

2023-04-24 Hamlet Net - RF Exposure Changes

Announcements:

- May 27th - Doug Sharp (K2AD) has invited the club to his house in Firestone to participate in the W1AW/0 event. This is part of the ARRL VOTA (volunteers on the air) event that is going on all year. Doug will have one of the RMHAM vans and other setups for hams to participate. Please contact Doug at doug@dougsharp.com for more info and to RSVP.
- Dave Castler, KE0OG, has had his YouTube channel hacked, and apparently, all his videos were deleted. He's trying to get his channel restored.
- Field Day is coming up in June, and the club is starting to work on planning for this event. See the Club website for more information.
- Breakfast Saturday morning will be at the Hidden Cafe near 9th and Main at 8am. If you get lost, give us a call on the LARC repeater!
- Chuck in process of submitting for multiple special event stations. Indian Peaks and possibly NCARC will participate with us to celebrate the 100th anniversary of the Peak-to-Peak. For more info, or to join the event committee to help
- Antenna building class on 2nd weekend in May (May 13) at the Clover Building at the Boulder Fairgrounds. There will be two classes - one for building your own Yagi antenna (there will be \$10 charge for this, but you will go home with your very own handmade antenna), and the second for wire antennas to be used by the club for Field Day.
- You can start earning your 2023 membership or future renewal by acting as NCS for at least 5 nets this year. You can run either this Tuesday night net or the Thursday night net (or both). We have scripts available for both, so all you need is a good connection into the repeater, and somewhere to keep track of names and call signs as people check in. If you're going to be on the net anyway, why not save some dough at the same time! There are four free memberships available for 2023, so don't wait to get started!
- Chuck has set a goal for the Club of running at least one activity a month. This can be a hands-on construction activity, an operating activity like Field Day, a fox hunt, or a special event station. The goal is to get people together to have fun with amateur radio! We have multiple locations at our disposal, as well as lots of Club equipment, so if you have an idea for something you think others hams would like to do, please let us know, and if you're willing to run it, even better!
- The Club is also looking for presentation topics for 2023. If you have any ideas, or better yet, would like to present, please let Chuck know and we'll get you on the schedule!

- All club activities are open to anyone - members and non-members. ~~If you have questions, ask them on a net or~~ send email to elmer@w0eno.org

Presenter: Bryan, AF0W

Topic: RF Exposure Changes

- Back on May 3 2021, the FCC announced changes to RF exposure rules
- The purpose of these rules is to protect both radio users and the general public from receiving excessive amounts of RF energy from radio transmitters
- New stations were required to conform to the updated rules immediately, but existing stations were given a 2 year transition period to comply - that period ends on May 3, 2023
- The May 2023 QST magazine has an article on the changes
- The exposure rules were initially implemented in 1996, and specified the Maximum Permissible Exposure or MPE for amateur stations
- These rules included some exemptions where amateurs were not required to actually perform an exposure evaluation of their stations
- These exclusions were based on power and frequency - for example, if a transmitter produced less than 225 W on 20 meters, an evaluation was not necessary
- All mobile and handheld stations were also exempted
- The changes to the rules were made by the FCC to standardize the exposure rules for all radio services
- There are two main changes for amateur stations - the exemptions for amateur stations were removed, and a different method of exposure analysis is now required for all radios with antennas that were less than 20cm (or around 8 inches) from a person
- They also implemented positive access control, which means that if a location causes excessive exposure to people inside it, the station must prevent unauthorized access to that location and post warning signs

Controlled versus Uncontrolled

- As with the prior rules, a distinction is made for what is called controlled and uncontrolled exposure, each with their own exposure limits

