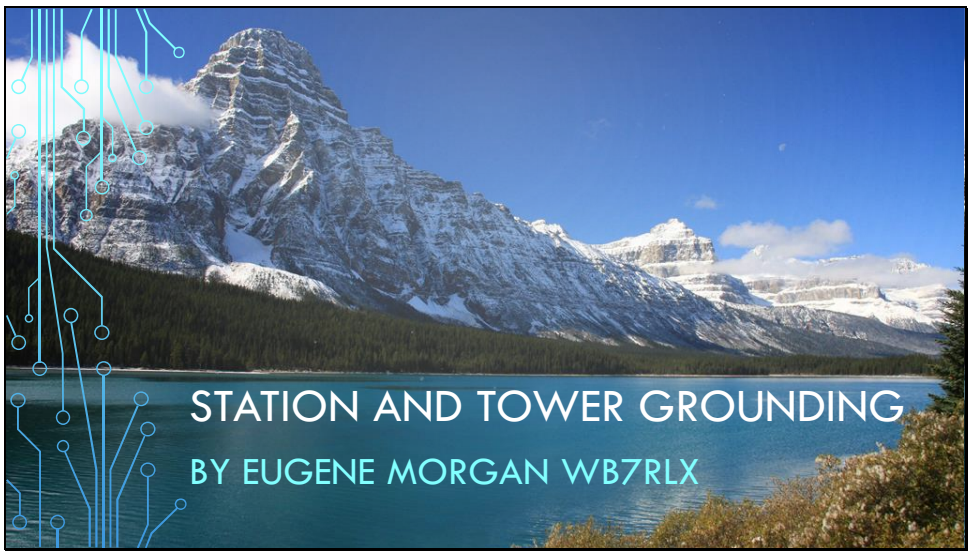
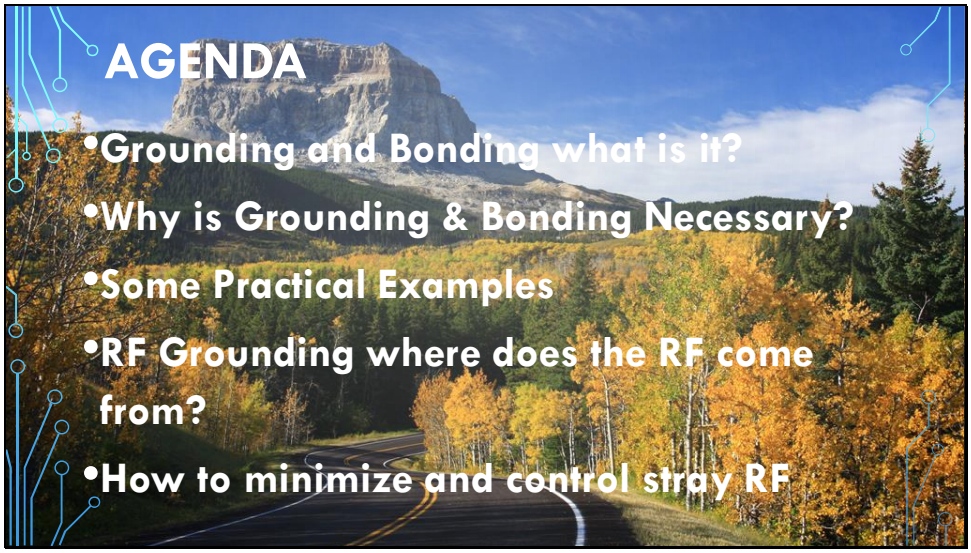
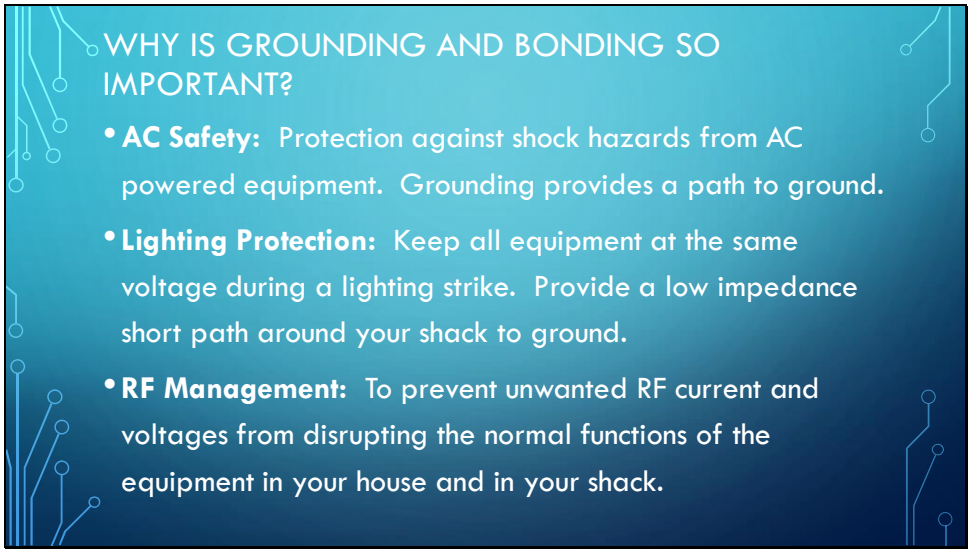
Slide 1



