INSTRUCTIONS FOR SAFE GROUNDING OF COMMUNICATIONS-ELECTRONICS EQUIPMENT IN THE FIELD

This document reviews earth ground systems and describes the equipment and methods used in implementing them. These instructions will help you to set up a safe ground system for your equipment or shelter.

1. WHY GROUND COMMUNICATIONS AND ELECTRONICS EQUIPMENT?

Grounding helps to protect personnel and equipment from faulty power systems and from lightning strikes. Grounding also reduces circuit noise and other transmission interference in communications systems.

2. THE EARTH GROUNDING SYSTEM

a. The earth grounding system helps to maintain any electrical potential on power generators and on metal surfaces inside a shelter or structure at the same level as the surrounding earth. Earth grounding also provides a discharge path for externally-generated electrical surges, including lightning. This is accomplished by electrically connecting the generator, shelter, or structure to a buried metal conductor in contact with moist subsoil or reaching into the underground water table. The types of ground conductors and methods of installation you use depend upon the climate and geography of the site. The specific method that you select will depend on soil conditions and whether you are grounding in moist temperate climates, tropics, deserts, mountains, or in arctic conditions.

b. Various types of conductors are used to establish an electrical connection with the ground. The most commonly used and generally most effective conductor is a ground rod. Several types are available in various lengths and configurations which are explained in paragraph 3. With certain restrictions and under certain conditions, you may achieve a good ground by connecting to a previously installed metal object such as a buried metal pipe or a steel building frame. In the desert or other locations where the ground conductivity is poor, a ground plate or a group of ground rods electrically connected together will be more effective than a single ground rod.

c. Different types of soil provide different qualities of electrical grounds. In choosing a ground conductor, you should use the type that works best with the soil in your location. Here is a summary of soil types, ground qualities, and suggested types of ground conductors.

TYPE OF SOIL	QUALITY OF GROUND	SUGGESTED GROUND CONDUCTOR
Fine sand granules with high moisture content	Very good	Ground rod
Clay, loam, or shale	Good	Ground rod or ground plate
Mixed: clay, loam, or shale mixed with gravel or sand	Poor	Buried pipes, building frame, or other metal object or a ground plate or
Gravel, sand, or stone	Very poor	several ground rods electrically connected together

Under very poor or poor conditions, you'll have to take special steps to establish and maintain electrical conductivity explained in paragraph 7.

3. **SELECTING A GROUND ROD**

a. Moist Soil Conditions

In locations where the soil is naturally moist, use either the 8 foot ground rod, NSN 5975-00-296-5324, or the 6 foot ground rod, NSN 5975-00-224-5260. The 6 foot rod is being phased out and replaced by the 8 foot rod. You may continue using a 6 foot rod as long as it is serviceable. Both are single-section rods with a built-in driving head and a thumbscrew coupling for connecting to a ground strap. Figure 1 illustrates a typical rod assembly.

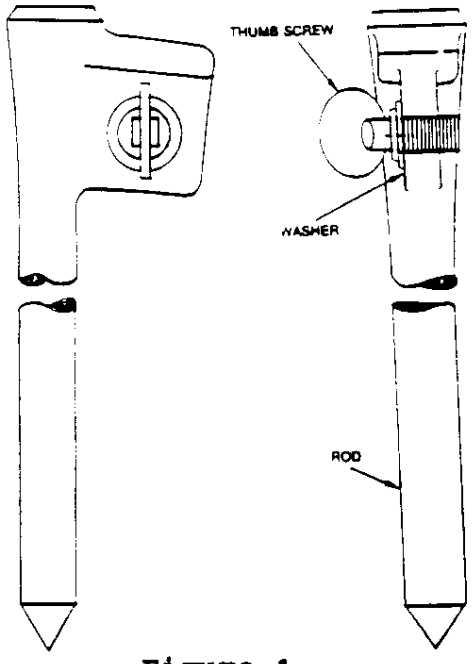


Figure 1

b. Dry Soil Conditions

(For desert conditions, see paragraph 7a.) At sites where the soil is dry, you need to take special steps to ensure that the electrical connection to the earth provides adequate conductivity. If you can, drive the rod deep enough to reach the moist subsoil; use a multiple-section rod assembly such as NSN 5975-00-627-1552 or NSN 5975-00-878-4868 which is illustrated in Figure 2. If there is no moist subsoil or if the soil condition won't allow for deep penetration, then drive the rod as deeply as you can and apply salt and water as explained in paragraph 5.

