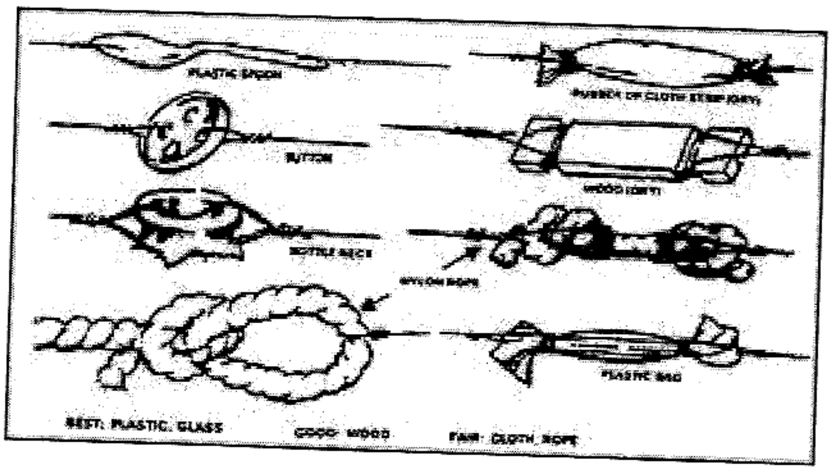
FIELD EXPEDIENT ANTENNAS

While most of us will never be in the position of not having our regular antennae and materials commonly used to construct them readily available. The field expedient antennae for most hams will probably be prepared and stored in a disaster response kit long before it is needed. But remember that Murphy's law, which seems to ride along with every disaster responder, will insert itself into the smoothest operation at the worst possible time. What can go wrong, will go wrong. So this presentation includes helpful information when you are expected to communicate and your antenna has left you for a safer location.

1. Insulators: As their antennae get shot at often, the military has put years of study into temporary antenna erected from scrap. Their recommended substitutes for antenna insulators are:



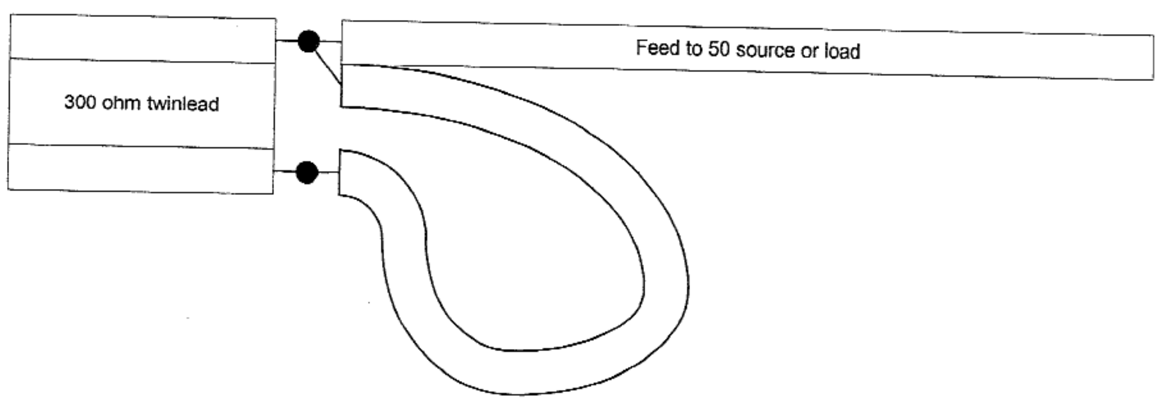
Keep in mind any substitute is not as good as the original and power level must be reduced to avoid arcing over the substitute insulator. With the exception of the button, most of the insulators shown above are good for 50 watts maximum. Some materials available locally during an emergency could be insulation removed from Romex wire, PVC pipe, nylon rope and a chain made of medium duty ty-wraps. When dry these substitutes can handle 200+ watts. The local hardware and farm supply store or farm can be a source of electric fence insulators that are designed to shed rain and can be used inline or as feedline wall supports. The longer porcelain or 4" or greater PVC insulators can be used up to 500 watts and in emergency the full legal limit.

2. Wire and antenna material: Sources of wire are all around us. Lamp cords, fences, electrical wiring and our own damaged antennae are all good sources. Copper and aluminum are the best choice and steel will work. In a temporary operation anything that can radiate such as copper water pipe, metal flag poles, light poles and TV antennae can be used in part or whole to construct antennae. Again the hardware and farm store have a wide selection of material to select from.

