

# Grounding and Lightning Protection

# Ideas for things to discuss

- **Grounding**

- Short and straight
- How much is too much?

- **New Sites**

- Planning ahead
- Staying flexible

- **Ferrites**

- Why Jeff loves them
- How they work when used with other things

- **Existing Sites**

- How to fix them
- What to look for



Photo credit: Elaine Jones Associates, [www.elainejonespr.com](http://www.elainejonespr.com)

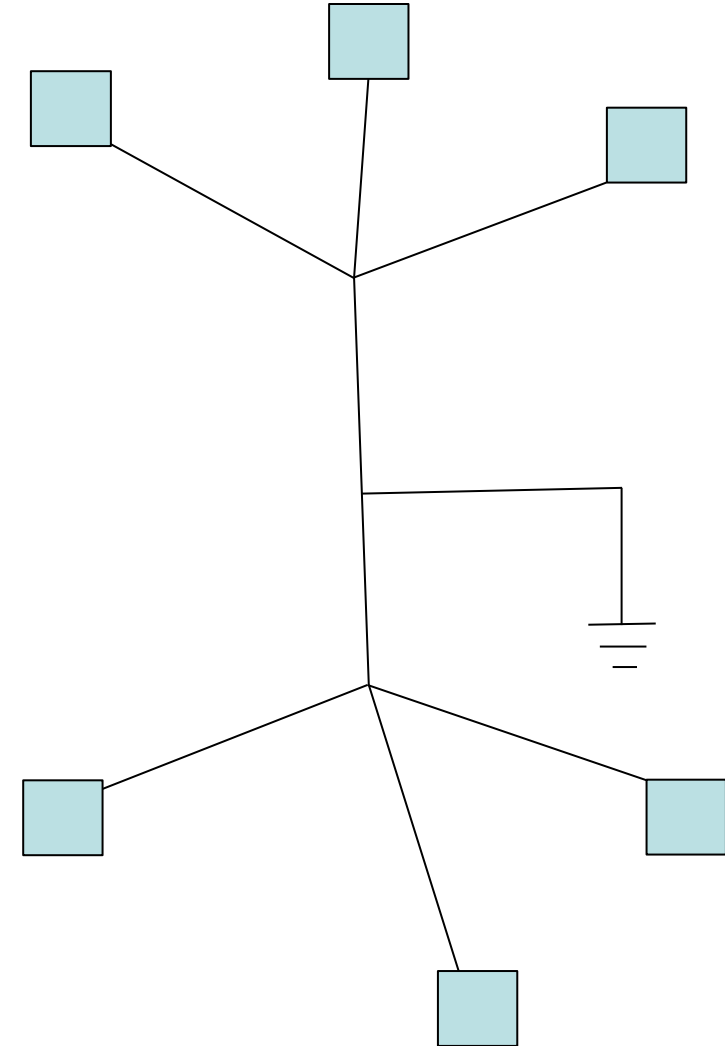
# Grounding vs Bonding

- Grounding is WHERE you connect the conductors
  - Ground rods
  - Ground terminals on equipment
  - Earth connections
- Bonding is HOW you connect the conductors
  - Mechanically
    - Clamps
    - Screws
    - Compression connectors
  - Exothermically
    - Brazed, either bronze or Sil-Fos (silver, copper and phosphorous alloy)
    - Soldered (whether silver, lead/tin or RoHS compliant)
    - Cadweld



# Get Well Grounded...

- But not too well grounded
  - Too many grounds cause issues too.
- Single point (star) grounding is the key
  - One ground per item, where possible.
  - Establish reference ground(s).
  - Use a tree, if need be.

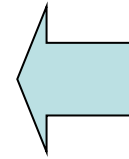


# Get Well Grounded...



- \_Single point ground for racks and individual pieces in a room
- \_Keeps all audio shields at a common potential
- \_What's wrong with this picture?

# Get Well Grounded...

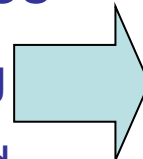


Buss bar for AC grounds

- Tied to station reference ground
- All primary equipment connected

Bulkhead ground for coax cables

- Best done where cables enter building
- Connected to station reference ground
- Keep ground leads as short as possible



# Get Well Grounded...



## Equipment Grounding

- \_Note the ground loop?
- \_Avoid attaching conduits to cabinet, except at designated conduit entry points
- \_Black cable shown is an AC safety ground; on a lightning strike, the chassis could become hot.



