Locating and Killing Receiver Interference

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Agenda

- Types of noise and interference
- Typical noise sources
- Finding the noise
- Noise mitigation
- Your rights per the FCC
- References

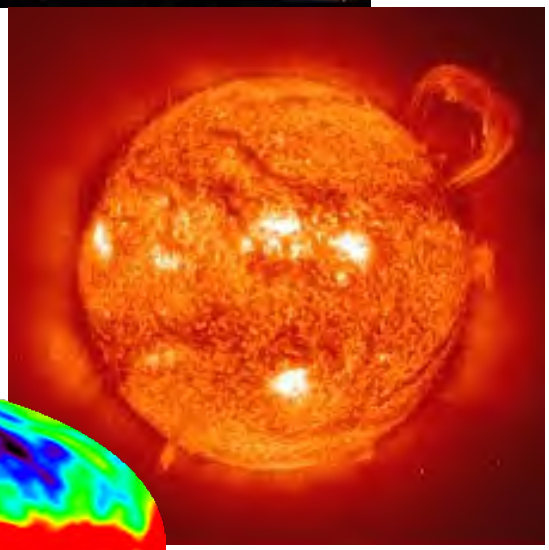
NOTE: While this talk focuses on noise arriving at your receiver, some of the mitigation techniques also apply where your transmitter is interfering with other equipment, e.g., getting into the stereo.

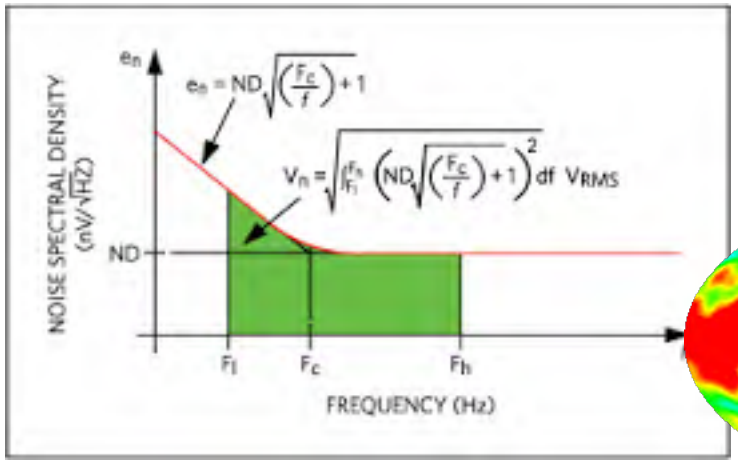
Types of noise and interference

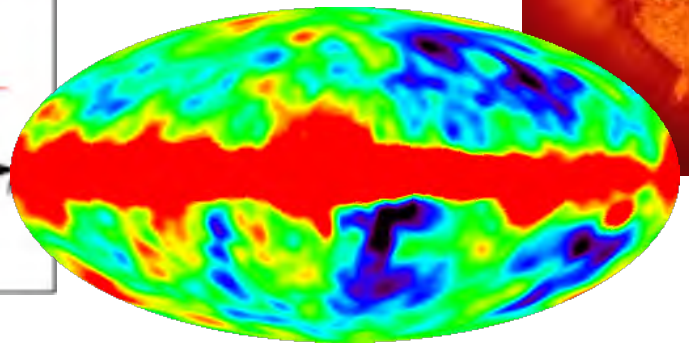
- Natural
  - A case where all-natural isn't better!
- Intentional emitters
- Unintentional emitters

Nature gives us “baseline” RF noise that we can’t do much about

- Lightning
- Solar activity
- Cosmic background
- Thermal noise







Intentional emitters are other legal transmitters, including other hams

- Strong signals may overload your receiver
- Multiple signals can mix (*intermodulate*) and appear at unexpected frequencies
- Licensed =
  - FCC regulated
  - Legal leverage
  - Negotiable

Unintentional emitters are almost always the problem… It gets worse every year!