3. **Feedline: Of course 50/72 ohm coax or 300 – 450 ohm open wire line we normally use in our stations is the best choice, but other type of cable can be used.**

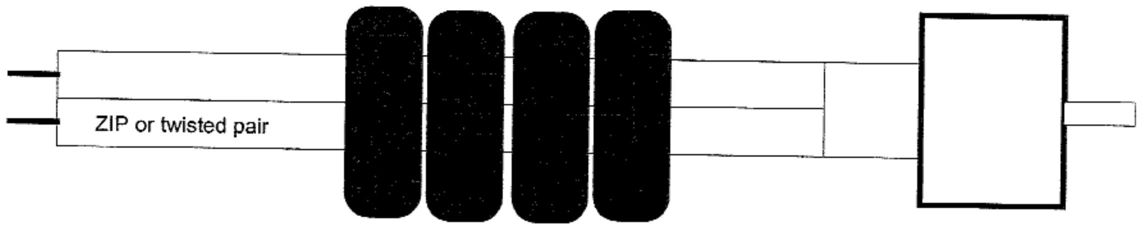
a. **When operating HF to UHF a low power substitute for short feedlines is 75 Ohm Cable TV coax. Keep in mind that this is a cheap foam insulated, foil shield cable never intended for use on a transmitter and due to the mismatch between the 50 ohm systems and 75 ohm cable any power over 25 to 50 watts may ignite the foil at possible VSWR nodes.**

b. **While not much of this cable is used anymore, 300 ohm TV twin lead is suitable for HF through UHF feedlines. Again as this was never intended for transmitting, at VHF and UHF the insulation may breakdown at over 50 watts. A simple ½ wave balun made from RG58 or RG59 coax can be used at either end to transition between 50 and 300 ohms. A balun design for RG58 is shown below. For two meters the balun section is 26 5/8 inches.**



1/2 Wave section in inches L= (5904 / F in Mhz) x .66

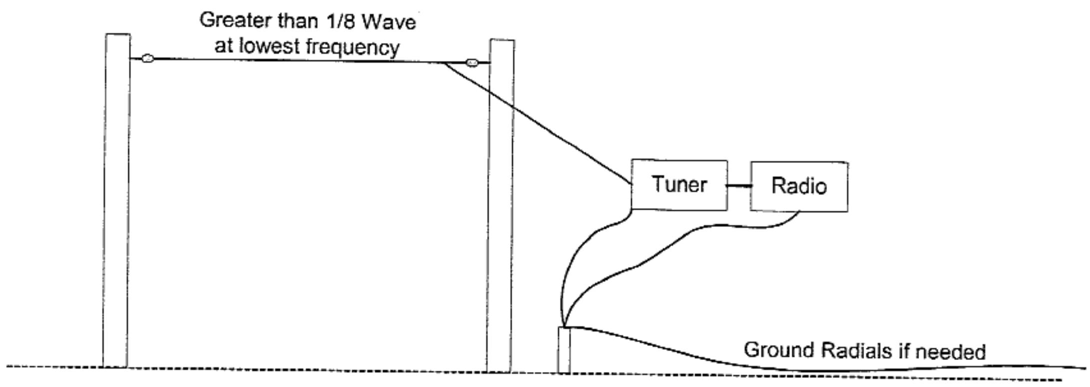
c. **Lamp cord can serve at HF as a low power, 50 watts or under, 72 ohm balanced feeder. Keep in mind this is cheap insulation and the higher the frequency the lower the power used. At 6 meters I would stay around 25 watts. This is useful for dipoles but requires a 1:1 balun to match the unbalanced SO239 output of most transceivers. If a balanced antenna tuner is available the balun is not required. A simple low power balun can be made by placing a several ferrite cores over the feedline close to the transceiver. Also keep in mind the snap on interference suppressor that are used on computer cables. The more ferrite the lower the frequency the balun is effective at. But also keep in mind this is a LOW POWER solution.**



A field built 1:1 Balun

d. **Twisted pairs such as military field wire or a pair of #14 house wire twisted at greater than 2 twists per inch is an effective solution and the usage of baluns described above also apply here.**

e. **But at HF the simplest solution is to use a tuner with a good ground and end feed a wire antenna. That way the antenna is also the feedline.**



4. Ground:

There are several reasons for establishing a ground connection. The first is safety and the prevention of shocks from accidental coupling to the AC power source. The second safety concern is that in most field operations the antennae are not perfect and high RF voltages can be reflected back to the operator position causing serious RF burns. The operational concern is when using an antenna that does not have a natural balance or counterpoise such as a vertical or long wire a counterpoise must be established for the antenna to function effectively.

