Obsoleting of Facility Electrical Grounding Protections

19 May 2022

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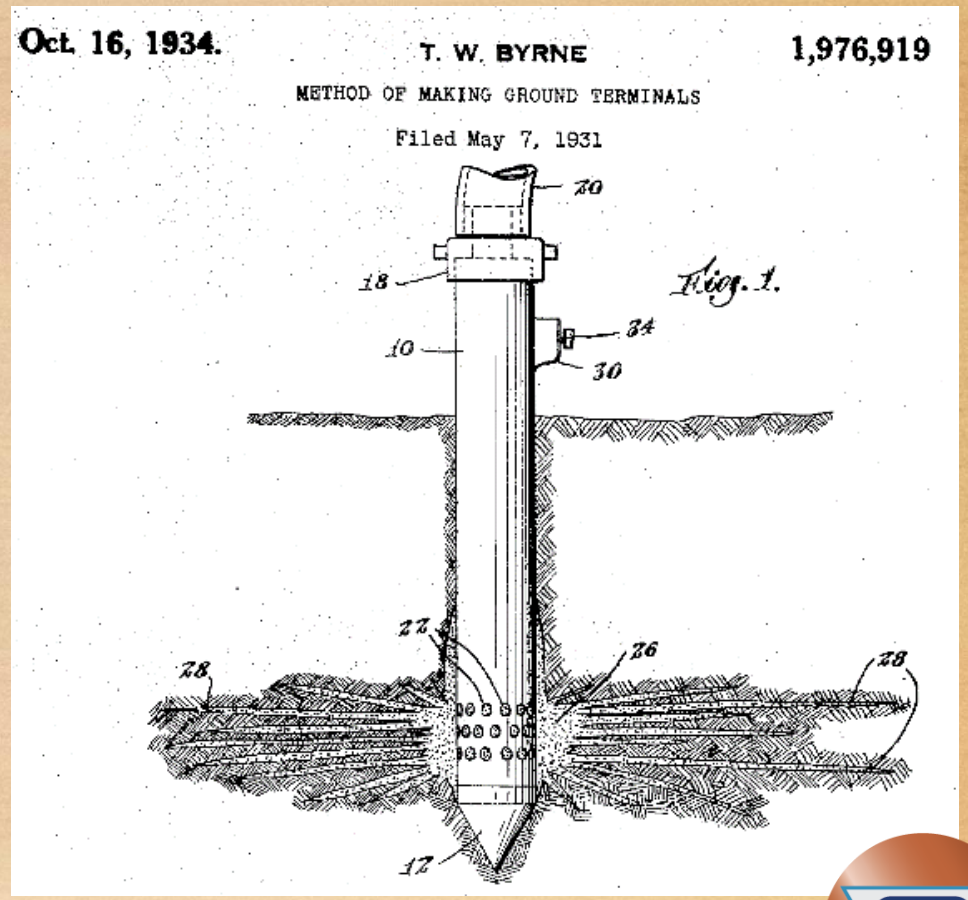
Introduction

- Lots is changing…
- Everything is aging, corroding.
- And new, digital/electronic advances are everywhere from content acquisition to transmission
- Culture seems to accept some damage as normal

"traditional" grounding (or earthing) is becoming obsolete

Ground Rod Progress Has Been *SLOW*

- Stephen Gray used metal hangers to hold cotton and hemp conductors in place (~1729)
- Steinheil replaced a telegraph return wire with ground (1836–1837)
- Garton modified the surrounding soil (1913)
- Byrne seeped conductive materials into the soil from a pipe (1931)
- Ufer replaced copper “rods” with modified concrete (1942)

