AFTER ACTION REPORT
EMERGENCY OPERATIONS CENTER HF BANDS INTERFERENCE INVESTIGATION
FRIDAY FEB 22 2019

METHOD:
The original goal was to study the possible effects of noise from a power pole that had been discovered radiating at the corner of SE 35th Street and SE 25th Place, with markings on the pole of 006 233 CG 39568. However when we were unable to find any noise coming from that pole on the testing day, and still apparently considerable noise at the EOC station (unable to raise KX4Z, which was EASILY done from Archer during the marathon on 80 meters same time frame) – we switched to hunting for noise sources at the EOC itself since Shannon (K4GLM) had astutely observed LOTS of noise coming from the power line and/or building areas of the EOC area as he drove up.

DISCOVERY CONCLUSIONS:

No.	Issue	Comment
1	BIG PROBLEM ON 80/40 METER BANDS We confirmed again that there is a very large man-made noise issue to emergency backup or SHARES communications on lower bands below about 10 MHz. Previous measurements made in November were very similar to measurements made on Feb 22. Normally on HF bands (3-30 MHz) the effective receiving noise floor is set by atmospheric noise (remote lightning and galactic noise sources). At the EOC, on the frequency bands of greatest interest for intra-state communications (SHARES below 10 MHz and Amateur 80/40 meter bands) the man-made noise is running S6-S9 on two receivers, roughly 4-5 S units or possibly 12-20 dB above normal background noise. This means that receiving sensitivity is effectively reduced to 1-8% of normal. You can't make effective communications on these frequencies below 10 MHz to any but the STRONGEST of stations. (See Appendix for measurements from November.)	
2	YAESU LOW POWER PROBLEM ON 80 METERS Yaesu Series 600 does not produce more than about 10 watts on 80 meters, but produces normal power on 40 and 20 meters, exact same setup from computer and Signalink.	Possible damage or mistuning to band pass filters? Since the radio makes normal power on other bands, it cannot be damage to transistors
3	POWER POLE LESS LIKELY CAUSE OF NOISE	

	We were unable to demonstrate any interference from the suspected power pole – but it clearly wasn't radiating either. However, since we appeared to have PLENTY of interference making connections to KX4Z or the normal number of stations audible on 80/40 meters – we have another noise source that may be more important.	
4	NOISE BEING DEVELOPED ONSITE Huge noise observed around the EOC buildings, with "hot spots" both within the building and outside the building, even over pavement.	Possible superposition of all the EMI from many switching power systems, network systems, etc throughout the building, with standing waves on power lines or communications lines causing high radiation from certain points.
5	ROOF LIKELY HAS SOME GROUNDED METAL IN IT The lower noise found when the antenna was laying on the roof MAY result from partial shielding of the antenna by grounded girders / steel supports of the roof. We do not know the exact construction of the roof but if similar to the Sheriff's building, it has thick layers of non-ferrous material topped by membranes or tar. Alternatively, it may have a corrugated metal form with concrete poured over it.	The fact that the noise gets WORSE when the antenna is raised may indicate that the noise source is in or close to the building and when the antenna is less capacitively coupled to grounded roof support structures, it is a more effective receiving antenna for both desired and undesired signals.
6	DIFFICULT PATH TO CONTROL NOISE Because the noise appears to be coming FROM the building, the only way to remove it is either to reduce the conducted/radiated EMI (electromagnetic interference) from equipment over which we have little to no control....or unwieldy solutions such as covering the roof with a giant conductive Faraday shield – also unable to be accomplished.	
7	NEAR FIELD NOISE SOURCE If the noise source is part of the EOC or Sheriff's equipment, our antenna is in the "near field" of that source. Near field signals decrease much faster than far field signals – by the 4^{th} and 6^{th} power of the distance, rather by the inverse square law. Hence getting 5 or 10 wavelengths away from the EOC (e.g., 800 meters, or ½ mile) would likely reduce the interference to negligible. (Reference: https://en.wikipedia.org/wiki/Near_and_far_field) The land immediately south of the EOC is privately	In initial discussion we identified a GARS member not far from the EOC. We might be able to find several possible locations for a remotely controlled ham radio station.

	owned. It is important to recognize that this noise source cripples only RECEIVING. It does not damage the transmission from the recently installed horizontal multi-band EOC HF antenna. Therefore, techniques to use a remotely controlled RECEIVER may mitigate the problem. Many mission critical systems use “diversity” receivers or antennas.	
8	Although it may not make that much difference, it might be useful to shield the tuner in the radio room.	
9	IMPACT: For winlink, daytime connections can still be made on 20 meters and possibly 30 meters. Nighttime connections may be more difficult. Will have to use distant stations. The real problem is that one can't have HF NVIS communications to desirable counter-parties such as the State EOC, because those likely require ham or SHARES frequencies below 10 MHz....the ones that are blocked by the wide band RFI.	