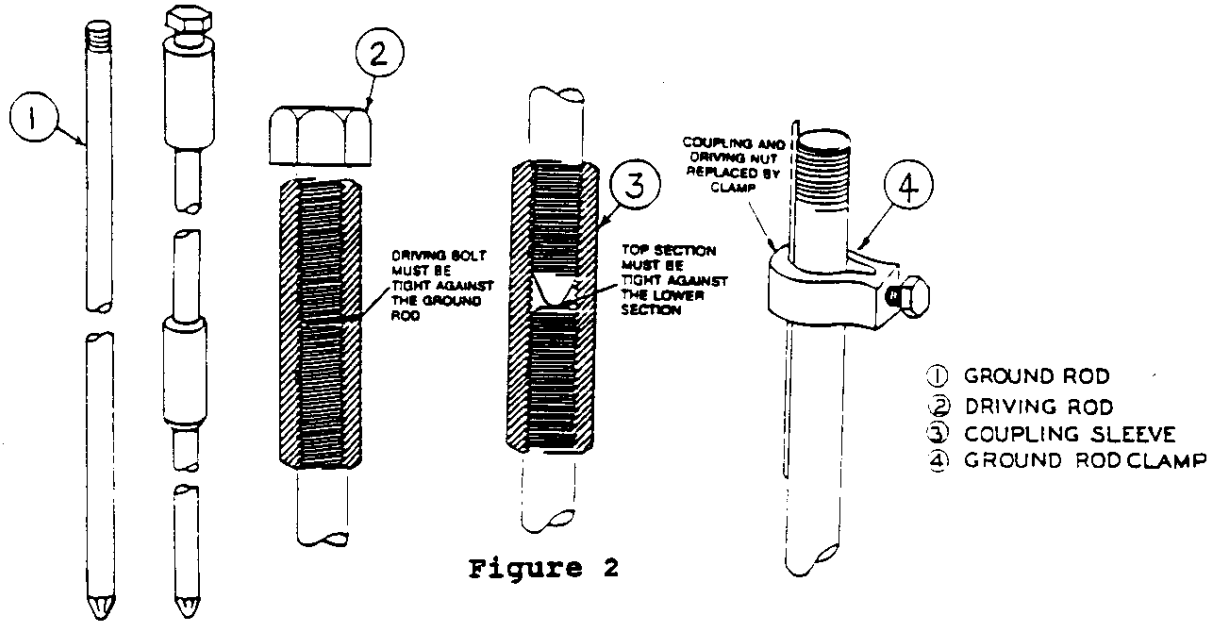
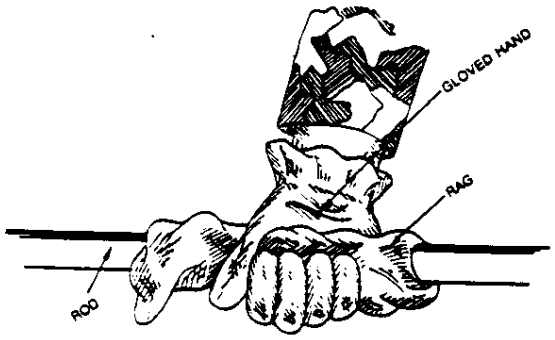


Figure 2

4. INSTALLING GROUND RODS

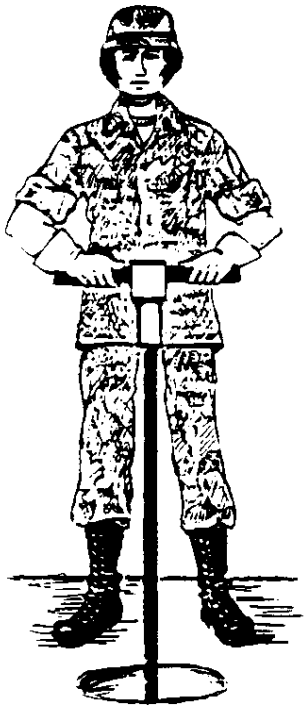
Take the following steps when you are ready to install a ground rod:



a. Clean the rod to remove all grease, oil or paint. Wear a safety glove to protect your hand from sharp metal fragments.

b. Dig a hole at least 12 inches deep and 36 inches across.

c. Drive the rod through to the moist subsoil. Allow about 3 inches of the rod to protrude above the bottom of the hole.



d. If you are installing a multiple section ground rod, use a driving hammer similar to the one illustrated in Figure 3.