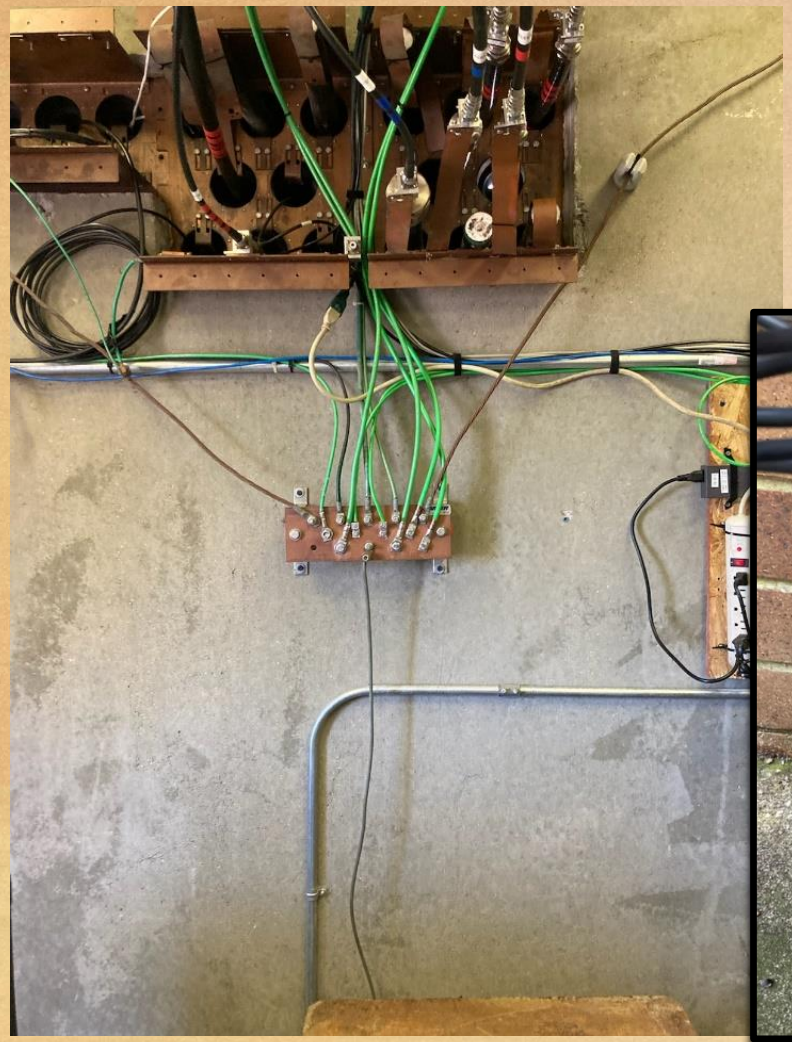


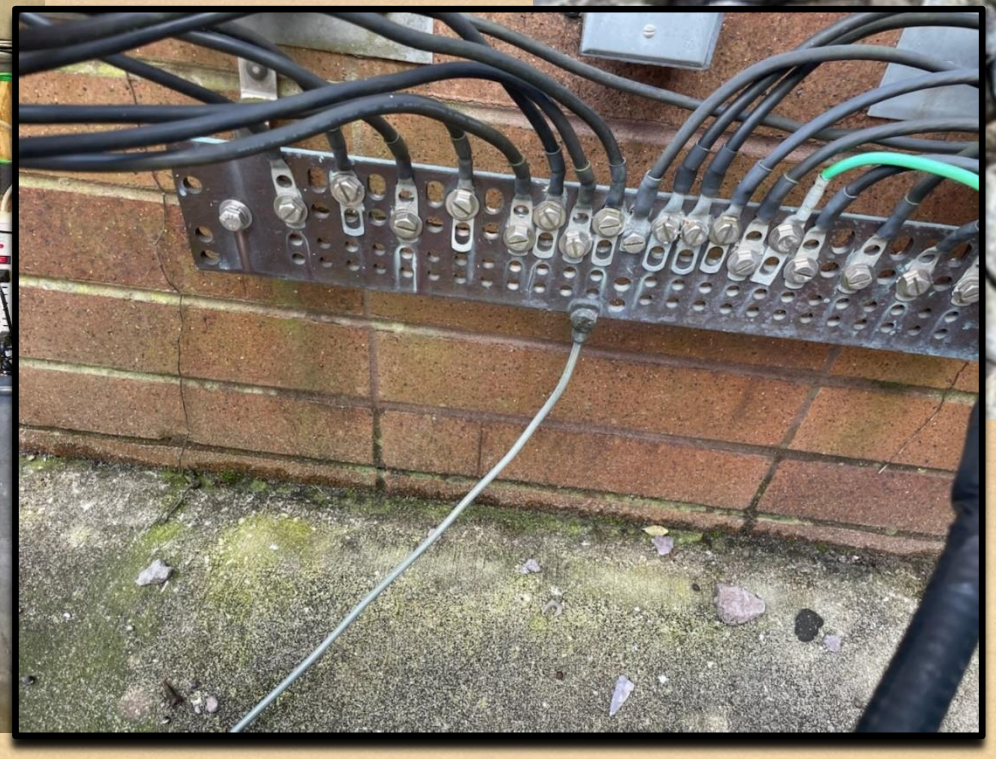
Facility Grounding Sensitivities

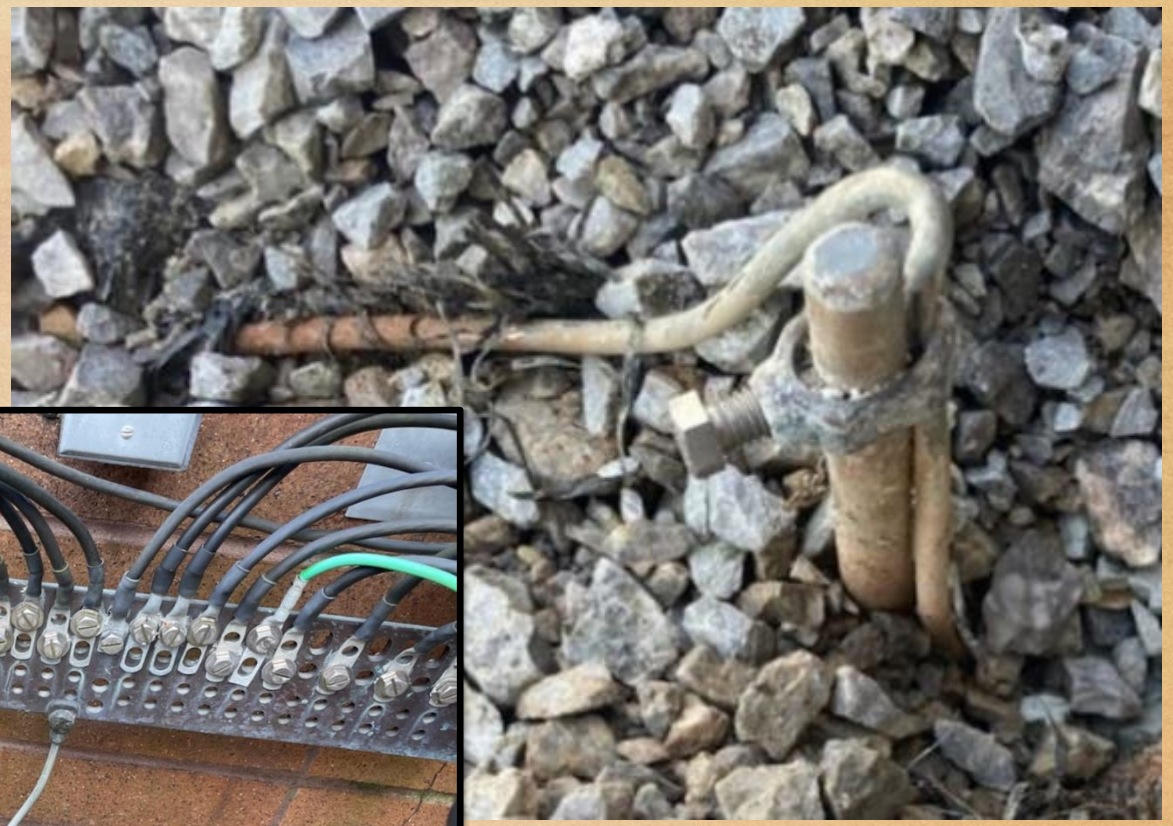
- Sensitivities can come from
  - Years of updates and upgrades
  - Poor grounding due to underground corrosion, poor soil
  - Updated systems relying on their original grounding systems

- Clues as to the grounding system being inadequate or seriously compromised can come from