# Get Well Grounded...



**MAKE SURE YOUR GROUND CONNECTION  
IS ACTUALLY GROUND!!!**

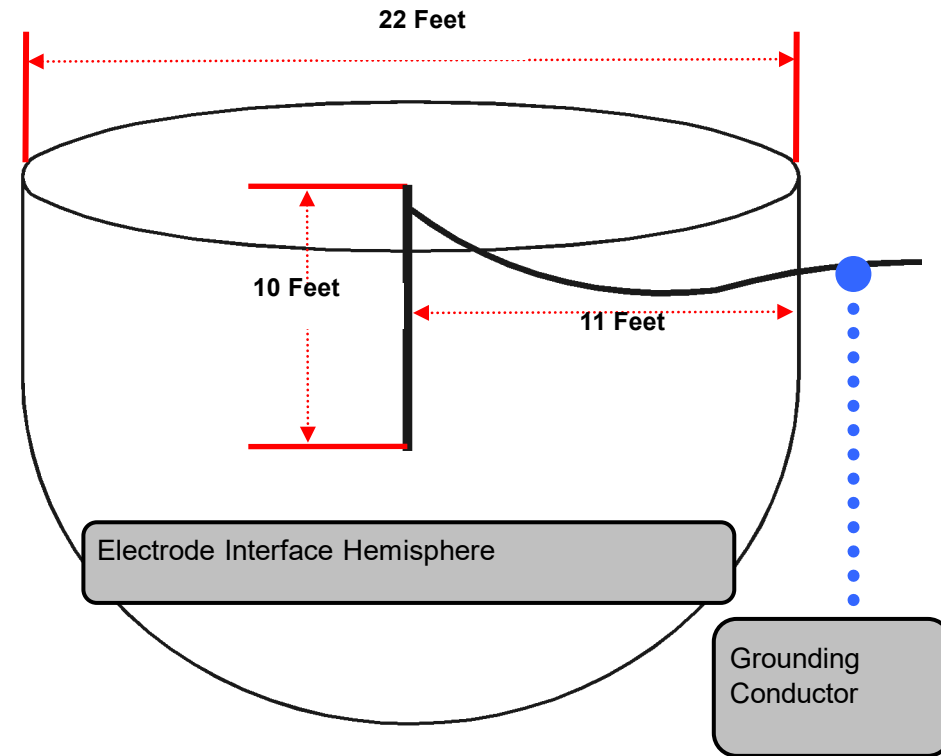
# Get Well Grounded...



The best building grounding in the world doesn't help, if it doesn't go anywhere when it reaches the outside world!

## Ground Rods

- Penetrate below the frost line
- Moist soil or the water table
- Diameter 3/8" or larger
- Connected with Cad welded or silver soldered copper straps
- Copper or copper clad steel



