Using a Short Vertical Antenna at HF

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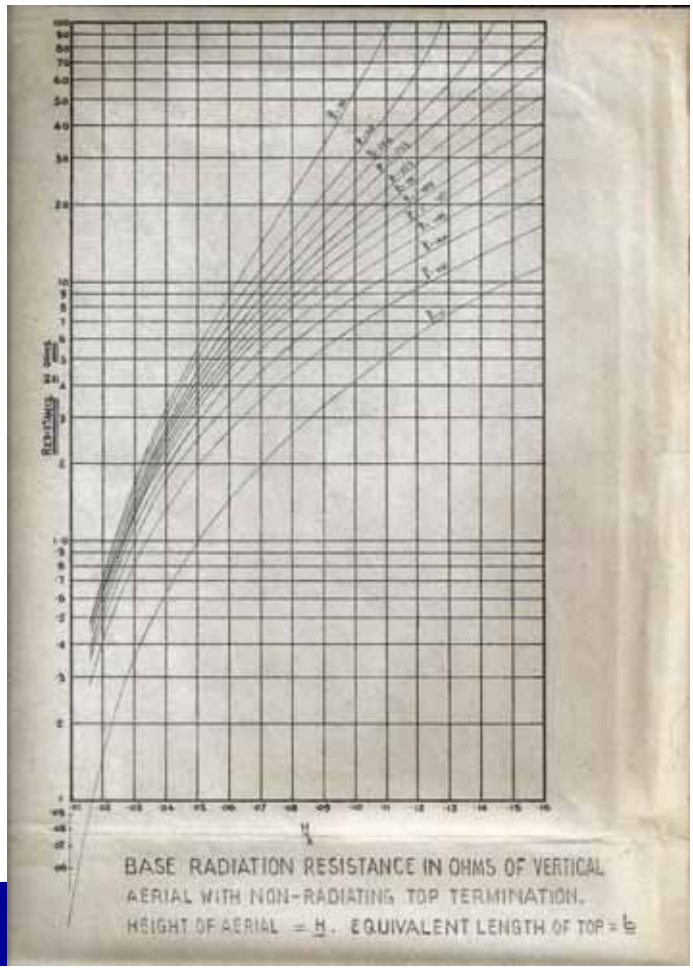
This brief article results from discussions we held during the summer on the weekly NVIS[1] HF net when it was noticed that one or two stations using mobile vertical antennas away from home on holiday produced much weaker signals than their home stations.

Every end-fed antenna can be depicted as a reactance X (L or C) in series with Radiation Resistance (Rr), in series with Actual Resistance of all antenna components (Ra), in series with Matching Resistance Losses (Rm), in series with Earth Resistance (more losses) (Re).

Therefore Antenna Impedance = Rr+Ra+Rm+Re+jX. The only part of all this which radiates is Rr, everything else except the jX term is lossy.

The chart below shows the Radiation Resistance of short vertical antennas. (Use only the lowest curve, all the others are for antennas with a "Capacity Hat" often used for broadcasting at medium waves to give the effect of a longer aerial.)



From this you will see that the Radiation Resistance of a 4m whip at 80m (= λ / 20) is 1 ohm.

From measurements I made during my employment 40+ years ago, the earth "resistance" from the body of an unearthed Land-rover to ground is about 10 ohms over a range of low HF freqs, about 3 - 8MHz. So, we would have about 1 ohm, in series with 10 ohms earth loss, in series with matching and other losses, perhaps another 5 ohms or more, so at least 15 ohms total of loss resistance. Therefore, take your carefully matched 100 watts into that 16 ohms and calculate the power actually dispersed (radiated) in that 1 ohm of radiation resistance. The same current flows through them all and I^2R will be dissipated in each in the ratio $I^2 \times 1\Omega$ to $I^2 \times 16\Omega$; in other words you are effectively radiating about 1/16 at best of your 100 watts, i.e. no more than about 6 watts.

This situation can be improved in several ways:

- use a longer vertical antenna;
- bang an earth spike 3 or 4 feet into wet, conducting ground;
- connect to an earth plate as large as possible on the ground under the vehicle;
- use a counterpoise wire at least λ / 4 long. Its best direction needs experimentation.

Note that a vertical antenna theoretically transmits NOTHING vertically, so it needs to be sloped back away from the desired direction of transmission for short ranges.

Vertical antennas with built in loading coils will have a higher impedance (R + jX) presented to the matching device, but their Radiation Resistance will be unaltered - that depends purely on its fraction of a wavelength. The resistance of the loading coil wire will introduce extra losses but this should be more than compensated by lower matching losses (which is the whole idea of loading).

Beware, transmitting 100W from an unearthed vehicle can be very dangerous to any outsider who touches the vehicle, particularly the antenna.

I have only discussed resistive losses above. However every antenna shorter than a quarter wavelength is capacitive (-jX), and needs series inductance (+jX) to resonate it, i.e. to "match" it, so that the -jX and +jX cancel out. This capacitance might typically be 20pF for the short vertical rods we are considering.

So, our antenna might "look like" 16 ohms in series with 20pF. 20pF at 3.7MHz is a reactance (-jX) of about 2150 ohms. (X=1 / 2πfC where f=Hz and C=Farads). !00 watts into 16 ohms produces a current at the antenna base of

about 2.5 Amps ($P=I^2R$). To make 2.5 Amps flow into an impedance of about 2150 ohms your ATU produces about 5,400 Volts ($V=IR$) ..... very nasty if you touch it. Big holes in the flesh can result.

So, **TAKE CARE** when using short HF antennas. Be especially careful if you are transmitting from an unearthed car or caravan, and you have a passenger. **DO NOT** let them get out whilst you are transmitting. Their hand on the door and feet on the ground would earth your vehicle with a possibly fatal result. Soldiers have been killed by jumping out of the back of an unearthed vehicle, operating TX whilst hanging on to the door.

[1] *Near vertical incidence skywave*