  - Continuing fault- or lightning-related expenses
  - Higher electrical noise than desired in systems (S/N, SNR)
  - Occasional shocks to staff (which sometimes go unreported)

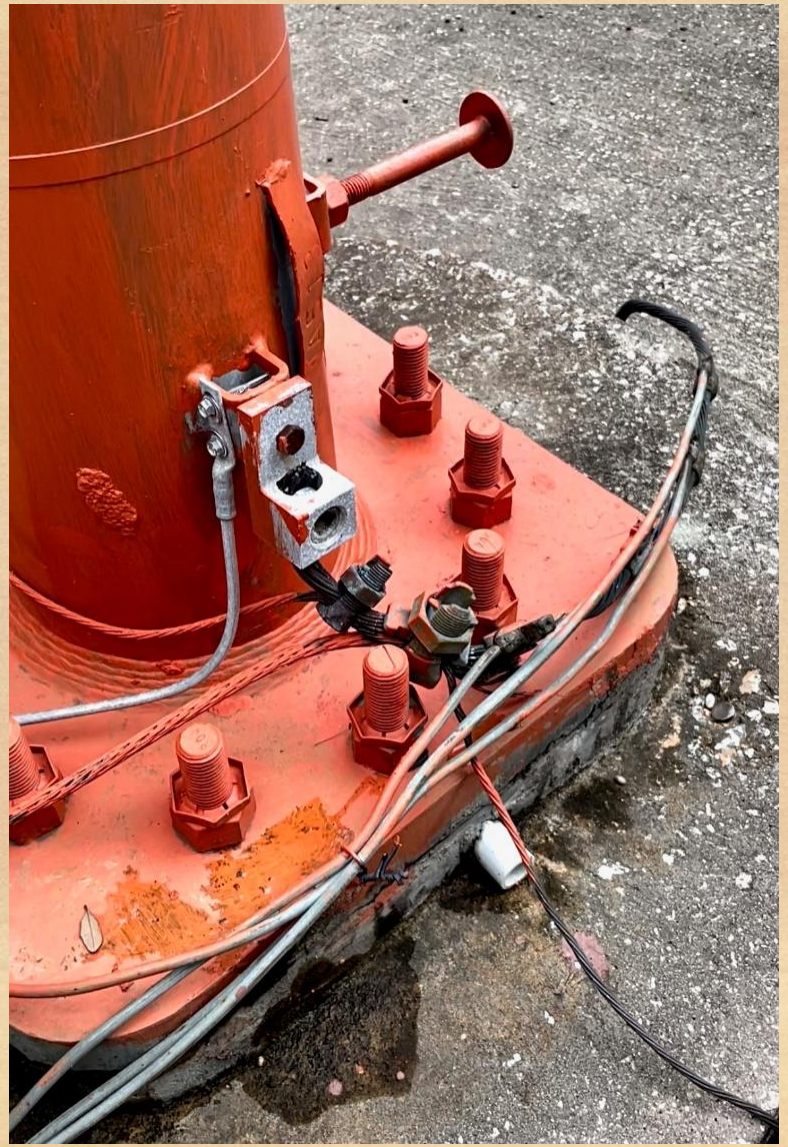
Poor Contact (Corrosion), Small Wires







Corrosion, Paint, Mechanical Fasteners



Corrosion, Paint, Fence Posts, Concrete

Really?