# Keep your Shields UP!

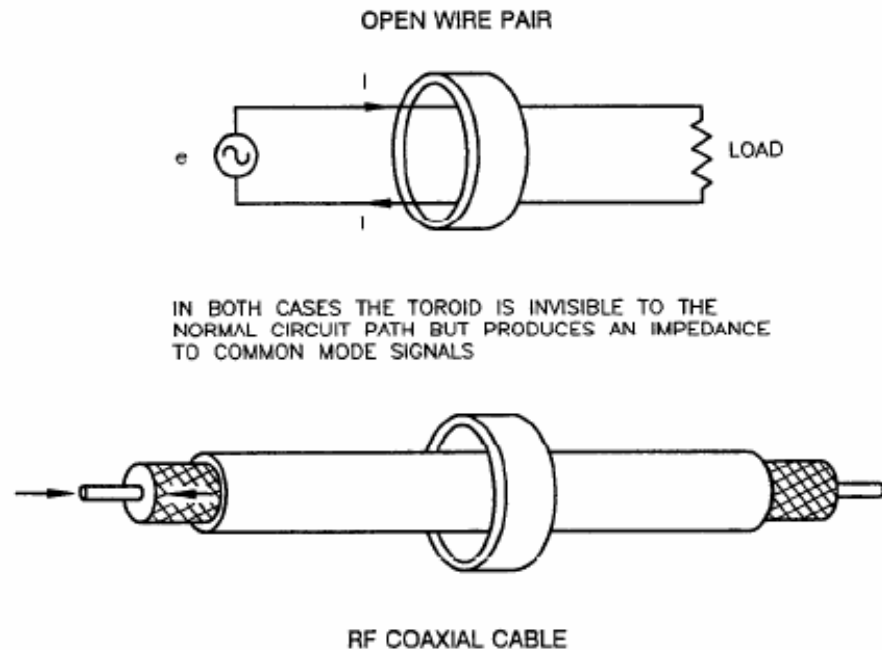


Figure F-4 Use of Toroids to Impede Common Mode Signals

Ferrites are good for reducing common mode signals

- \_ Lightning surges
- \_ Induced RF (especially at co-located AM and FM sites)
- \_ Power line and power supply noise

# Keep your Shields UP!



Ferrites on AC cabling can protect against surge related power supply damage

- \_All feeds and a ground return through the ferrite
- \_In some cases, such as with purely balanced power supplies, it's desirable to make chokes (wrap each AC conductor around a separate ferrite). In this case, ferrite composition needs to be considered more carefully.

# Always Use Protection



AC Power line protectors are a must – and they **MUST** be connected to your station reference ground.