Many electrical devices not designed to be transmitters may radiate interference

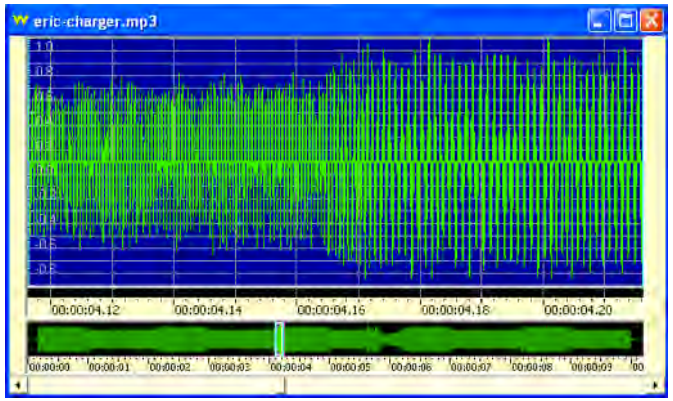
There are tools and techniques to help locate interference sources

- Spectral fingerprinting
- Power-down until it goes away
- Radio direction finding
- Ultrasonic detection (for arcs)

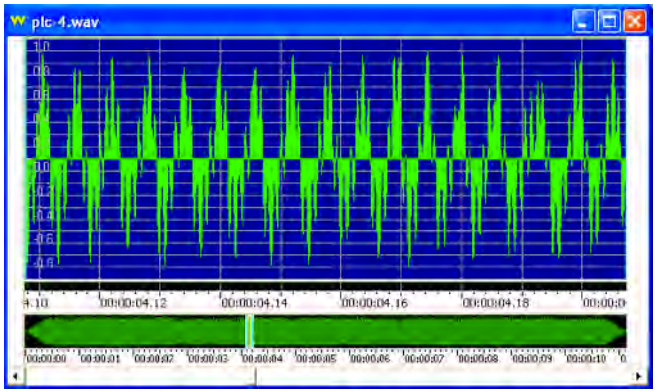
Fingerprints: What do you hear?

- Tune around. Note frequencies. Is the same signal periodic? What interval?
- Listen. 60 Hz hum? Video? Pulses? Voice?
- Record audio, ask others for identification

