

Chapter 3

Set-Up, Installation, and Operation Procedures

Equipment operators must be able to set up and install an electric generator set in the field and determine locations for the fuel supply and maintenance facilities. This important function, if performed properly, helps ensure safe and efficient equipment performance throughout the field operation. The tasks required to set up and install an electric generator set and support facilities in the field are described in this chapter.

PRELIMINARY INSTRUCTIONS

An electric generator set may arrive in the field completely operational and ready for use. However, if the equipment was shipped from a supply or maintenance point, the fluids have been drained out of the set and it is not in an operational ready status. Several preliminary tasks are required to set up the equipment and support facilities for a field unit.

Inspect the Equipment

The equipment operator must carefully inspect all incoming equipment:

- Inspect the identification plate. Ensure the information on the plate matches the equipment.
- Inspect the generator set for damage. Document all damage on a DA Form 2404 (Equipment Inspection and Maintenance Worksheet). Submit the form to the next echelon of maintenance.
- Compare the equipment with the packing list to ensure all items shipped are present and serviceable.
- Inspect the entire unit carefully for loose and missing hardware. Tighten loose hardware and replace missing items.

- Turn the engine over by hand to ensure all moving parts in the engine and generator move freely.

Service the Equipment

Perform the following daily preventive maintenance services after the equipment is inspected:

- Remove all tags, tape, cloth, and barrier materials.
- Lubricate the generator set's engine according to the instructions in the current lubrication order.
- Correct as many of the deficiencies as you can. Report the rest to organizational maintenance.

Install the Fuel Supply

One of the equipment operator's most important tasks is to properly install the fuel supply and storage tanks required for the generator set. Gasoline, diesel fuel, or jet fuel (JP-4) may be used to power the generator set. Operators must consider the following factors when planning the installation arrangements for the fuel storage area:

- Planned duration of the field installation.
- Security requirements.
- Potential fire and safety hazards.
- Potential sources of contamination.

The length of time the field unit will be in operation partly determines how the fuel storage facilities are installed. For a long-term field unit, install the fuel tanks underground using proper fittings. Ensure the tanks comply with the manufacturer's instructions. Select a location that is convenient to the using equipment. Proper installation and a convenient location minimize the hazards of fuel contamination, vapor lock, and fire.

For a short-term field unit, locate the auxiliary tanks or drums above the ground. Place them as far from the using equipment as the auxiliary line allows. If a metal pipeline is used, locate the tanks about 25 feet from the generator set. Keep the auxiliary fuel line as straight as possible.

Maintain Security

Follow the unit's standing operating procedures.

Eliminate Potential Fire and Safety Hazards

Fire and safety are critical elements in the design of a fuel storage area. The following tips will help eliminate many fire and safety hazards:

- Clearly mark the entire fuel storage area with NO SMOKING and OPEN FLAME signs to indicate it is a hazardous area.
- Dig an open trench 4 feet wide and 6 inches deep around the area to contain any fuel leaks or spills. Pile the earth in a mound around the trench. Place crushed rock or sand inside the trench to absorb spilled fuel. Immediately cover any small spills with dry sand or earth.
- Prohibit trash burning within 200 feet of any fuel storage area.
- Do not place any electrical wires above or near the fuel tanks.
- Direct hot exhaust from operating engines away from the fuel supply.
- Bury or cover fuel lines leading away from fuel tanks to protect them from the sun and physical damage.
- Do not use a rubber hose for fuel delivery except as a temporary measure. To make the hose safe, attach or clamp a light, flexible copper wire to the end fittings of the hose. Twist a ground wire around the hose to prevent breakage and to provide a path for static electricity to flow to the ground. Attach one electrical grounding wire to the auxiliary tank and another to the generator set.
- Do not use a long, nonconductive hose for fuel delivery except as a temporary measure. Static electricity builds up when fuel flows through a long pipe or hose.
- Maintain adequate fire extinguishing equipment near the auxiliary fuel tank area and the generator set. The fire point must include a shovel, pickax, and a fire extinguisher. Include buckets of sand in the fire point if they are available.

Maintain the Fuel Supply

The operator must maintain a fuel supply adequate for all needs. The following tips will help ensure the proper fuel is on hand and is used for each task:

- Ensure the type and grade of fuel used in a generator match the specifications.
- Never mix different fuels. Label each storage tank clearly with the type and grade of fuel it contains. Ensure only that fuel is put in the tank.
- Clean a tank thoroughly before changing the grade and type of fuel stored in it. Drain all the old fuel out and remove the sediment and condensation. This procedure prevents improper operation or damage to the generator set.
- Ensure fuel does not spill on any engine parts when draining an engine-mounted fuel tank. Connect a flexible hose between the petcocks and the container if the fuel cannot drain directly into the container.

The fuel supply for an electric generator set must be free of contamination. The equipment operator can help ensure a pure fuel supply by identifying potential sources of contamination and planning around them. Locate the fuel storage area at least 50 feet from all work areas and equipment that does not require fuel. The storage area must be at least 50 feet from heavily traveled roads but be easily accessible by the fuel supply trucks. Locate the storage area so that any fuel leaks there flow away from the equipment, personnel work areas, and housing. A shelter or cover may be needed to protect the fuel from contamination.

Perform Before-Operation Checks and Services

Equipment operators must perform several checks and services before starting an electric generator set. The checks and services usually performed on all generator sets are described in this chapter. Refer to the manual issued with the set to ensure all checks and services required for a specific set are performed properly.

NOTE: Use the equipment manual to obtain the correct operating data.

- Check the fuel lines for leaks. Check the fuel level in the tank and refill it as needed. If winterization equipment is used, check the heater for fuel leaks. The heaters in some generator sets use diesel fuel from the main tank. Check the fuel level in the auxiliary tanks. Drain condensation from the tanks, and clean the fuel filters before operating the equipment.
- Inspect the plenum drain fitting before starting a gas turbine engine-driven generator set. Ensure it is clear and that no fuel has accumulated in the plenum chamber. Use only clean fuel. Drain the sediment from the filter into a small container and dispose of the sediment. Check the fuel control valves for proper positioning.