Figure 3

e. After the ground rod is in place, connect the rod to the equipment or shelter using a ground strap. Figure 4 illustrates a completed earth ground system with the rod installed and the strap attached. If you don't have a ground strap, use a piece of the heaviest gauge wire you can find, #6 AWG or larger and preferably copper.

f. Connect the ground strap to the ground rod.

(1) Use the terminal screw on the ground rod. If your ground rod has no terminal screw or if it is missing or broken, connect the ground strap (or the heavy wire substitute) with a tight-fitting clamp similar to those in Figure 4.

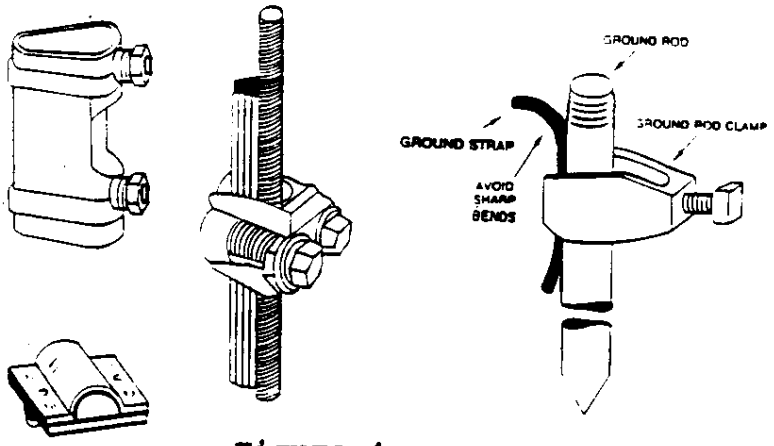


Figure 4

(2) If you can't find a clamp, bind the ground strap, copper cable, or heavy wire substitute, to the ground rod with at least 24 turns of stripped telephone wire or other bare wire. Next, tightly twist the ends of the wire together. Tape the connection to block out moisture. See Figure 5.

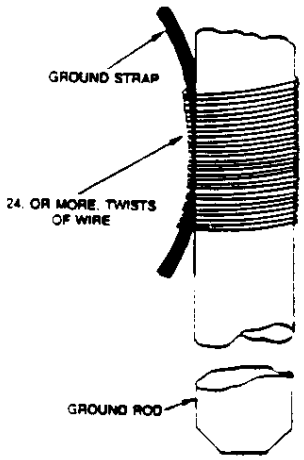


Figure 5

(3) <u>Do not</u> tie the ground strap or the heavy wire substitute to the rod or loop it around the rod. The strap <u>must</u> be connected <u>only</u> to the terminal screw or bound with wire to the rod.

g. After you connect one end of the ground strap or wire to the ground rod, connect the other end to the ground lug on the shelter

or equipment. Keep the strap or wire as short and straight as possible. Make sure that there are no loops or knots in the ground strap or wire. See that all connections are clean and tight. Figure 6 illustrates a completed earth ground system with the rod installed and the strap attached.

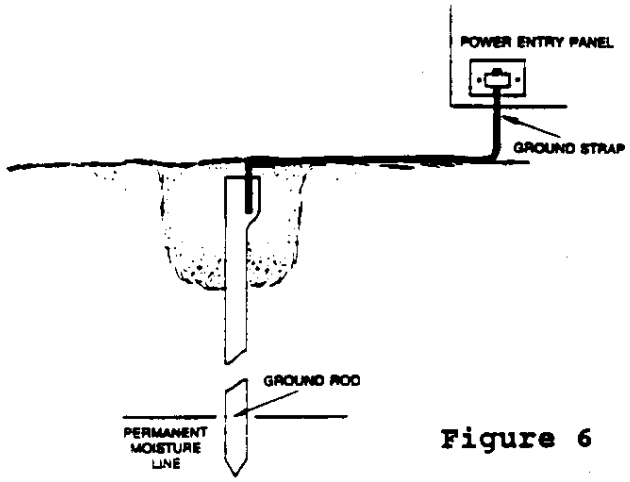


Figure 6

h. Fill the hole with water, and let it soak in. Then fill the hole with soil. Add water as often as needed to keep the soil moist around the ground rod. Do it at least once a day if it doesn't rain.

i. Check the strap or wire connections every day. Keep them clean and tight.