Grounding is one of the most misunderstood concepts in the world of antennae. So to accomplish the safety and operational goals outlined above it may

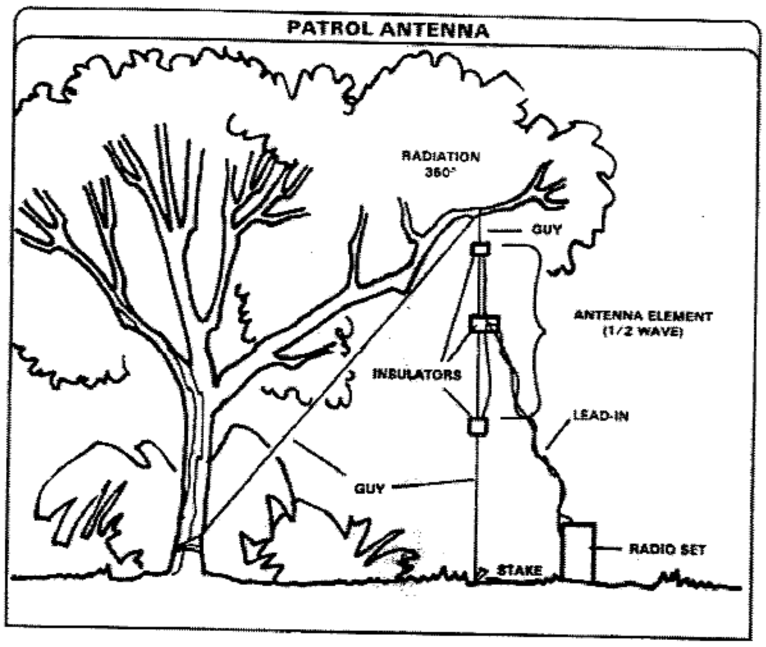
take two different ground systems. AC safety ground is established using ground rods, existing electrical system grounds or metal water pipe that extend below ground. Depending on soil condition and type of antenna used this maybe also adequate for the RF ground. If it is not radials of any type of wire can be spaced out on the ground, on a rooftop or floor. These radials in ideal conditions should be a minimum of ¼ wave in length but shorter radials are better than nothing and at ideally 8 or more should be spaced out around the antenna base or operating position. They do not have to be buried and in some cases they are more effective if they are a few inches above the ground.

Ground Don'ts:

a. Do not tie to ground wires on utility poles.
b. If you are using a wire fence as a counterpoise be sure it does not have a chance of power line contact during a storm.
c. Ground the generator if you are using portable power.
d. Do not skip the grounding as it may kill you!

5. Antennas:

The simple dipole maybe constructed in either the horizontal or vertical plane. An omni-directional antenna maybe constructed using the simple dipole and suspending it from a tree. This will work at any frequency as long as you have sufficient height to suspend the antenna. Keep the ground end higher than a person can reach as even at low power a Dipole's endpoint is the voltage node and may cause burns if contacted. This is a balanced antenna and will operate effectively without a good ground plane. Dipoles are ½ wave antennae and each leg is ¼ wave long – 5%. So the formula for each leg of the dipole is in inches L = (2952 / F in Mhz) x .95. If the vertical dipole is fed using coax keep the end connected to the shield down.



The long wire antenna also requires a good ground system to be effective and protect the operator against RF burns. With an antenna tuner this type of antenna need not be resonant but only long enough to be tuned at the lowest frequency to be used. Some tuners are happy at 1/8 wave or less at the lowest frequency. But remember the more wire, up to a point, the more effective the antenna will be. Ground should be secured from ground rods, metal water pipes, building frames and fences that do not pass under power lines. If you cannot get a good ground in addition to ground rods or pipes try to space out radials from your operating position opposing the direction of the long wire.

While not usually used as a directional antenna a long-wire maybe modified to have a small gain off the end of the wire. This is useful if you need more range or you are trying to get interference out of the system. The below pictured version of the long wire is a directional antenna and adds a resistor to the end of the line to gain the directivity. A two watt 560 ohm resistor will work for power ranges of 5 to 25 watts.

