EARTH ELECTRODES FOR SAFETY UNDER DIFFICULT EARTH CONDITIONS

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1.0 Overview. Fault currents and lightning events need the lowest available impedance grounding destination. How to achieve this where rocky or sandy conditions are present? We discuss options in this Paper. The intended application is military-tactical-poor soils situations.

2.0 Step One. Throw out the Codes.

2.1 The NEC figure of 25 ohms only applies to rods and plates.

2.2 And 25 ohms does not consider volumetric efficiencies available with "concrete-encased electrodes" (aka UFER or slab-on-grade/rebar) or "ring-type (counterpoise) grounding methods. Or the use of man-made "backfills" such as bentonite, Coke Breeze, GEM, GAF, San-Earth and other highly conductive & expensive additives.

2.3 Copper and copper plated electrodes are not needed. Consider that the electric power industry has used galvanized steel underground for 100+ years. Aluminum, of course, raises corrosion and material strength issues so don't go there…

2.4 This Paper does not apply to MILVAN/CONEX storage containers with ammo inside. While the Faraday Cage principle may apply, DDESB Memorandum Sept 11,2015 requires grounding of EODRSL and EODMAG..

3.0 Some Designs and Design-Situations which are not described in Codes.

3.1 Solid Rock. The grounding electrode must be on top of the earth surface.

3.1.1 Copy techniques on Stone Mountain Georgia. Lay down smooth weave cable or flat strap electrodes directly on the surface. Use a radial (crow's foot) or counterpoise or metal mesh or whatever configuration works for the local site.

3.1.1.1 Nail gun the electrodes directly to the rock.

3.1.1.2 Keep length of individual electrode distances under 10m. More electrodes are better than longer electrodes.

3.1.1.3 Separation distance of individual runs should be min. 20 degrees to avoid performance overlap.

3.1.1.4 Lay it all out in a direction away from comms vans and other sensitive electronic/electrical equipment.

3.1.1.5 If this is a tactical situation where rapid deployment is important, use knife-switch or jumper cables connections from the earth electrode to the primary bus bar of equipment grounds. Disconnect and GO !

3.2 Semi-Broken Ground where Burial of Electrodes is Possible.

3.2.1 Repeat parts 2-3-4-5 above.

3.3 Sandy and Very Dry Conditions.

3.3.1 Questions: How much area is available? How much depth have we got? Can we ADD moisture to the Electrode? (Will it rain while we are here?) What is the cheapest/fastest solution. Do we accept the risk of an inefficiencies solution?
Other?

3.3.2 Plan A: Single Rod. Use any metal that will withstand pounding into sand. OK to substitute standard rod with rebar or with existing in-place abandoned passive metal object (ex. railroad rail/signpost/other metal post/etc.).

3.3.3 Plan B: Metal mesh, galvanized or other.

4.0 Add salted water to A or B, above. In desert environments upside down jerrycans with 2 lb. salt to 5 gal. water at bases of temporary wooden power poles. This drip-irrigated (directly onto the rod electrode) solution was successful in 120 F. degree situations. The Jerrycan was refilled each 24 hours. Consider recycling urine. (Contains sodium, potassium and chlorides.)

5.0 Conclusion. Earth Loops and Lightning Ground Potential Rise (LGPR). Multiple ground paths will create unwanted currents where there are potential differences from the service ground. Consequences may range from noise in circuits to arcing and flashover. Grounding is frequency-dependent and since lightning frequencies cover a large spectrum low impedance paths are not consistent. Vertical ground rods are inductive at lower frequencies (between 5KHz and 500KHz) representing an open circuit. Horizontal grounding using capacitive radials (where frequency components may approach 1.0MHz) represent a short circuit. At Time T = to Zero a capacitor is a short circuit where an inductor is an open circuit.

High impedance grounding affects the current path. IEEE Std 1692-2011 “IEEE Guide for the Protection of Communications Installations from Lightning Effects” has concluded that in highly resistive soils over 50% of ground currents are impressed onto the AC phase and neutral lines. IEEE 1692 provides further details about LGPR lightning effects for SPDs, for AC power surge protection, for alternative grounding considerations and for personal safety.