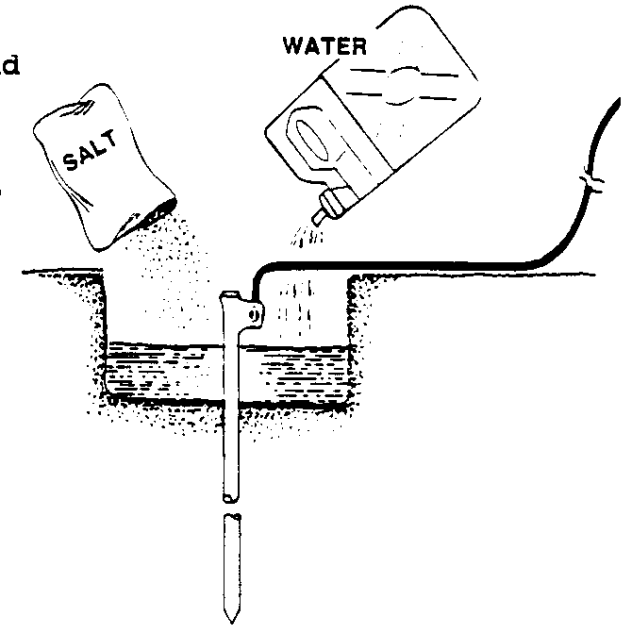


Figure 7

5. IMPROVING SOIL CONDUCTIVITY

For soil conditions where the conductivity may be poor, conductivity can be enhanced by adding salt to the water as shown in Figure 7. Use 1 pound of salt per gallon of water. To replace the salt that leaches into the soil, mix salt with the water at least once a week for the first four weeks of use. After the fourth week of use, add the mixture of salt and water at least once a month. (Special measures apply to grounding in the desert; see paragraph 7a.)

6. GROUNDING TO UNDERGROUND OBJECTS

a. Underground metal objects (buried metal pipes, steel building frames, metal poles, storage tanks) provide excellent grounding IF:

(1) They are buried at least 6 feet below the earth's surface.

(2) They do not contain gasoline or other flammable liquids or gas.

b. Connect the ground strap to the underground metal object with a straight, clean, and solid connection. Do not wrap or tie it on. Avoid sharp bends. Figure 8 illustrates some examples of good ground connections to buried objects.

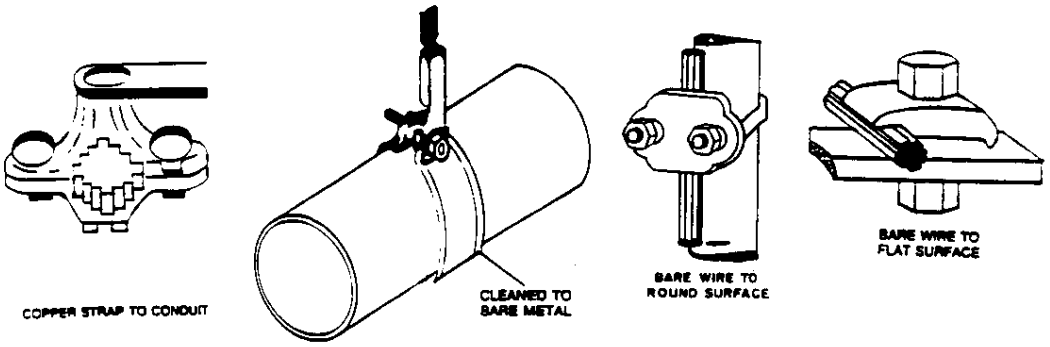


Figure 8

7. GROUNDING IN POOR SOIL

When your site does not have fine topsoil, clay, loam, or shale, you must compensate for poor electrical conductivity by taking applicable steps described in paragraphs 7a through 7e and 8 below.

a. Desert

(1) In the desert, a ground plate may work better than a ground rod. (See Figure 9.) Select any clean, bare metal plate or sheet that's at least 3 feet square and at least 1/8 inch thick. Select a metal bolt, nut and lock washer and drill a hole in the center of the plate just large enough for the bolt. Fasten a ground strap to the plate as shown in Figure 9. Make sure the connection is clean and tight. Pour a mixture of water and salt into the soil around the plate. (See Figure 10; also see instructions in paragraph 5 for improving conductivity.) Bury the plate horizontally at least 4 ft below the surface.