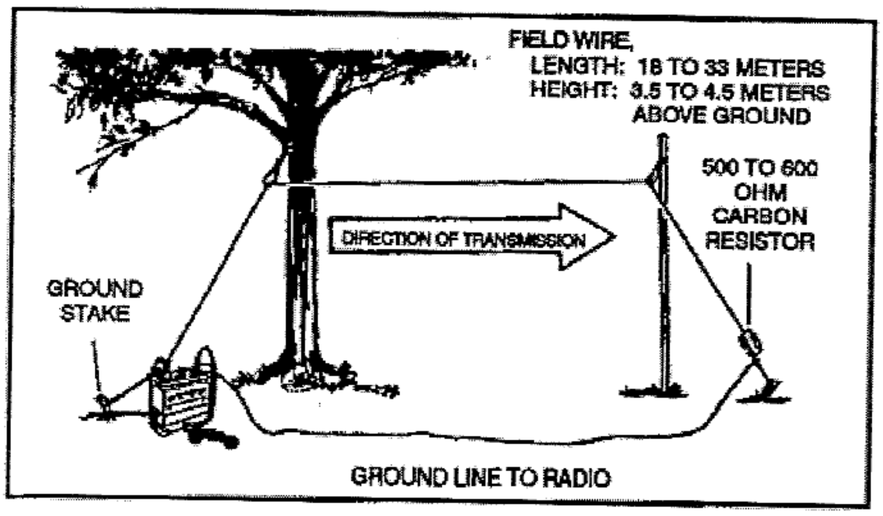
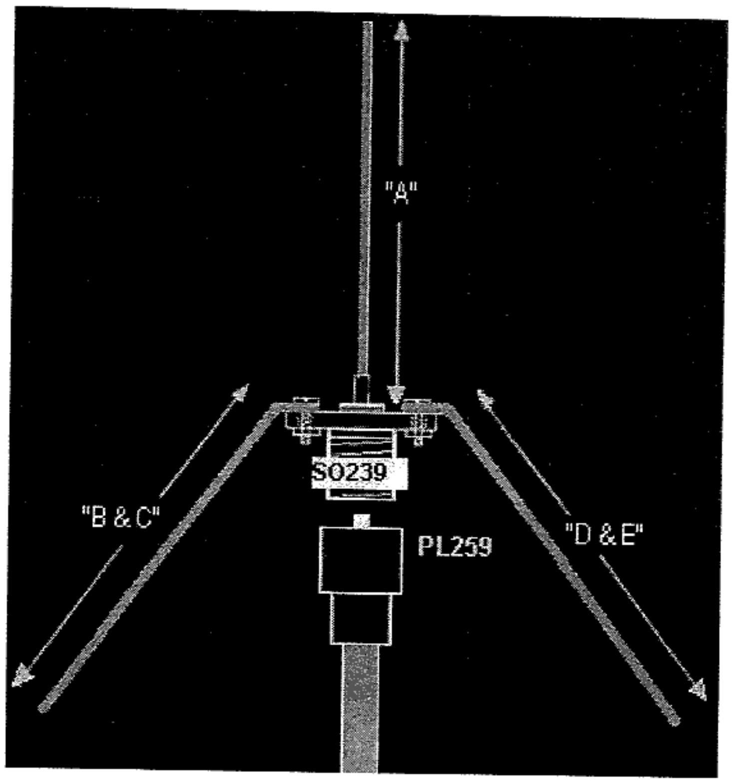


Figure 7-10. Long-wire antenna.