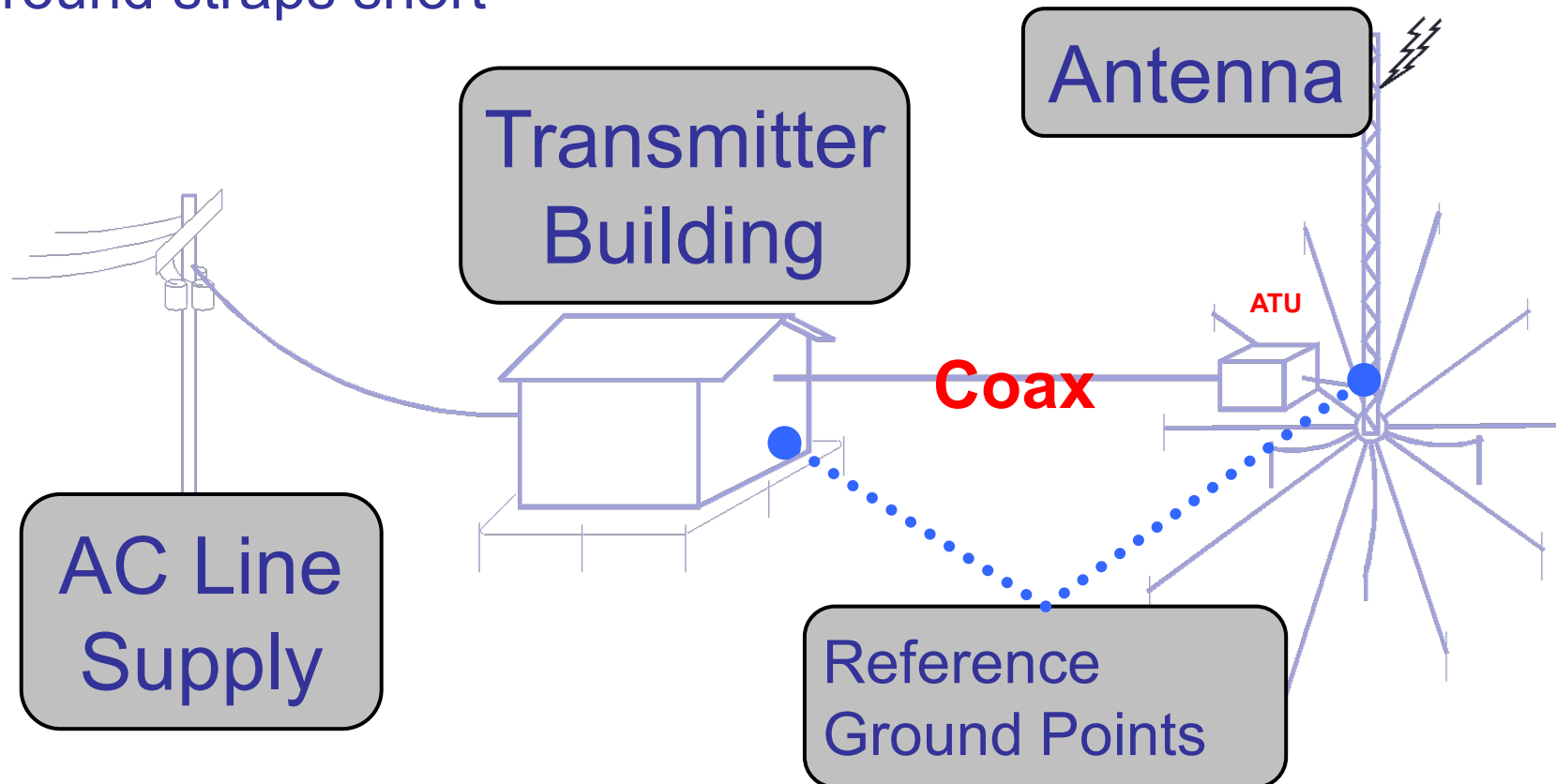
# Always Use Protection



As a minimum, a shunt type MOV protector with fused links (and a solid ground connection!!!) is recommended.

