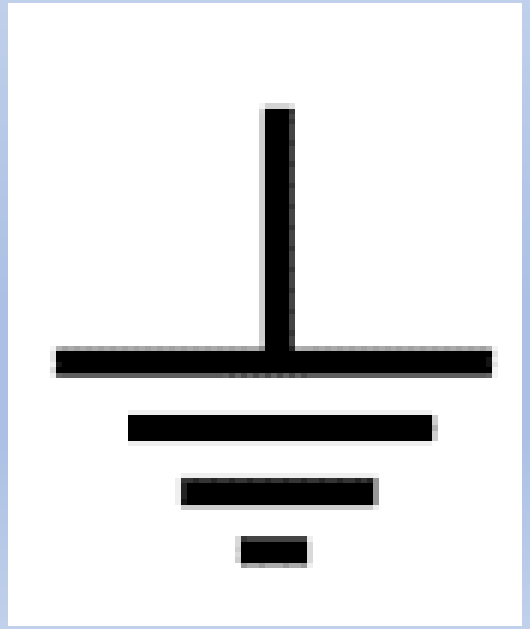
Amateur Radio Station Grounding Common Practice

Single Point vs. MESH vs. Multi-Point? It depends!

Why Grounding is Important?

1) Cause operation of overcurrent protection.
2) Zero reference for entire building electric system
3) Equalize all potential differences.

How many Ground Rods?



SURGE PROTECTORS

Is there a Sure Method of Lightning Protection?

Dave, N9KMY

Three Types of Grounding (Earthing)

1. **Electrical Power System for Safety** – Single Point Ground at the Breaker Panel is Connected to an External Ground Rod and it is Extended to Every Outlet, ie., the GREEN Wire
2. **RF Signal Ground** – Relief of Common Mode Interference such as RFI, Lots of Surface Area and Short as Possible
3. **Lightning Protection** – Antenna Surge Protector Short Circuits an Atmospheric Discharge to the Earth {Mechanical Connections, Welding or Silver Solder}

Proper installation techniques will reduce the potential of surge damage and offer more noise control.

Common Grounding Mistakes

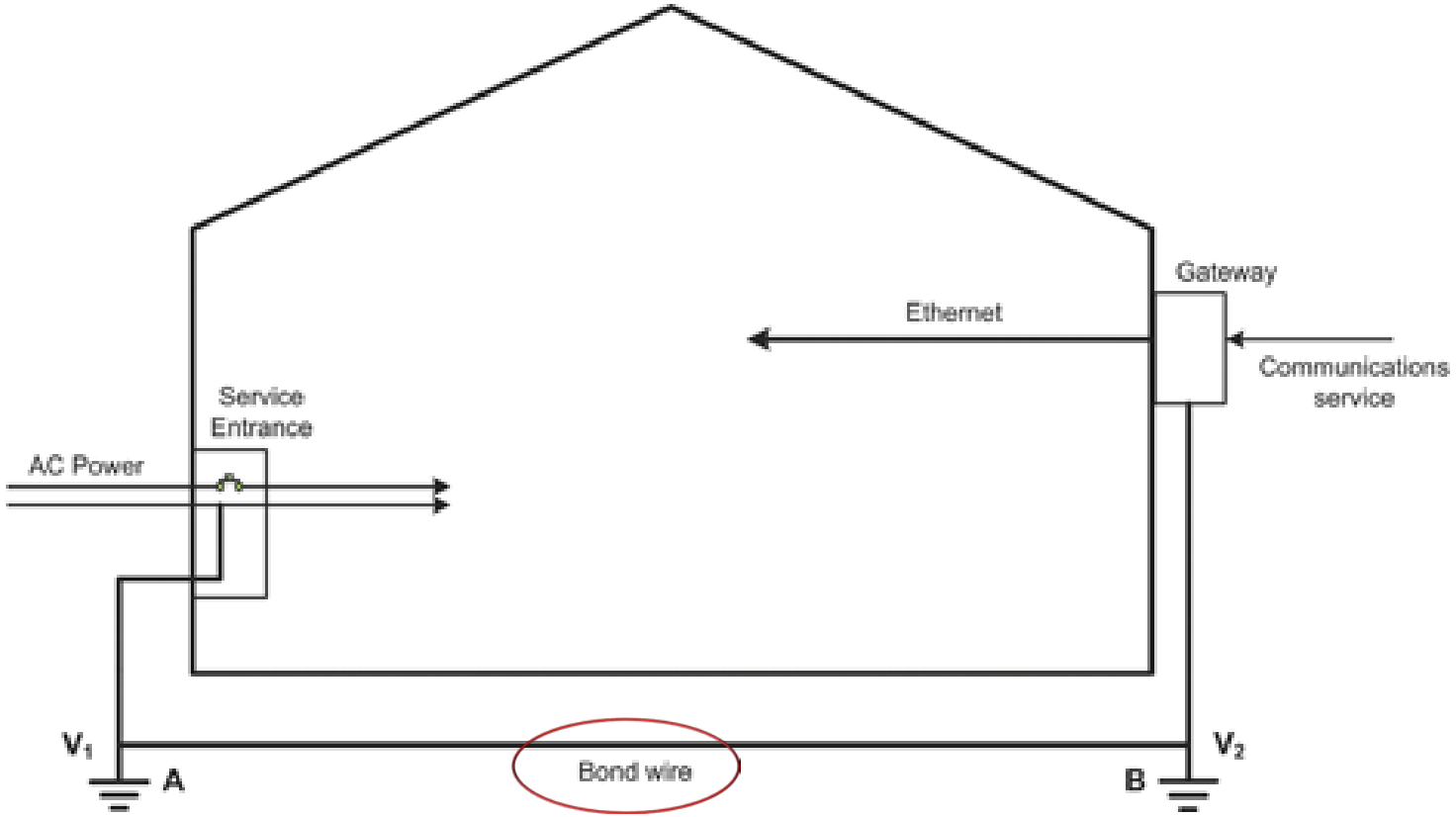
- **Not** Enough Ground Rods
- **No** Surge Protection at the Base of the Tower
- All Site Grounds **not** Bonded Together
- Ground Rods **too** Close Together
- Ground Wire **too** Small (#2 Min. or copper Strap)
- Bends of Wire **too** Short
- **Connecting** Dis-similar Metals
- **No** Single Point Ground in the Shack

Remember it is all about risk! Pay now or pay later?

Disclaimer: You are on your own to do the best job possible to protect your amateur radio systems as the following describes common practices followed by many to reduce their risk. --Dave, N9KMY

The ALL Important Bonding Jumper!

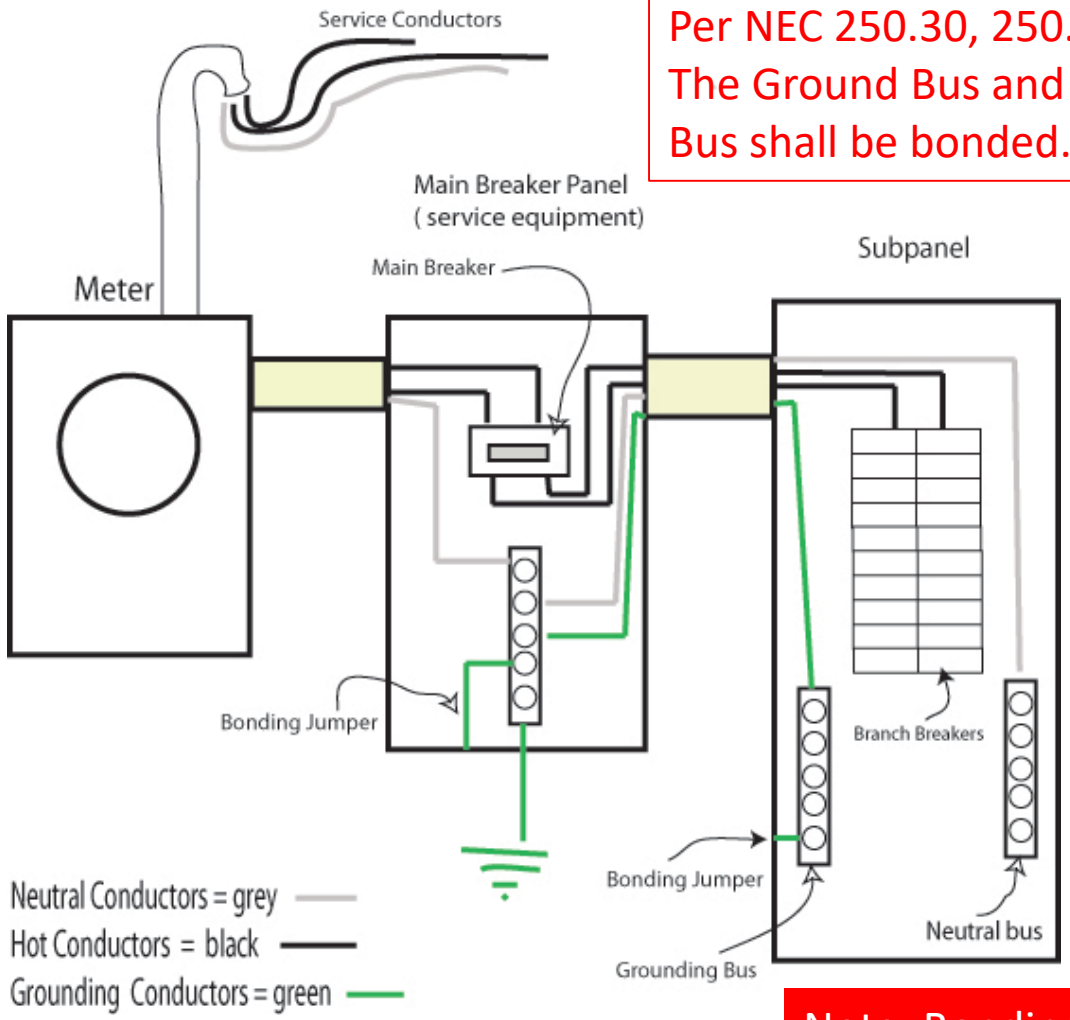
The National Electrical Code Defines this as “Touch Safety”

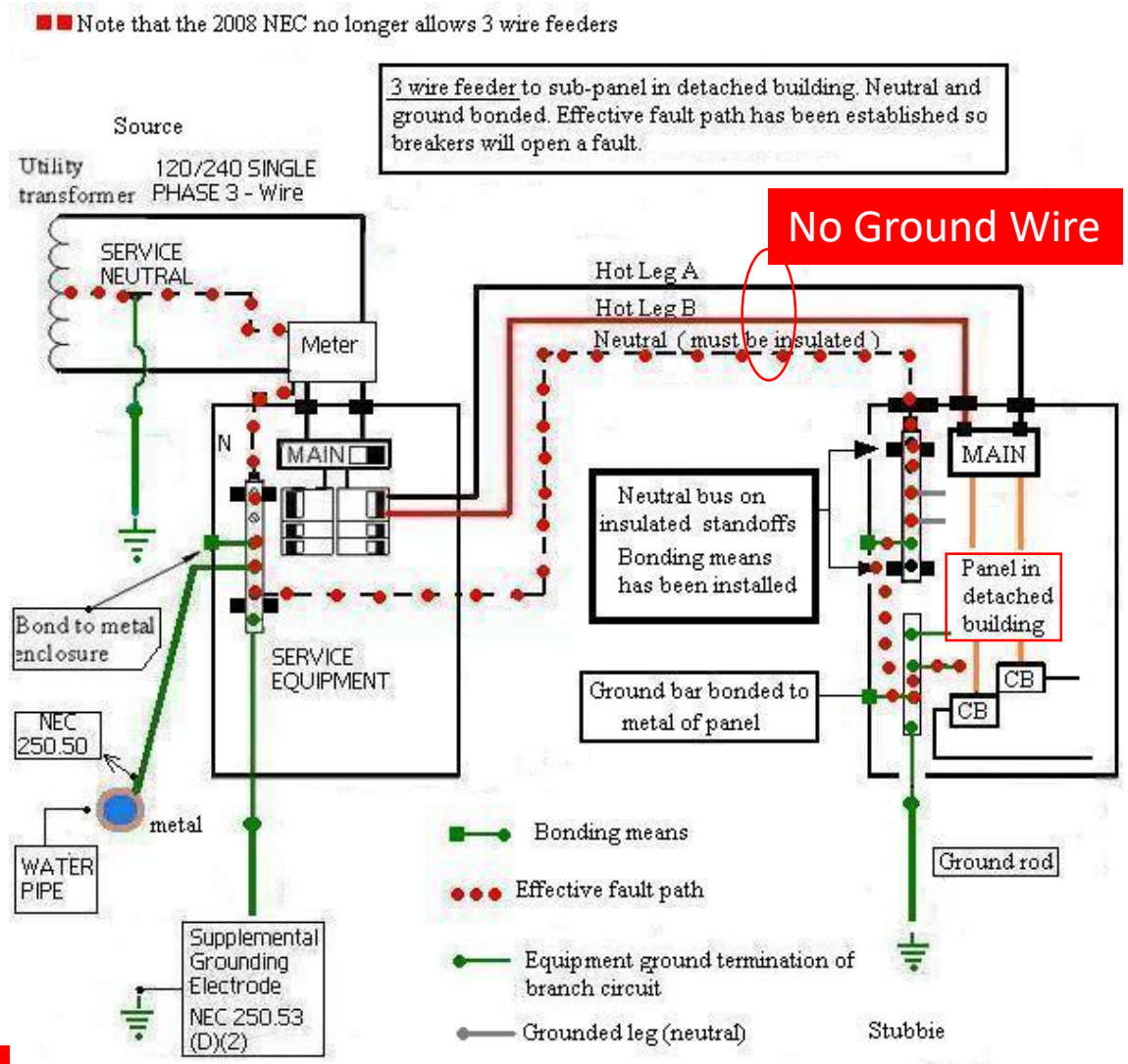


NEC (NFPA 70) and National Lightning Protection Code (NFPA 780) Bonding Jumper is Absolutely Essential

Electrical Entrance Ground per NEC - Safety

Per NEC 250.30, 250.52:
The Ground Bus and Neutral Bus shall be bonded.