- Check the radiator coolant level; add coolant if necessary. Allow room for expansion when filling a cold radiator. If cold weather is anticipated; add antifreeze according to the instructions in the table below.

FREEZING POINTS, COMPOSITION, AND SPECIFIC GRAVITIES OF MILITARY ANTIFREEZE MATERIALS				
LOWEST EXPECTED AMBIENT TEMP °F	PINTS OF INHIBITED GLYCOL PER GALLON OF COOLANT ¹	COMPOUND, ANTIFREEZE ARCTIC ²	ETHYLENE GLYCOL COOLANT SOLUTION SPECIFIC GRAVITY AT 68°F ³	
+20	1¾	Issued full-strength and ready mixed for 0° to -65°F. Temperatures for both initial installation and replenishment of losses.	1.022	
+10	2		1.036	
0	2¾		1.047	
-10	3¼		1.055	
-20	3¾		1.062	
-30	4		1.067	
-40	4¼		1.073	
-50	Arctic		DO NOT DILUTE WITH WATER OR ANY OTHER SUBSTANCE	
-60	Antifreeze			
-75	preferred			

¹ Maximum protection is obtained at 68 percent by volume, that is 5.4 pints of ethylene glycol per gallon of solution.

² Military Specification MIL-C-11 755 Arctic type, nonvolatile antifreeze compound is intended for use in the cooling system of liquid-cooled internal combustion engine for protection against freezing primarily in Arctic regions where the ambient temperature remains for extended periods of time close to -40°F or drops below, to as low as -90°F.

³ Use an accurate hydrometer. To test hydrometer, use 1 part ethylene glycol type antifreeze to 2 parts water. This should produce a hydrometer reading of 0°F.

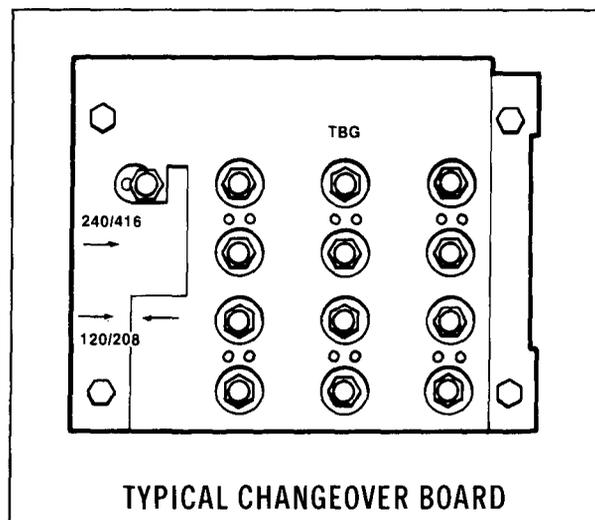
NOTE—Fasten a tag near the radiator filler cap indicating the type of antifreeze.

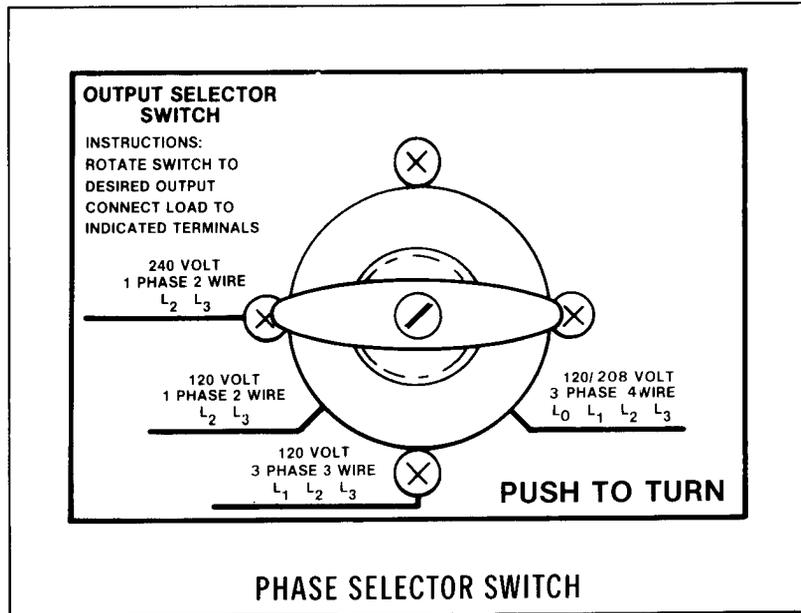
- Check the electrolyte level in the batteries; add distilled water as necessary. Ensure the level is about 3/8 inch above the battery plates. Never add water from a metal container to batteries. Refer to TM 9-6140-200-14 or Chapter 5 of this manual for additional battery services.

WARNING

Do not smoke or use an open flame near a battery. Batteries generate hydrogen gas, which is highly explosive. Handle electrolyte with extreme care. Electrolyte contains sulfuric acid, which severely burns skin, clothing, and paint on contact. Immediately flush water over any area that comes in contact with electrolyte to wash away all traces of acid.

- Tools are used to install and maintain a generator set. Operators must ensure all required tools, technical manuals, and basic issue items on the inventory list are on hand and are serviceable. Included in the basic issue items are an auxiliary fuel hose, grounding rods and cables, a fire extinguisher, paralleling cable, load terminal wrench, and grounding wire clamps. Most generator sets have a storage compartment for the tools, technical manuals, and basic issue items.
- Check the engine oil level; add oil if necessary. Lubricate all other parts according to the lubrication order issued with the equipment.
- Carefully check the fuel tank, radiator, oil covers, and oil pan for leaks. Check all lines and connections for leaks.
- Ensure all generator and engine instruments are securely mounted, properly connected, and undamaged. Check all gages when the generator is operating to ensure they work properly.
- Inspect the entire generator set for cracks, breaks, and loose or missing hardware. Inspect all wires and terminals for damage and loose connections. On gas turbine units, inspect the air inlet screen assembly and remove obstructions. Inspect the changeover board and phase selector switch (figure on page 47) for the correct link connections or positioning for the desired voltage. Set the frequency selector switch for the desired frequency output on the 50/60 cycle, precise class 1 sets. Place the circuit breaker (main switch) in the open (off) position. Connect the output service cable to the load panel terminal connections.