Slide 2

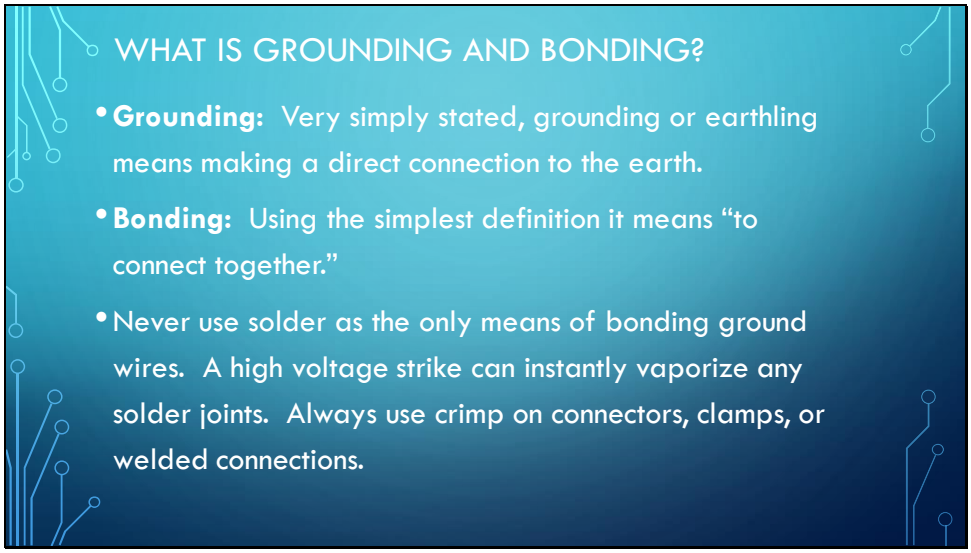

AGENDA
•Grounding and Bonding what is it?
•Why is Grounding & Bonding Necessary?
•Some Practical Examples
•RF Grounding where does the RF come from?
•How to minimize and control stray RF

Slide 3



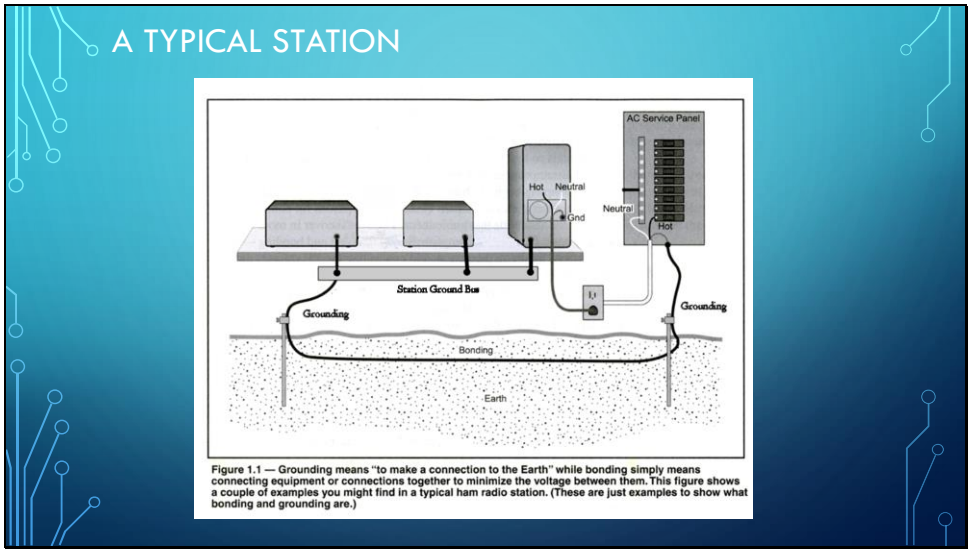

We are not going to cover AC Safety aspect in this presentation. Primary reason is AC Safety relies heavily on having a proper grounding system in place so we will focus on that. Also note that much of the wiring in your house has been done to address safety concerns. So we will focus our attention to Lighting Protection and RF Management.

Slide 4




Grounding can have a much broader context when talking about electronics. What we are focused on in this presentation is equipment grounding specifically.

Slide 5

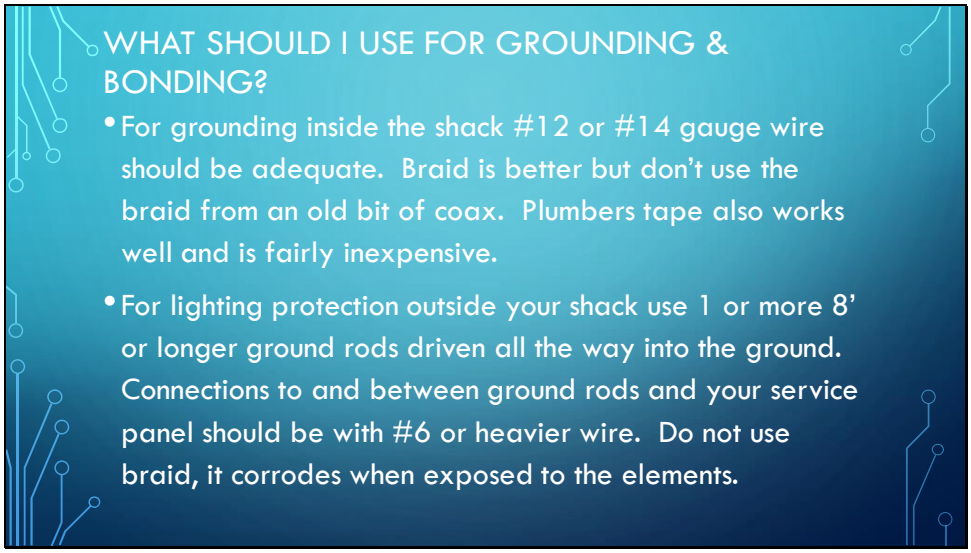



This slide shows an example of a properly connected station. Note the Electrical service and the ground rods and the station ground bus bar are all bonded together and that each piece of equipment is bonded to all the other equipment through the station ground bus. This configuration will also help to eliminate ground loops which are often responsible for humming on your signal when you transmit.