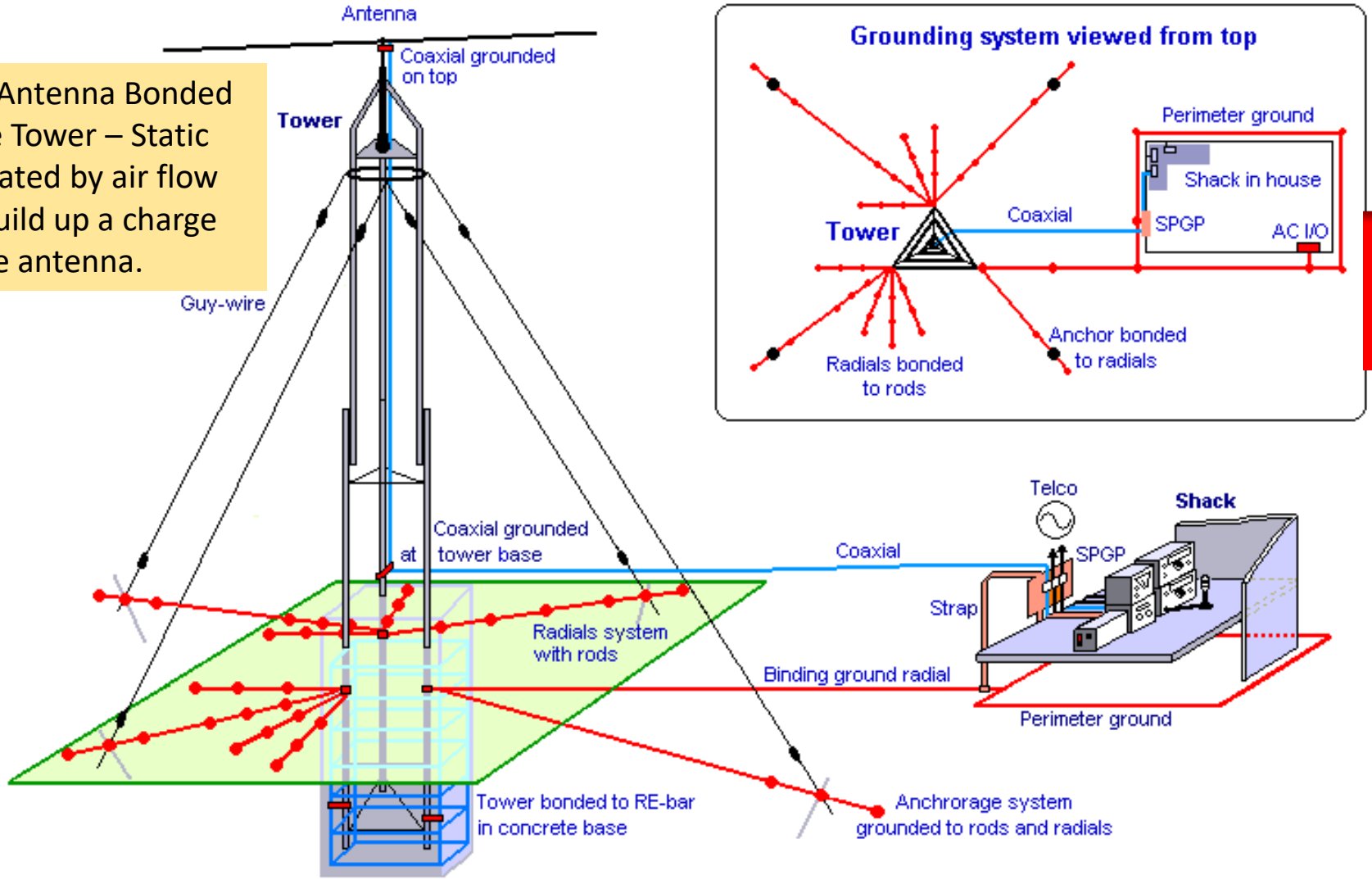
Note: Bonding Jumper

AC Power Surge Protection – MOV/Selenium Cell

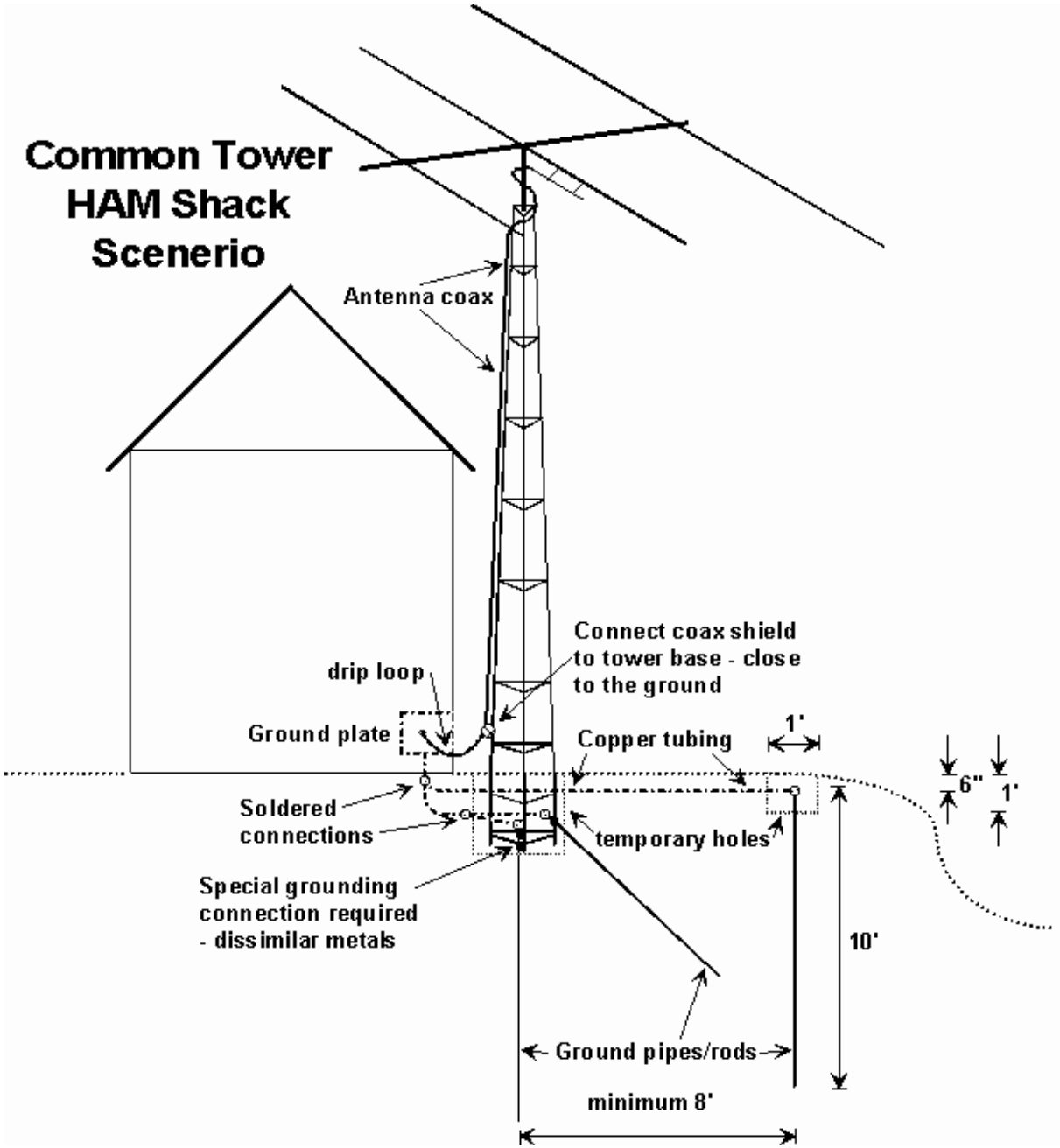
- Type 1 – Protects from externally produces surges {Line Side}
- Type 2 – Protects internally produced surges {Load Side}
- Type 3 – Individual outlet protection {Plug in Power Strip}
- Type 4 – Industrial end device protection {Wired In}

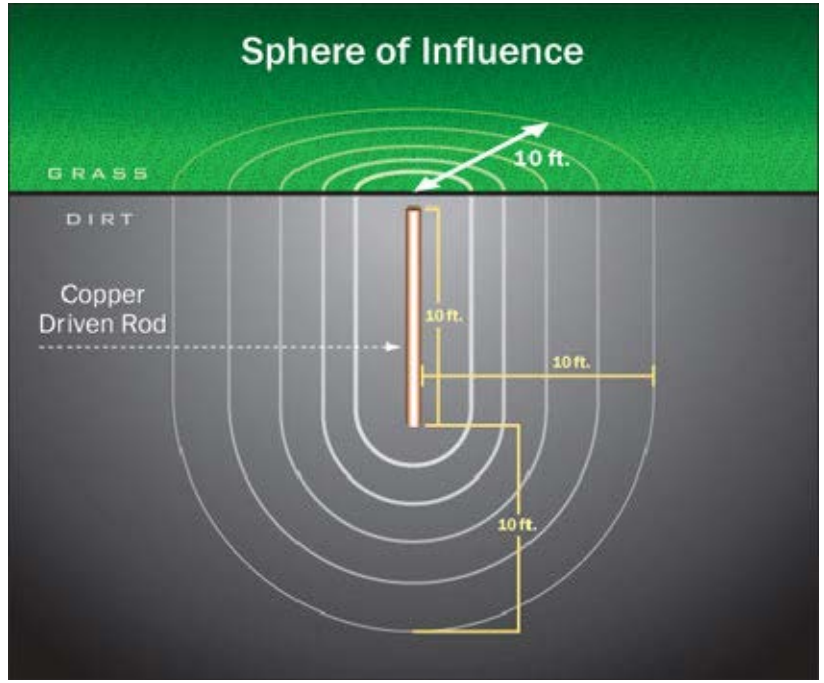
Polycom Recommends This Layout

Note Antenna Bonded to the Tower – Static generated by air flow can build up a charge on the antenna.

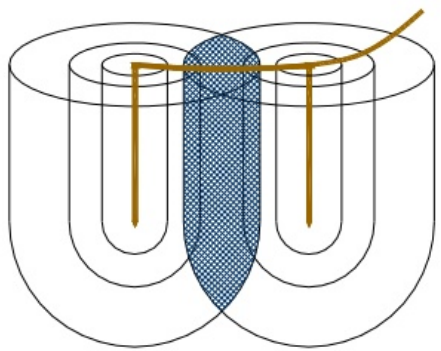


Special Note: Check out all the ground rods.