IMPROVEMENT PLAN

Plan #	Description	Difficulty/Benefit Considerations	
1	PILOT TEST Test the concept of remote receiver by getting a volunteer to pipe the output of their 80 meter receiver to us over simplex VHF, modeling a possible solution with auto-frequency control and auto-ID provided by a raspberry Pi sub-carrier	Ease: 9 out of 10 Benefit: 10 out of 10 knowledge	
2	DETECTIVE WORK This will have to be coordinated by Alachua County EM. Suggest that the next time the CCC tests a backup control station, try to isolate the cause of our interference by sequentially powering down equipment after equipment while watching the noise level. Once the equipment(s) causing interference is located, attack the issue with shielding and filtering Similar work was recently successfully accomplished for a Champion Inverter Generator, using commercial EMI/RFI filters and a homemade Faraday cage. Most of the CCC/EM equipment is likely already in metallic cases, so assuring proper grounding is the only need; however their power wiring is in effect a common-mode end-fed “antenna” – this can be mitigated by commercial EMI/RFI filters with connection to the (green) power ground. These filters are simple LC filter sections, and the technology is quite mature. Additional techniques include ferrite beads or rings for the power cable which can add common-mode HF impedance. Here is one manufacturer: http://www.ramayes.com/OnFILTER_EMI_Filters.htm https://www.reliantemc.com/OnFILTER-AC-Filter-AF-XXXX-FG-D.html	Ease: 4 out of 10 (requires approval and planning) Benefit: 10 out of 10 – might eliminate or mitigate the problem	

	Typical data sheet: https://www.reliantemc.com/download/OnFILTER/OnFILTER-AC-Single-Phase-AF-XXXX-FG-D.pdf We can easily build a test filter set in a standard electrical outlet box to assist with initial testing.		
3	REMOTELY CONTROLLED RECEIVER OR TRANSCEIVER SOLUTION Allows the EOC to control via simplex, wire or microwave point to point connection, a receiver or transceiver that is outside the field of the interference generator. A remotely controlled receiver could be as simple as a USB SDR receiver, or it could be a full receiver or transceiver. Control over the device can be created using digital control. A remote receiver could be controlled by a simplex vhf/uhf channel with a bit of software, and received audio delivered by another simplex channel on vhf/uhf For full remote control of an entire ham radio transceiver, there is an extensive existing literature. ARRL has an entire web page list of links on how to do this: http://www.arrl.org/link-remote-control They even publish a text on how to do it: https://www.amazon.com/Remote-Operating-Amateur-Radio-Softcover/dp/0872590925 in which text the ARRL indicates the FCC just considers the Internet to be a very long cable between the operator and his radio. See: http://www.cqdx.ru/ham/ham_radio/the-legal-aspects-of-remote-radio-station-control/	Ease: 2-5 out of 10 depending on whether receive or transceiver Benefit: 9 – solve interference problem but with added complexity	