http://www.arrl.org/sounds-of-rfi



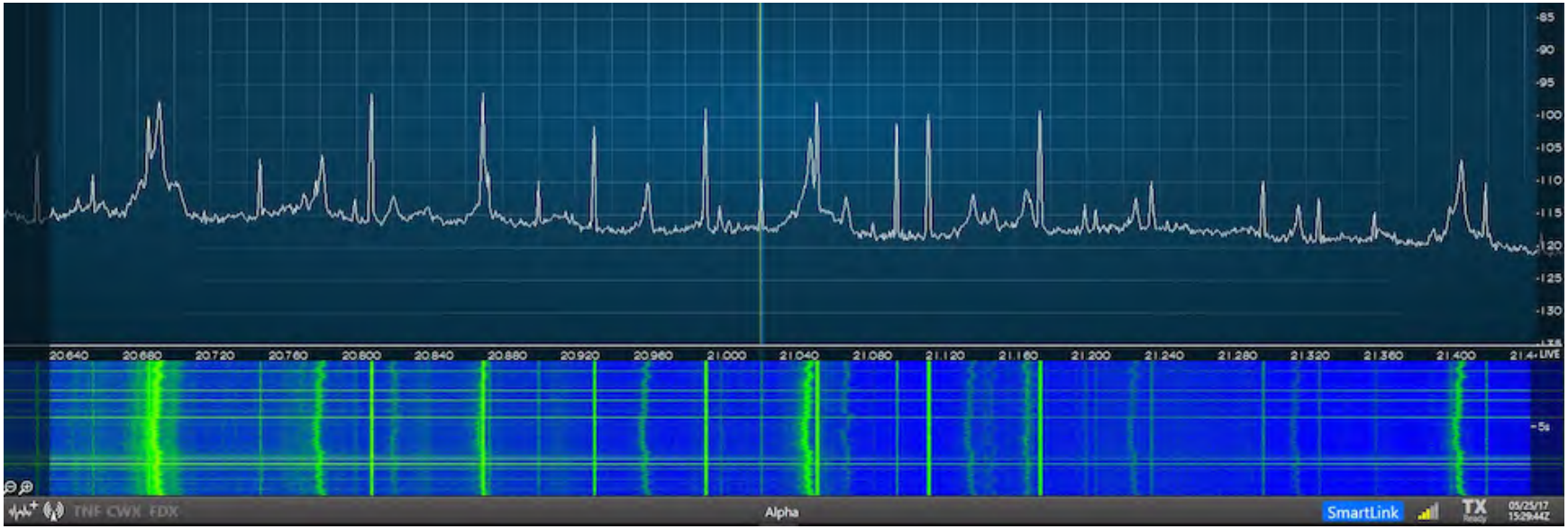
Phone charger



Power Line Control (PLC-4)

Fingerprints: SDR with panfall display

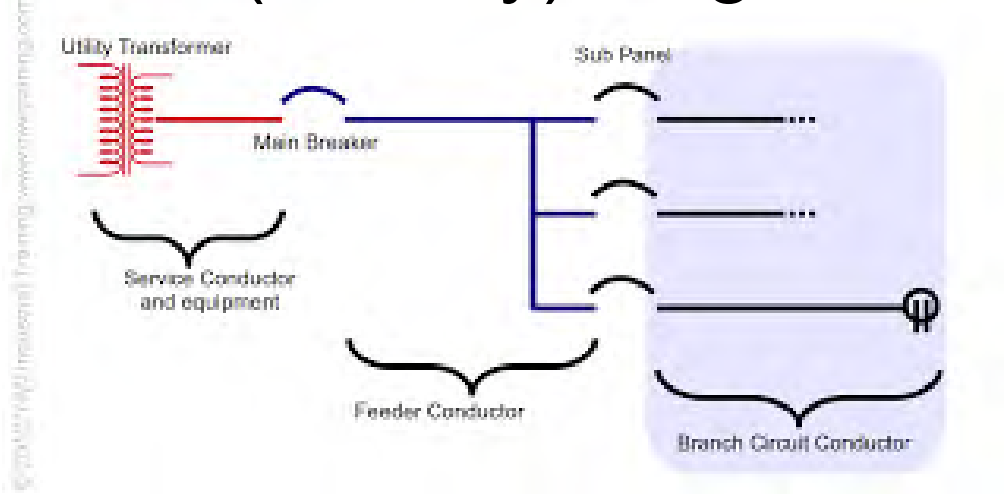
- Measure amplitude and frequency
- Track dynamic signals
- Compare before and after mitigation



Wideband RFI observed on 15m at N6RO

Power down:
Start with your own house

- Unplug everything, then plug in one thing at a time
- Even better, turn off breakers
- See when the noise appears or disappears
- Same with (friendly) neighbors



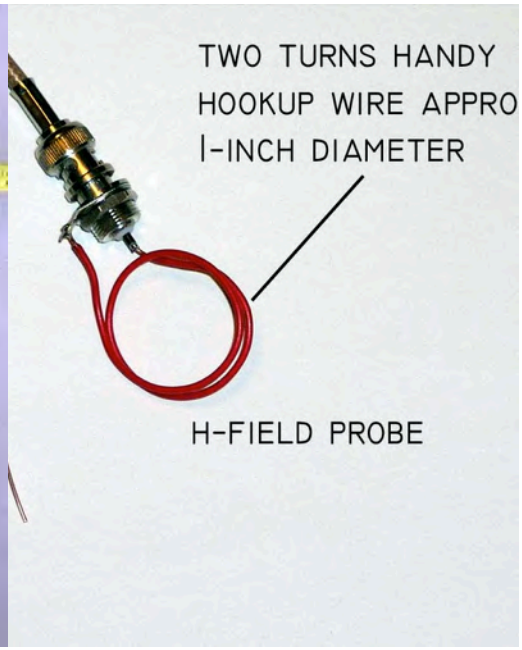
Head for the field:
Radio direction finding