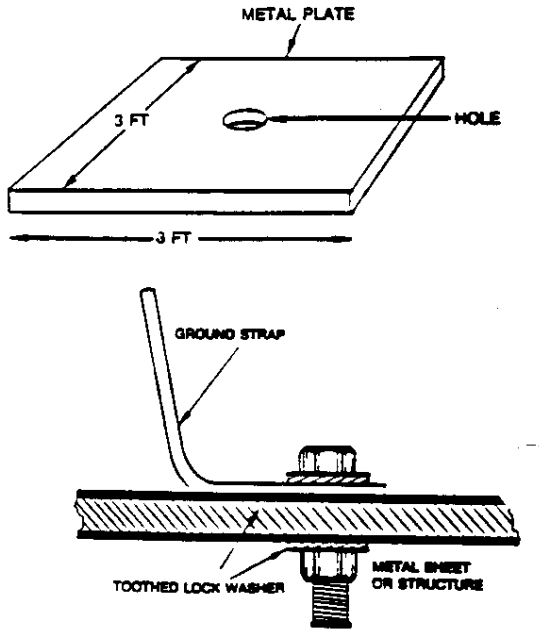


Figure 9

(2) Connect the strap to your equipment or shelter. Make sure the connection is clean and tight and check it every day.

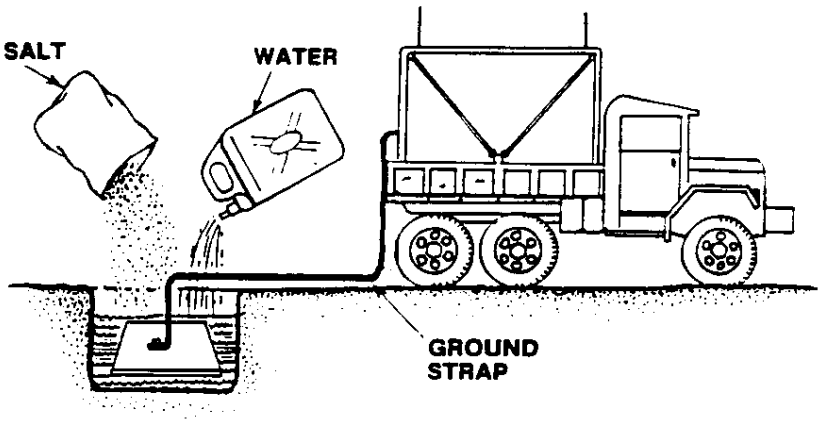


Figure 10

(3) If you use ground rods in the desert or in soils with poor conductivity, you may need to install several rods and connect them together to achieve a good electrical connection to the earth. See paragraph 8.

b. Sandy soils, gravel, stones, and soils mixed with gravel or sand

If you are installing a ground rod, dig a hole 1 ft deep and 36 inches in diameter. If you intend to use a ground plate, dig the hole at least 4 feet deep and large enough to install the plate horizontally. Install the ground rod or ground plate as described above in paragraphs 4 and 7a. Follow the instructions in paragraph 5 to improve conductivity. Keep the soil around the rod or plate moist at all times.

c. Mountains

The soil in mountainous areas is often only a few inches thick. Therefore, it is especially difficult and often impossible to penetrate to moist soil or a water table in the mountains. To properly ground your equipment, you must carefully select a site where a ground rod can be installed. Sites near a stream bed are usually your best locations for grounding. (See Figure 11.) If you cannot drive a rod to its full length, you will have to install additional rods; see paragraph 8.