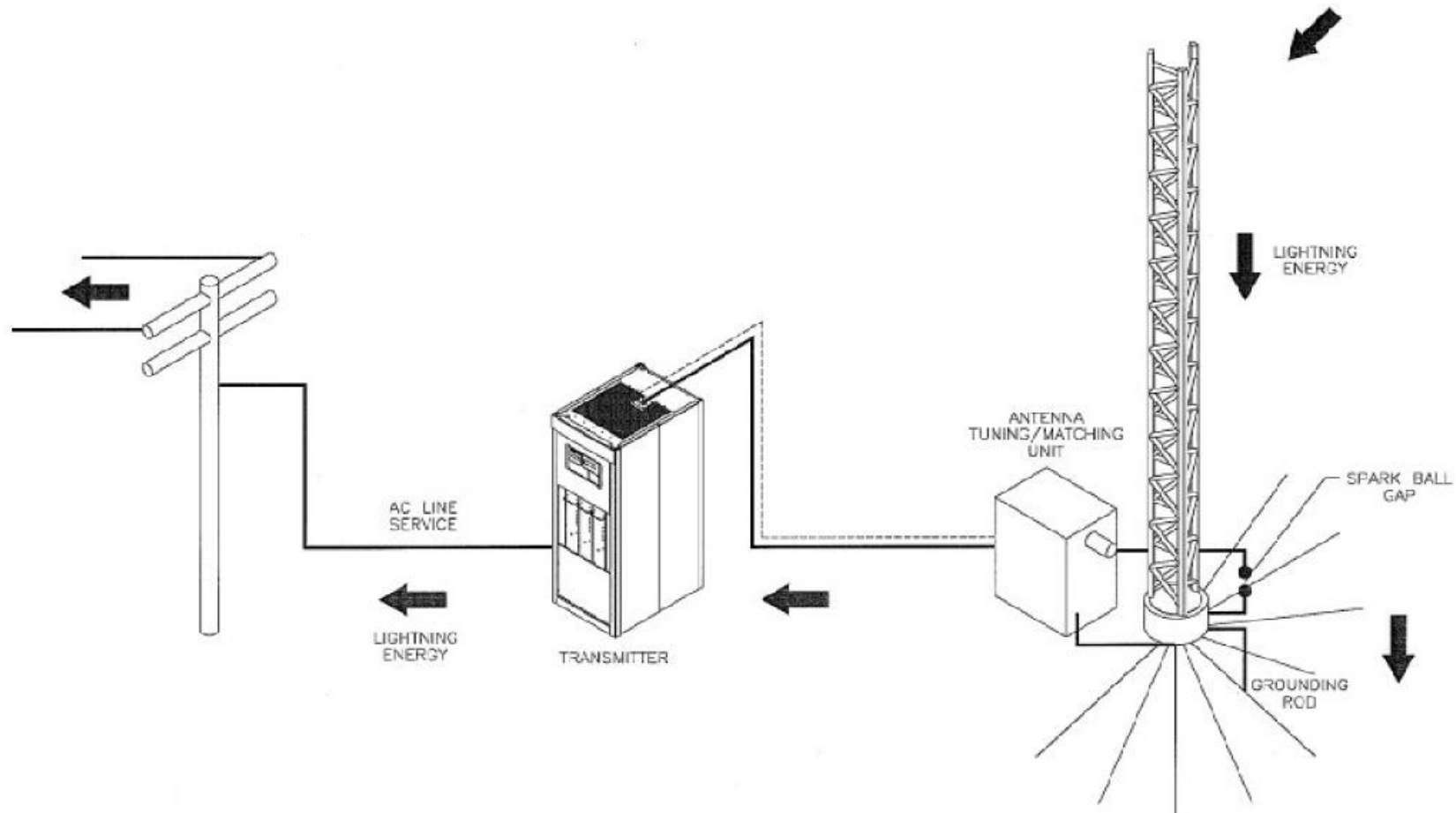
# Typical Site

- Try to have AC, coax, and reference ground enter the building in close proximity
- Keep ground straps short