Soil and Measurement Practice Failures

Main Distribution Panel	17.25
Gen 1	17.26
Interior Main Panel	17.23
Battery Room	17.25
Main Power Supply	17.24
Raised Floor Pedestal IT Room	17.23
Mechanical Panel Room O	17.21
Telephone Room Ground Bar	17.04
Equipment room under floor ground conductor	17.05
Equipment room large ground bar	17.04
Equipment room large ground/buss bar east wall	17.04
Telephone room raised floor pedestal	17.14
Telephone room buss bar east	17.17
Battery room raised floor pedestal	17.17
Electrical panel battery room	17.16
Battery room panel F	17.23
Battery room panel M	17.17

New Tech Complicates Matters

- Each time a new broadcast technology arrives on the scene

1. We focus on the potential benefits of that technology
2. **We forget about the infrastructure demands** that will need to be faced as a result of adopting new technologies
3. Then we quietly begin analyzing the real costs of this adoption while leaving the public and our end customers firmly rooted in naïve excitement

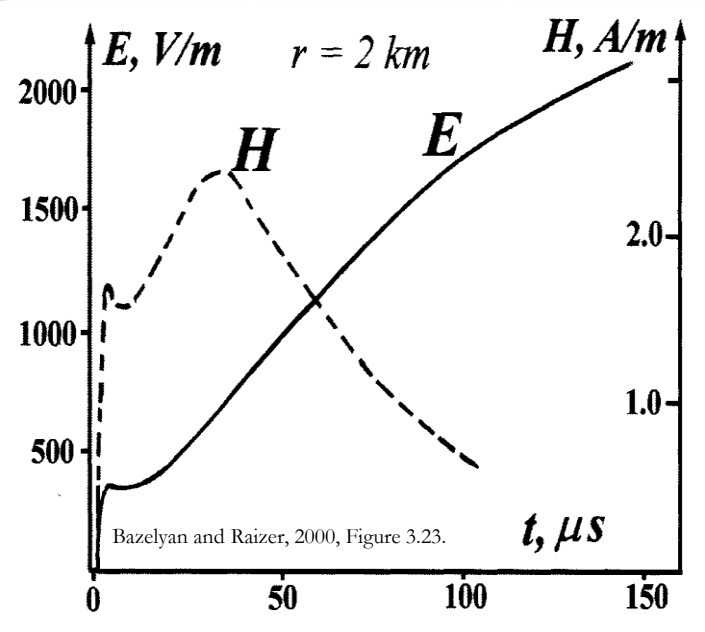
The number of new technologies being considered and adopted is huge and replete with acronyms like ATSC, 5G, 6G, WiFi6, AI, SVOD, UX, OTT, TV3.0, UHDTV, DVB-I, and AEA&I, all of which bring with them digital electronics.

What's Also new or Changed?

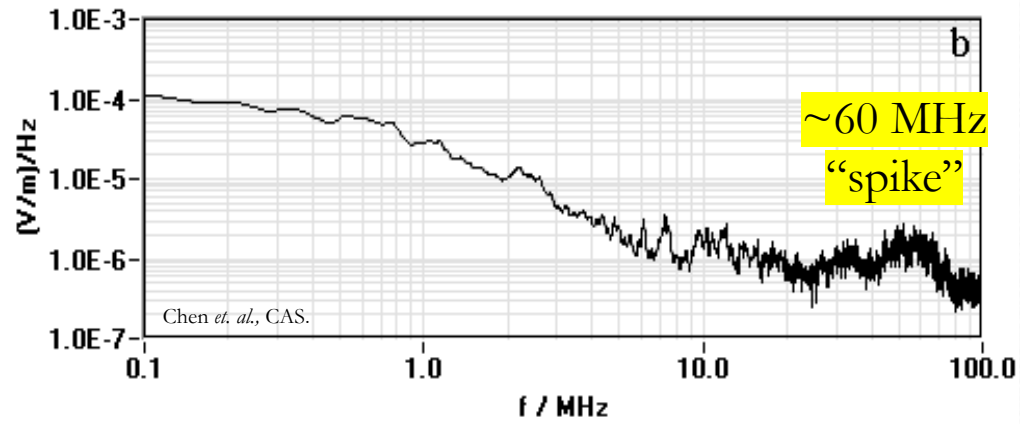
- Lightning is a broadband discharge. We have learned that there is plenty of energy in high frequencies.
- Ground rods are low efficiency energy dissipators and very poor emitters at higher frequencies.
- Frequency content driven by skin-effect depth considerations for grounding system conductors. Stranded cables are a key to grounding.
- Low electrical conductivity soil is common. Simple ground rods are not well suited for bad soil.
- Carefully choosing placement of grounding devices to maximize dissipation and to minimize reintroduction of faults.
- Limitations of using simple low voltage low frequency resistance-to-ground (RTG) measurements to evaluate high-energy system performance (e.g., faults).
- End of branch facility location as contributing factor.

High Frequency Considerations

Pulse shape showing steep front edge. Electric field (E) and magnetic field (H) both have steep rises which create lots of high frequencies.