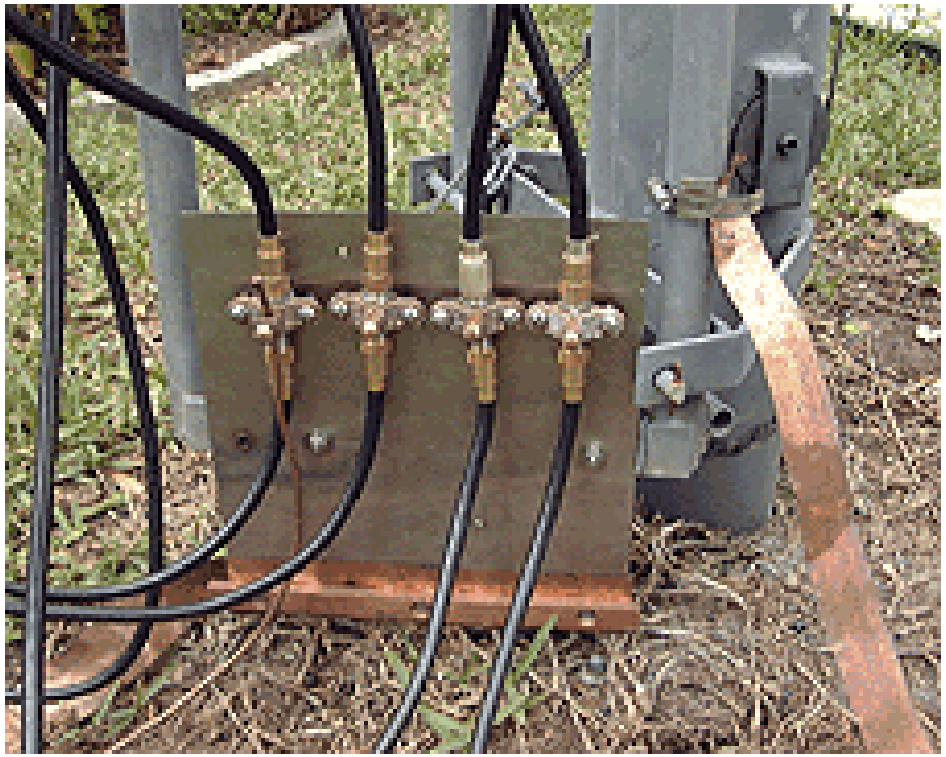
Lowering Ground Resistance



Concentric Shell Overlap Decreases Efficiency of Ground Rod Resistance

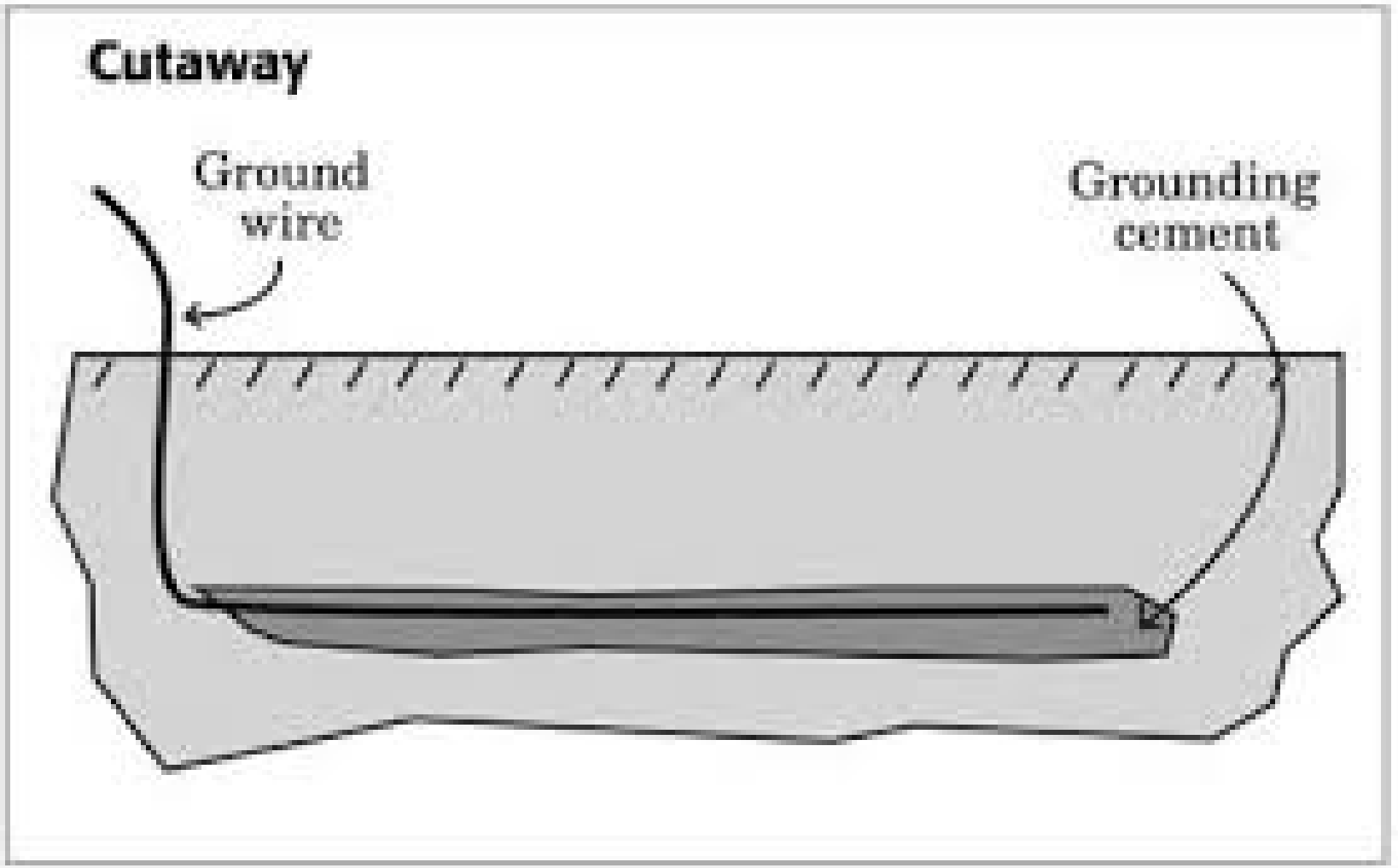
Typical Tower Ground Array & Twr. Base Coax

Ground Rods are Much too Close Together



The grounding near the tower provides a place for the common mode noise current to go, thus “short circuiting,” where it cannot couple significantly to the receiver. KV5R

Ufer Ground



Grounding the Coax Runs

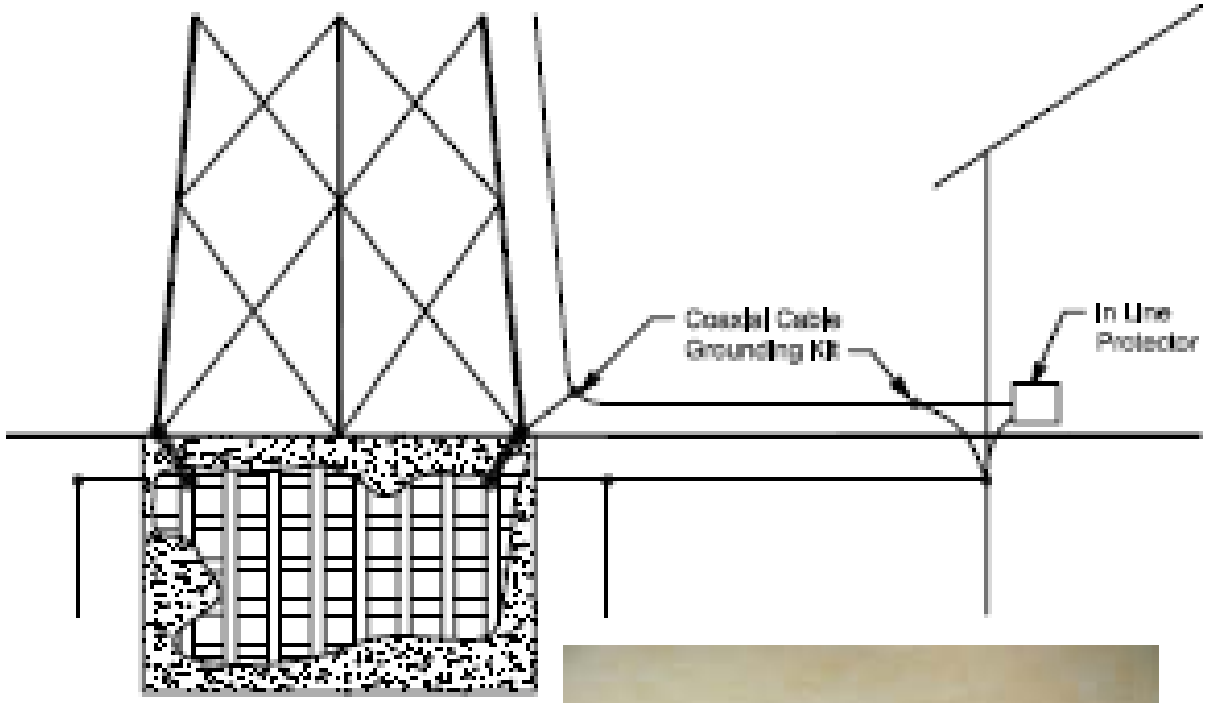
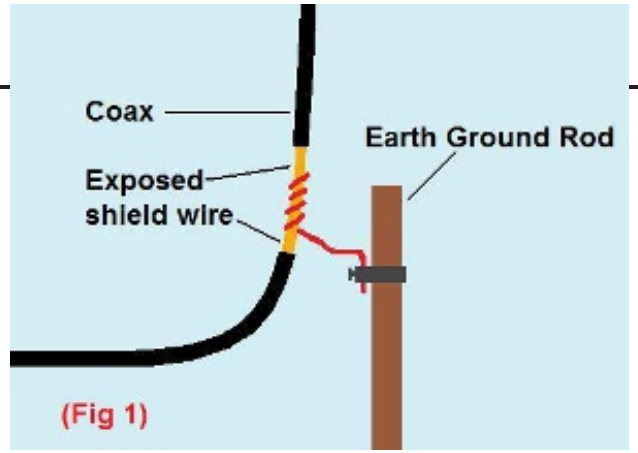
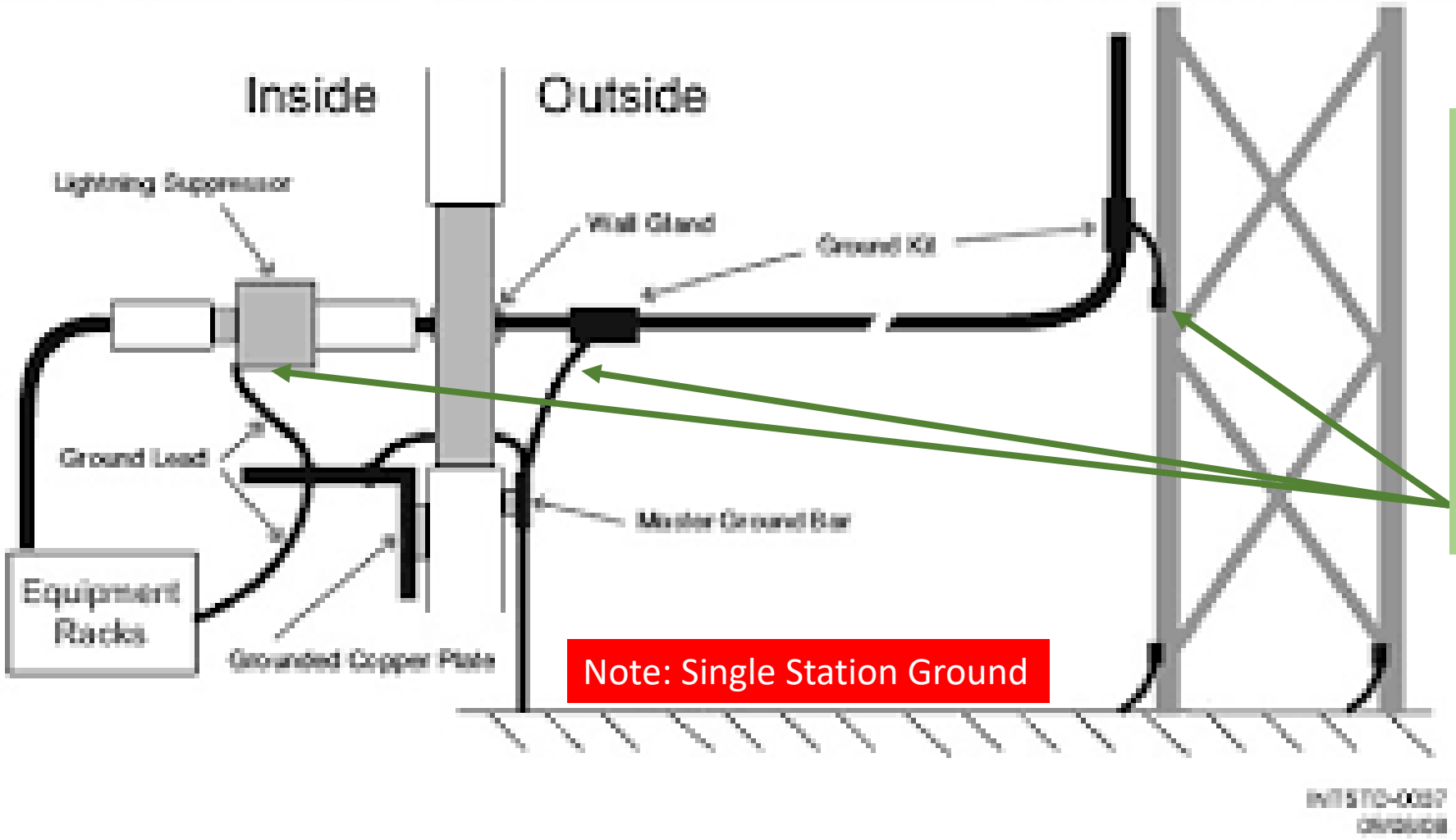


Figure 14—Grounding coaxial cables should be done at both the tower base and the entry point to the house or building. For minimum energy transfer from the tower, bring the coax all the way down the tower and apply a ground kit. Coax Take-off Point drawing, *The "Grounds" for Lightning and EMP Protection*, Roger R. Block, PolyPhaser Corporation, Minden, Nevada.