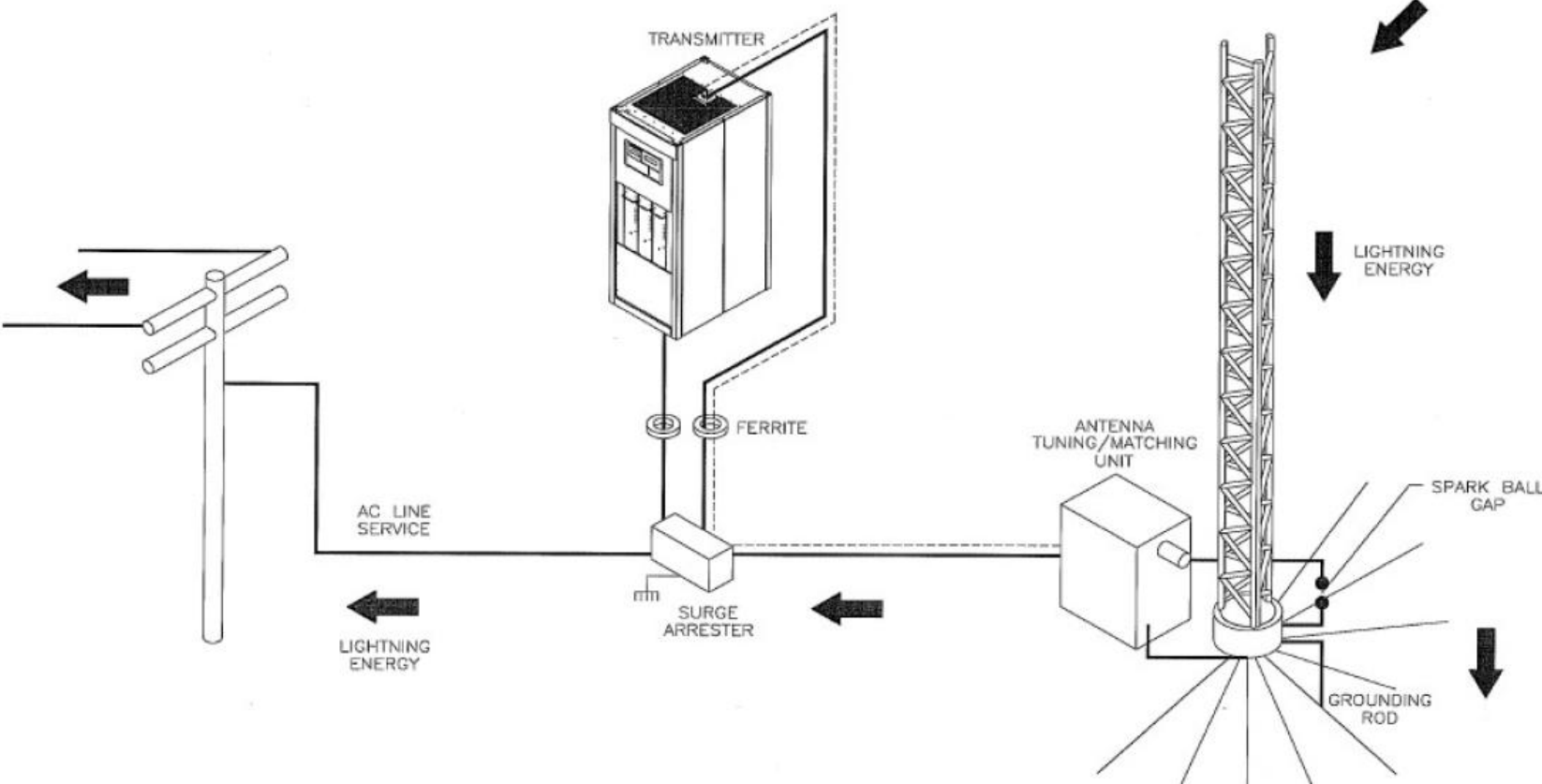




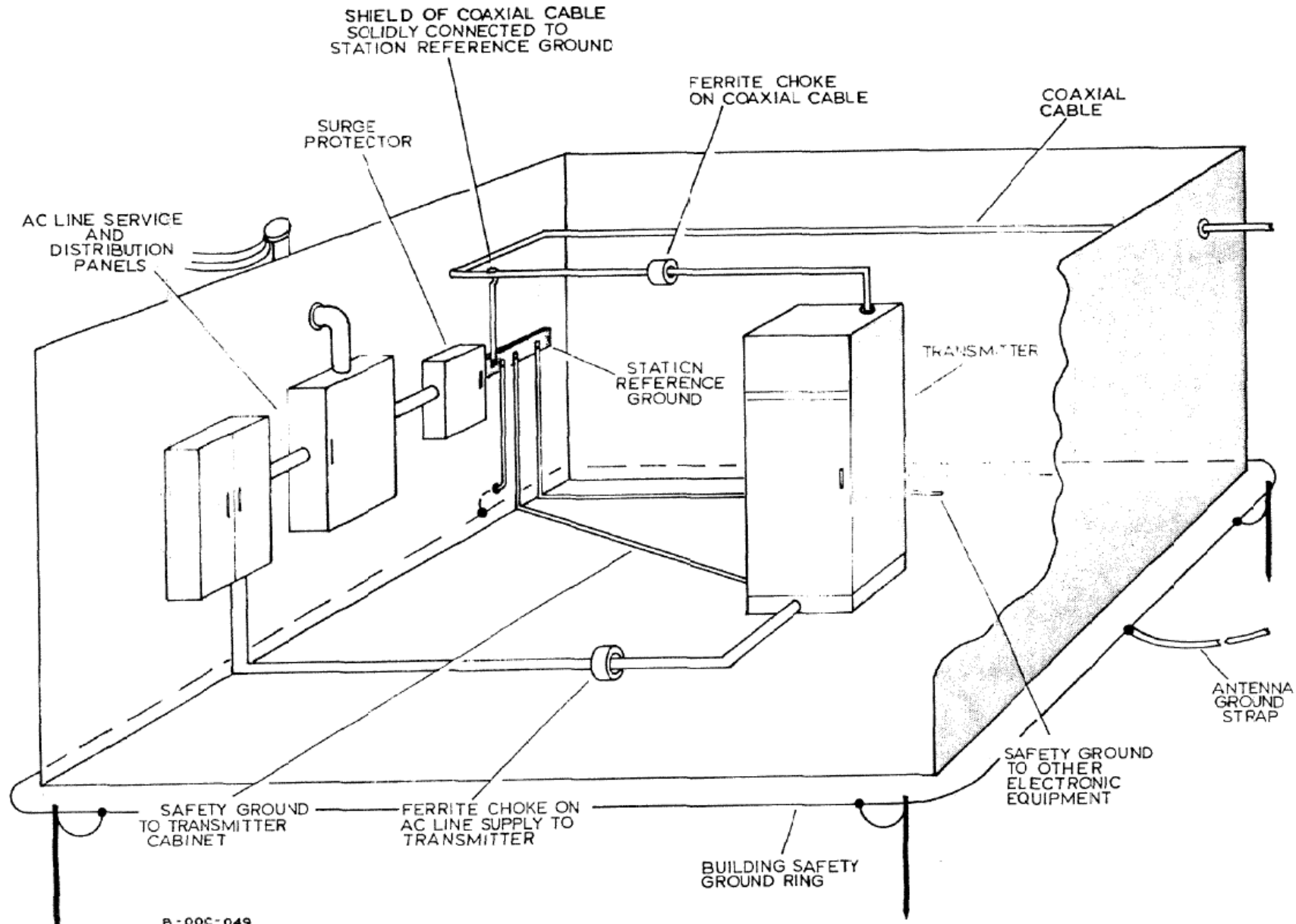
# Typical Site



# Installation of Surge Protector



# Improving Layout



B-00C-049

# Keep Your Cool

Air handling is very much a cost vs. benefits discussion

-These days, computerized equipment, keeping the site (or at least the equipment) cool is more important than ever

-In hot, dusty environments, air conditioning is sometimes the only viable solution

-In cooler climates, with sufficient incoming air filtration, cooling with outside air can be quite acceptable

-Points to consider:

-Airflow direction (ideally, cooler air will come into the transmitter/equipment intakes, not shooting past it, or coming into the building at the other end).