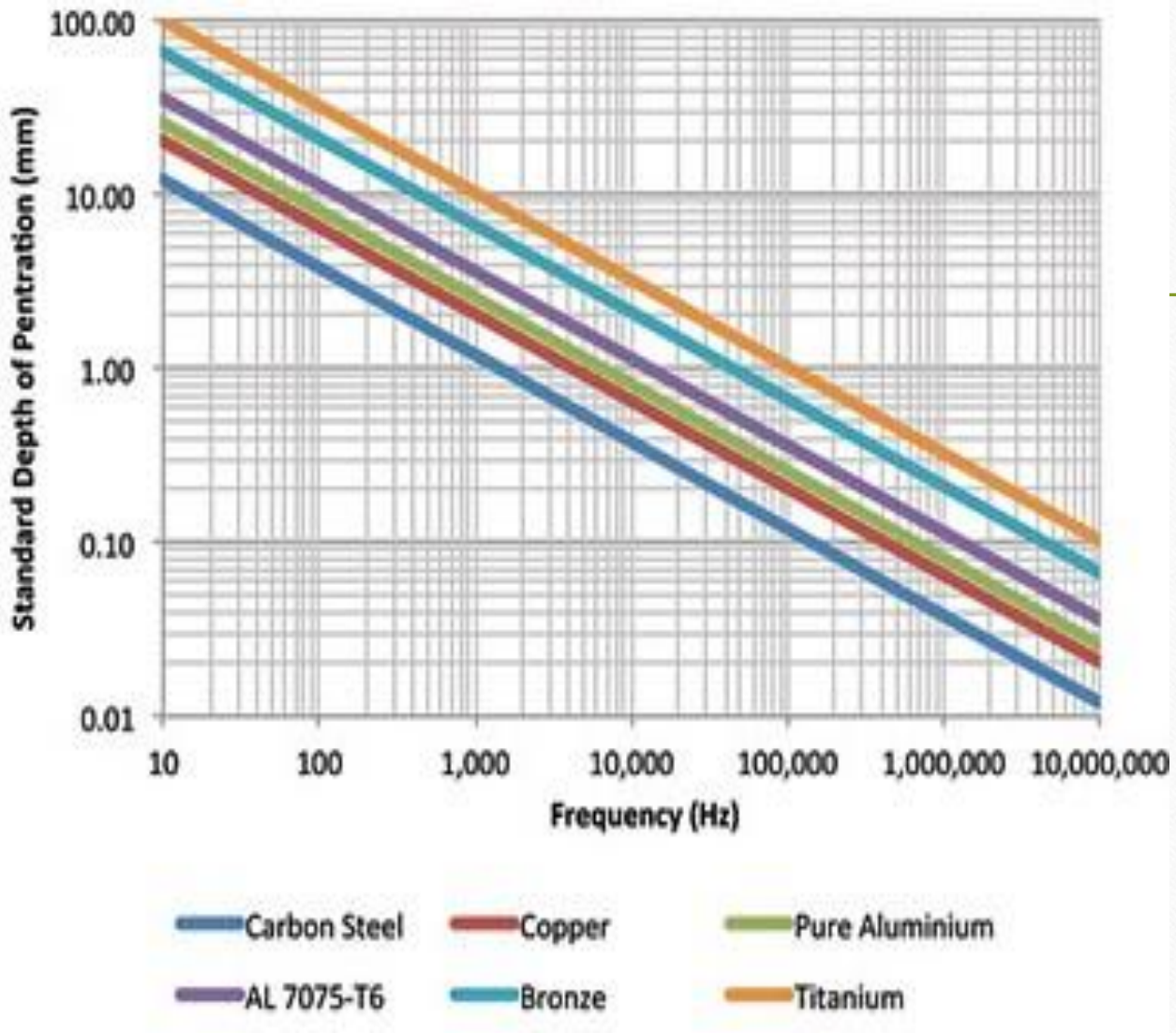


Cloud-to-cloud electric field (E) average (applicable to aircraft, mountain installations, and very tall towers.)