CAUTION

Never attempt to start a generator set with the circuit breaker closed (on). A closed circuit breaker will cause a power surge and damage the equipment.

- Ensure the grounding connections (figure on page 48) on the equipment and the grounding rod are tight. Use No 6 American wire gage or a larger wire for the ground.

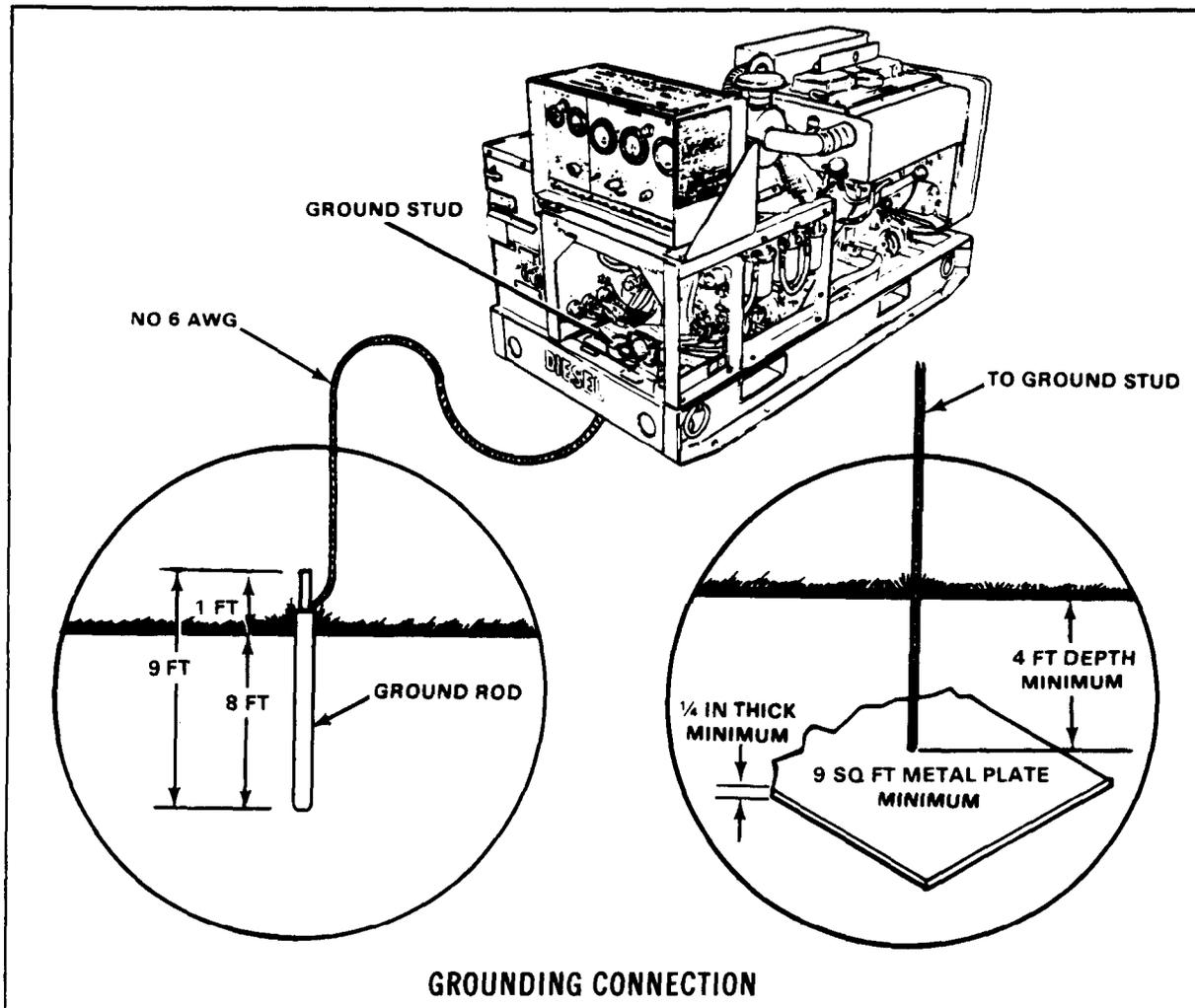
CONNECTION INSTRUCTIONS

After the preliminary tasks are completed, the operator must install and connect the distribution cables.

Install the Distribution Cable

A distribution cable connects the generator set to the load. The cable may be installed overhead, buried underground, or laid on the ground. TWO types of distribution cables are used in military-constructed distribution systems:

- Cable supplied in predetermined lengths and sizes and equipped with quick-disconnect connector plugs.

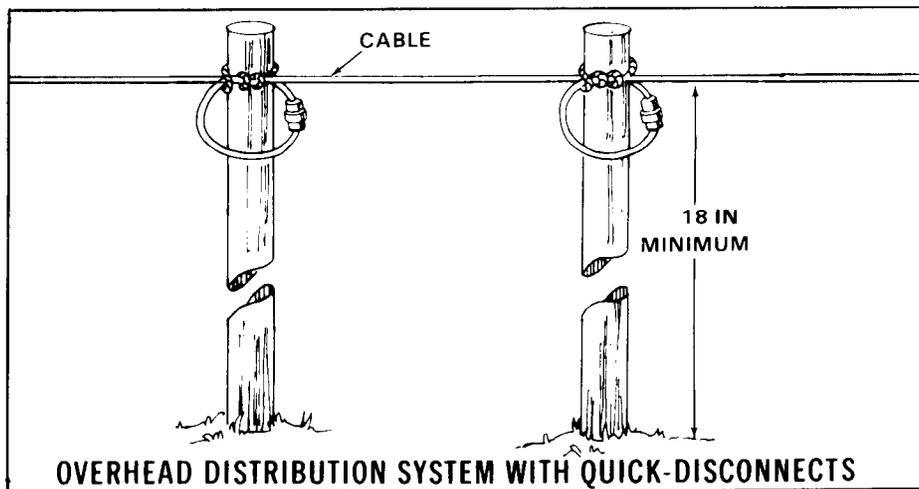


- Building wire, supplied in rolls.

