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. So long as these all-steel boxes do not have any AC power entering them no grounding whatsoever is required. They MUST sit directly on the ground. (If they do have incoming AC power, the Faraday Cage principle will not apply.

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 one Arizona desert situation, we installed upside down jerrycans with 2 lb. salt to 5 gal. water at bases of temporary wooden power poles. This was a drip-irrigated (directly onto the rod electrode) solution in 120 F. degree situations. Jerrycan was refilled each 24 hours. Consider recycling urine. (Contains sodium, potassium and chlorides.)

5.0 Conclusion. Thinking outside of the box is essential. See IEEE 142 - Grounding for good ideas.