

Frequently Asked Questions About the FCC RF Exposure Rules Changes

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ARRL has received a questions related to the changes that the FCC has made to the ways that all radio services determine whether they need to do a station evaluation as required by the RF-exposure rules. The most common questions ARRL is receiving are answered below.

Q: Are these new rules?

A: Amateur radio has been subject to a requirement to meet the RF-exposure limits that apply to virtually all radio transmitters for over 25 years. Older rules had different evaluation requirements and different exemptions from the need to do evaluations for each separate radio service. The new rules change this and set a single, formula-based criterion for all radio services to determine whether an evaluation is required. This criterion is a formula in the rules that take into account transmit power, antenna gain and frequency. This is shown as Table 2 later in this document. While application of the rules has changed, the underlying substance has not. Knowledge of the FCC's RF-exposure rules has long been required of examinees for all class levels of amateur licenses, and amateurs continue to be required to certify on their FCC Form 605 applications that they comply and will comply with the requirements of the FCC RF-exposure rules.

Q: I was categorically exempt under the old rules. Do I now need to do an evaluation?

A: The rules change allows stations that complied with the old rules to continue to be operated under the old rules until May 3, 2023. If you were exempt from the requirement to evaluate your station under the old rules, by May 3, 2023, you will need to determine that you are still exempt using the new criteria for exemption described in the new rules or perform an evaluation. If you have previously evaluated your station, the evaluation is still valid, so you will not need to do the same evaluation again in two years unless you make RF-safety related changes to your station. If you make a change to your station after May 3, 2021 that could affect RF exposure, such as increasing your transmitter power, putting up a new antenna or moving an existing antenna, you need to calculate whether you are exempt from the requirement or do an evaluation before you put your changed station into operation. In many cases, using one of the on-line web pages to do a calculation is just as easy as doing the calculation to see if you are exempt.

Q: How do the new rules affect the exemptions for amateur radio?

A: Under the old rules, many amateurs were categorically exempt from the need to do an evaluation, based on transmitter power on each band, for example. Under the new rules, there are no longer any service-specific exemptions. These have been replaced with formulas that can be used to determine whether a specific installation needs to be evaluated. The formulas can be used for exposure that is beyond the near-field, far-field boundary of your antenna, defined

as wavelength/ 2π , or 0.16 wavelength. Most stations that were exempt under the old rules will still be exempt from the need to perform a more complete evaluation under the new rules.

Q: Have the exposure limits changed?

A: No. The limits have not changed. The new rules changed the way that operators of radio transmitters can determine if they need to do an evaluation but did not change the exposure limits. Even if a station was exempt under old rules, the operator has always been required to comply with the exposure limits.

Q: How complicated is it to do this evaluation?

A: For most stations, it is not complicated at all. Most station operators can use the RF-exposure calculator page that is linked on the ARRL RF-exposure webpage and use either their transmitter peak-envelope power (PEP) and antenna gain as "worst case." They can also do some easy calculations using mode duty factor and on/off duty factor times if needed to find their average transmit power to demonstrate compliance at closer distances. Real antennas generally do not radiate as much energy towards people as these theoretical maximums, so some amateurs may want to use other methods. Many calculations using these methods are available for free from ARRL's information pages, listed below.

Q: I read that now we have to measure the field strength from our stations. What equipment do I need to buy to do this?

A: Although amateurs could measure the field strength from their stations, measurements are not required. As was true under the old rules, amateurs may use any valid method they feel appropriate to evaluate their stations. For most amateurs, this will involve calculations, either using simple formulas or antenna modeling, although some amateurs may elect to make measurements. To accurately measure field strength, expensive and calibrated instrumentation is required, so calculated methods are more practical for most amateurs.

Q: How do I report my results to the FCC?

A: You do not report results to the FCC. If not exempted due to power, frequency and antenna gain, you are required to do an evaluation and make any changes necessary to your station to ensure compliance. Although it would be a good idea to keep information about performing the needed evaluation of a station, the FCC rules do not mandate that amateurs keep records of their evaluations. The FCC could inquire of you about the results of your evaluation, but they generally do so only in response to a complaint or in relation to some other issue.