The operator must decide how the distribution cable is installed. The method used depends on the type of material available and the conditions at the field unit.

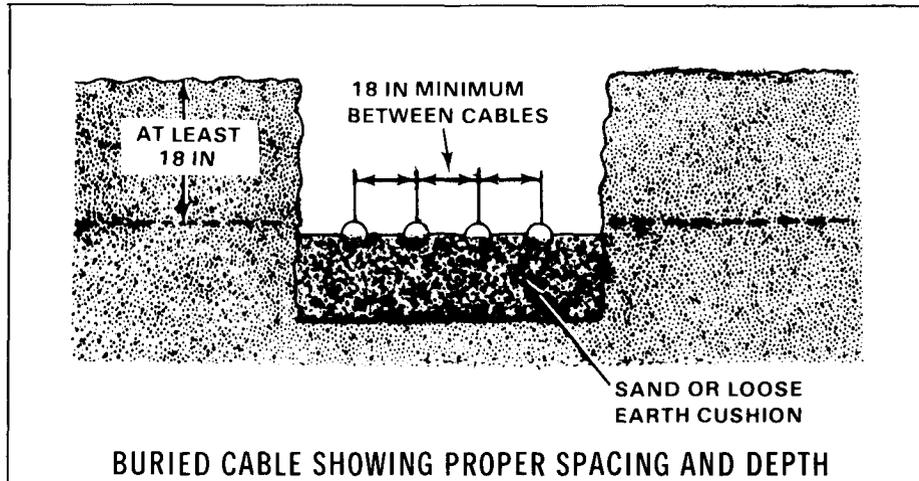
Overhead. When conditions dictate the use of an overhead line, it must be constructed properly. utility poles, the most convenient method of supporting the lines, seldom are available in the field. Pieces of wood 6 inches by 6 inches in width may be substituted for poles if they are long enough to set rigidly in the ground and provide safe clearance for the wires. Trees may be used for support as a last resort if the proper weatherproof cable is available. Use the following guides when installing an overhead distribution system:

- Allow a minimum height of 20 feet for vehicle clearance when crossing over roads.
- Space the poles so the joints where the cables connect are supported by the pole, as shown in the figure below.
- Tie the cable with the quick-disconnects together.
- Use the proper plug connections when installing multiphase cables equipped with quick-disconnects. This type of cable has male and female receptacles that must be properly aligned to prevent a reverse power condition in the system. Match the cable markings or apply markings before installing the cable to ensure proper alignment. Most cables are marked by the manufacturer. The marks are countersunk circular or triangular depressions or raised buttons in the insulation on each receptacle. Most receptacles have one pin and one jack larger than the other pins and jacks. The large pin and large jack represent a grounding (neutral) conductor. Match the large pin and large jack to ensure the receptacles are connected properly if there are no other markings. If the cable is marked at the field unit, paint a color code on the receptacle.



Underground. Sometimes the cable must be buried underground. Use the following guides to ensure proper cable installation underground:

- Dig a trench that is at least 18 inches deep. This depth will prevent the cable from being disturbed by surface digging (figure on page 50).

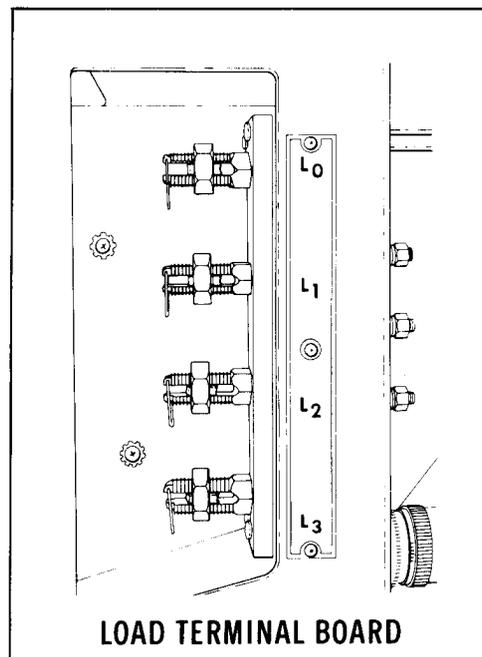


- Use only moistureproof cable. Lay the cable in the trench on a cushion of sand. If sand is not available, loosen the trench base and remove all rocks and stones.
- Ensure the joints are moistureproof if the cable is equipped with quick-disconnects.
- Separate the cables uniformly to protect the circuits. Allow a minimum of 6 inches between the cable centers for mechanical and electrical protection.
- Cover the cable with earth that has no rocks or stones. This procedure should protect the cable if the surrounding earth is disturbed by flooding or frost heaving.

On the ground. Most cables are laid on the ground to save time. Because many mobile generator sets can be moved almost to the point of use, it may be necessary only to lay the cable over the ground to the load. Protect the cable from mechanical damage by laying planks or logs on both sides of it. This prevents vehicles from driving directly on the cable. Lay the cable where it will have the least interference from personnel operations, and install warning signs indicating the cable location. Use only moistureproof cable that can withstand inclement weather.