Slide 6

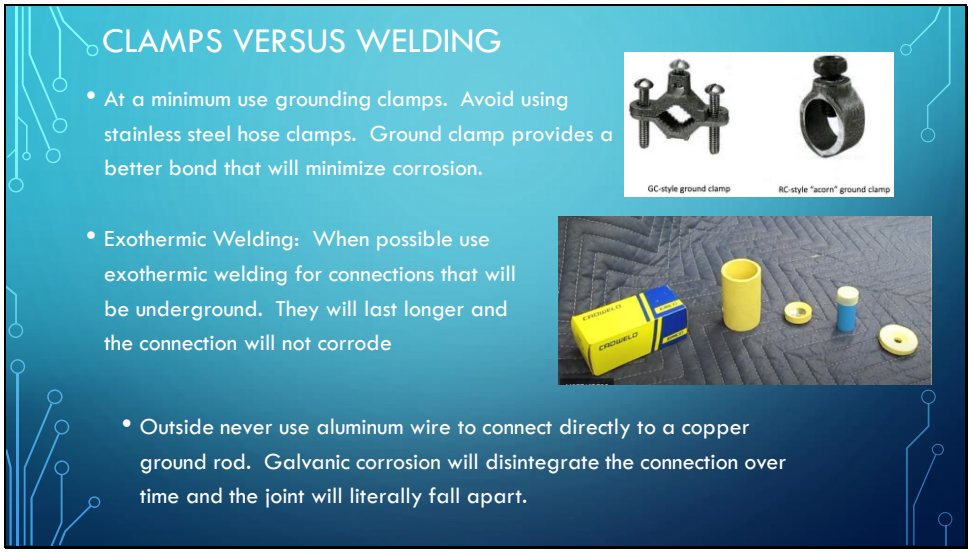

This slide simply shows some of the examples of grounding done by some of the hams in our club. Note in the last picture, which is my station the size of the cable running from the tower to the ground rod. The tower is also connected to two other ground rods. All three ground rods are bound together and are all connected to the common service ground on the electrical service panel.

Slide 7




I have seen first hand examples of braid that has been use outside. Over time it corrodes. I would recommend you not use braid outside, instead use #6 or heaver copper wire or flat copper strips..

Slide 8



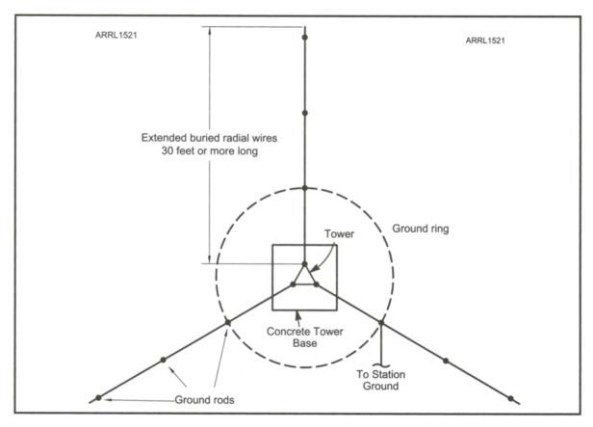

A note about galvanic corrosion. Over time galvanic action will result in the two metal components literally dissolving over time. Although in our dry Utah climate the problem is not near as bad in areas where there is exposure to salt water. There is a real problem for boaters on the Great Salt Lake. In your shack it's okay to connect copper and aluminum together as in the case of your station bus bar because the connection is not exposed to water or high humidly, but outdoors it a bad idea.

Slide 9

## HOW MANY GROUND RODS?

- I believe currently
- Place ground rod
- ARRL recommends
- optional

Schematic of a single family dwe typical tower grounding system. Buried radials beyond tower installations check building co the bonding ring are along with a "ring together and whe



Slide 10

## ADDITIONAL LIGHTING PROTECT FOR ANTENNAS

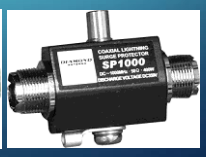
All coax should be grounded before entering the shack. There are two ways of accomplishing this.

Use a Grounding Block. However this method does not ground the center conductor.

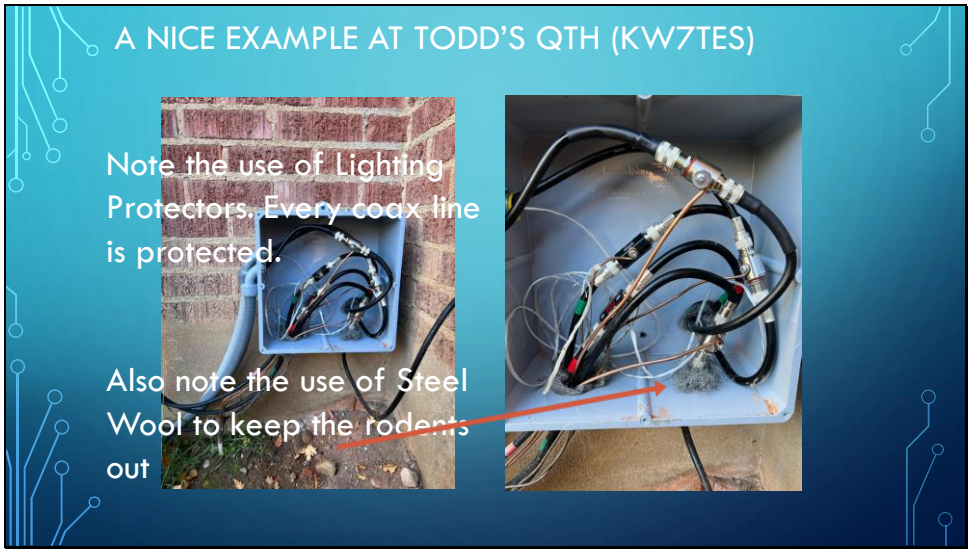
Slide 11

## ADDITIONAL LIGHTING PROTECT FOR ANTENNAS

Using a lighting arrestor is the better approach. It grounds the center conductor and allows static electricity to bleed off as well