-Positive pressure – more air should be brought into the building than is exhausted. If the transmitter is ducted, exhaust airflow should be higher than the airflow throughput of the transmitter, with incoming airflow even higher than that.

# Cooling and Air Handling

- Points to Consider

- If using forced air:

- intake air must be filtered

- draw in more air than is exhausted, to maintain positive pressure

- exhaust more air than the transmitter airflow requirement

- allow for redundancy (use louvres to allow warm air to heat room in cold weather, use multiple blowers to avoid overheating in the event of a failure)

- If using chilled air (air conditioning):

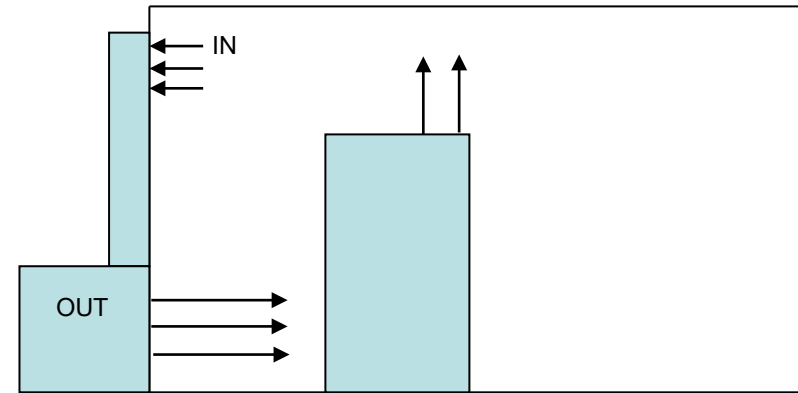
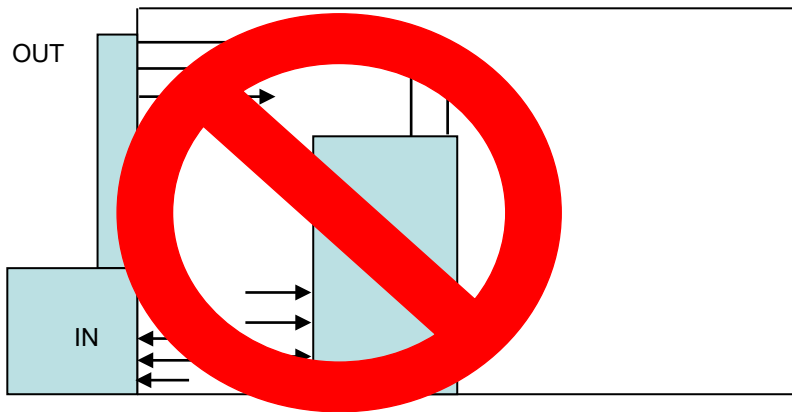
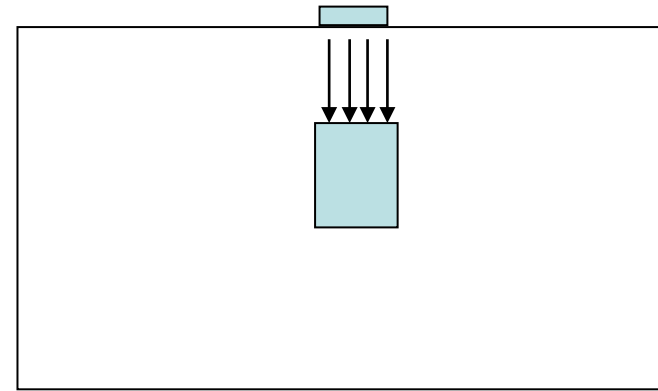
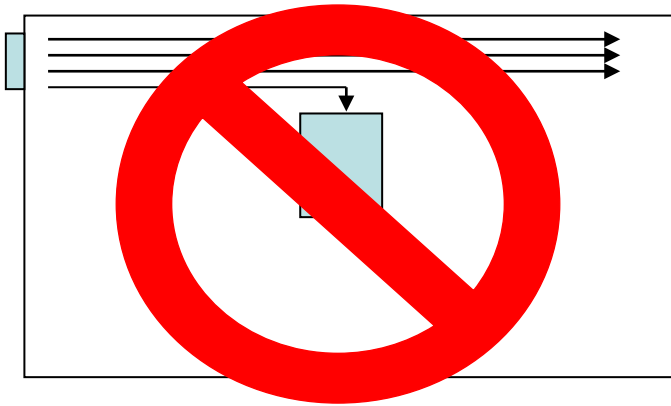
- allow sufficient headroom for building convection (heat from sun, and other equipment in building)