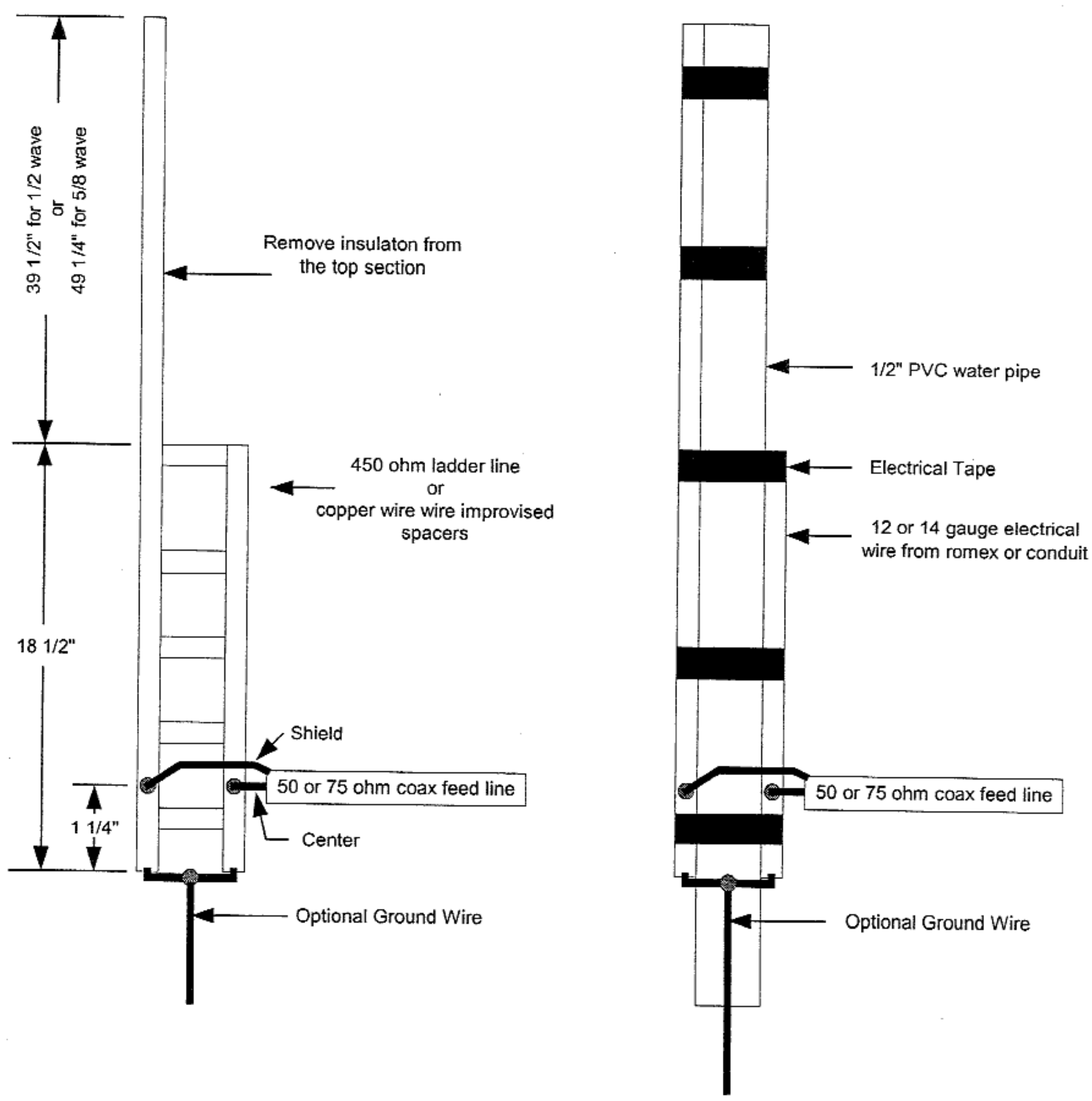
A vertical antenna maybe made from any conductive rigid material or as a wire stretched vertically between the ground insulator and a tree or pole. A ground rod or radials will be needed at the base of the radiating element. The formula for the dipole ¼ wave element can be used to calculate the length of the radiator. As many ground radials greater than ¼ wave in length as practical should be used. But as stated above even shorter radials are effective.

VHF and UHF ground plane antenna. A simple ground plane antenna can be built using solid wire salvaged from Romex house wiring, 4 crimp on ring connectors, a SO-239 connector and some hardware. If a SO-239 is not available a section of PVC water pipe can be used to support the radials and radiator. Soldering or crimp connectors maybe used to connect the radiator and radials directly to the coax cable. For the ground plane to have the proper 50 ohm resistance the radials need to be bent down at roughly 30 degrees. Length A in inches is calculated by A = 2808/F in Mhz, The radials are calculated by B,C,D,E = (2808/F in Mhz) x 1.05 as the radial should be 5% longer.