Connect the Distribution Cable

Electric power is distributed to the load in a direct line from the generator set or it is processed through a load terminal board. A direct line is used when relatively few items make up the load and when the phase requirement is fairly constant. A load terminal board is used when many items make up the load, the loads are scattered, and the phase and voltage requirements differ. In either case the load must be balanced between the phases, as explained in the previous chapter.

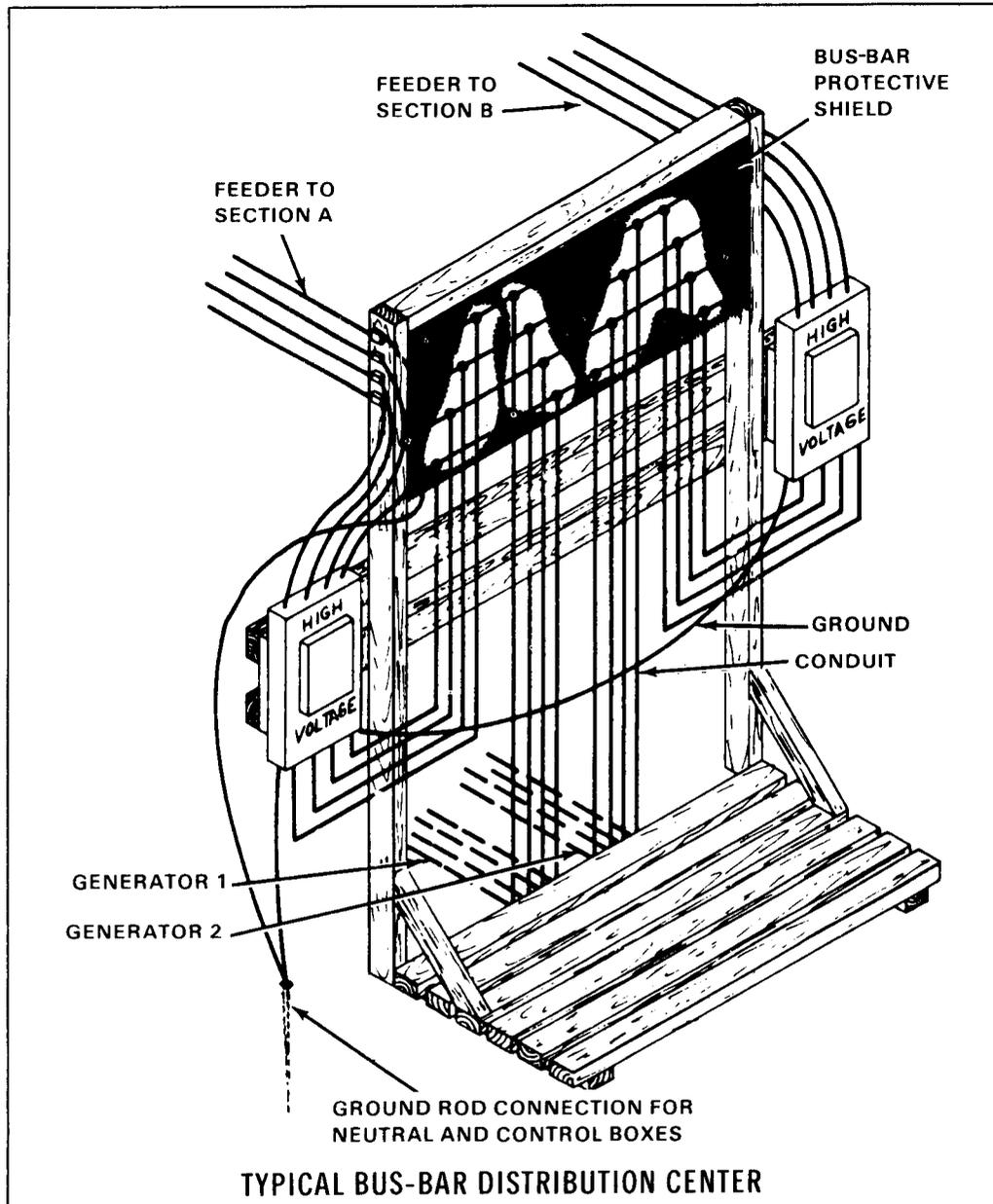


All AC generator sets are equipped with a load terminal board. The board has four terminals marked L₀, L₁, L₂, and L₃. The terminals simplify the process of connecting the distribution cable at the generator.

A field unit may use a distribution center when no generator set large enough to supply the total electrical load is available. In this situation it is necessary to make parallel connections between two or more sets and distribute their total load through a bus-bar distribution center (figure on page 52). A bus-bar distribution center is also used when the equipment requiring power is so widely scattered that two or more branch-feeder lines are required. Power to the branch-feeder lines is controlled from the bus-bar distribution center.

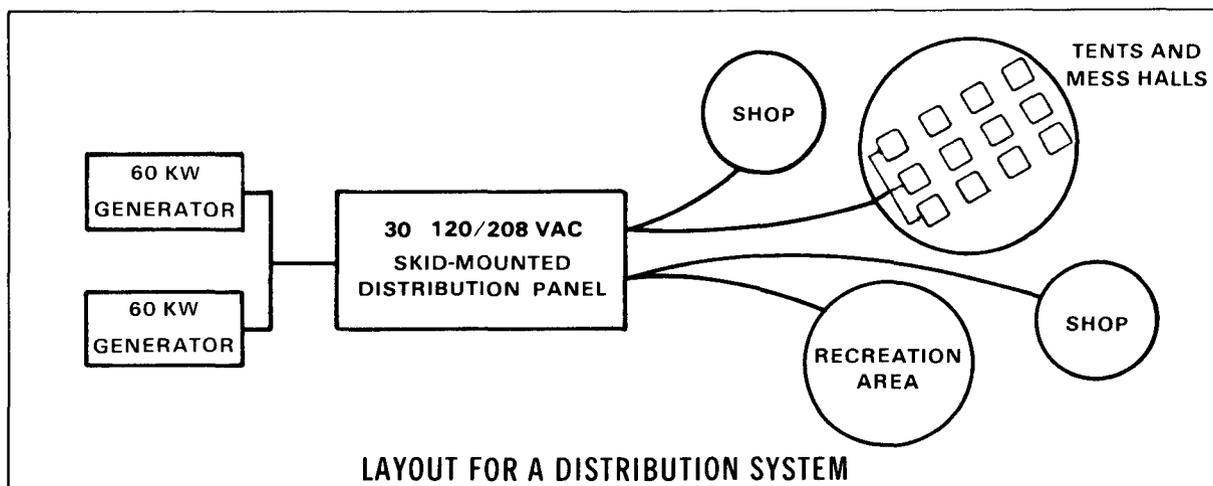
Perform the following checks before connecting a distribution system:

- Ensure all equipment is securely mounted, securely supported, and properly insulated.
- Select the proper size of wire to connect the load. The size of wire used depends on the load current. Refer to the table on page 18 to select the proper wire size.
- Ensure the current rating of the fuses or trip elements provide adequate protection against overloads and short circuits on the branch-feeder lines. The switches that control the output to each branch-feeder line are of two types: The circuit breaker and the fused-knife switch. The operator must be sure that the components of the circuit breaker (contact points) or fused-knife switch (switch blades) can carry the rated current and voltage of the branch-feeder lines.



- Protect the switch gear and bus bar from inclement weather. Equipment damaged by rain or snow can injure personnel when they contact the electrical distribution devices. A weatherproof canopy provides adequate protection.

The layout of a typical distribution system is shown in the figure below. Shielded cables of various lengths connect the loads in four central areas to the power equipment. The shielding on each cable must be grounded at one end as a safety precaution.



Power distribution in the central areas usually requires three-conductor, stranded-copper cable. Use the tables on pages 19 and 20 to compute the proper wire size. Operators must use three-phase voltage that ranges from 120 volts to 208 volts.

ADVERSE OPERATING CONDITIONS

Generator sets are designed to operate under adverse conditions. The procedures required to operate equipment under different adverse conditions follow:

Extreme Cold

Generator sets can start and operate at temperatures of -25°F (-32.7°C) without a winterization kit. When the ambient temperature is -25°F (-32.7°C) or lower, most engines require preheating before they are started. The engine type determines the method used. For example, a blowtorch is used on most air-cooled engines. Most liquid-cooled engines are equipped with a winterization kit that contains a preheater. Refer to the manual issued with the generator set for preheating and cold weather starting instructions. Some general checks for starting equipment in cold weather follow:

Cooling systems.

- Before installing a generator set in extreme cold, check the equipment manual for installation instructions. The two basic types of cooling systems used on power generating equipment are air-cooled and liquid-cooled.
- Check the antifreeze solution. Ensure it will protect the equipment at the lowest temperature expected. Use the information in the table on page 45 to mix antifreeze.
- Inspect the level of the coolant in the radiator. Keep the radiator filled to the proper level.
- Inspect the cooling system frequently for leaks. Check all gaskets and hose connections.
- Check the thermometer (water temperature gage) during operation for abnormally high readings.
- Ensure all shutters, shutter controls, and thermostats function properly.
- Ensure the shutters and the baffle rods on air-cooled systems are positioned for cold weather operation.
- Report all uncorrectable faults to organizational maintenance.

Electrical system.

- Ensure the batteries are fully charged to prevent freezing.
- Inspect the electrolyte level daily. The electrolyte level must be 3/8 inch above the battery plates.
- Keep the batteries clean and free of ice, moisture, and corrosion.
- Ensure the battery connections are clean, lightly greased, and tightly secured.
- Ensure the battery cap vent holes are open.

CAUTION

Water added to a battery may freeze unless it is immediately mixed with electrolyte by charging. Do not add water unless the engine is immediately operated for 1 hour or longer.

- Inspect all electrical wiring insulation for cracks, frays, and breaks.
- Tighten loose connections. Report all defective wiring to organizational maintenance.

CAUTION

Disturb the wiring as little as possible. Wire insulation becomes brittle and breaks easily in extreme cold.

Fuel system.

- Keep the fuel tank as full as possible to reduce condensation.
- Ensure the proper grade of fuel is used for existing temperatures.
- Service the fuel filters more frequently than usual to remove water from the fuel system.
- Keep the fuel tank cap and filler necks free of ice, snow, and moisture during operation and when refueling.
- Drain the fuel tank if the fuel becomes contaminated and refill it with clean fuel. Drain sediment from the fuel tank daily.

Lubrication. Lubricate the generator set for cold weather conditions according to the current lubrication order.

Cleaning. Remove ice, snow, moisture, or other foreign material from the generator set before each period of operation.

Generator warm-up period. When operating in extreme cold, warm the generator set to the operating temperature before applying the load. Some generator sets are damaged when the engines operate at low revolutions per minute (RPM).

Extreme Heat

Operating electric generators when ambient temperatures are high requires efficient equipment cooling and adequate lubrication. General checks and services required to operate equipment in extreme heat follow:

- Provide maximum ventilation for the cooling systems at all times. Keep the equipment clean, especially the engine shrouds and cooling

fins, and the generator blower cover. Ensure all air passages are free of obstructions. Move all shutters and baffle rods to the proper position.