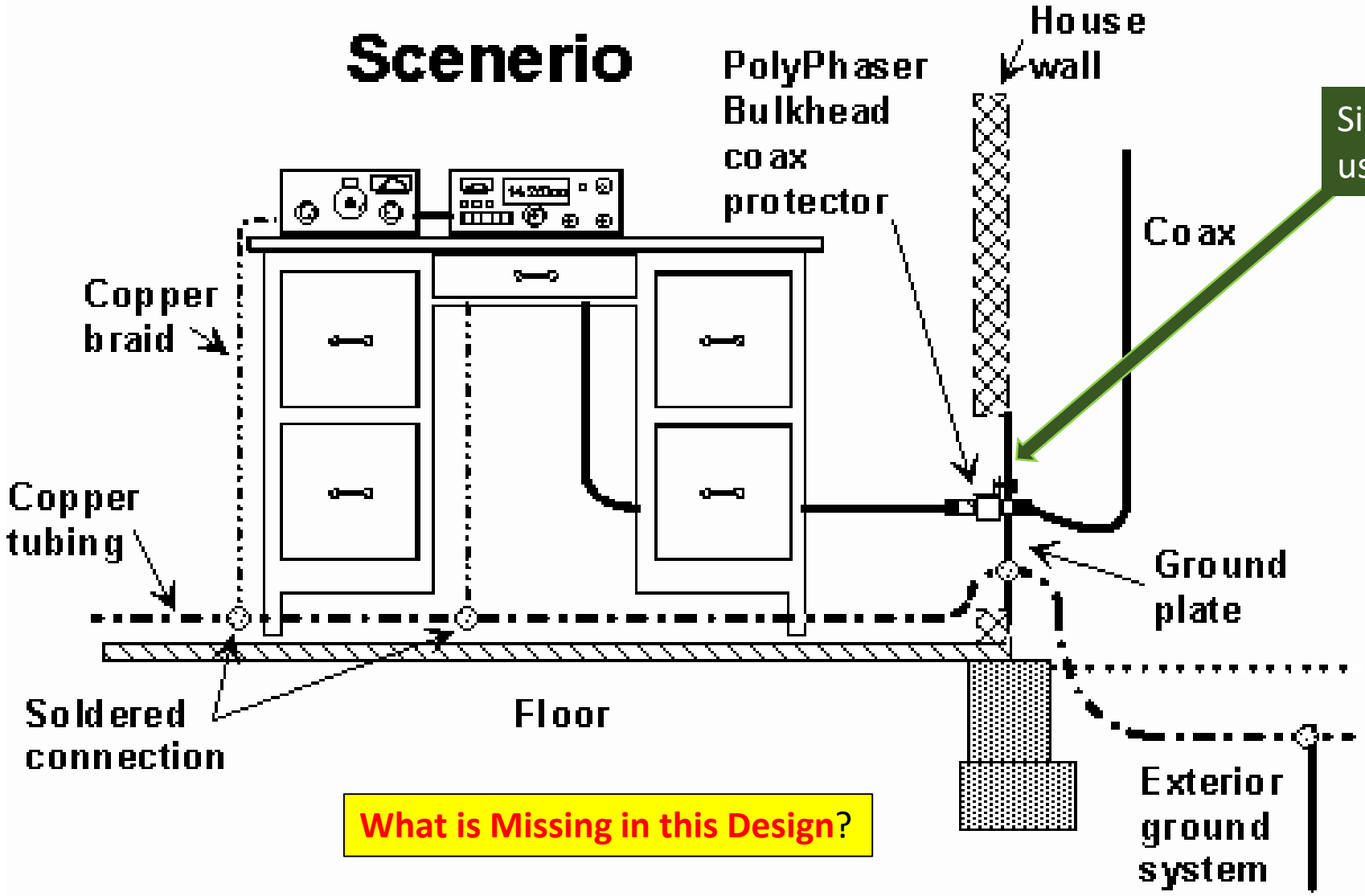


Alcatel Lucent Recommendation



Multiple places coax is bonded to the ground system. Don't forget anti-corrosive paste and brass to couple copper and steel.

Common Interior HAM Shack Scenerio

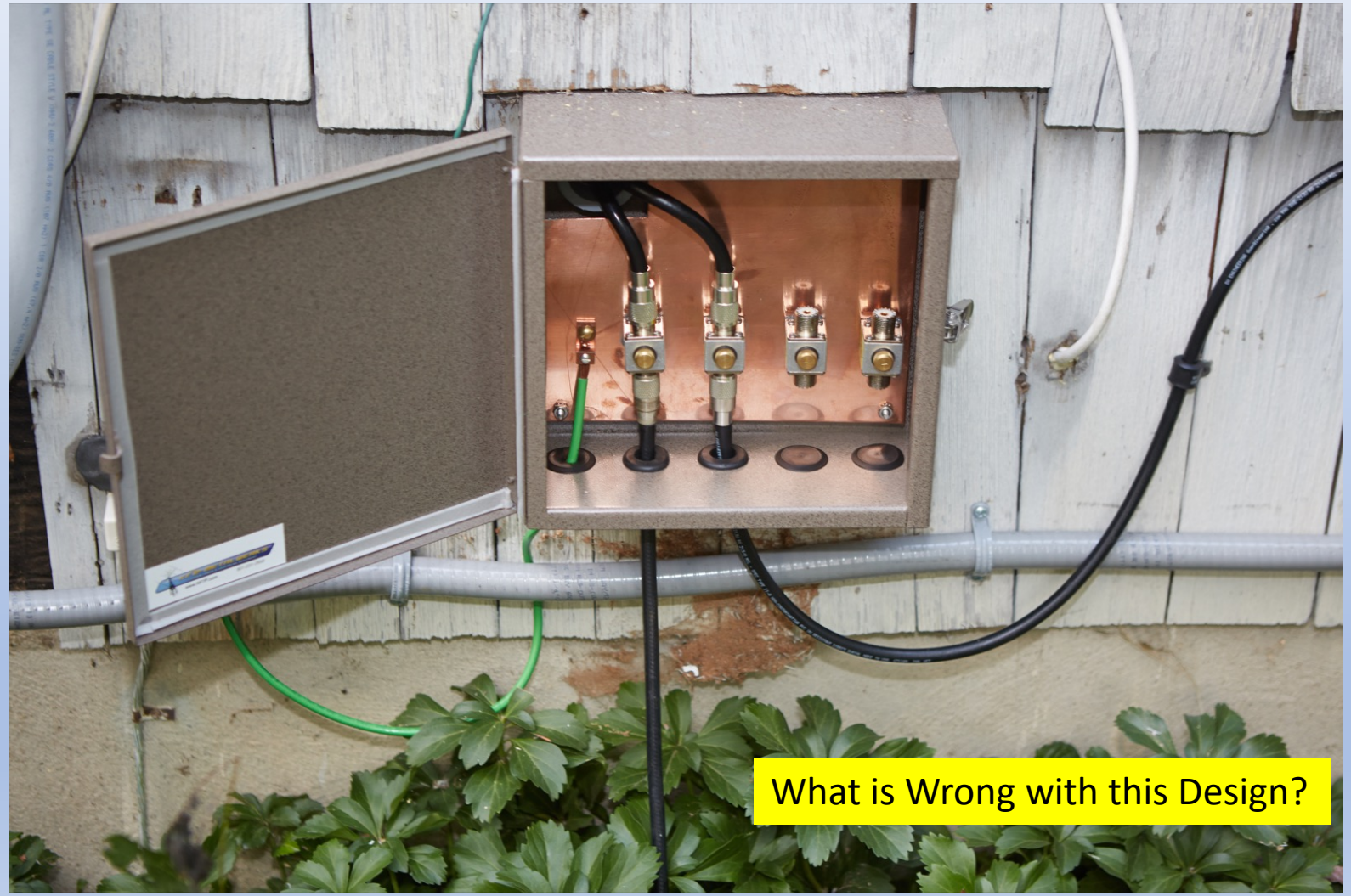


Single Point Ground using Copper Plate

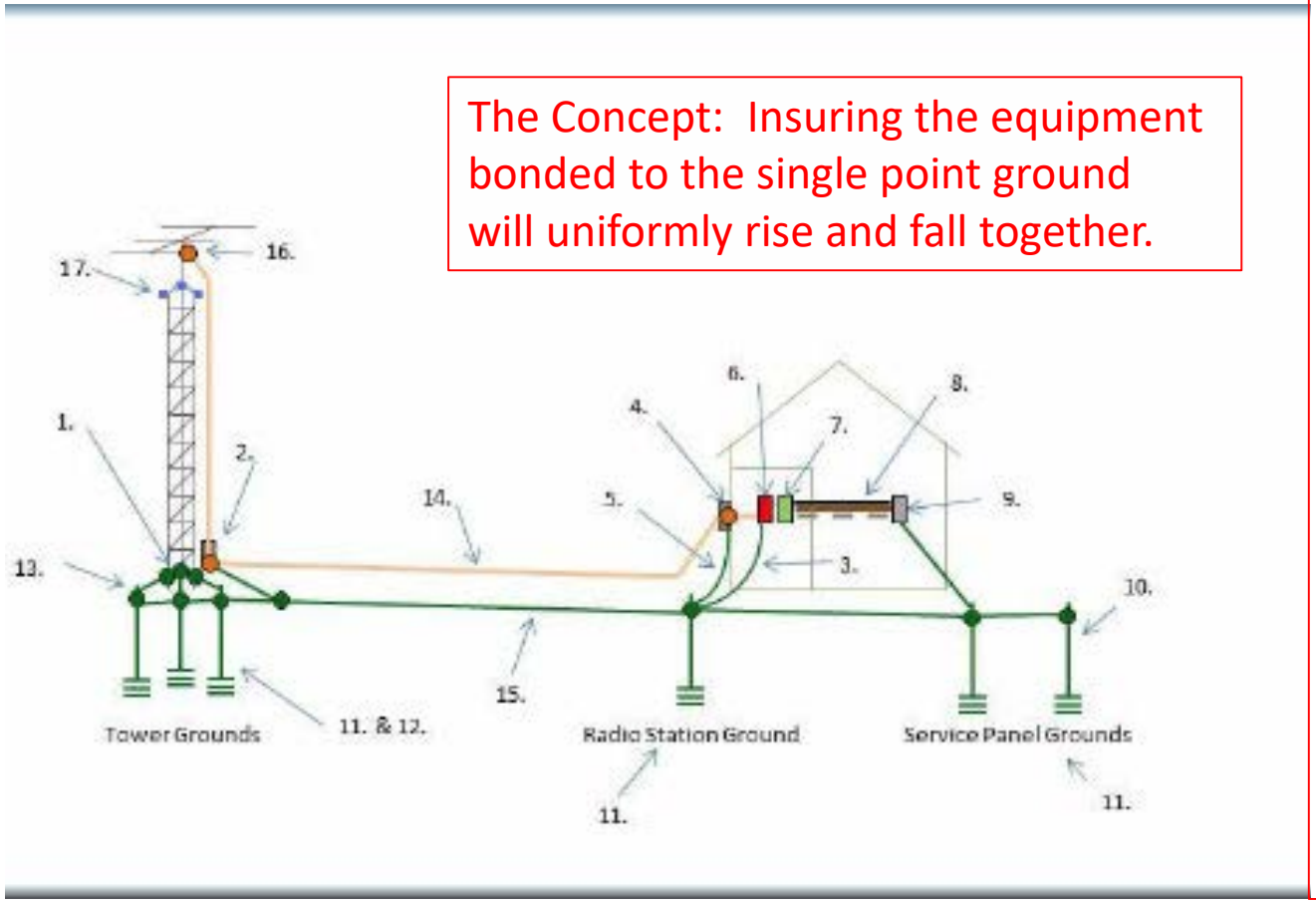
What is Missing in this Design?

The ground stake near the house provides a place for the common mode noise current to go, far from the antenna where it cannot couple significantly. KV5R

Coax Entry Point to Shack

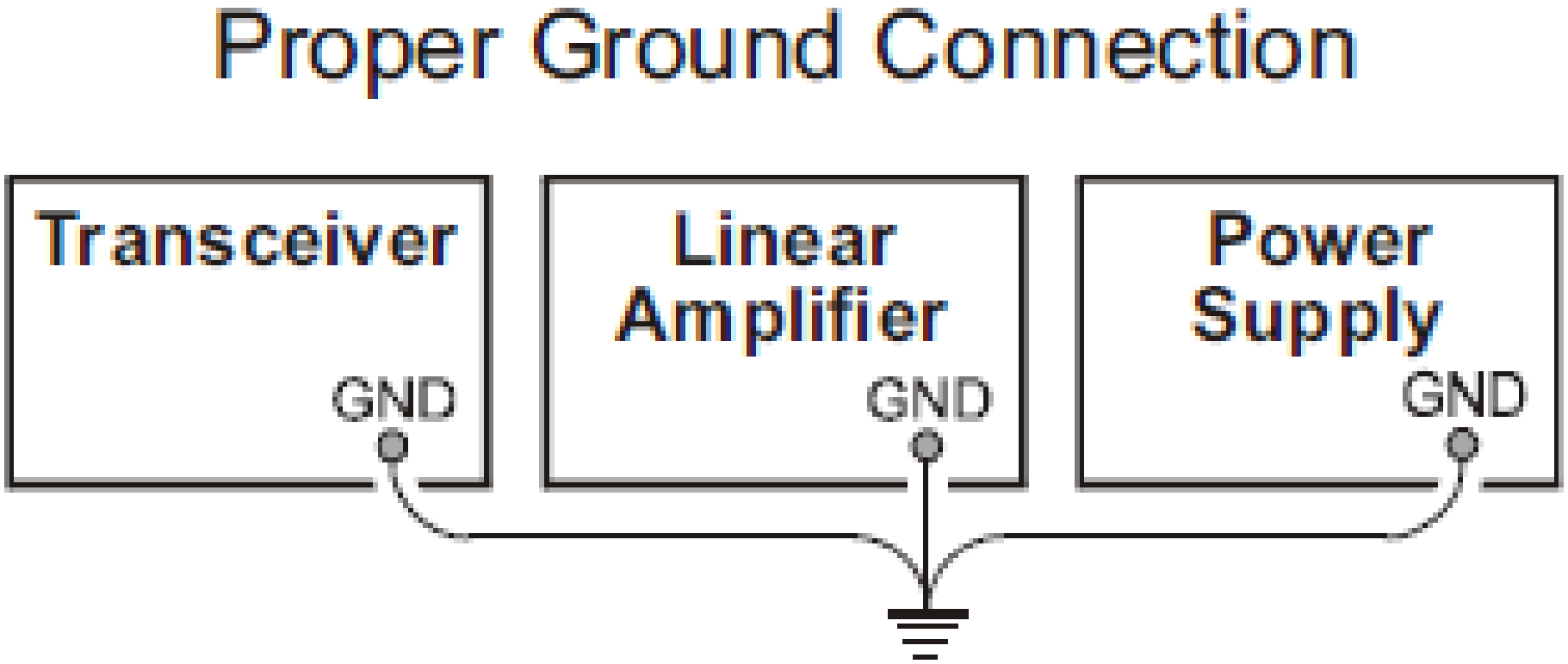


Overview Summary of Ground Bonds



- Tower Ground System (1, 11-13)
- Antenna Coax Bonded to Tower (2&16)
- Tower Ground Bonded to External Shack Ground (15): Note: Earth is no acceptable!
- Shack Single Point Ground (6)
- Shack Single Point Ground Bonded to Electrical System (8)
- Electrical Outlet for Shack is Bonded (7) to Shack Single Point Ground (6)
- The Main Electric Panel (9)
- Ground Rods (11): Note how many!