The J Pole antenna is probably the most used 6 meter through 440 Mhz field expedient antennae. This is an effective antenna that has a built in ground counterpoise so it is not finicky about where it is installed and is tolerant of having it base grounded for safety reasons. A properly built J Pole interfaces with 50 ohm coax roughly 7.5 to 10% up from the bottom of the antenna. A J pole may yield up to 2 DB gain over a dipole antenna. A simple J Pole maybe built from 450 Ohm ladder line and RG58 coax. This maybe rolled up and fit in a very small space in your emergency kit. Depending on the local frequency plan several band maybe accommodated and practical deployment of this antenna ranges from 10 Meters to 902 Mhz.

An alternative antenna maybe built using sections of salvaged Romex and either PVC or PEX ½" water pipe. Stretch the wire to get any kinks out, cut it to length and carefully tape in on opposite side of the pipe. As the dielectric constant of the materials is unknown use the dimension for the open wire J pole and using a wattmeter trim the elements equally for lowest VSWR.



Two field expedient J Pole antennae

Formula and charts for length and spacing

5. J Pole or other wire antenna
   a. Velocity Factor for insulated wire is .92 and bare wire is .98.

   b. The lower section of a J Pole is ¼ wave and the formula is in inches L = (2952 / F in Mhz) x velocity factor.

   c. The upper section of a J Pole is ½ wave and optionally 5/8 wave the formula in inches for ½ Wave is L = (5904 / F in Mhz) x velocity factor. For 5/8 wave the formula is L = (7380 / F In Mhz) x velocity factor

   d. These formula also work when cutting coax to length and the common velocity factor for RG8 and RG58 is .66.

2. Quick Reference chart courtesy of the U.S. Army.

QUICK REFERENCE CHART EXPEDIENT ANTENNAS

HIGH FREQUENCY (HF) ANTENNA LENGTH IN FEET AND INCHES				VERY HIGH FREQUENCY (VHF) ANTENNA LENGTH IN FEET AND INCHES			
Op freq in MHz	1/4 wave	1/2 wave	1 wave	Op freq in MHz	1/4 wave	1/2 wave	1 wave
2	117'	234'	468'	30	7'10"	15'7"	31'2"
3	78'	156'	312'	33	7'1"	14'2"	28'4"
4	58'6"	117'	234'	35	6'9"	13'5"	26'10"
5	46'9"	93'7"	187'4"	37	6'4"	12'7"	25'2"
6	39'	78'	156'	40	5'10"	11'8"	23'4"
7	33'5"	66'10"	133'8"	43	5'5"	10'10"	21'8"
8	29'3"	58'6"	117'	45	5'3"	10'5"	20'10"
9	26'	52'	104'	48	4'10"	9'8"	19'4"
10	23'5"	46'10"	93'8"	50	4'9"	9'5"	18'10"
11	21'3"	42'6"	85'	55	4'3"	8'6"	17'
12	19'6"	39'	78'	57	4'1"	8'2"	16'4"
13	18'	36'	72'	60	3'11"	7'10"	15'8"
14	16'9"	33'5"	66'10"	65	3'7"	7'2"	14'4"
15	15'7"	31'2"	62'4"	68	3'5"	6'10"	13'8"
16	14'7"	29'2"	58'4"	70	3'4"	6'7"	13'2"
17	13'9"	27'6"	55'	75	3'1"	6'2"	12'4"
18	13'	26'	52'	80	3'	5'11"	11'10"

6. **Personal safety: Climbing around putting up temporary antennae under emergency conditions is quite hazardous. Damaged structures, tree and the power grid are significant hazards and every year emergency responders are killed while dealing with these hazards. So the rules of the road should be firmly kept in mind: Stop, Inspect and Test or SIT and think about it is the best first course of action. Resist the pressure to rush in and get started, just briefly stop and think. Carefully inspect the area you will be setting up both your temporary station and antenna. Look for physical hazard such as trees, damaged building, propane or other damaged fuel tanks, power, cable and phone lines and natural hazards such as flooding or earth collapse. If you are suspect about anything the first thought should be to locate to a safer area. As many responders are killed by invisible electrical hazards a non-contacting voltage detector should be part of your emergency kit. Test the environment including fences and any ground points you may hook to. Make sure the generator is grounded and verify it with the tester. Plan your approach to raising your antennae avoiding climbing if at all possible. Be vigilant throughout the operation as condition are always changing and your safety depends on how much you know about what is happening around you. Shut down the generator while fueling so you do not make an ash out of yourself!**