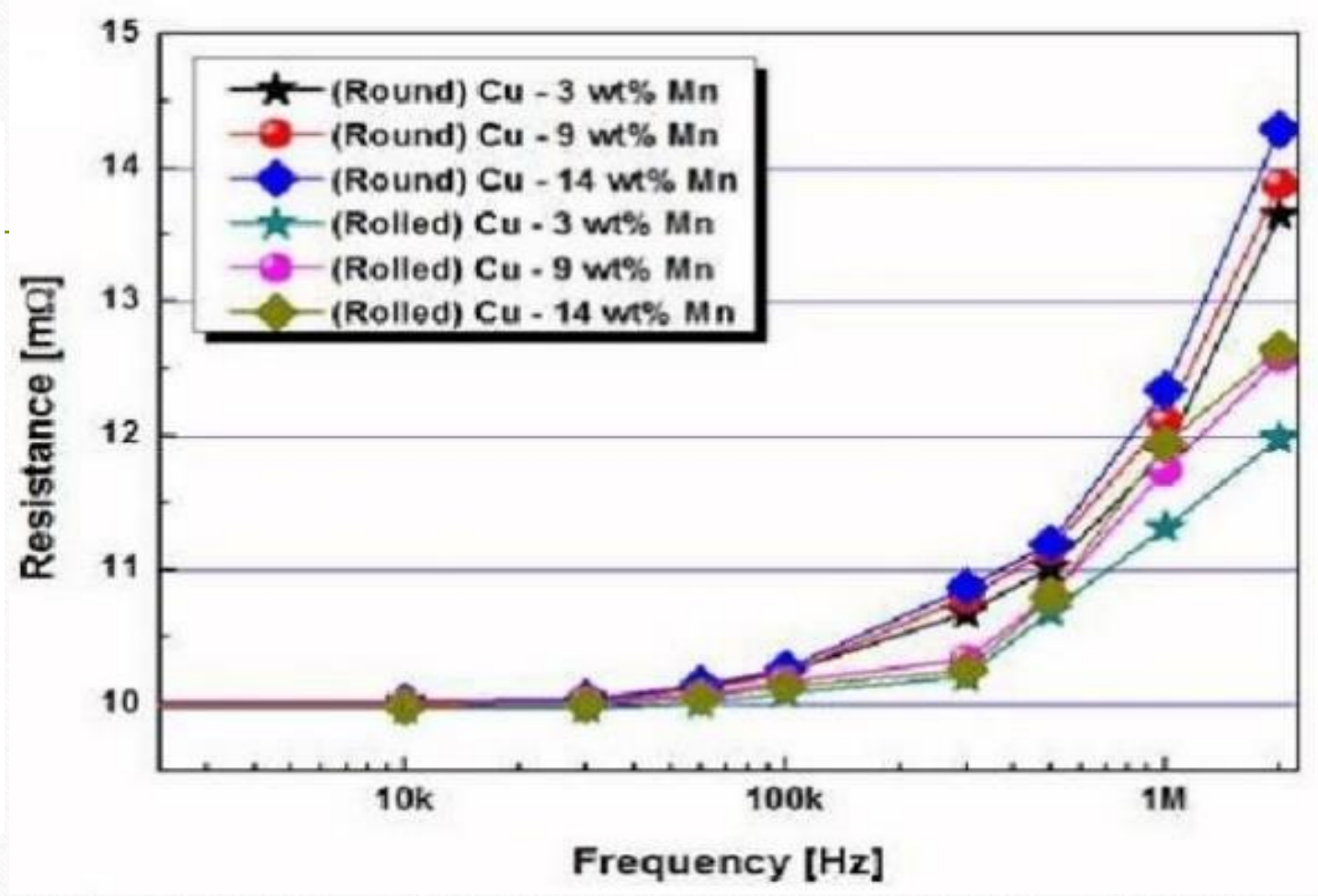
Result:
Induced High Frequency Currents

Skin Depth Impact: High Frequency Considerations

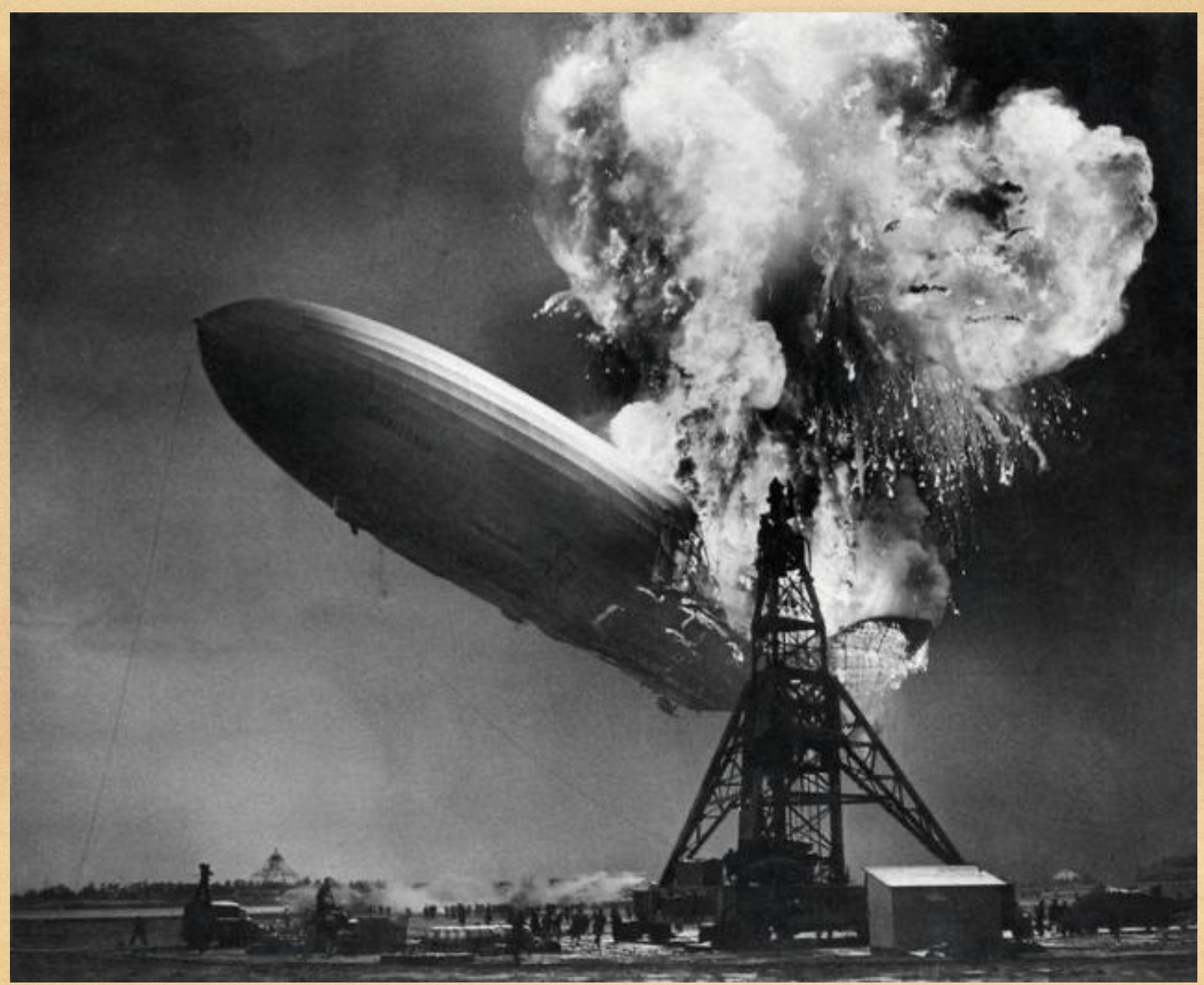


Copper: High Frequency Considerations

Although copper is accepted as the primary grounding material, typical grounding structures made of bulk copper or copper-cladded steel are limited at frequencies exceeding 100 KHz.



So Maybe We Can Avoid This…



…Even if it Looks To Us Like This