Single Point (Low Impedance) Ground



Ground Loops in the Shack per Radio Works

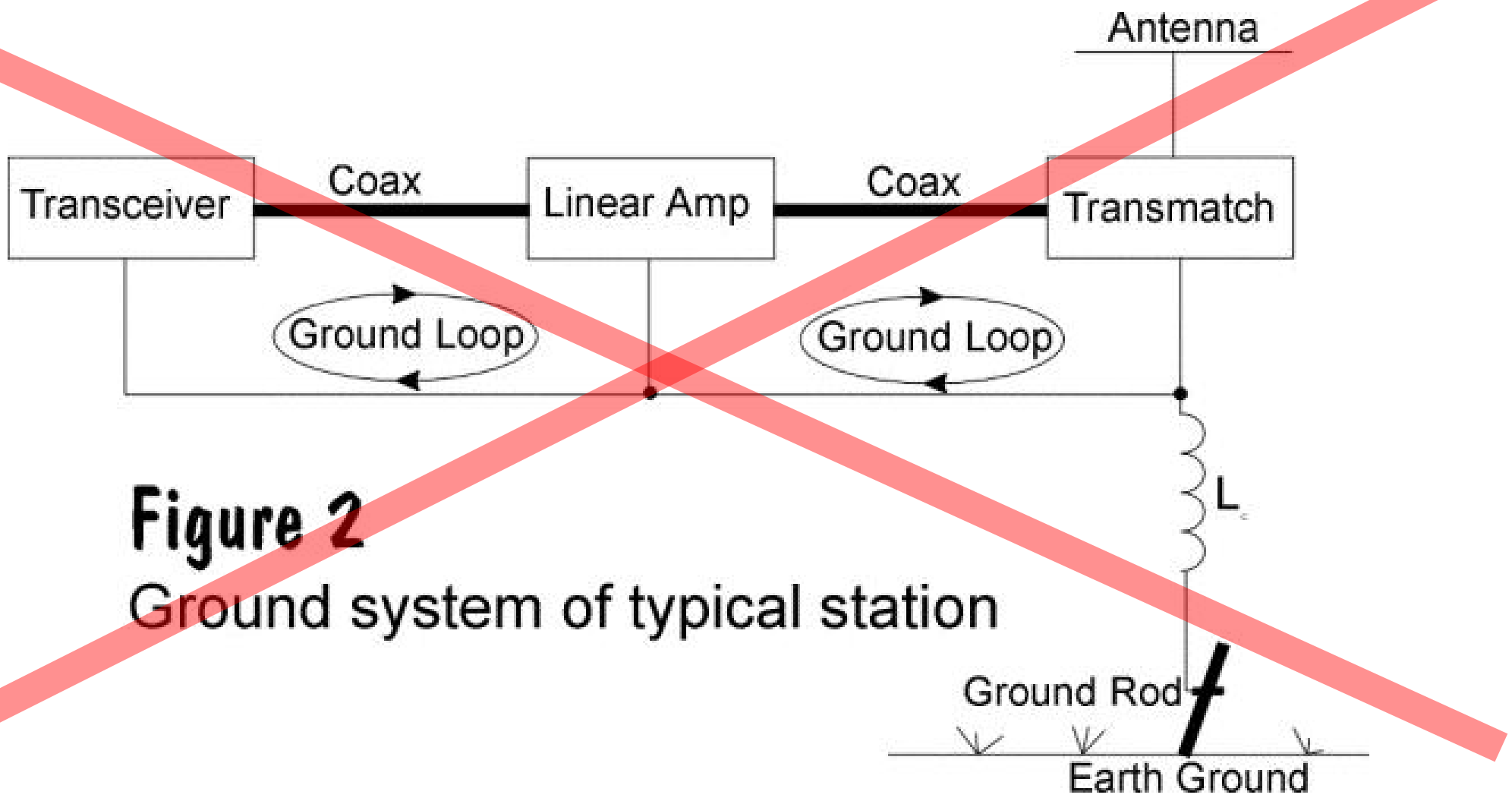


Figure 2

Ground system of typical station

Skyward Forum
Suggested Ground Bar

Jumpers Ready to be Attached to Equipment!

Large Cable or Strap To Shack Single Point Ground!

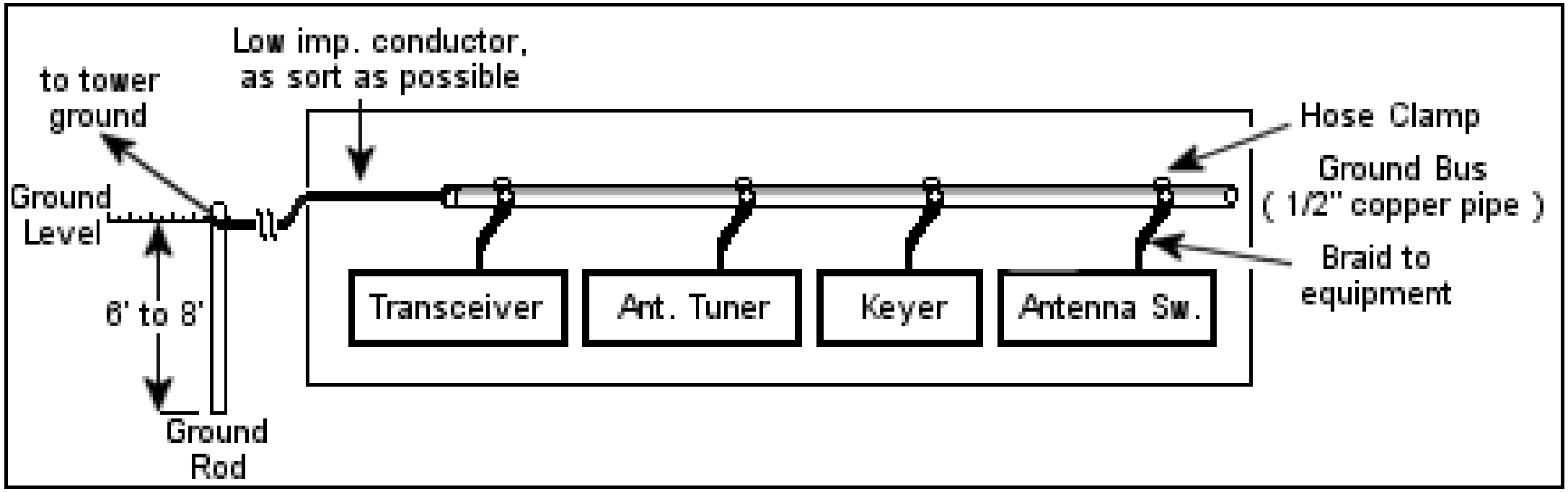
Short Cables to Shack Equipment

My Station Behind Radios

Cables from Antennas

Cables to Radios

Another Option for Shack per QSL.Net



Why Short Bonding Cables?

Single point grounding tends to break down at higher frequencies due to the length of the conductors. When conductors approach ¼ wavelength they become efficient antennas, thus bonding conductors should not be longer than 1/10th the wavelength of the highest frequency to be grounded. An option is to move to a combination of single point and multi-point defined as a mesh to reduce conductor length though insuring the mesh is bonded to the single point ground.

Lighting Storms per Year

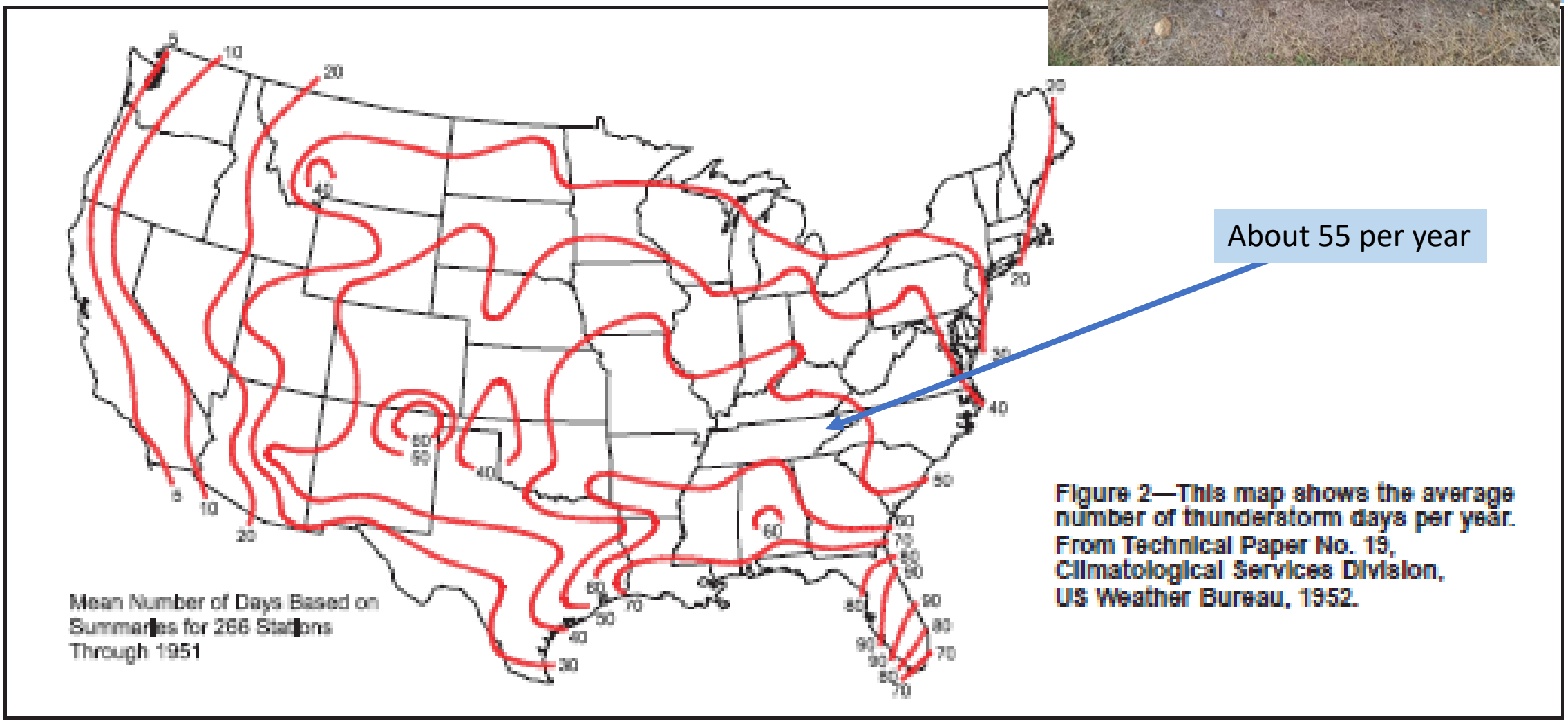
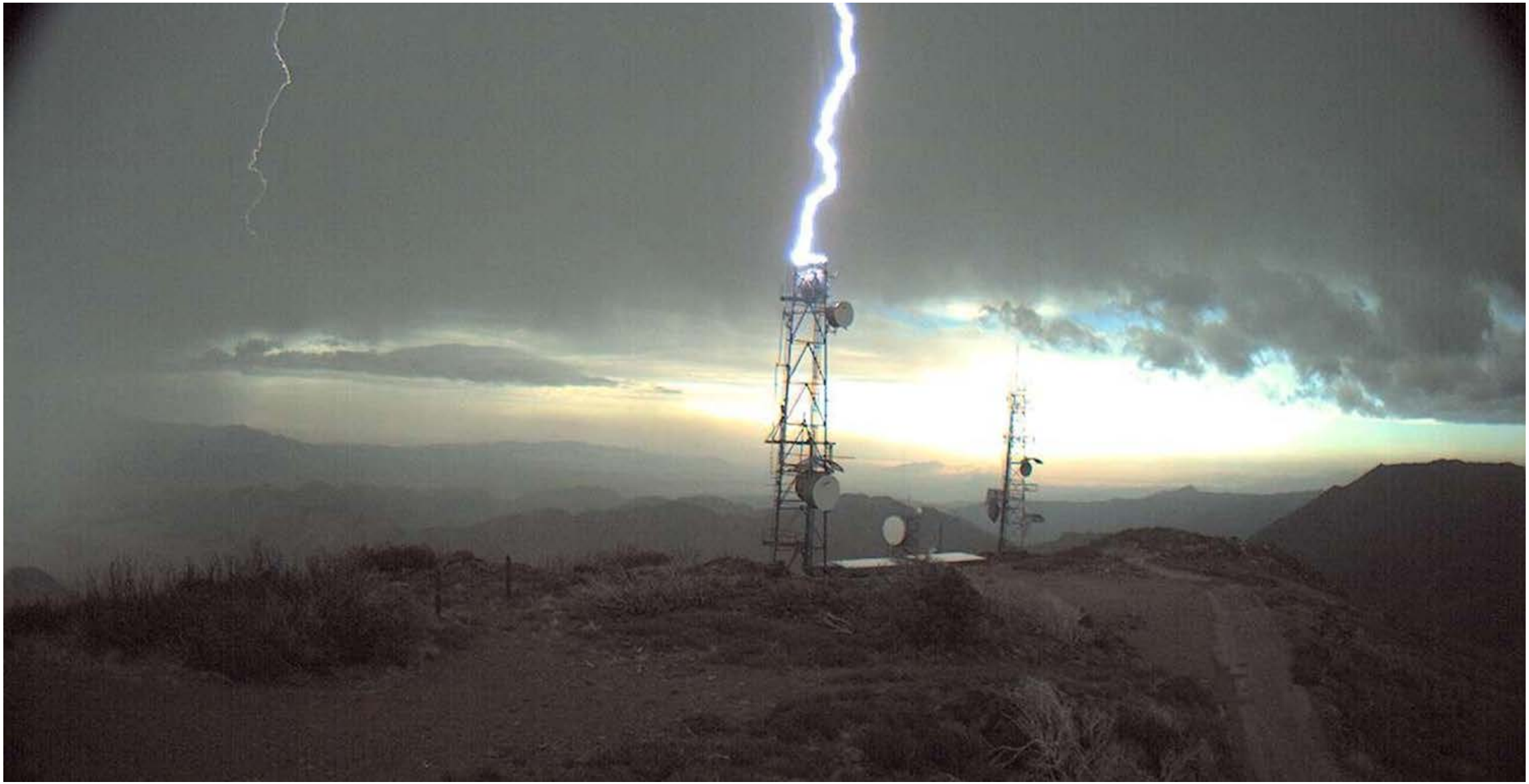