DATA MEASUREMENTS FEB 22 2019

#	Event	S meter	Significance
1	Antenna on roof, antenna tuner ("AT") tuned to 3.913	S6	Baseline noise on roof
2	Antenna raised above roof, AT tuned. Note: quality of noise is "machinery" – like switching impulses at a very high rate, not musical.	S8	More noise when OFF roof!
3	Remote crew striking suspect power pole (they hear no interference at pole whether striking or not)	S8	Unable to make that pole make any noise this day.
4	20 meter contact to N5TW; able to get full power from transmitter (tuner tuned)	Background S4	20 meters seems usable as has been previously noted
5	Recheck power on 80 meters: only 1 bar of power (10 watts) on Yaesu 600 – very different from 20 meters		Something is wrong with Series 600 transmitter on 80 meters
6	Checking on 40 meters: full power. Signalink flat tops around 9:30 mark as expected	Background S6	Noise may be elevated, unsure.
7	K4GLM hears noise all around the EOC but cannot pinpoint a single discrete source		
8	Unable to hear the South cars net on 7.251; heard one CS station at 7047.	Background S5	
9	Disconnect antenna connector at patch panel 40 meters	S4 noise 40 m	
10	Disconnect antenna connector at rear of rig	S0	Implies even the antenna tuner is either making or picking up S4 noise!!!
11	Take power connection (miniDIN) away from tuner	S2 40m S3 80m	Less noise when tuner unpowered
12	Connect power back to tuner	S4 on 80 m	
13	Connect tuner back to antenna and tuner is powered	S8 80 meters	Exactly the same as measured above.
14	Wire radio directly to antenna (no tuner in between) SWR 2:1 in CW band, still only 10W; 80 meters	S 7 noise	Similar noise, better SWR than expected
15	Drink machine unplugged, radio still wired directly to antenna	S7 80 meters	Although our portable AM receiver heard a

			howl at the drink machine—it must be from wires in the wall!
16	Meeting room lights off	S 7 80m	Not the lights
17	40 meters direct to antenna, 7.102 SWR 2:1,	Noise S5	
18	40 meters direct to antenna 7.251 area – able to barely hear a Pensacola station S5	Noise S5	First south cars station heard
19	Put tuner back inline, tune at 7.251	Noise S5	Same as without tuner
20	K4GLM survey crew heard loud noise in the DRIVEWAY of the South East corner of the building		There are PEAKS of radiated noise at various places – driveway, near the drink machine

APPENDIX: NOV 28 2018 NOISE INVESTIGATION

COMMENT: The S meter readings documented on the ICOM radio are quite similar to those heard on Feb 22 2019 on the Yaesu 600 at the EOC. S meters from one receiver are not necessarily comparable to those of another receiver, but in these case there is fairly good agreement.

From an email documenting my findings:

4. We were unable to hit any RMS stations on 40 meters Now I think I know why. The only "RF SIGNAL STRENGHT METER" that I have is a ham radio receiver --- so I lugged my go-box station down there with Jeff's help and we carefully made measurements on several ham bands -- each time doing an AUTO TUNE with the mfj auto-intellituner for perfect match -- and then measuring the background S-meter atmospheric + man-made static. I then took the exact same receiver home to MY station and repeated the exact same measurements at the same frequencies also TUNING the system each time for optimum power transfer. The results were VERY dramatic:

BAND	NOISE AT EOC	NOISE AT MY HOME
3.8 MHz	S8	S4-5
7.250	S6-1/2 -- S9	S ZERO
10.120	S Zero	S Zero
14.300	S Zero	S Zero

The results were so stunning that I redid the measurements a couple of times at my home -- and I had been very careful to check them again at the EOC, which is why I discovered the 40 meter noise at times reached S9 there.

I can calibrate my S meter with fixed attenuators and turn these into exact dB measures, but "in general" 1 S unit is around 6 dB (I've seen it be as much as 12 db) -- So basically...

On 80 meters, the background static at the EOC is at least 4 S units louder,, which is approximately 24 dB --- or about TWO HUNDRED TIMES STRONGER. A 200 watt signal is necessary for the EOC to hear the same loudness as my home antenna can hear a ONE WATT signal.

On 40 meters, the background static at the EOC is between 6 and 9 S Units louder --- or between 24 dB and an astounding 54 dB. 54 dB is TWO HUNDRED THOUSAND TIMES STRONGER. Absolutely astounding.

Thankfully, we have some decent results on higher frequencies, but the 80 and 40 meters bands are key for medium distance daytime and nighttime communications. We're going to have to try and track down where this noise is coming from -- it is definitely man-made. It could be a bad power pole insulator within a mile of the EOC....it could be a street light, it could be lighting or computers at the EOC. Remember when we had to track down the interference at Art Grant's house? Same problem here. i have a portable Bitx40 that may allow us to rig up a simple antenna and drive/walk around with it near the EOC in the coming weeks/months and start to solve this problem. They now have a workable antenna....but they have enormous man-made noise problems. If we solve those (I did, as a

teenager, found several power poles that Georgia Power fixed for me) things will be far far better there for federal or ham short wave communications on lower bands.

It is always possible that the source is something we can't fix --- but we won't know that until we find it.