- use redundant systems... if you require 5T of air conditioning, consider using two three ton units and alternate the main monthly

- remember maintenance (clean filters and condenser coils as required)

# Cooling and Air Handling

AIRFLOW DIRECTION IS CRITICAL!!!



# Keep Your Cool



This is an example of poorly considered airflow

- The gray rack is the transmitter.
- The silver pipe is the incoming air – directed away from the transmitter
- The hole below is the exhaust fan – pulling air AWAY from the transmitter air intake (the rear of the transmitter, or left side of the photo)
- This site was plagued with PA and power supply failures.
- Rerouting the airflow has helped resolve that problem.

# Keep Your Cool



Air Conditioners come in many shapes and sizes (and costs)

-Consider redundancy

-Size air conditioners at just under the full building heat load and install two, in a main/alternate configuration

-Always take building and environmental heat load into effect. The transmitter, while the primary source of heat, will not be the ONLY source.

-Depending on location, security to protect outside units from copper thieves may be required.



# Clean equipment is happy equipment



Poor airflow, or insufficient cooling,  
can be expensive!!!

# Clean equipment is happy equipment



Air filters – on incoming air and equipment – are there to keep things clean

- They must be cleaned or replaced regularly
- Equipment should NOT be operated with air filters removed, unless a provisions are in place for additional filtering of incoming air. This is rarely advisable
- Do NOT replace air filters with a different type without consulting the equipment manufacturer
- Some air filters require spraying with a sticky substance (FilterKote™) for proper operation

# Clean equipment is happy equipment



On an AM site, there are other things that should be cleaned occasionally

- The owner of this 50 kW AM site wondered why the transmitter shut down with VSWR every time the humidity was high

# Wrapping it all up...

- Keep it grounded
- Shield as needed
- Move that air
- Keep things clean
- Be Safe
- Protect Yourself – equipment can be replaced

# Resources

<https://www.fair-rite.com/determining-the-material-of-a-ferrite-core/>

<https://www.ti.com/lit/ml/slup124/slup124.pdf>

[https://en.wikipedia.org/wiki/Permeability\\_\(electromagnetism\)](https://en.wikipedia.org/wiki/Permeability_(electromagnetism))

[https://www.nutsvolts.com/magazine/article/July2015\\_HamWorkbench](https://www.nutsvolts.com/magazine/article/July2015_HamWorkbench)

**THANK YOU!**