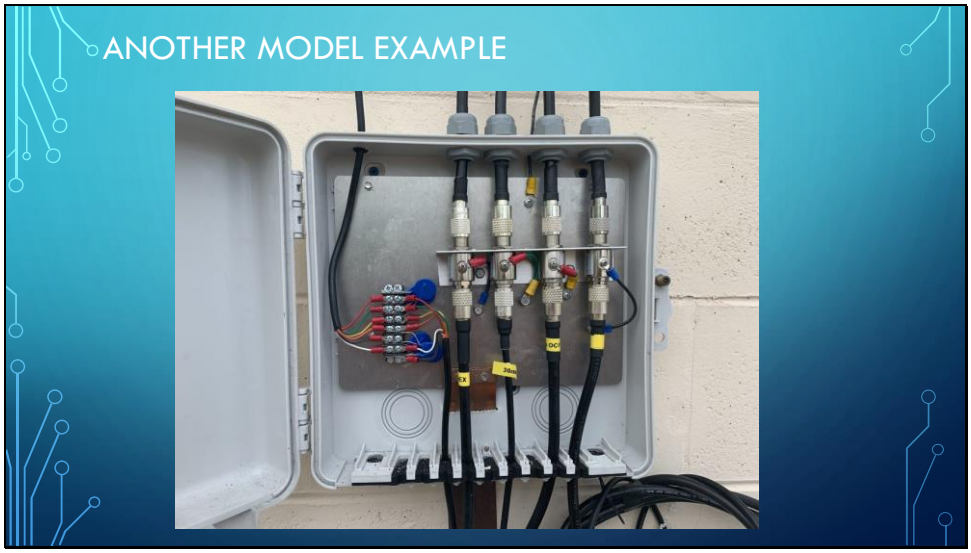



Slide 12




This is a good example of protecting your shack from surges from entering the shack. Todd has installed a lighting Arrestor on every bit of coax in his shack.

Slide 13




This is a model example.  Note how the rotator wires are also protected.

Slide 14


This picture is of the entry point into the Mount Ogden building. On the inside of the building EVERY coax line is protected with a Lighting Arrestor. They do not overlook lighting protection here. It's understood that a lighting strike is a certainty. Through the use of proper grounding they have turned a high probably risk into a low impact event. This is lighting protection done right.

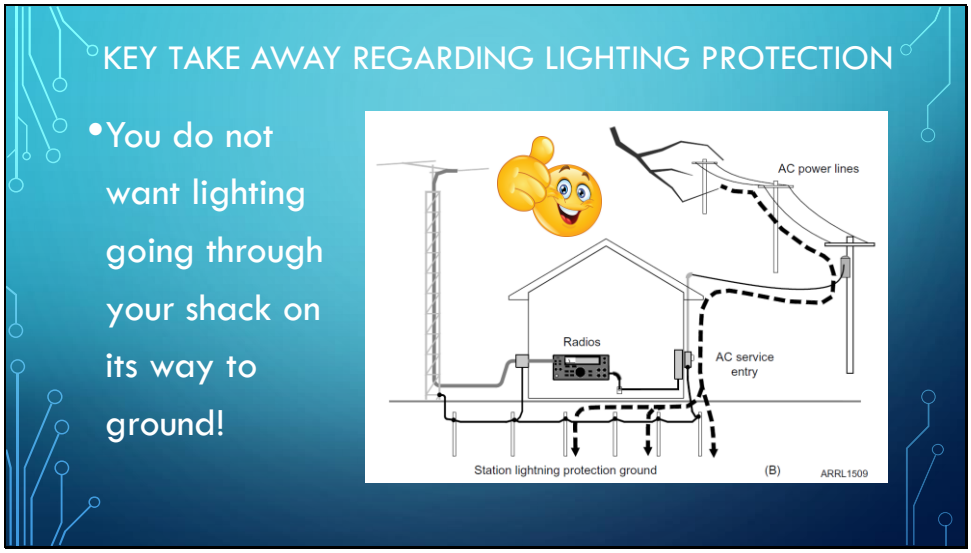
Slide 15


This slide shows a typical bonding buss for a station with ALL equipment connected to a single buss. You can use a copper pipe or a length of aluminum angle attached to the rear of your desk or wall. The key to keep the cable between your equipment and the common bus as short as possible. #14 gauge wire is usually adequate. You can also use wire braid. You do not want to “daisy chain” equipment. Each piece of gear needs to have a direct connection to ground otherwise a ground fault in any one piece of equipment can take out all the other equipment.

Slide 16


This slide shows the outside of my shack. The white and black wires go to the single point grounding bus on the electrical service panel. The other wires go to additional ground rods that I added. The single point grounding buss on the service panel also connects to other ground rods. I will be adding one additional ground rod to my system and replacing all exterior grounding wire with #6 wire. I currently have 4 ground rods outside my shack.

Slide 17

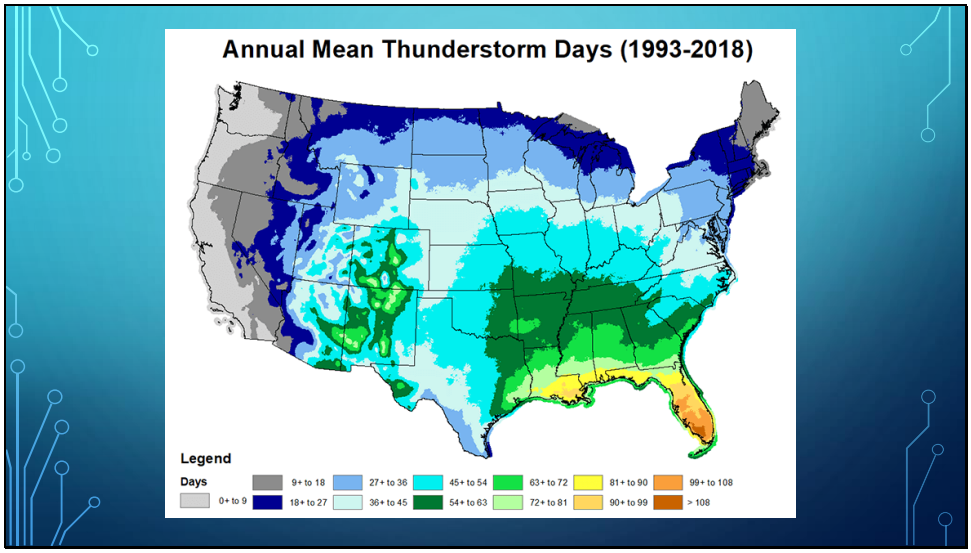



As you think about your ground system consider how a lightening surge would find its way to ground. You do not want it going through your shack on it way to ground. That's why it's important that you ground your antennas and rotator cable so that in the event of a lighting surge the electricity bypasses your shack on its way to ground.