- All bands may be useful: MF, HF, VHF
- Directional antennas are most useful
- Walk around, tune around, triangulate

VHF Yagi

HF Loop

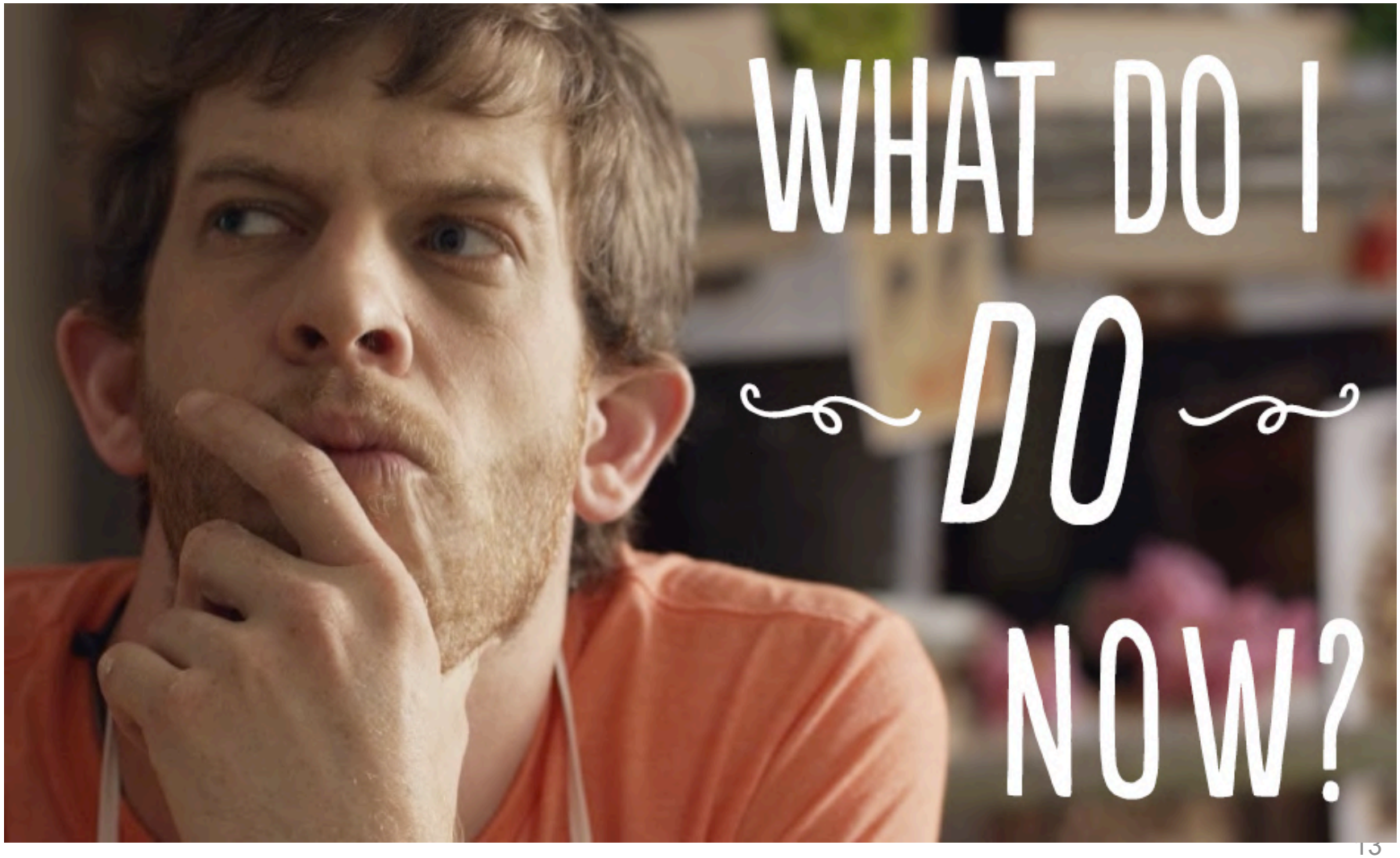
Sniffer Probe



Direction Finding

DEMONSTRATION

Now that you found it…



Well, you can do several things

- Remove the offending device, or turn it off when you're operating
- Replace it with something less noisy
- Choke, filter, or shield it to reduce radiation
- …Or try to make your station more resistant to that interference