Figure 2—This map shows the average number of thunderstorm days per year. From Technical Paper No. 19, Climatological Services Division, US Weather Bureau, 1952.

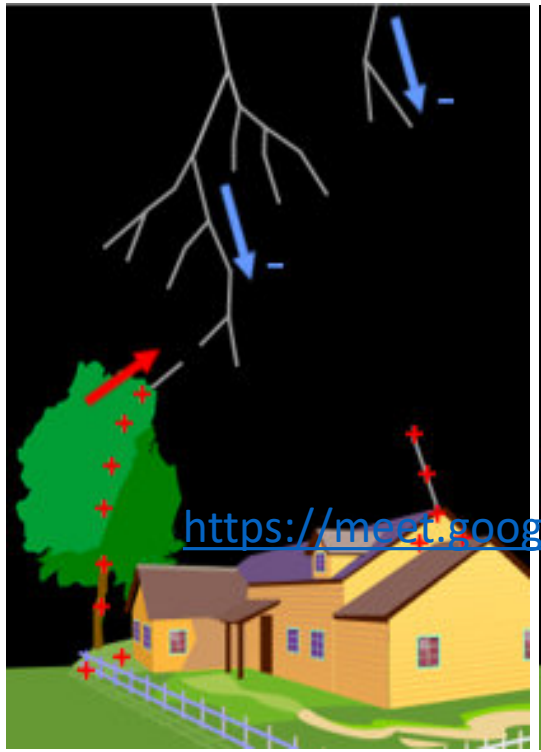


Lightning is a High Frequency Event

- Charges in a cloud build up forming highly negative particles
- Objects on the ground are positively charged
- A negatively charged stepped leader is formed and moves downward in a haphazard ways forming surging steps (1usec pulse, 49 usec pause)
- 3-4 branches of this stepped leader go in unpredictable directions
- When the stepped leader is about 100 feet above the ground it finds a target and positive leaders surge upward from ground objects
- A path is now formed and the electrons flow as a “return stroke”, 7ms