- Controlled refers to situations where people are aware of an antenna and RF energy and can do something about it. In this case, higher power levels are allowed, and limits are based on a 6 minute average exposure.
 - a. An example of controlled exposure would be if you had an attic-mounted antenna installed near bedrooms in your home. You know where and when there are people in the rooms, and can adjust your operating accordingly
 - b. Controlled exposure is also referred to as occupational exposure
- Uncontrolled refers to situations where you have no control of people near your antenna, such as neighbors or pets, and allows a lower exposure level and a 30 minute average exposure.
 - a. An example of uncontrolled exposure would be your next door neighbor and your outdoor antenna that is near the fence separating your yards. You don't know if they will be close to your antenna at any given time
 - b. Uncontrolled exposure is also referred to general population exposure
- In either case, proximity to the radio antenna is the single most influential factor when it comes to exposure levels
- As mentioned previously, the MPE limits are dependant on the frequency being used
 - a. This is because some human tissue and structures heat more at certain frequencies than others.
 - b. The frequency range with the lowest MPE is 30 to 300 MHz, so the VHF band is of greatest concern for radiation, including the 6 and 2 meter bands.

Exposure Evaluation

- So how do you see if your station is compliant with the regulations or not?
- There are three ways to perform the evaluation:
 - a. Via direct measurement. Most accurate, but very expensive - thousands of dollars of professional, calibrated equipment needed
 - b. Using computer modeling software. Requires you describe your antenna system to the software, so pretty complicated
 - c. Using tables and formulas to estimate power density
- The ARRL has an RF Exposure Calculator (<http://arrl.org/rf-exposure-calculator>) that determines the minimum distance from the antenna that someone can be located

- The tool takes the following as input:
 - a. Power at the antenna. Note that this includes any feedline loss, which will be much more apparent at VHF and UHF than at HF
 - You can use a coax loss calculator (https://www.qsl.net/co8tw/Coax_Calculator.htm) to determine this loss
 - You could also place a power meter at the antenna feed point and read the power directly
 - b. The mode duty cycle, which affects the average output power
 - For example, conversational SSB without speech processing uses a 20% duty cycle
 - Voice FM, RTTY, and AFSK SSB (such as FT8) uses 100% duty cycle
 - Conversational CW uses a 40% duty cycle
 - c. Percentage of transmitting time versus receiving time
 - d. Antenna gain in dBi
 - e. Operating frequency
 - f. It also allows you to indicate if signals from RF reflecting from the ground should be included or not
 - This setting should be used for low or non-directional antennas
 - It can also be used for a more conservative exposure evaluation
- The tool outputs the maximum allowed power density, and minimum safe distance for both controlled and uncontrolled exposure
- You then check these distances against your physical antenna installation to see whether you are in compliance or not
- Note that the tool makes some assumptions:
 - a. An omnidirectional antenna is assumed - that is, that all the RF energy reaching the antenna will be subject to the gain of the antenna, and will then be radiated equally in all directions
 - b. If ground reflection is enabled, the tool assumes perfect reflection

- c. These assumptions can make it appear that people are being exposed to more RF than they actually are
- d. For example, the pattern of a typical HF beam antenna will focus more RF energy in the horizontal plane, meaning someone standing below such an antenna will receive far less RF

Mitigations

- So what if your system does not comply with the FCC's exposure limits?
- As mentioned previously, distance to the antenna is a major factor - the RF exposure decreases as the square of the distance
 - a. Moving your indoor antenna outside, or raising your outdoor antenna will make significant differences in exposure
- You can also reduce your output power when transmitting
- Using a different mode (with a different duty cycle) may also help
- If you have a movable directional antenna, such as an HF beam on a tower, you could possibly reduce your uncontrolled exposure distance toward a neighbor by only transmitting with the antenna pointing away from their home
- Note that if you make any changes in your station that would affect the parameters input into the calculation tool, such as purchasing an amplifier, changing your feedline, or getting a new antenna, you will have to redo the exposure calculations before using your upgraded station
- While there is no requirement that calculations be submitted to the FCC, it is a good idea to print out a copy of the results and keep them in your station records

Examples

- As an example, I have an Ed Fong dual-band J-pole antenna installed in my attic, which has a gain of 2.5 dBi
 - a. I feed it with 50 feet of RG-8x coax, which at 147 MHz has a loss of approximately 2 dB
 - b. If I use the high power setting on my Kenwood D710, it outputs 50 watts on VHF, which results in 31 watts making it to the antenna.
 - c. I plugged in a transmit time of 15 minutes, followed by 10 minutes receiving