- Inspect the coolant level frequently, and add clean coolant as needed. To keep the cooling system free of rust and scale, add an approved rust inhibitor and flush the cooling system regularly. Do not use alkaline or salt water as a coolant. Ensure the radiator core fins and screens are free of obstructions. Ensure the fan-drive V-belt tension is adjusted properly. Ensure the radiator shutter operates properly. If the automatic shutter control (thermostat) fails, open and close the shutter manually. Report the failure to organizational maintenance. Refer to the appropriate technical manual to determine if the panel doors should be opened or closed.
- Inspect the electrolyte level of the batteries daily, and add distilled water as needed. The electrolyte level must be 3/8 inch above the battery plates. Keep the batteries clean and free of corrosion. Inspect the terminals for corrosion and loose connections frequently. Corroded and loose connections generate heat during operation, and extreme heat causes the wiring insulation to swell and soften. Chafing and fraying of the wires due to vibration are more frequent during extreme heat than in other conditions. Inspect the wiring for damaged insulation frequently. Report damaged insulation to organizational maintenance.
- Lubricate the generator set according to the current lubrication order.
- Provide ample air circulation around the generator set if it operates in an enclosed shelter. Allow air from outside to circulate within the shelter. Keep the main generator's ventilation screen and louvers free of obstructions. Inspect the instruments on the control panel frequently for overloads. Overloads cause the main generator to overheat and may cause the main circuit breaker to open. Do not fill the fuel tank completely; allow room for fuel expansion. Before an operating set is shut down, run it without the load to cool the engine.

Dusty and Sandy Areas

Perform the following checks when operating electric power generating equipment in dusty and sandy areas:

- Erect a protective shield for the generator set to provide wind protection. Dust and sand cause mechanical failures and shorten the life of the equipment. Natural barriers can form a wind shield. For

example, locate the generator set on the prevailing windward side of dusty areas, roadways, and construction sites.

- Clean the generator set frequently with an approved cleaning solvent. Keep the unit clean, especially the screens and grilles. When water is plentiful, wet the terrain surrounding the immediate operating area.
- Keep all equipment clean. Keep the main generator free of grease and oil. Clean obstructions from the ventilation screens. Blow dust and sand from electrical components with low-pressure, dry, compressed air.
- Inspect the cooling system frequently for leaks. Ensure the radiator and shutter operate properly and are free from obstructions. Keep the radiator cap tightly closed. Drain and flush the cooling system more frequently than required for normal conditions. When adding coolant, take any precautions needed to keep dust and sand from entering the cooling system.
- Maintain lubrication. Lubricate the generator set according to the current lubrication order. Keep all lubricant containers tightly sealed, and store them in an area free from dust and sand. Service the engine oil, oil filter, and air cleaner more frequently than required for normal conditions. Clean all lubrication points before applying lubricants. Clean around the crankcase oil fill cap and crankcase oil level gage before checking the oil level or adding oil.
- Prevent dust and sand from entering the fuel system. Inspect the fuel filter after each operating period. Clean the filters and strainers more frequently than required for normal conditions.
- Check the air cleaner for restrictions frequently.

Rainy and Humid Areas

Perform the following checks for power generating equipment used in rainy and humid areas:

WARNING

Keep the area surrounding a generator set dry at all times. Use insulating materials around the set if conditions are damp to avoid serious shocks.

- Provide protection from rain. Keep all doors and panels on the generator closed when the set is not in use. Open the doors and panels during dry weather so the equipment can dry.

- Keep electrical equipment dry to prevent corrosion, deterioration, and short circuits. Inspect all electrical wiring for cracks, breaks, or frays. Report defective wiring to organizational maintenance.
- Keep the fuel tanks as full as possible so moisture cannot accumulate in them. When adding fuel, ensure no water enters the fuel system. Keep the reserve fuel containers tightly closed. Drain contaminated fuel tanks, and refill them with clean fuel.

Saltwater Areas

Salt water is corrosive to metal. It is an excellent conductor of electricity. Perform the following checks and services on equipment operating in saltwater areas:

- Ensure the electrical equipment is never in contact with salt water. If contact occurs, wash the equipment with fresh water and allow it to dry thoroughly before operating it.
- Cover nonoperating generator sets that are outside with canvas or other weatherproof material.

CAUTION

Do not use salt water in the cooling system of a generator set except in an emergency. Salt water damages the equipment.

- Ensure the coolant used in the cooling system is free of salt. Use an approved rust inhibitor to prevent rust and scale from forming in the cooling system.
- Paint all exposed, nonpolished surfaces. Coat exposed parts of polished steel and other ferrous metals with standard issue rust-proofing material or a light coat of grease.

High Altitudes

Generator sets are rated based on sea level altitude. The rating of the set may decrease as the altitude increases. Information about operating equipment at high altitudes usually is printed on the data plate. The kilowatt rating may be reduced at high altitudes depending on the type of engine used to drive the generator. Refer to the appropriate technical manual for information about each model of generator set.

Combat Areas

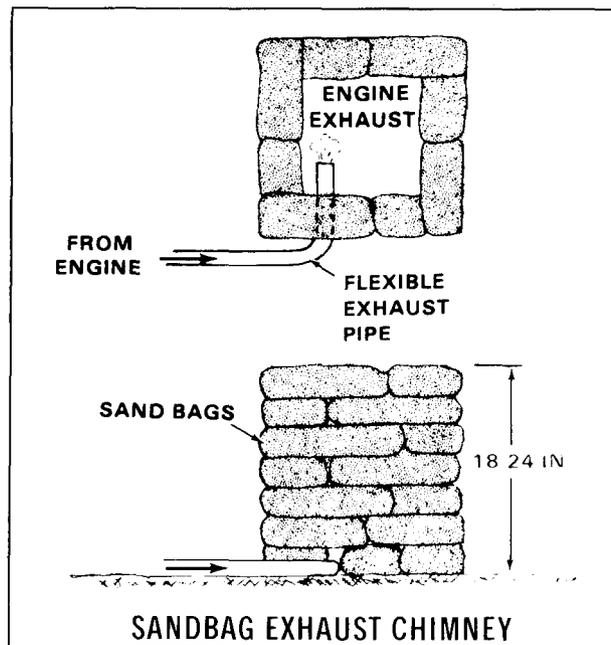
Operating generator sets in combat areas requires special precautions. It is difficult to operate electric generators without making the location known to the enemy. The equipment is noisy and produces large amounts of heat, which may endanger personnel and equipment nearby. The discomfort caused by the noise and heat may result in decreased performance of mission goals by personnel. The ability to hear enemy activity may be reduced. New signature-suppressed generator sets that reduce noise levels are being studied. These sets will be available to field units in the future.

