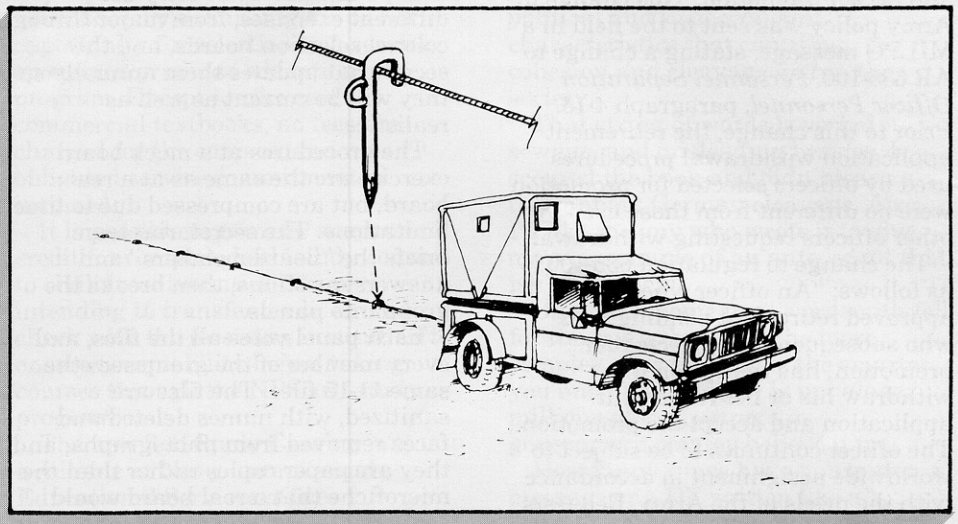
Grounding: our weakest link?

by Walter N. McJilton and Bernard E. Keiser



An earth ground seems simple enough to make. Take a 6-foot metal rod and pound it into the ground. Wrap your ground lead around it and there you are, safely grounded. Right?

Not necessarily. Scientists from the Army's Human Engineering Laboratory Grounding Analysis (HELGA) project have shown that grounding with the standard 6-foot metal rod—or even several rods in parallel—is often unsafe and even more often inadequate for good low noise communications. They have also proposed an alternate method, the surface wire grounding system, that has several advantages over the grounding rod.

Basically the surface wire technique is very simple. As shown in the accompanying illustration, the surface wire grounding system is a 100-foot length of standard 1/8th inch stranded steel wire that is "stapled" to the earth every 4 feet by short 6-inch pegs. A 3-pound hammer (in lieu of the 10-pound sledge hammer used with the ground rod) should be sufficient to drive in the pegs. If pegs are not available, an alternate approach that gives similar results is to bury the wire 1 to 2 inches below the surface.

The comparative results between ground rod and surface wire are impressive. Data obtained at sites all over the country, including Ft. Bliss, Texas, Ft. Drum, N.Y., Yakima, Wash., Ft. Lewis, Wash., Ft. Huachuca, Ariz., and Ft. Story, Va., show the surface wire to be 32 to 95 percent more efficient than the standard 6-foot grounding rod.

The HELGA surface wire technique has the additional advantages of being reusable an indefinite number of times, of minimizing any hazardous voltage drop along its length, and of being able to be set up even in an area covered with surface rocks. In addition, the horizontal wire provides an especially good conducting path for any electromagnetic pulse (EMP) currents that may flow in the ground system. (Because EMP currents have a large high frequency content, they do not penetrate deeply into the earth, but instead flow mostly within a few feet of the surface. Most EMP currents would thus not even reach the lower 60 to 90 percent of a vertical ground rod.)

While tests proved the surface wire method definitely superior to the grounding rod method, they also showed that in soil of very high resistivity, such as exists at Ft. Lewis, Wash., even the horizontal wire may produce a higher resistance than tolerable. What then? HELGA testing indicates that multiple interconnected surface wires, where the area around the pegs has been treated with a salt solution, provides a definite improvement.

However, in order to determine when such measures are necessary, we need a way to measure the resistivity at a given location. The resistivity is best evaluated using what is called the four probe method. Insert four short metal rods, or probes, vertically into the ground in a straight line, with a spacing of 6 to 8 feet (since we are usually interested in the resistivity to a depth of 6 to 8 feet). Then send current in the low audio frequency range (not dc, not 60 Hz, not 400 Hz) through the outer electrodes and measure the voltage drop across the inner electrodes. From these measurements, you can calculate the earth resistivity using formulas and charts provided with the measuring equipment.

By knowing the value of the earth resistivity, one can determine how extensive a ground may be required in a given area. Information on how to compute the resistance of a horizontal wire ground is provided in "Human Engineering Laboratory Grounding Analysis," an article by Bernhard Keiser in *U.S. Army Human Engineering Laboratory Technical Note,* pp. 9-84, June 1984. For additional information, contact Mr. Phelps, (301) 278-5958.

Mr. McJilton, HELGA project leader, is a physicist assigned to the Communications Electronics Team, U.S. Army Engineering Laboratory, Aberdeen Proving Ground, Md. Dr. Keiser, Keiser Engineering Inc., Vienna, Va., was the technical consultant on the project.