- **TV Tower**
- **August 2021 strike**
- **No down time**
- **Lost one camera motor**
- **Upgraded grounding system had just been installed.**

Don't Let Your Obsolete Grounding System Take you *Down*

- **Take your pick of reasons**
  - Profits are at stake
  - Uptimes are at stake
  - Content S/N (or SNR) is at stake
  - Mission completions are at stake

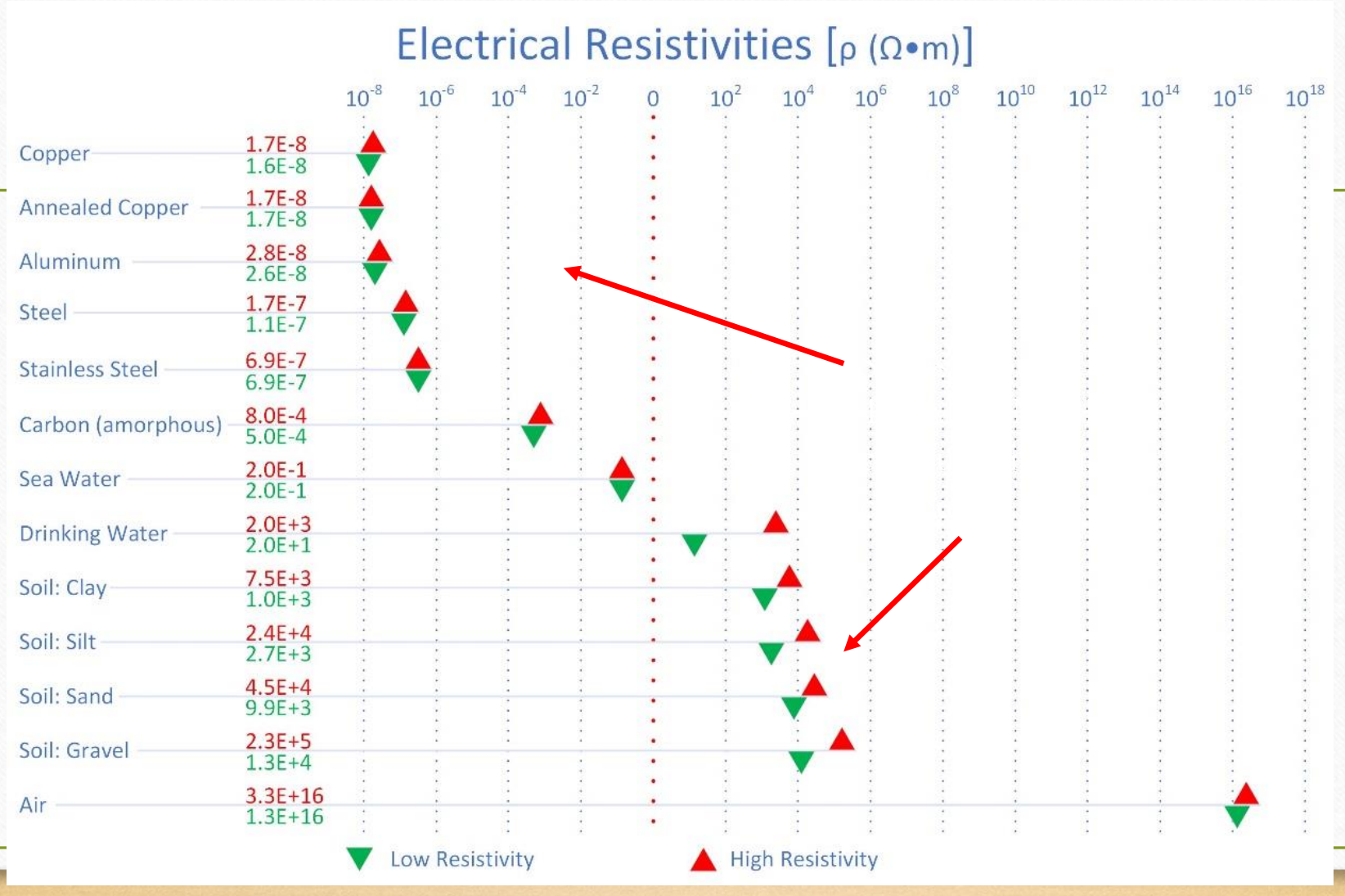
Audit, Fix, Maintain, and Upgrade

Thank You!