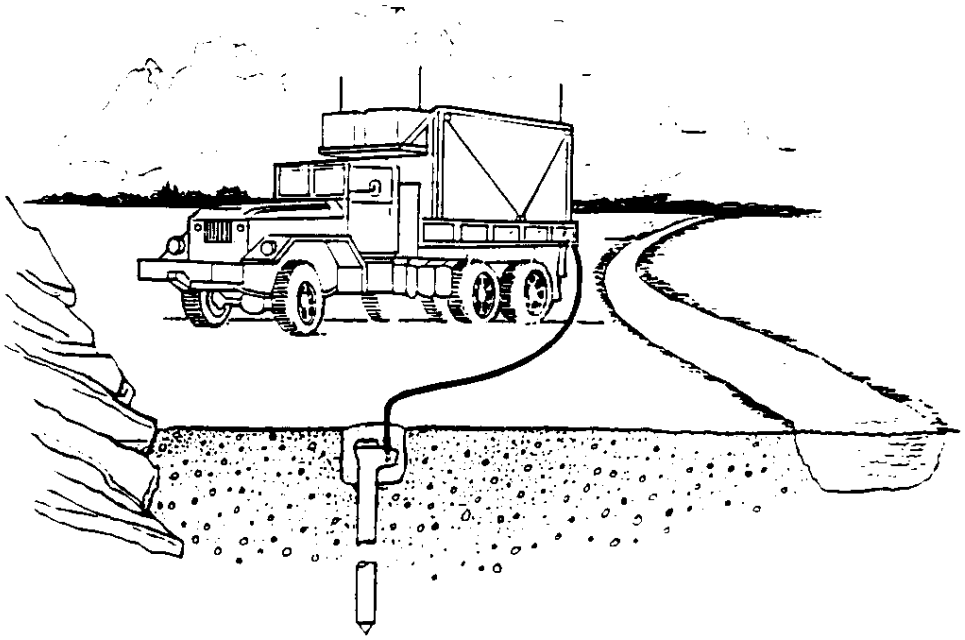


Figure 11

d. Tropics

Install the ground rod as described in paragraph 4. Because of the constant high humidity, take extra care to keep the strap connection at the equipment clean and dry. Cover the connection of the ground with waterproof tape and **check it every day.**

e. Arctic

Try to ground to an extension of a buried metal object such as an underground pipe or a building frame. If no buried object is available, drive in several ground rods as deeply as possible. Space them at least two rod lengths from each other.

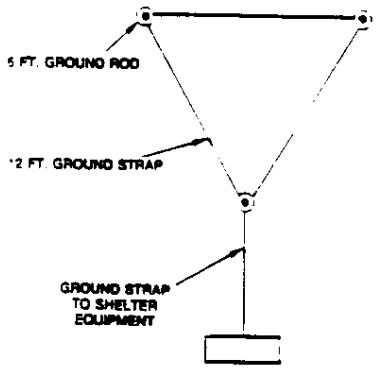


Figure 12

Connect them with #6 AWG or larger bare copper cable or braid. Connect the ground lug on the power entry panel of the shelter to the closest ground rod. Treat the soil with a mixture of salt and water as explained in paragraph 5. Figure 12 and Figure 13 illustrate two methods of grounding that could be used under these conditions.

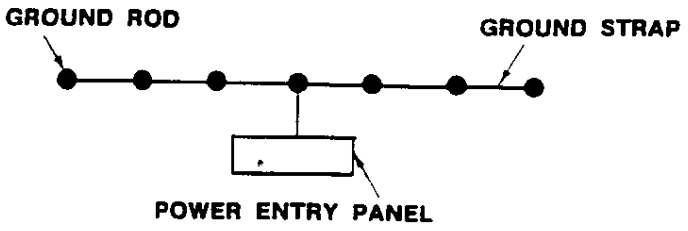


Figure 13

8. HINTS TO IMPROVE YOUR GROUND

When a single ground rod provides a poor ground, drive in additional rods spaced 2 rod lengths apart. If you can, use 8 or more rods. The more rods you use, the better will be the electrical connection to the earth. Install them around the perimeter of your shelter or equipment as indicated in Figure 14. Connect all rods together and connect the closest rod to the shelter's power entry panel using the heaviest wire you can find, preferably #6 AWG or larger bare copper cable. If possible, connect the other perimeter rods to other points on the shelter to further enhance the grounding. Treat the soil with a mixture of salt and water as explained in paragraph 5.

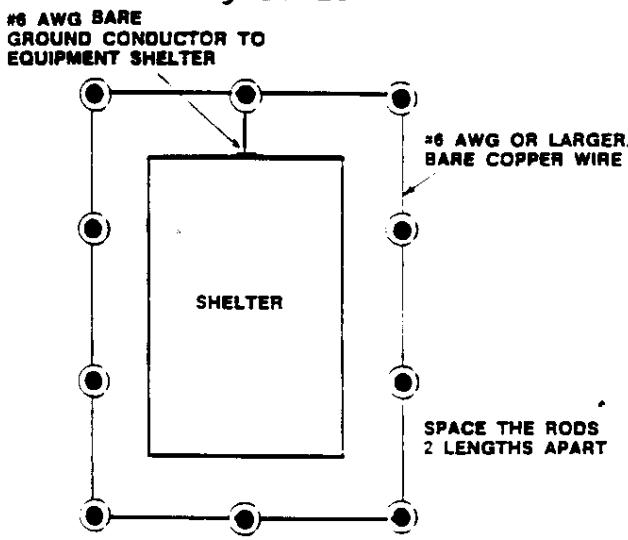


Figure 14

If a perimeter installation is impractical, you may install the rods in a star-ground configuration as shown in Figure 15. Connect the center rod to the shelter as shown and treat the soil as explained in paragraph 5.