Here are some examples

Arch-nemesis: Wall-warts and other switching-type AC adapters

- Replace switching supplies with linear supplies (find them on ebay)
- Apply common-mode chokes and/or filters to AC line and DC line
- Plug them into a choked outlet strip

Not all are defective but always be skeptical

LED lights contain switching power supplies. Some are HORRID for RFI

- Usually can't fix this. Must replace them.
- Best bet: Only buy trusted name brands that actually pass FCC certification

  Cree, Phillips, GE, Westinghouse

Christmas lights are a total wildcard… and they have great antennas!

Mobile: Inverters can be very noisy

This is what it took for K9YC to fix his 120V 1A inverter

Defective power strips: Can generate noise, intermodulate like crazy

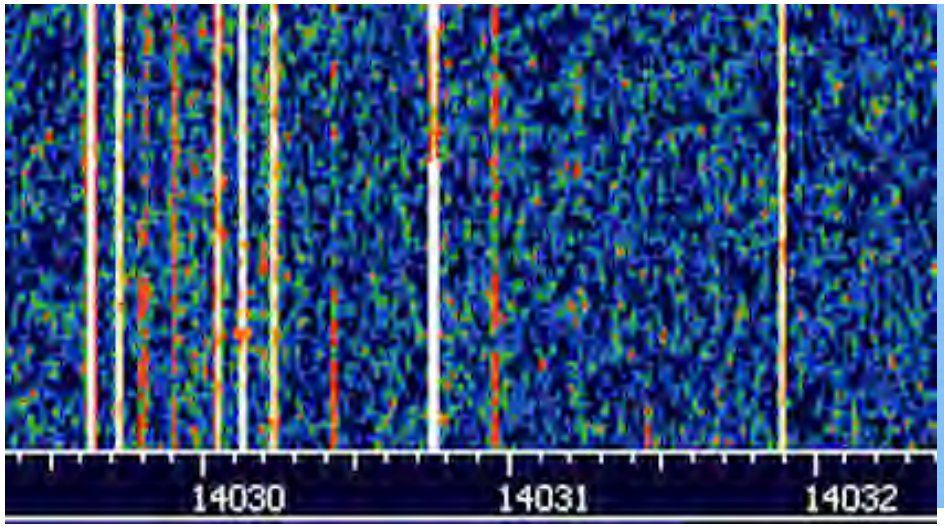
- 90% of these are total crap!!!!
  - Besides being likely noise generators, many are poorly made and just plain unsafe
- *Surge suppressor* types are the worst
  - Many active components, MOVs

Waber

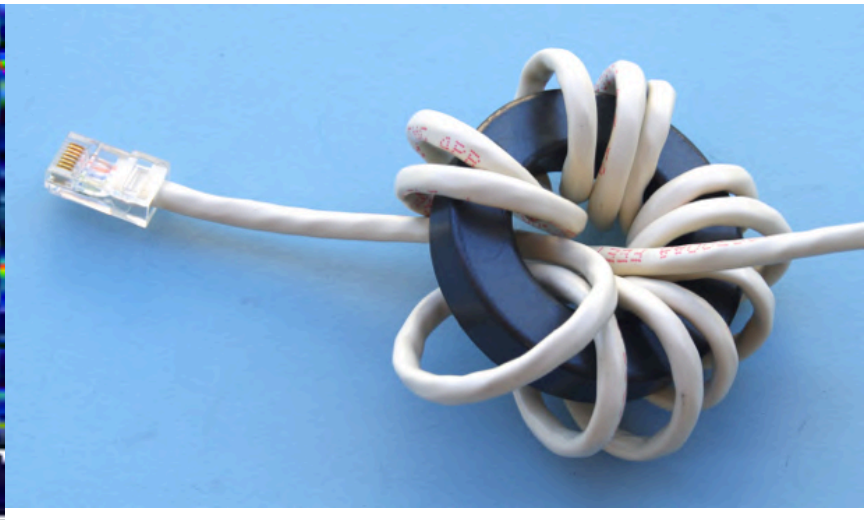
- All metal enclosure
- Quality outlets
- No electronics