Slide 18

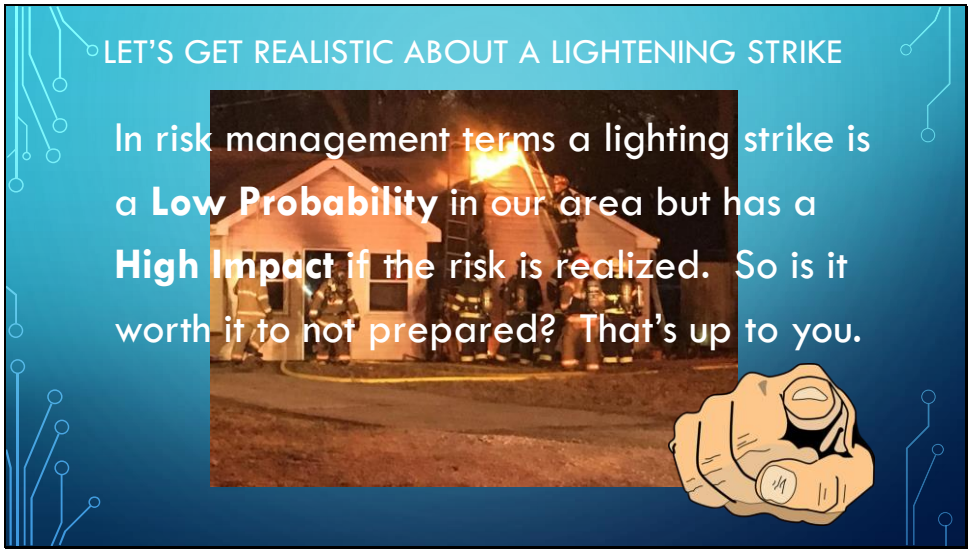

LET'S GET REALISTIC ABOUT A LIGHTENING STRIKE
How likely is your house going to be hit by Lighting?

Slide 19



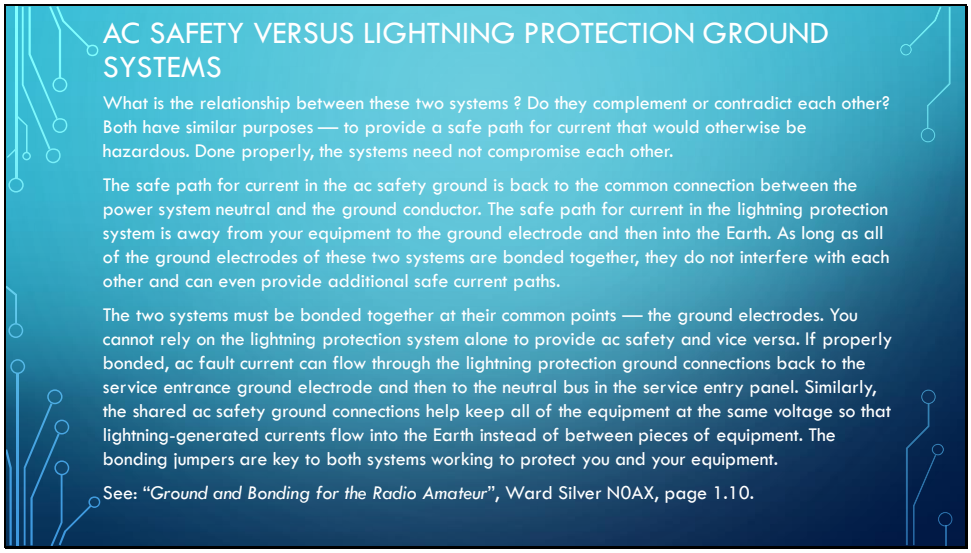

Although the risk of a lighting strike at your house is low, in some cases extremely low, a lighting strike is a high impact event. So do you really want to take a chance given the consequences if your house is struck?

Slide 20

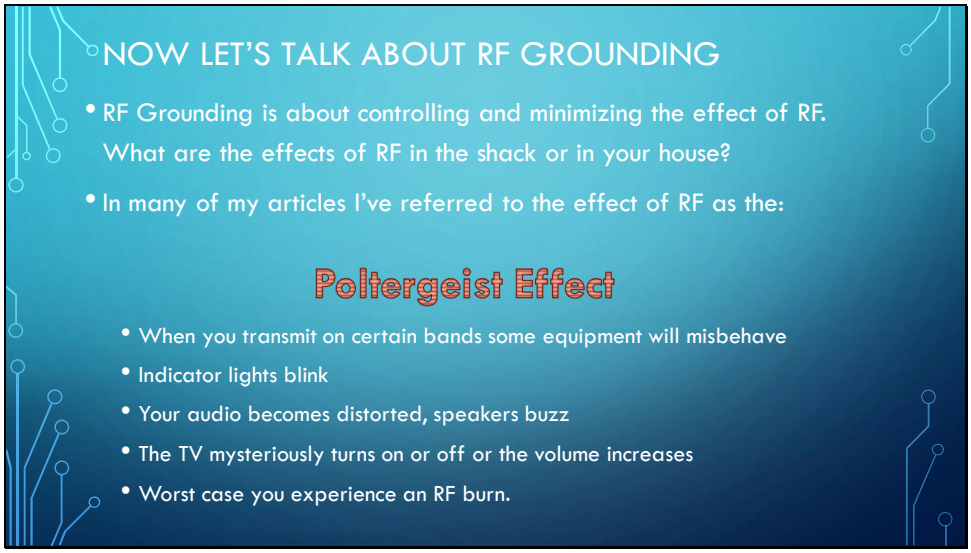



I'd suggest you prepare for the worst, hope for the best, and pray that your grounding solution was well planned and implemented. You don't want to end up replacing several thousands of dollars of expensive equipment or worse yet, having to call the fire department.

Slide 21


AC SAFETY VERSUS LIGHTNING PROTECTION GROUND SYSTEMS
What is the relationship between these two systems ? Do they complement or contradict each other? Both have similar purposes — to provide a safe path for current that would otherwise be hazardous. Done properly, the systems need not compromise each other.
The safe path for current in the ac safety ground is back to the common connection between the power system neutral and the ground conductor. The safe path for current in the lightning protection system is away from your equipment to the ground electrode and then into the Earth. As long as all of the ground electrodes of these two systems are bonded together, they do not interfere with each other and can even provide additional safe current paths.
The two systems must be bonded together at their common points — the ground electrodes. You cannot rely on the lightning protection system alone to provide ac safety and vice versa. If properly bonded, ac fault current can flow through the lightning protection ground connections back to the service entrance ground electrode and then to the neutral bus in the service entry panel. Similarly, the shared ac safety ground connections help keep all of the equipment at the same voltage so that lightning-generated currents flow into the Earth instead of between pieces of equipment. The bonding jumpers are key to both systems working to protect you and your equipment.
See: "*Ground and Bonding for the Radio Amateur*", Ward Silver N0AX, page 1.10.