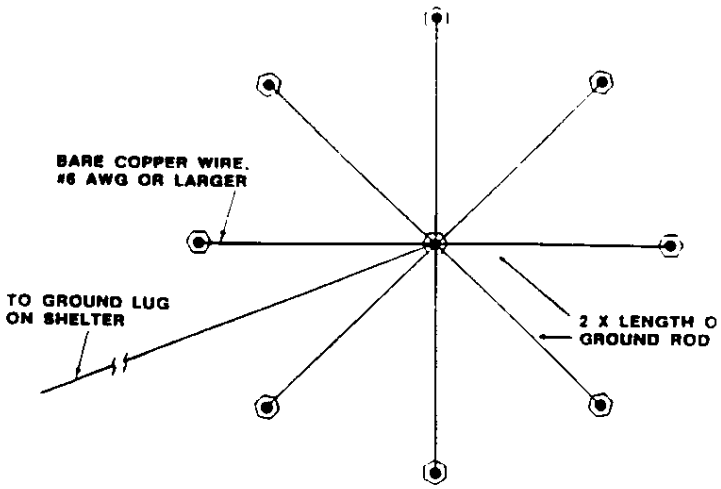
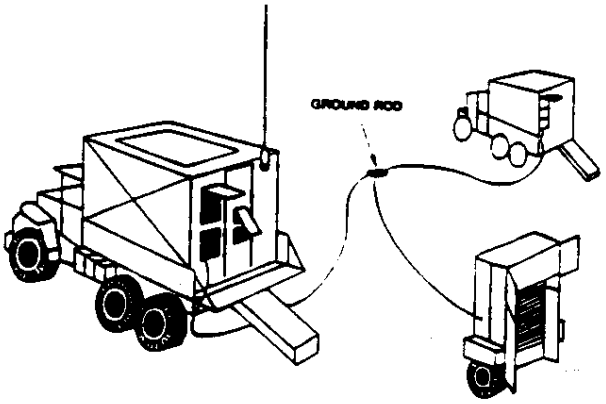


Figure 15

9. CO-LOCATING SHELTERS AND STAND-ALONE EQUIPMENT

During thunderstorms, lightning flashover or arcing can occur between two or more unconnected or poorly connected metal structures that are located close to each other. Flashover between objects can cause lethal voltage on the ground in the vicinity of these objects. To avoid lightning flashover, separate equipment shelters, antenna masts, and other metal structures at least 6 ft from each other or bond them together with heavy copper cable. The cable lengths should be as short and as straight as practical. Connect both the shelter and the other close objects to a common ground rod.

Use a common ground rod for any two or more shelters or pieces of equipment that are located within 25 ft of each another. This will help to prevent dangerous voltage between shelters and reduce signal interference from stray (or common mode) ground currents.



10. LIGHTNING CAUTION FOR STAND-ALONE EQUIPMENT

When thunderstorms threaten, disconnect power from stand-alone equipments that are not sheltered by a separate lightning protection system. Then separate all such equipments by at least 6 ft or bond them together with heavy copper cable.

NEED MORE INFORMATION?

See FM 11-487-4 and MIL-HDBK-419A, Vol. II. For help, concontact your local safety office or your CECOM Logistics Assistance Representative or the CECOM Safety Office. You may call CECOM Safety at DSN 992-0084 or (908) 532-0084, or write to:

Commander
US Army CECOM
ATTN: AMSEL-SF-SE
Fort Monmouth, NJ 07703-5024

COORDINATION/CONCURRENCE: The U.S. Army Signal Center has concurred with CECOM including this information in equipment technical manuals and with publication as a technical bulletin.

APPROVED: William H. Hulse Jr.
WILLIAM H. HULSE, Jr.
Chief, Systems Engrg. Div.