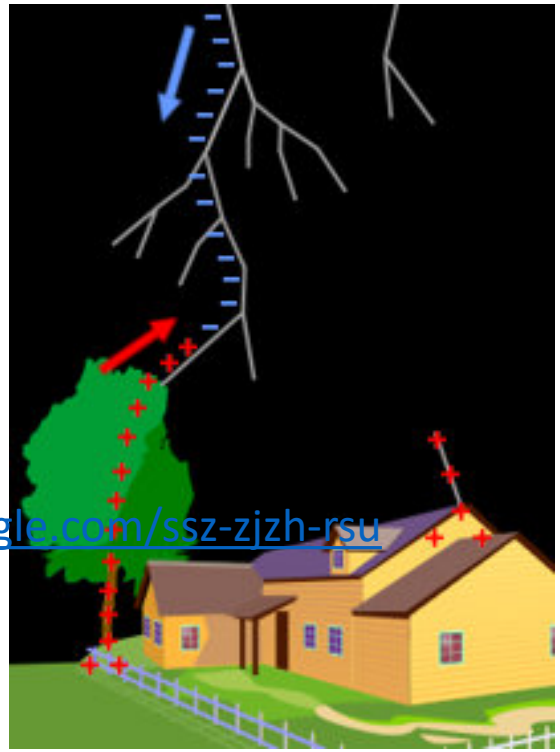
Step 1 - 4

Stepped Leader – ZigZags

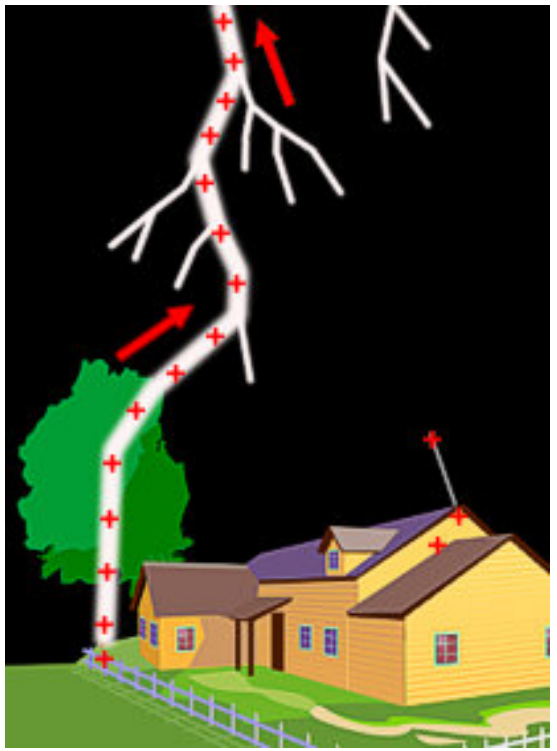


Leader Draws Streamers

https://meet.google.com/ssz-zjzh-rsu

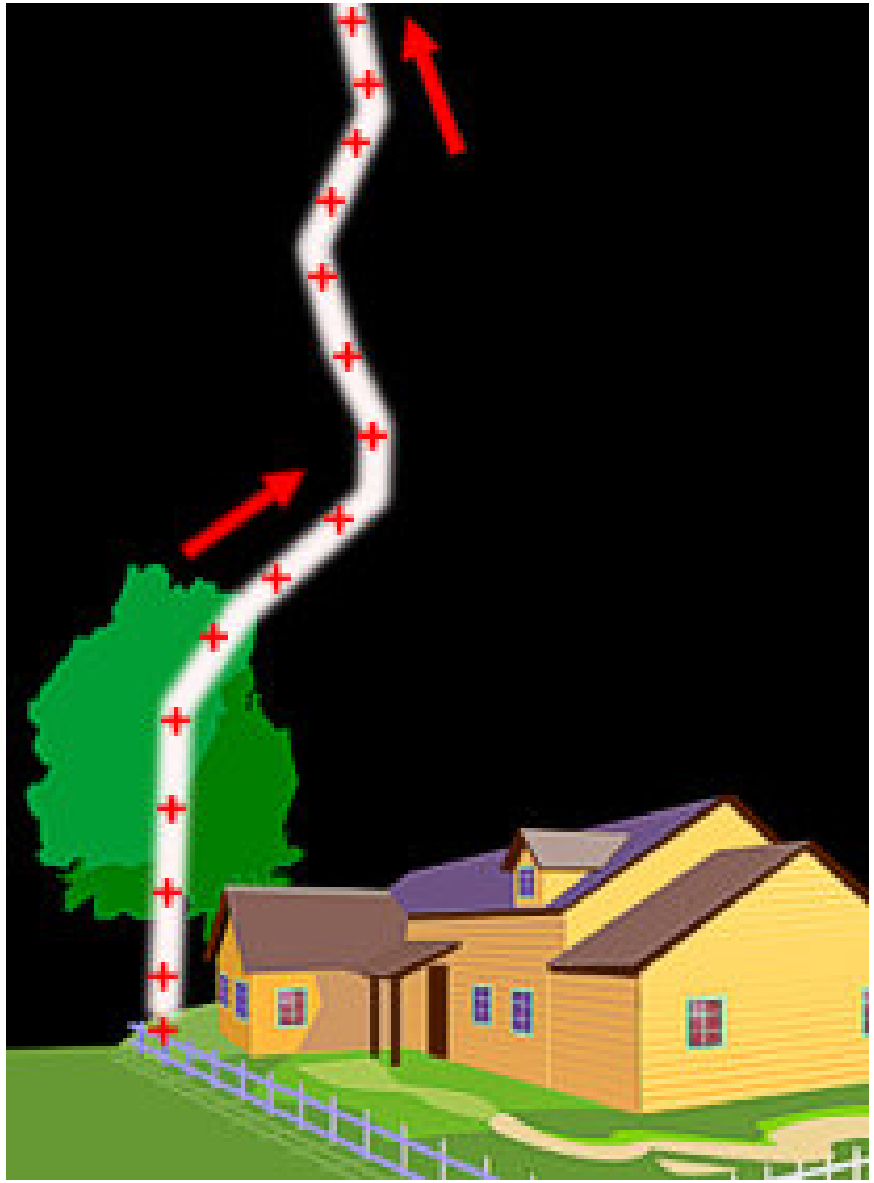


Connection Draws Current



Return Stroke Begins
60,000 miles/second
and about 7 ms duration

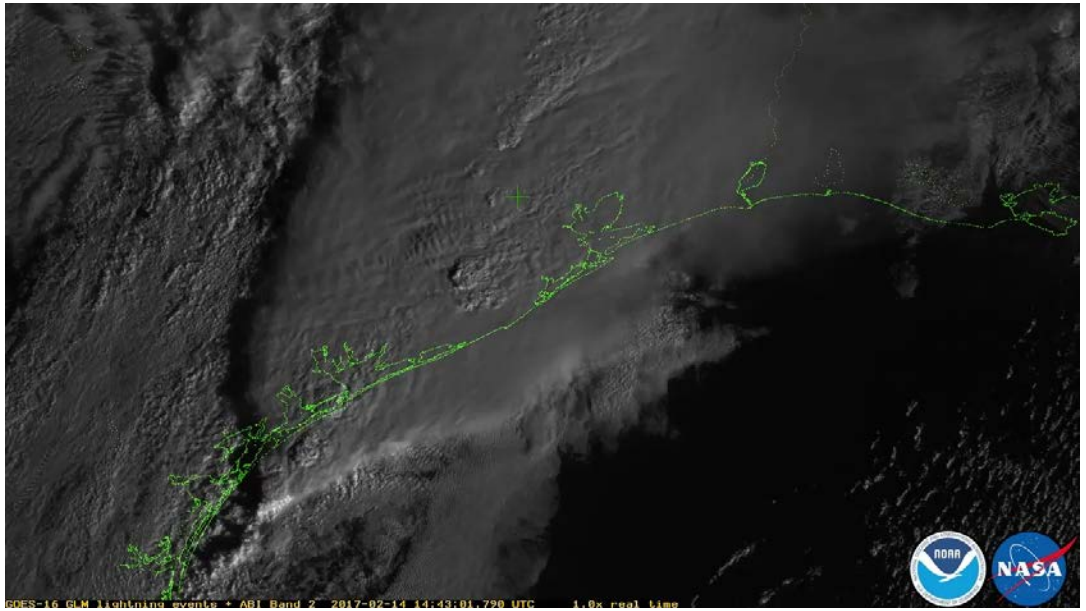
Drawings per NOAA

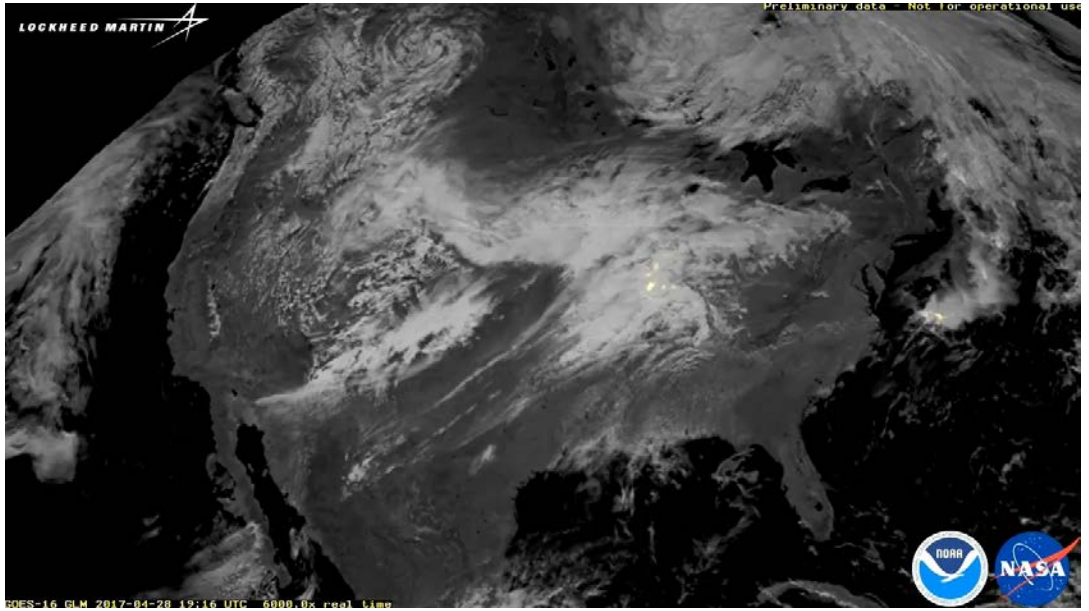


Strokes: 2-4 possible and 1-5 the reach the ground

Lightning from Space

NOAA/NASA Images





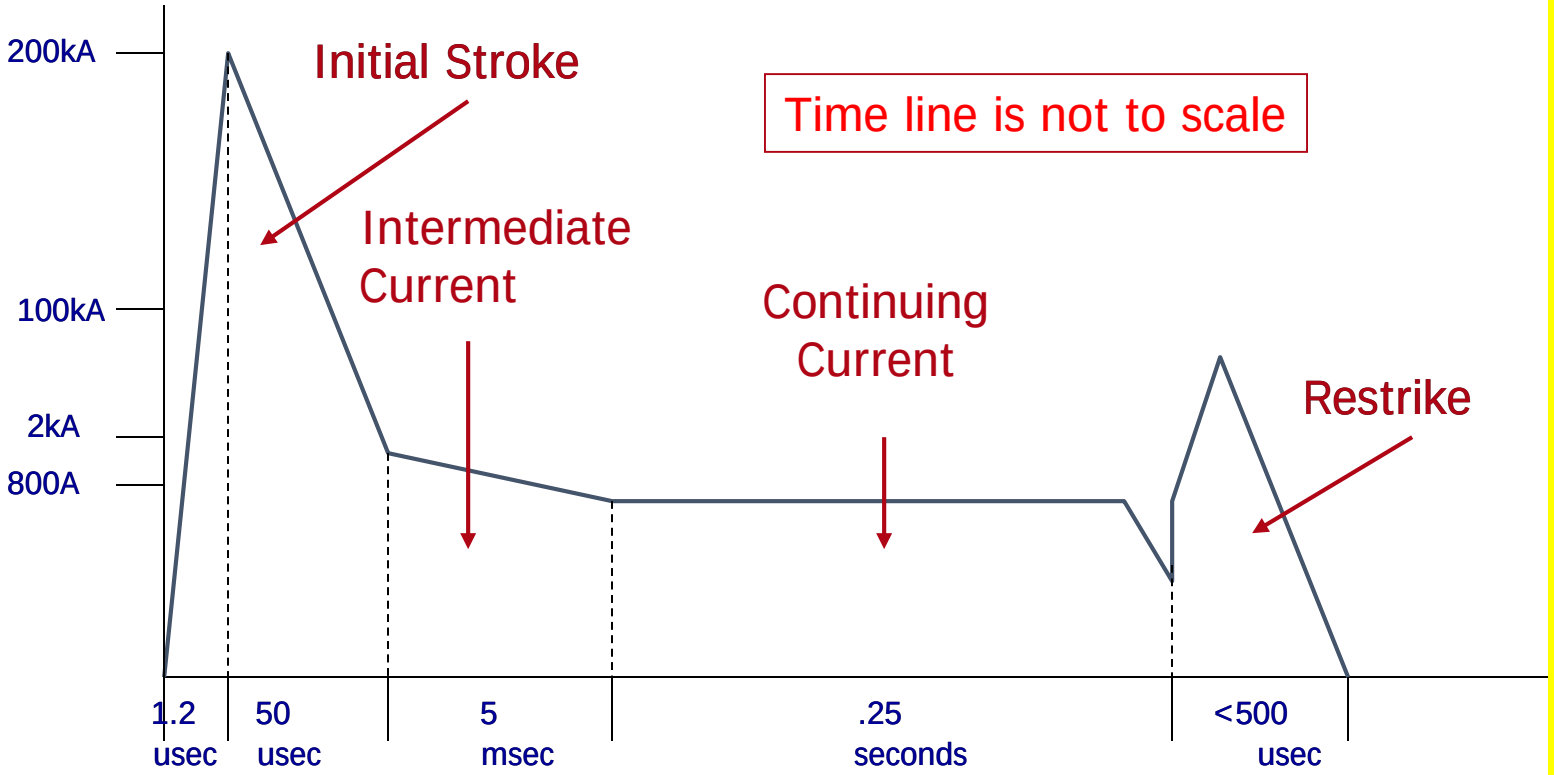
LEO Satellite Image with optical 777mn filter and time integrated filtering sending images every 90 minutes

GEO Satellite Image with spectral and time domain filtering sending images every minute

Anatomy of Lighting Stroke Hitting Tower

- Tower, transmission line and ground rods present both resistance and inductance to the surge
- Electrical surge spreads along the tower as it heads to the earth
- The bottom of the tower will NOT have zero voltage, could easily reach 180,000 volts for a 1/4 second
- Adding ground rods around the tower base reduces earthing resistance though their inductance slows down charge dissipation
- Ground rod spacing is important – minimum distance length of the rod

Anatomy of a Lightning Pulse

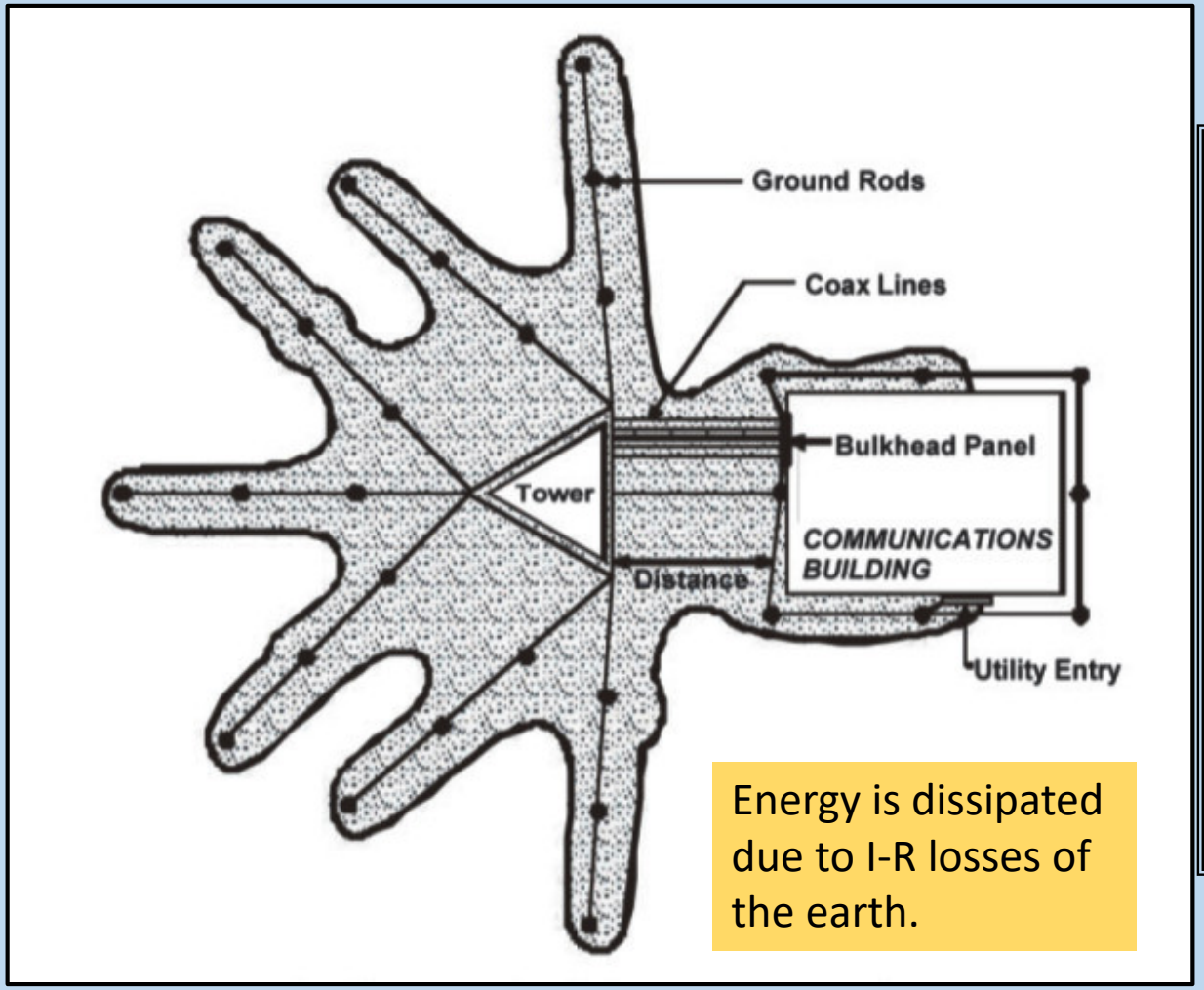


Myths & Legends

- Lightning never strikes twice in the same place
- Tower down conductors are needed
- Nothing can save you if you get hit
- Lie as flat as you can on the ground if out in the open
- A grounded tower is more likely to be hit
- Dissipation Arrays
- Lightning attractors/rods

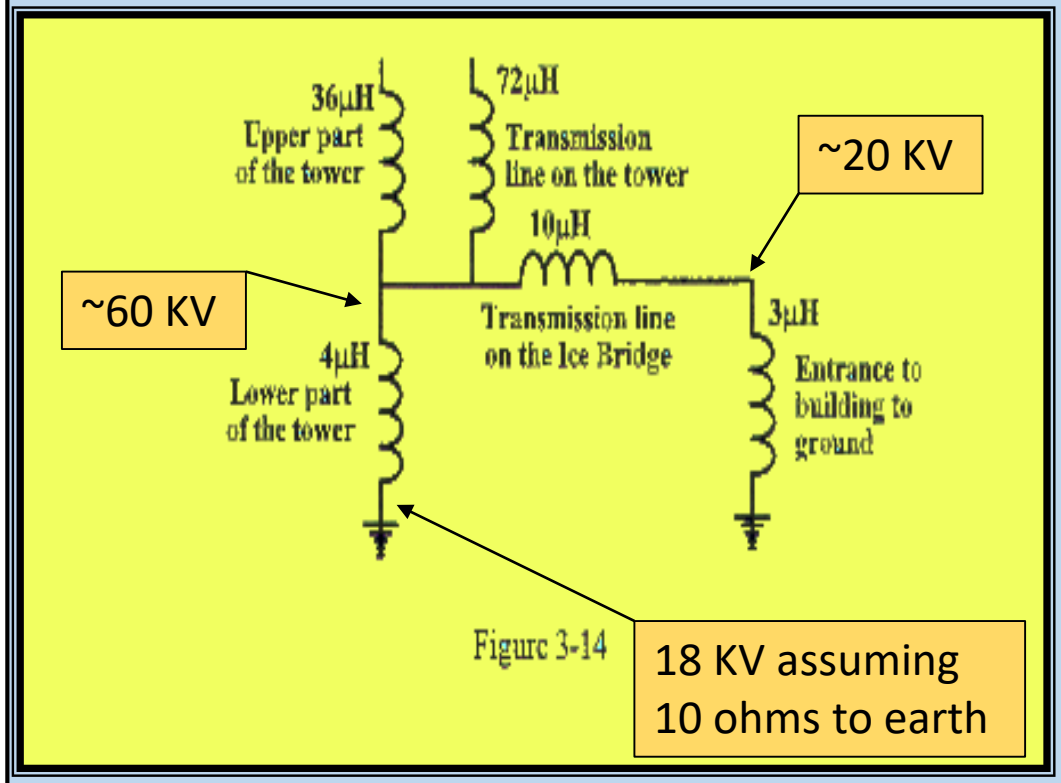
Average Strike is 18,000 amps with only 1% greater than 140kA

Ground Dissipation of Lighting Stroke



Energy is dissipated due to I-R losses of the earth.

