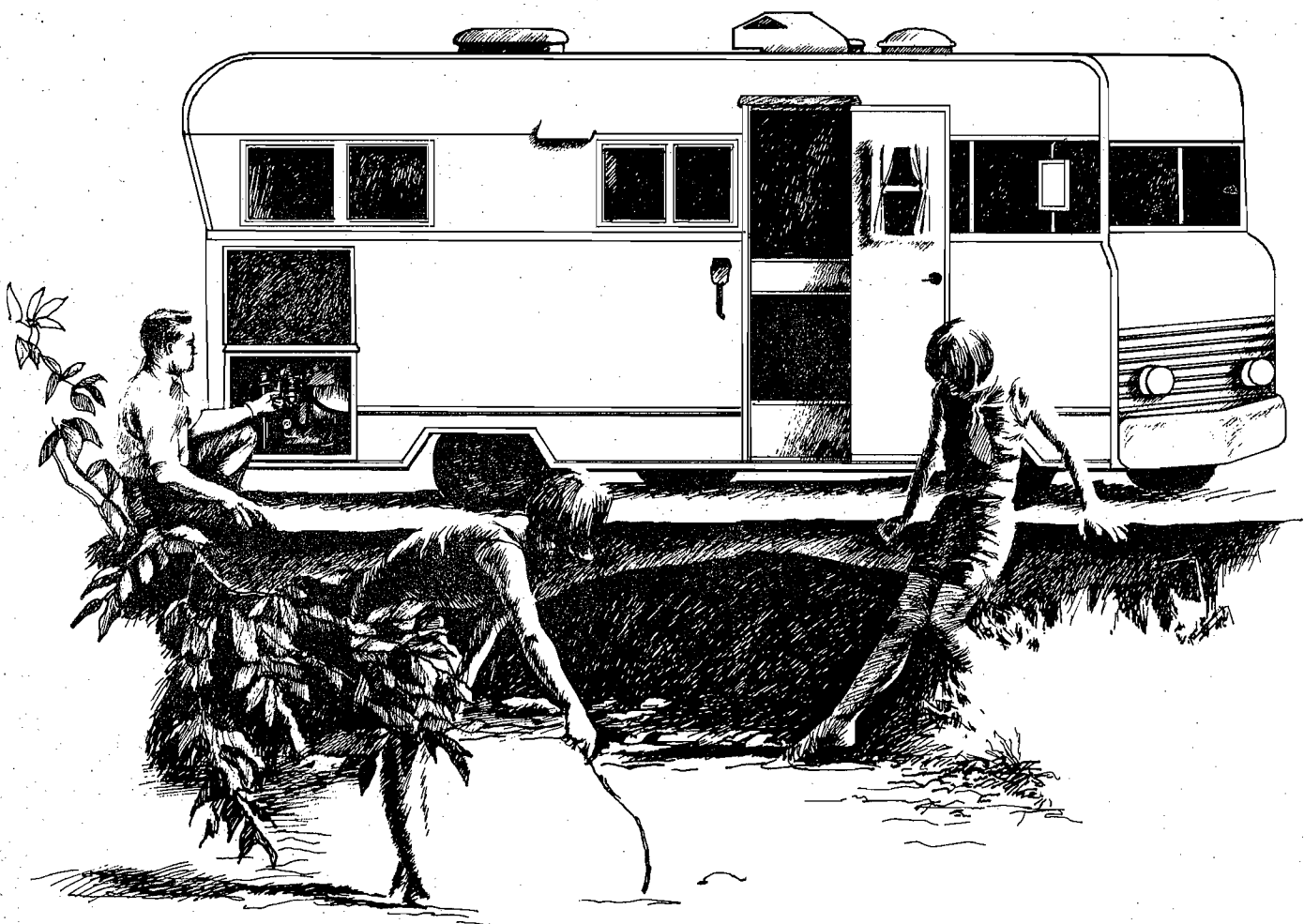
*Larger capacity batteries may be required if battery is also used to power other coach accessories.

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.



WHAT IS A GOOD INSTALLATION?

An owner of an RV electric generating set considers his unit well installed if it produces electricity quietly, reliably and efficiently.

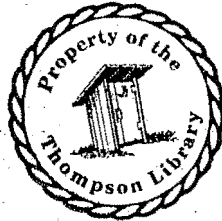
But how do you — the installer — provide a good installation? Here are some guidelines:

The electric generating set should be mounted on vibration isolators and the isolators, in turn, firmly mounted to a strong base. The fuel and electrical lines should be mounted to the frame and connected to the unit through flexible sections. Exhaust system components must be installed with good automotive practice.

Cooling is important. All good RV installations call for a well-ventilated generator compartment (see section on *Ventilation*), one that cools adequately while running and completely purges heated air after shutdown.

A good installation must also be fireproof and vapor-proof. This bulletin tells how to accomplish this . . . read it carefully.

Our recommendations for the proper installation of an RV electric generating set are based on years of experience in the manufacture of generator sets. We offer these recommendations through this technical bulletin so you can be assured the Onan unit selected for your recreational vehicle will operate quietly and efficiently for many years to come.



Onan manufactures a complete line of electric power systems from 1 to 750 kW (generator sets • automatic transfer switches • industrial engines), gas-, gasoline- or diesel-driven. For standby power in homes, industrial plants, commercial buildings and institutions. For auxiliary or portable power in boats, recreational vehicles, service trucks and construction equipment.