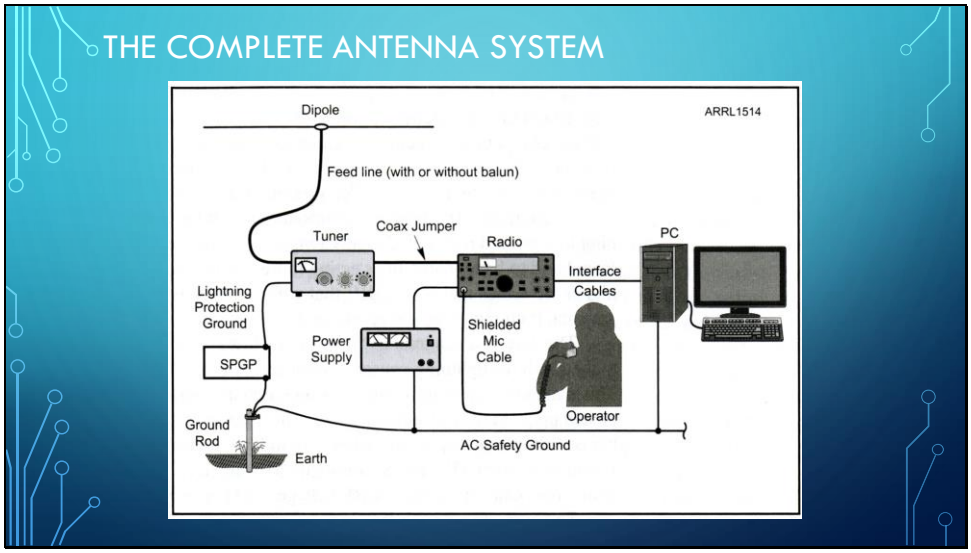
Slide 22




At this point we have talked about grounding a bonding which are both necessary steps in protecting against shock hazards from AC powered equipment and preparing for a potential lighting strike. These are two important aspects of a well-designed shack. Now let's talk about RF Grounding.

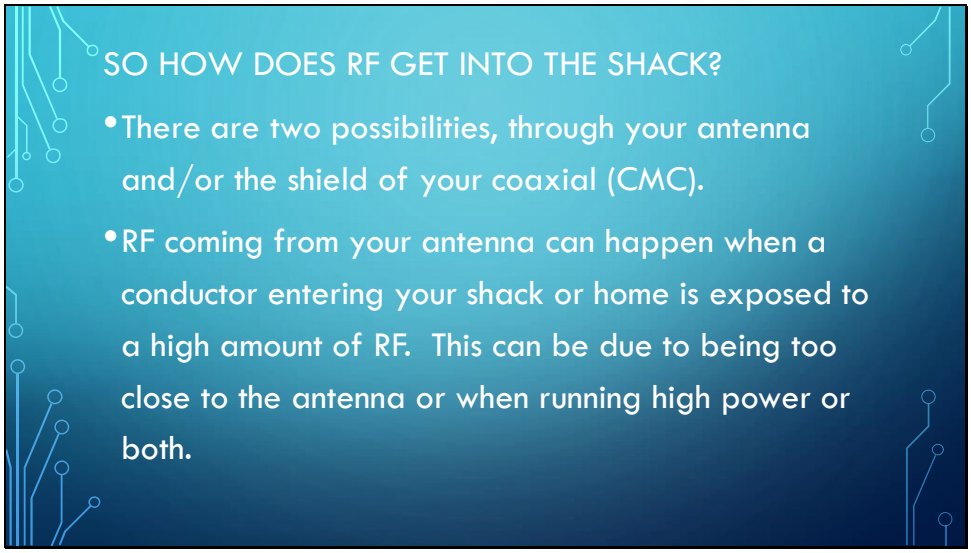
The key takeaway is RF grounding is different than electrical grounding and serves a different purpose than electrical grounding but they can work together to minimize the effect of RF in the shack.