Ethernet cables can radiate groups of birdies all over the HF bands

- 10/100 is far worse than GigE
- Upgrade all equipment to GigE or go WiFi
- Apply chokes near each end of long cables



Typical 20m birdies



10-12 turns, type 43

Plasma TV… Thankfully they are falling out of favor

- Video-modulated interference with wide bandwidth on multiple HF bands
- Radiates from the screen!
- Only solution: Get rid of it.

Failing electrical equipment can be tracked and fixed

- Fluorescent lamps—replace the bulb
  - **Class A (non-consumer)** switching ballasts are also well known for generating RFI
- Flickering street lights—call the city
- Bad capacitor on an A/C compressor

Filtering AC lines can be effective, but more difficult and expensive to install

- Requires fabrication of a **safe** 120 VAC enclosure, or embed the filter inside of equipment

Corcom, Schurter, Delta

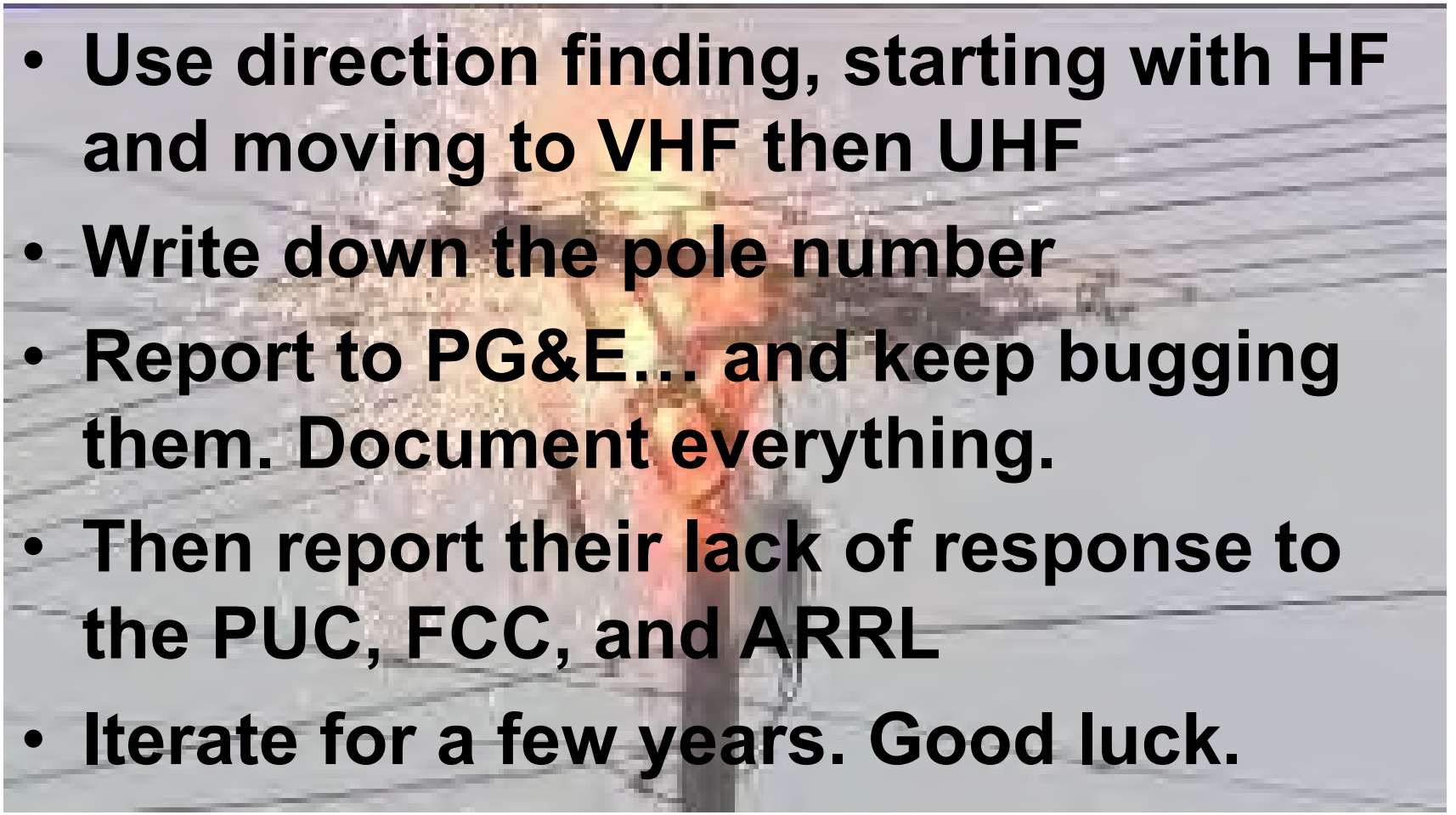
Field Day generator filter

Heaven forbid that it's a neighbor's solar panel system

- Can be difficult and expensive to fix
- See *QST* article, April 2016
- "Power optimizer" modules are worst offenders but not often installed
- Some hope: *"FCC issues a Notice of Violation to Solar City for RFI Interference"*

Every system generates *some* noise…
Death by 1000 cuts

HV PG&E power line interference is often challenging to locate and fix



- Use direction finding, starting with HF and moving to VHF then UHF
- Write down the pole number
- Report to PG&E… and keep bugging them. Document everything.
- Then report their lack of response to the PUC, FCC, and ARRL
- Iterate for a few years. Good luck.

Reduce your station's susceptibility to noise

- Common-mode chokes on transmission lines and other conductors
  - Prevent radiated noise from getting to your RX