Additional information on GroundLinx™ Technologies and our approach to grounding is available at **www.groundlinx.com**

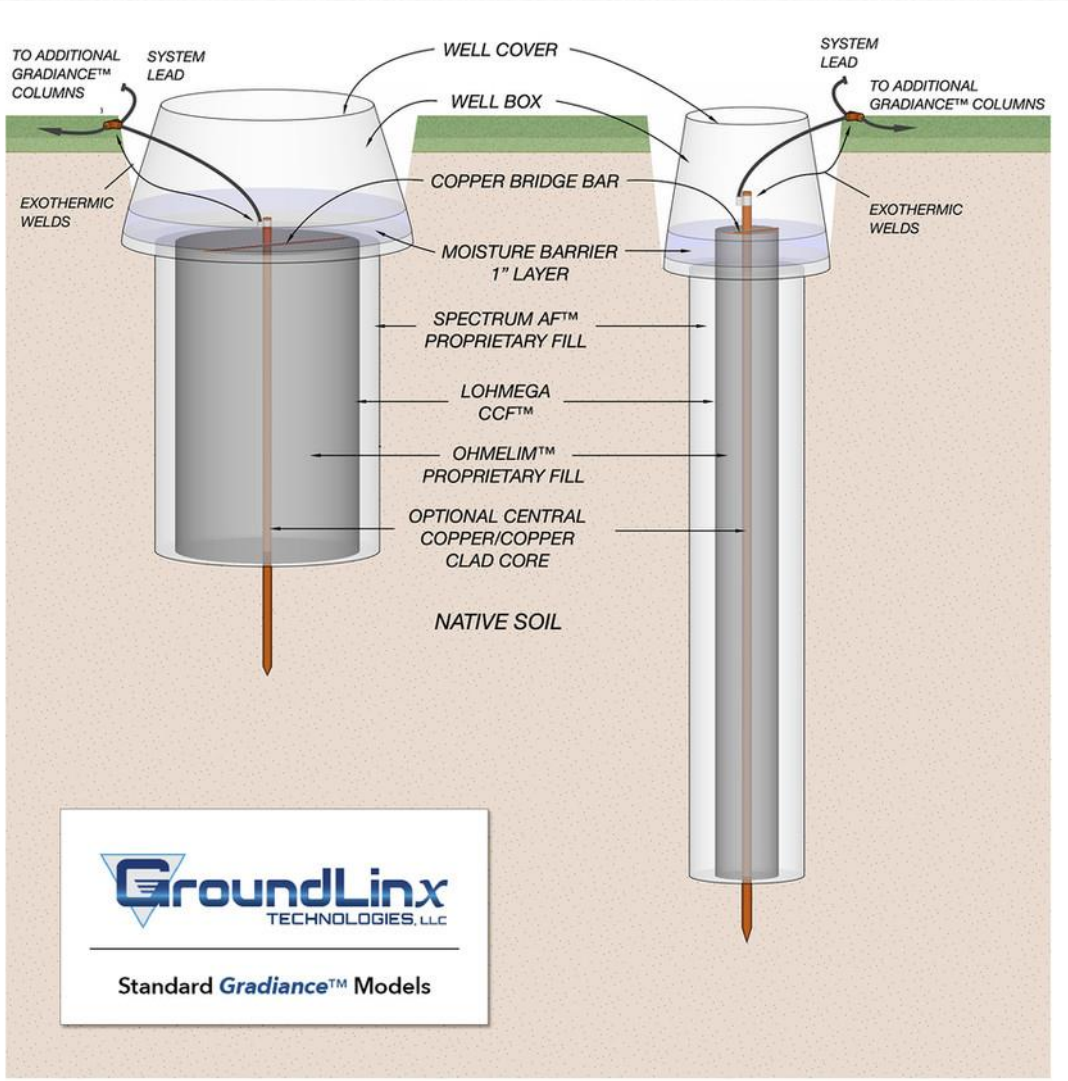
Our Story: In its youth, the Appalachian Mountain range reached heights similar to those found in the Alps today. Over the last 200 million years, it has eroded to its current state leaving a thick layer of soil with very high electrical resistance. The knowledge gleaned from learning how to address system grounding in such challenging conditions led us to embark on the journey that uncovered the hard fought learnings discussed herein.

Appendix 1: Soil Interface Impedance Mismatch is HUGE



Appendix 2: GroundLinx® system design approach

Large volume to spread out fast rise time faults
Large volume to absorb large faults
Huge surface area for dissipation
Millions of emitters for dissipation
Multiple conductor materials for broadband frequency dispersion
Reduced conductor-to-soil impedance mismatch
Reduced current back-reflections
…and more



Appendix 2: GroundLinx® system design approach, cont.

U.S. Patents 11,329,406, 10,236,598, and 10,230,182. Another US patent is scheduled to issue May 31, 2022.