- d. The tool shows the minimum controlled distance is around 2 feet, while the minimum uncontrolled distance is 4 feet
 - This is sufficient to cover the occupied areas below the antenna
- e. If I were to upgrade my coax to 50 feet of LMR-400, my loss drops to .75 dB, and the power reaching the antenna goes from 31 to 42 watts
- f. This upgrade results in my controlled distance going from 2 feet to 2.5 feet, and the uncontrolled distance going from 4 feet to 4.5 feet
- The tool works fine for base and mobile stations, but what about HTs?
 - a. These are commonly used right next to the operator's head
- RF exposure in this near field does not affect the body at the same rate as when farther away
- The FCC specifies this exposure in terms of SAR, or Specific Absorption Rate
- The process for evaluating this exposure is very detailed and typically conducted in a laboratory
- Previously, commercial handhelds (not only radios, but also cell phones - really any device operated with an antenna closer than 20 centimeters to the body) were required to perform these measurements before being imported or sold in the US, but amateur radios were exempted
- Due to the difficulty and complexity of making these measurements, they aren't really practical for the average operator
- One potential workaround is to use the FCC's equipment approval database compiled from commercial radios over the years that appears to indicate that a 2 meter HT operating at less than 23 watts and a 70 cm radio operating at less than 5.3 watts would likely comply with the SAR standards.
- Note that these exposure rules do not only apply at your home - they apply to mobile installations as well any and all operating activities, such as POTA, SOTA, and Field Day
- Since 2008, every licensed amateur has signed a form 605 (or NCVEC 605) that contains six bullet points to which they agree by affixing their signature
 - a. This includes the following: "I have read and WILL COMPLY with Section 97.13(c) of the Commission's Rules regarding RADIO FREQUENCY (RF) RADIATION SAFETY and the amateur service section of OST/OET Bulletin Number 65."

- With the ARRL's RF exposure calculator web page, there is no excuse for neglecting this important activity at your station.

Questions:

- **The question for the week is:** Have you conducted any exposure calculations for your station, and if so, did you have to adjust anything to meet the FCC requirements?
- **In my case,** I plugged the numbers into an online tool back when I became licensed, and found that my 100 watt HF radio and outside G5RV Jr. antenna were within the limits both for controlled and uncontrolled exposure.

I've not repeated the tests with the updated ARRL calculator.

More Info:

- ARRL RF Exposure Calculator: <http://www.arrl.org/rf-exposure-calculator>
- ARRL RF Exposure page: <https://www.arrl.org/rf-exposure>
- RF Exposure and You: <https://www.arrl.org/files/file/Technology/RFsafetyCommittee/RF%20Exposure%20and%20You.pdf>
- Feedline loss calculator: https://www.qsl.net/co8tw/Coax_Calculator.htm
- FCC RF Safety FAQ: <https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety>
- FCC OET Bulletin 65: https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

Notes:

- If you have ideas for net topics or general meeting topics / presenters, please let us know! Tell us on a net, or send email to k0itp@w0eno.org

Email to elmer@w0eno.org

1. K0ITP - Chuck - Firestone
2. AE0DO - John - N of Longmont
3. K0DBL - Don - Mead
4. WA7EM - Ed - Erie
5. WB4FAW - Charles - Longmont
6. KE0EE - Don - N Longmont
7. KF0FEC - Will - Boulder

8. KM6SJA - Steve - Longmont
9. KC0RRT - Liz - S Longmont
10. KV0N - Raman - Lafayette
11. W0PPC - Steve - Lyons
12. AF0W - Bryan - Echolink from El Paso, TX

May come into play if you receive interference complaints

Found the MPE graph - the relationship between MPE and frequency is linear from around 1 to 30 MHz, so if you are compliant at the highest frequency at which you operate, you should be fine at those below

Chuck -> Bryan - send email to Bob to add these calculations for Field Day IAP