- Low-noise receiving antennas
  - As a rule, horizontal is better than vertical polarization for local QRM rejection
- Use your rig's noise blanker

Ferrite common-mode chokes can benefit nearly any antenna

- Noise on the outside of coax shield is conducted to the antenna then to your RX
- An EFFECTIVE choke is required at the feedpoint

K9YC article “RFI, Ferrites, and Common Mode Chokes For Hams”

Low-noise receiving loop rejects local RFI within ~one wavelength

- Covers all HF bands
- No tuning required
- Orient to null out QRM
- Some makers:
  - Wellbrook
  - Pixel Technologies
- Resonant loops are also very good

Note very elaborate mount

Myth: “I need a better RF ground to reduce my noise”

- **Fact:** There is no such thing as an RF ground, due to wavelength, inductance, and skin effect.
- **Fact:** A connection to Earth almost never reduces noise or RFI, and it will often make it worse, because the “ground wire” can act as an antenna.
- **Fact:** A connection to Earth is very important for lightning protection.

As a licensed ham, the FCC grants you rights (and responsibilities)

- Devices that **cause** harmful interference are at fault and the owner or manufacturer is legally responsible for fixing it
- Devices that **cannot accept** interference from licensed and legally-operated services are handled the same way
  - So make sure your transmitter is clean

But as a goodwill gesture, you should always help

For help, contact your RFI committee

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References

- ARRL: *The ARRL RFI Handbook*
- ARRL RFI pages http://www.arrl.org/rfi
- Jim Brown, K9YC
  - http://k9yc.com/publish.htm
  - RFI, Ferrites, and Common Mode Chokes For Hams
  - Killing Receive Noise
- ARRL: *Grounding and Bonding for the Radio Amateur*