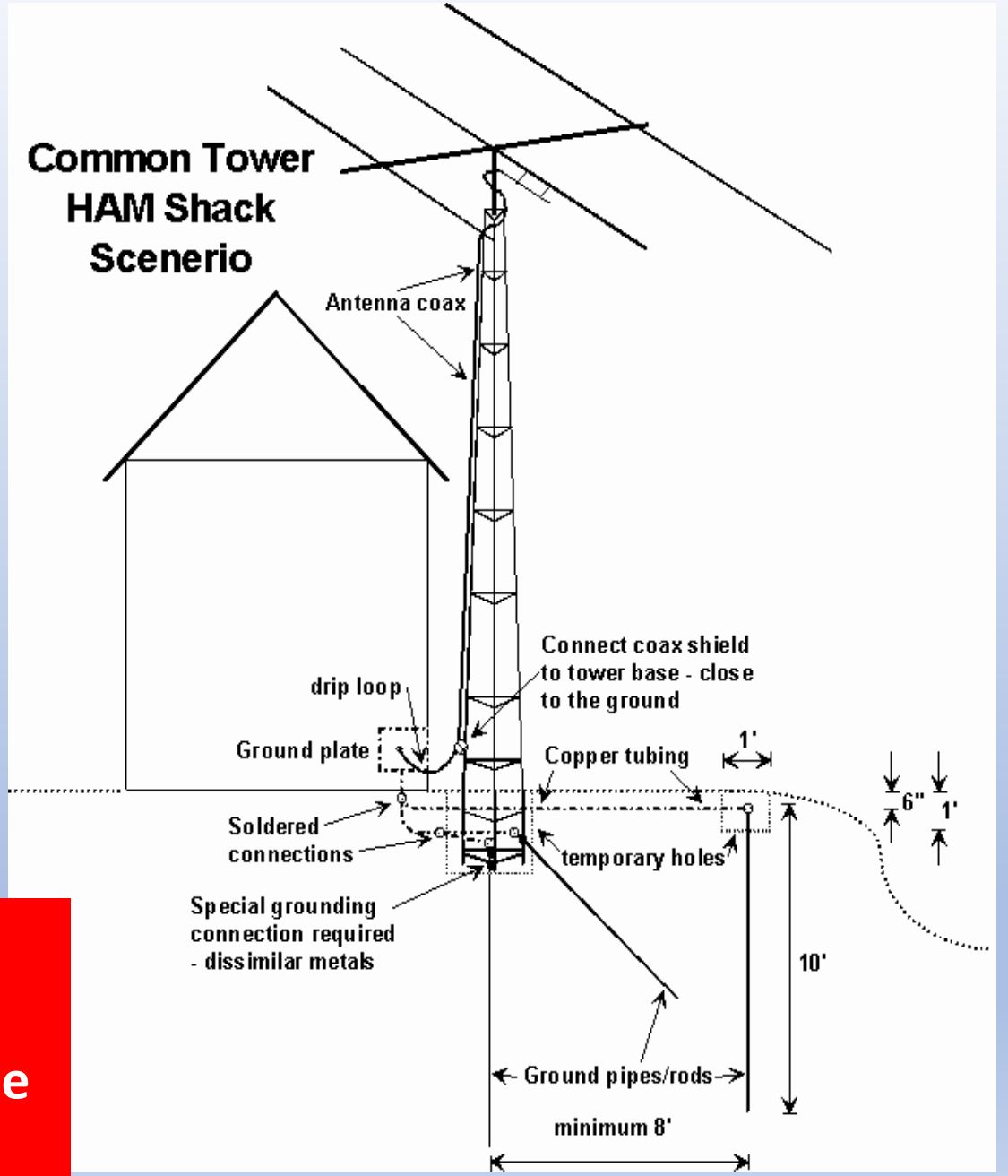
Typical 18-20 kilo amp – Top of Tower Hit



For every one ohm reduction in earth resistance reduces earth potential rise by 50 KV per Novaris.

Recommendations

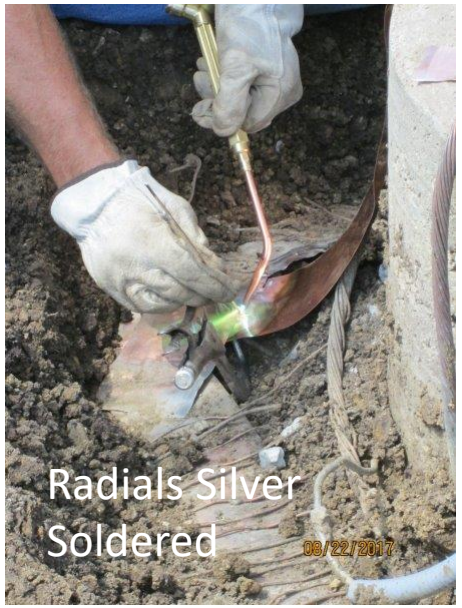
- **Properly Grounded Tower and Antenna Support System**
- **More than One Ground Rod for Tower (3 to 4)**
- **All Site Grounds Bonded Together**
- **Surge Protected AC Power**
- **Single Point Ground for the Ham Shack**
- **All Cables Entering the Ham Shack Surge Protected**
- **Use Proper Size Ground Conductor, as Short as Possible**



Disclaimer: You are on your own to do the best job possible to protect your amateur radio systems as these common practices may work for you to reduce risk. --Dave, N9KMY

Questions


No Copper Strap was Used
08/22/2017

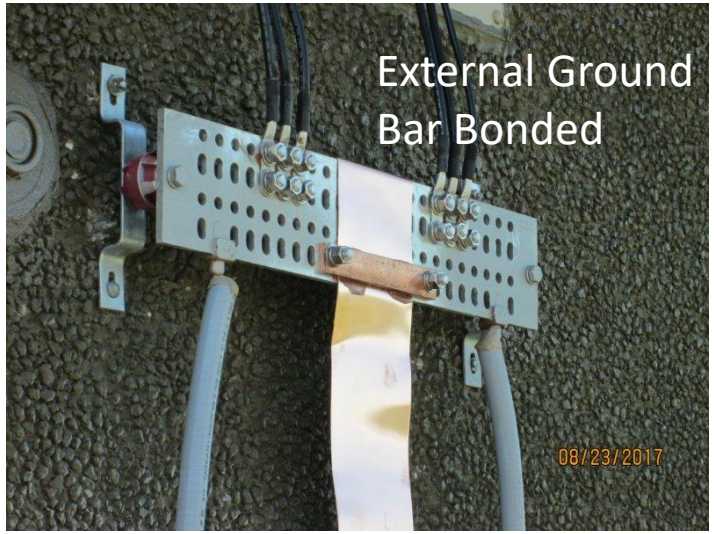

Radials Silver Soldered
08/22/2017

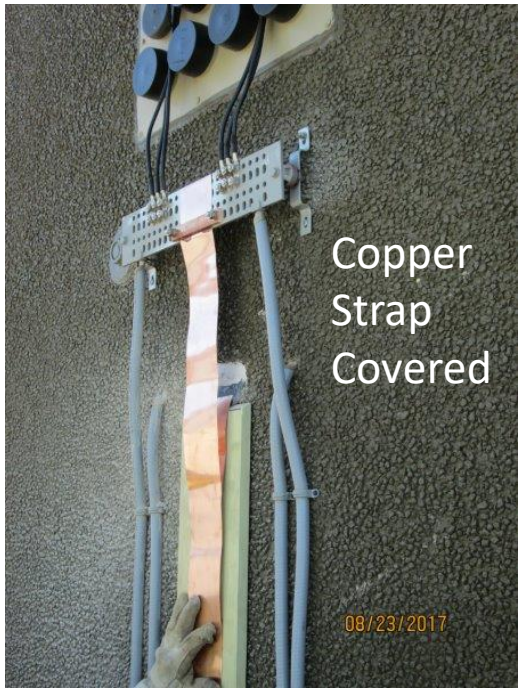

Copper Strap was Added
08/22/2017

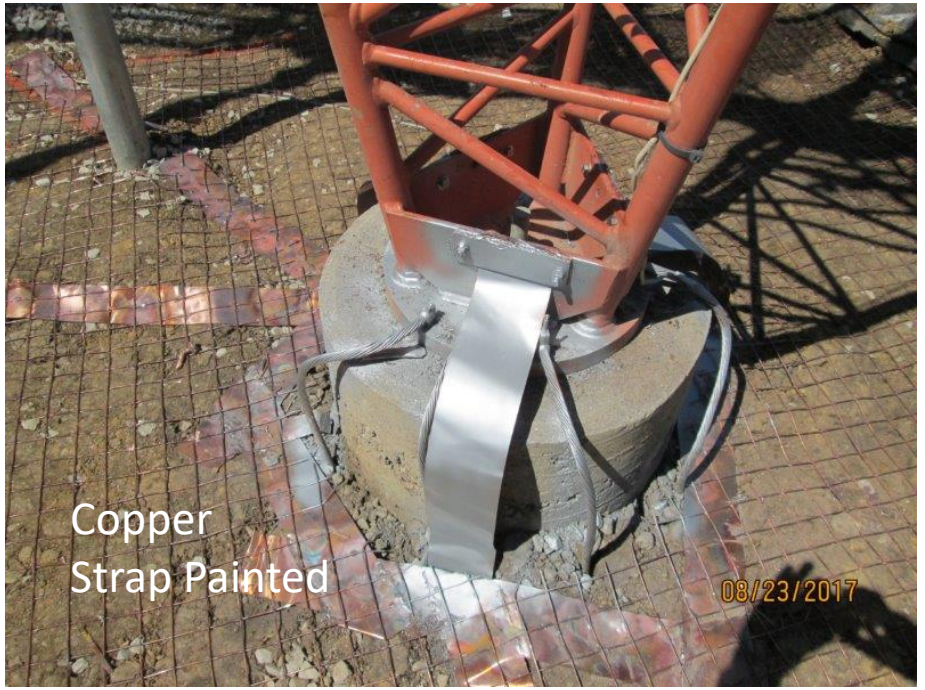

Copper Strap was Extended to Building
08/22/2017

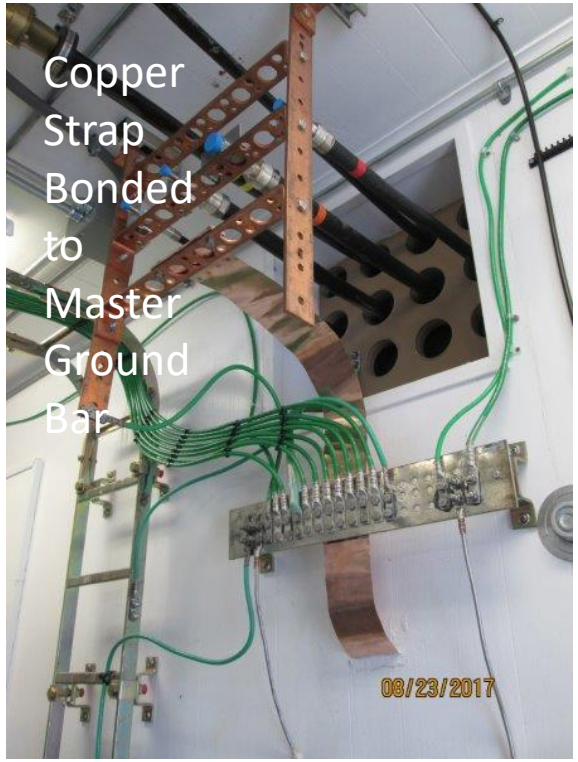

Copper 2” x 2” grid Screen Installed
08/22/2017

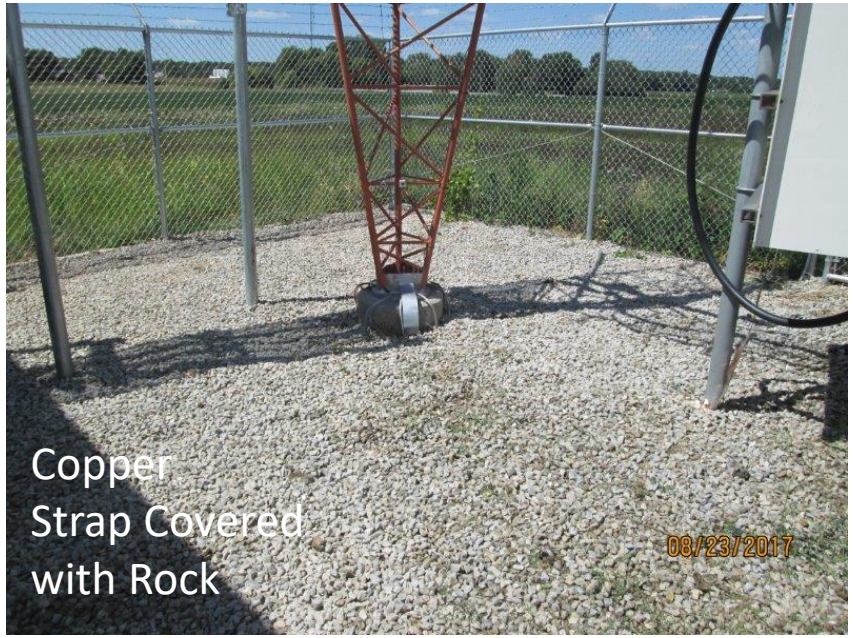

Copper Strap Bonded to Tower
08/23/2017


External Ground
Bar Bonded
08/23/2017


Copper
Strap
Covered
08/23/2017


Copper
Strap Painted
08/23/2017


Copper
Strap
Bonded
to
Master
Ground
Bar
08/23/2017


Copper
Strap Covered
with Rock
08/23/2017


CRAFTSMAN
Only 2.43
amps vs.
60 amps
08/23/2017