WARNING

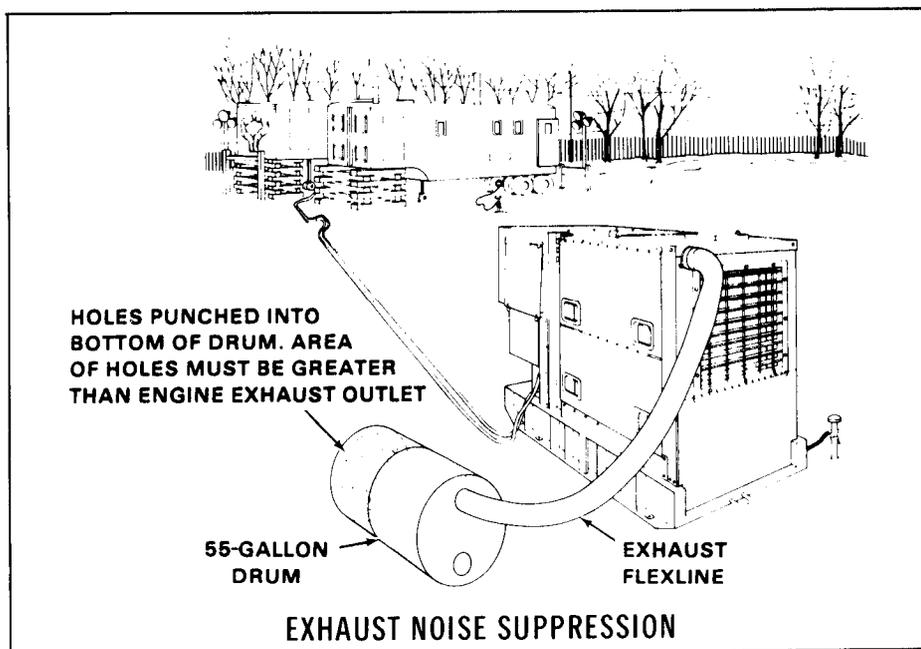
Do not overload a generator set. Heavily loaded generators produce excessive noise, dangerous sparks, and hot exhaust gases that can injure personnel.

Major sources of noise associated with generator sets are the engine exhaust system, air intake cooling fan, and vibrating metal. Operators in combat areas can use several methods to reduce the noise from operating generators. The methods used depend on the size of the generator set.

Sets producing 0.5 kw through 10 kw of electricity. The most effective method of suppressing the noise from small-sized generator sets is to install them in a revetment (figure on page 38). Connect an auxiliary exhaust line from the engine to the revetment chimney to remove the exhaust, as shown below. An empty 55-gallon oil or fuel drum can be

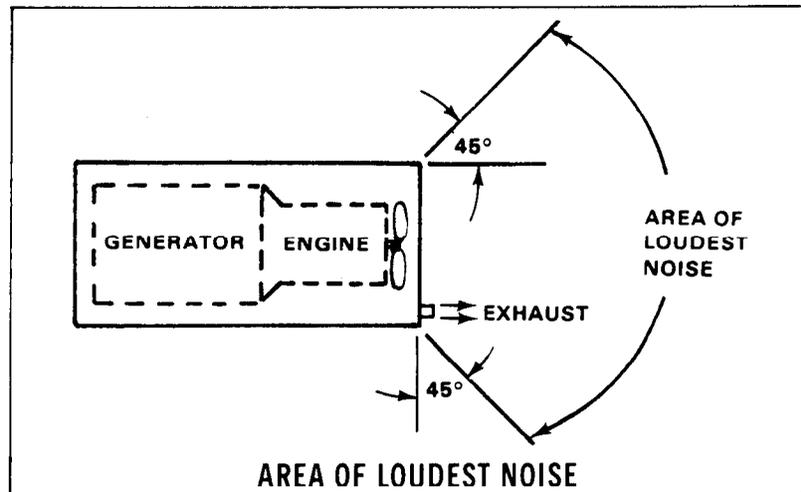


substituted for a sandbag chimney. To do this, punch a number of small holes in the bottom of the drum. The area with holes must be the same size or larger than the area of the engine exhaust. Lay the drum on its side and insert the auxiliary exhaust line inside the large hole in the drum, as shown below. Use any flexible or rigid metal pipe that has a diameter larger than the exhaust outlet on the engine muffler.



To reduce mechanical noises and the noise from the engine fan, locate the generator behind a barrier such as a hill, dense woods, large vehicle, or plywood wall. Do not restrict air flow around the engine. An air-cooled engine operating in a confined area such as a foxhole will severely overheat and possibly destroy itself in hot weather.

Sets producing 15 kw through 500 kw of electricity. The noise from medium- and large-sized diesel generator sets with liquid-cooled engines is very loud at the radiator end of the set. The main sources of noise are the radiator cooling fan and exhaust, as shown on page 61. Operators in long-term field units can build underground muffler systems for medium- and large-sized sets. Even with an underground exhaust system, the noise level will be high because of the unsuppressed fan noise. To reduce the fan noise, place a barrier such as a van, plywood sheets, or convex containers in the noise path. Another option is to locate the equipment so that a natural barrier lies between the radiator and the direction where the noise reduction is desired. Do not restrict air flow out of the radiator.



Another problem in combat areas is that the equipment may be seen by the enemy. It may be necessary to camouflage the equipment and revetments to avoid detection.

Generators have a thermal signature that can be detected by infrared sensors. At this time there is no way to eliminate this problem.

Ice fog caused by engine exhaust is a problem in very cold climates (-25°F and below). To eliminate ice fog, install a tube to the exhaust pipes. Cover the tube with a tarpaulin to diffuse the exhaust in the snow.

Operators in combat areas must use any means available to avoid detection by the enemy.