Slide 23



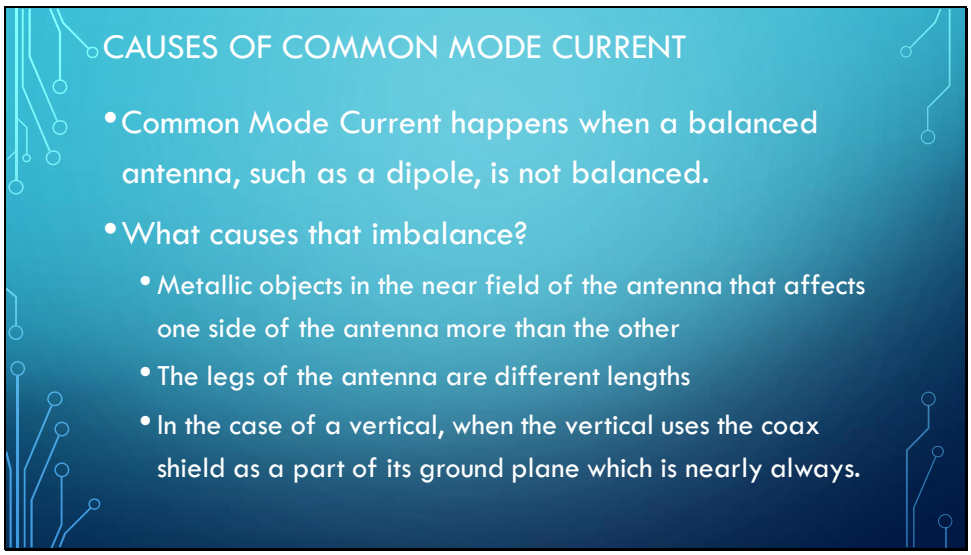

The thing to note is that RF is being introduced through two avenues: By the antenna and in some cases and as Common Mode Current. If the antenna is far enough away the RF introduced by the antenna may be so weak as to not be able to overwhelm the protections built into much of today's equipment. Common mode current on the other hand can affect any number of devices it invades. So of course one of the best things to do is try to locate your antenna away from your shack. That means you want to avoid putting an antenna in your attic if possible. If you using a vertical don't locate it a few feet from the outside of your shack. If you do locate your antenna in your attic you may find it necessary to limit your transmitter power to a few watts. It all depends on what conductors are close to the antenna. Does that length of RG6 in your attic that feeds the TV in the living room run in proximity and parallel to your attic dipole. Or how about that run of Romex that feed the utility room where the washing machine sits dutifully waiting for that next load of laundry? Also consider, if this is the entire antenna system what RF is it picking up that I don't want it to, such as the RF coming from wall warts, LED lights, the motors various appliances, the doorbell transformer, and so on.

Slide 24



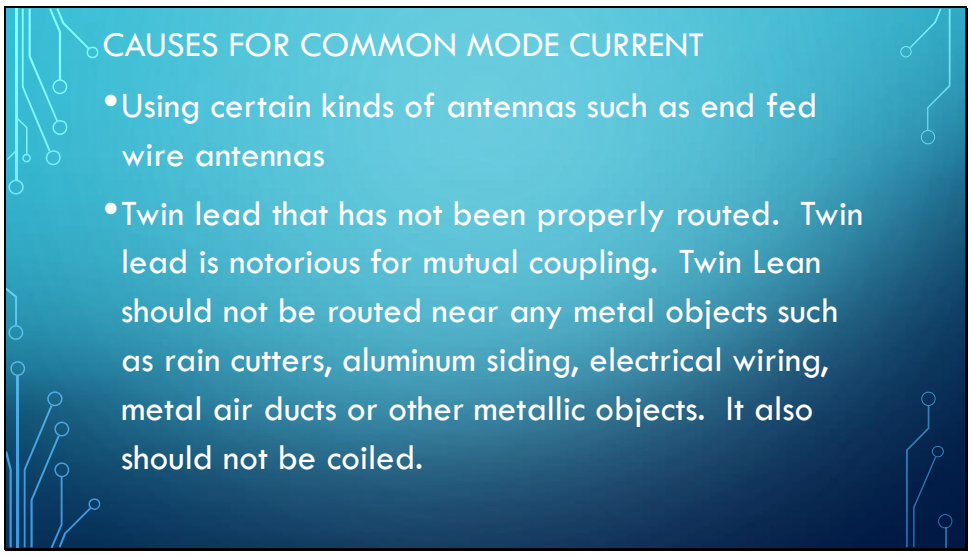

There is a way to tell where the RF is coming from. If you transmit into a dummy load and you don't see any of the effect you see when transmitting into your antenna then it's clear the RF is coming from either CMC or your antenna. If you still see the same effect when transmitting into the dummy load then it's likely that you have a bad bit of coax in the circuit or a faulty piece of equipment and/or you have a faulty ground or no ground at all.

Slide 25




We could make this entire discussion about common mode current but due to time we will touch on the high lights. Common mode current is cause by an imbalance in the antenna. This is a common occurrence in dipoles and vertical antennas. The imbalance can be cause by metallic objects in the near field of the antenna that affect one side of the antenna more than the other. In the case of a vertical it happens when the antenna uses the coax shield as a part of its ground plane. The unbalanced current flows down the outside of the coaxial cable looking for a path back to mother earth. On its way it can cause all sorts of issues including giving you a good RF burn.

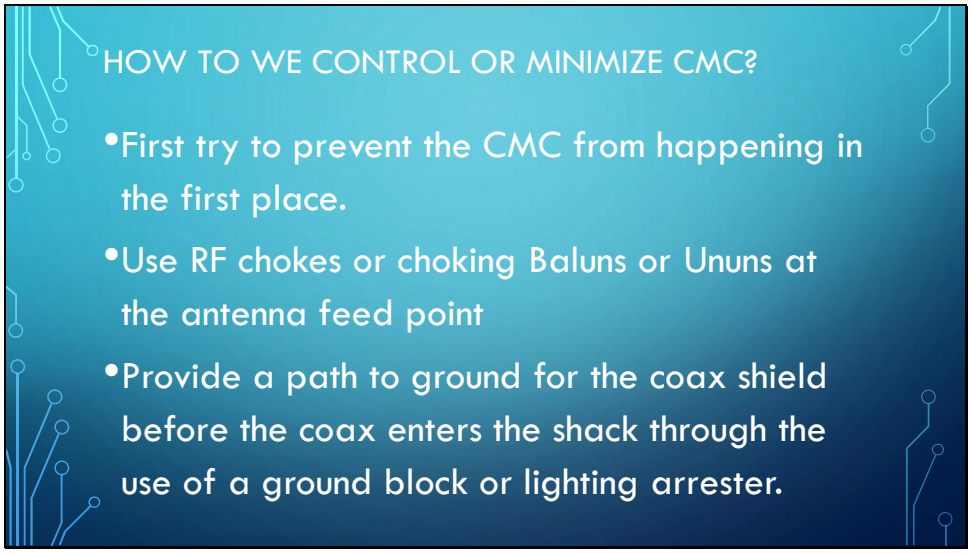
Slide 26




There's nothing wrong with using end fed antennas. They make a very good antenna when done properly. What that means you must use an unun AND a choke to minimize the CMC. It also helps if you can ground the other side of the UNUN provided the ground lead won't be too long. The short length of wire going to ground will be a part of the antenna.

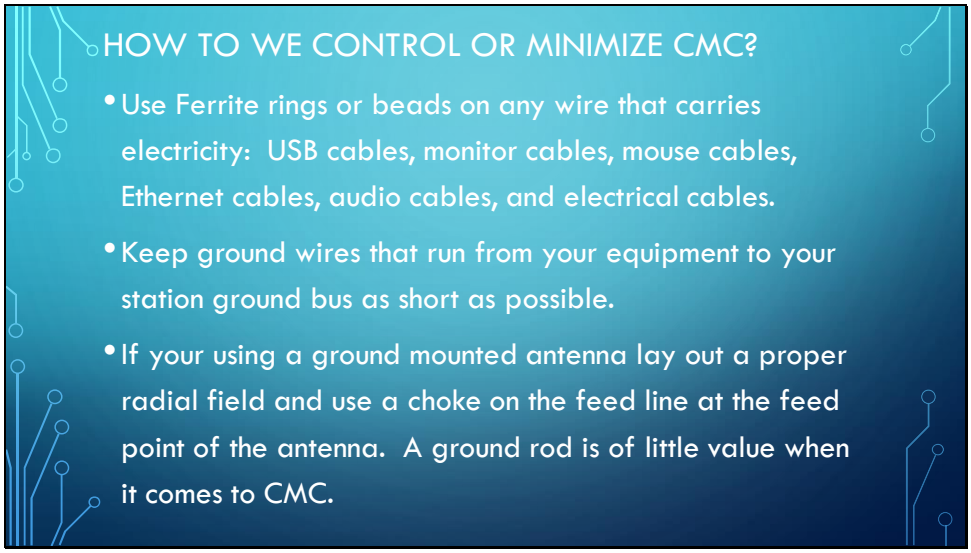
In the case of twin lead, if you can't route it properly then simply replace it with coax and remove the twin lead altogether. Yes that could mean turning that G5RV into a multiband dipole.

Slide 27




Use Baluns on balance antennas, and unun on unbalance antennas such as end fed wires. In the case of ununs always use a choke as well if the unun provides no choking. If you're into building your own chokes the best Ferrite cores or beads are the Mix 31. They provide the best choking over a broad range of frequencies from 1 Mhz to 300MHz. Note that a lot of the cores and beads bought online are from china and you never know what you are getting. If you're buying cores always know what mix you are getting.

Slide 28

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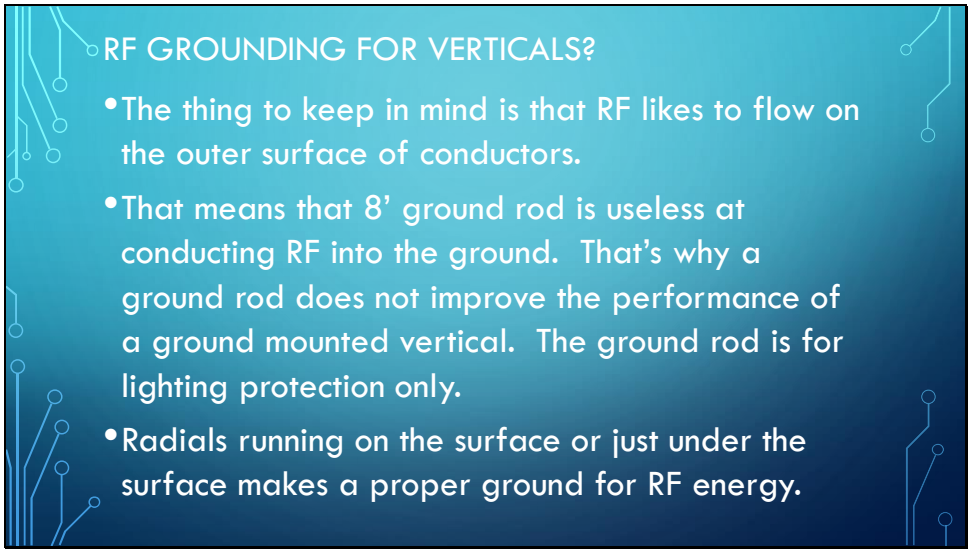
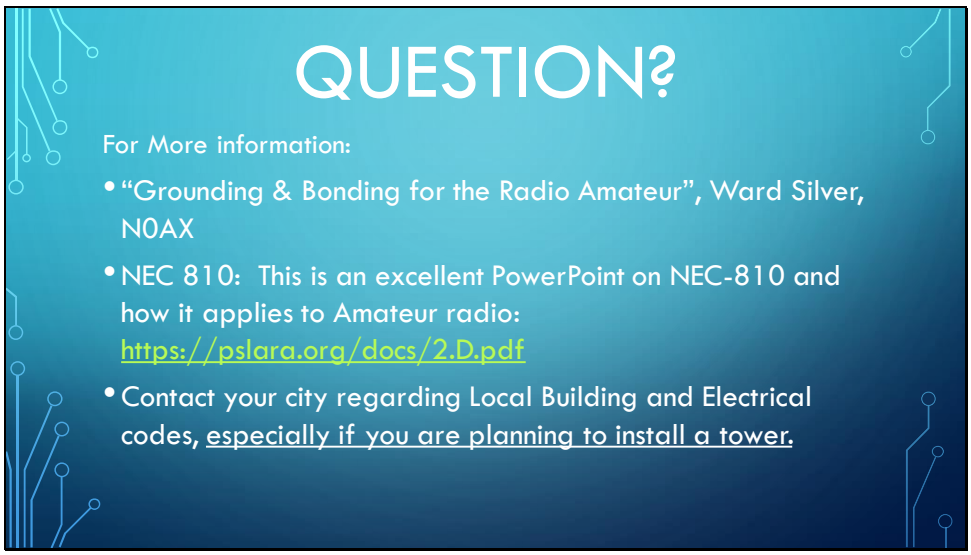
Slide 29




Ground rod are great at conducting DC current to ground. But they do nothing for AC current. Yes a ground rod will help dissipate CMC but the real purpose is for managing DC currents. Remember your utility power also has a connection to ground and that is why a ground rod as part of your electrical service grounding is important. It can make sure that AC circuit can be completed when there is a ground fault.

Slide 30


QUESTION?
For More information:
• "Grounding & Bonding for the Radio Amateur", Ward Silver, N0AX
• NEC 810: This is an excellent PowerPoint on NEC-810 and how it applies to Amateur radio: https://pslara.org/docs/2.D.pdf
• Contact your city regarding Local Building and Electrical codes, especially if you are planning to install a tower.

Slide 31