Q: I am doing an evaluation of my station. Should I use the distance to the center of my antenna or to the nearest part of my antenna? I am using the RF calculator recommended by ARRL. Are the results it gives the horizontal distance between the exposure points and the antenna, or the diagonal distance? My antenna is up 30 feet in the air, so this will make a big difference in distances.

A: Because the ends of antennas can be voltage points, that could be where the E fields are maximum. For loop antennas, the same can be true for the H field (magnetic) at some points along the loop. If you use the RF calculators, use the diagonal distance between exposure and any part of the antenna to give you a conservative estimate. If you were to use antenna modeling to evaluate your station, the modeling software will predict fields at specific locations, so the distance is then moot. Radials can be a bit more tricky. If they are on the

ground, or buried, they are so closely coupled into the ground that they can be ignored. If elevated, they are an integral part of the antenna, so if you have a ground plane up 10 feet at the radials, you need to assume the distance to the ground plane.

Human exposure is actually whole-body averaged, but that can be a cumbersome evaluation, so it is generally best to assume 6 feet above ground as the human exposure point for people walking nearby. I usually use 10 feet for first-story exposure and 20 feet for second story exposure, although you can use actual conditions near you. Again, calculate the diagonal distance between areas where people are exposed and any part of your antenna.

MORE INFORMATION

Q: Where can I learn more about this?

A: The following resources are available from ARRL, or linked from ARRL's information page about RF Exposure.

- <http://arrl.org/rf-exposure> - All ARRL information about RF exposure. Some of the information still points to the old rules.
- RF Exposure calculator:
<http://www.lakewashingtonhamclub.org/resources/rf-exposure-calculator/>
- ***RF Exposure and You*** book free download. Material about the old rules will be updated.
<http://www.arrl.org/files/file/Technology/RFsafetyCommittee/RF%20Exposure%20and%20You.pdf>

Q: I still would like some help. What can I do?

A: The ARRL can help if you run into difficulty. Contact ARRL by email at tis@arrl.org and one of our engineers will get back to you. If you need to talk, provide your name, phone number and time to call between 9AM and 4PM eastern time. Reviews the following pages for information about doing an evaluation of your station and download the book, ***RF Exposure and You***, referenced above, for more detailed information.

HOW TO CALCULATE WHETHER YOUR STATION OPERATION IS EXEMPT FROM THE NEED TO PERFORM AN EVALUATION

You can use the method the FCC describes in its rules to determine whether you need to do an evaluation. This table, from the FCC Report and Order about RF Safety, and also contained in the FCC's rules as Section 1.1307(b)(3), provides the formula used by all radio services to determine whether an evaluation is needed. If an area where people might be exposed is at a distance greater than this formula indicates and that distance is not in the near field of the radiating element, an additional evaluation is not required.

Table 2. Single RF Sources Subject to Routine Environmental Evaluation under MPE-Based Exemptions, $R \geq \lambda/2\pi$

Transmitter Frequency	Threshold ERP
0.3 – 1.34	$1,920 R^2$
1.34 – 30	$3,450 R^2/f^2$
30 – 300	$3.83 R^2$
300 – 1,500	$0.0128 R^2f$
1,500 – 100,000	$19.2 R^2$

Note: Transmitter Frequency is in MHz, Threshold ERP is in watts, R is in meters, f is in MHz.

49. Single RF sources are exempt if, using Table 2 above, for the frequency (f in MHz) and separation distance (R in meters) at which the source operates, the ERP (in watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 2 to apply, the separation distance in meters, R,¹⁴⁶ must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength. If the ERP of a single RF source is not easily obtained, then the available maximum (source-based) time-averaged power may be used in lieu of ERP if the device antenna(s) or radiating structure(s) do not exceed the electrical length of $\lambda/4$. If the ERP of the single RF source and transmitting antenna(s) (including coherent array) exceeds the ERP threshold, then the RF source is not exempt and the applicant must prepare an evaluation.¹⁴⁷

ERP, Effective Radiated Power, is the power radiated by a transmitter in any direction relative to the power radiated if the transmitter is being operated into a half-wave dipole.

In some cases, it may be easier to simply do a calculation to evaluate your station than to calculate whether you need to do an evaluation using ERP.

Table 2, above, may be used for any distance where people may be exposed if that distance is not within the near-field region of the frequency being calculated. The following table shows the near-field distance for different bands. If the distance from your antenna to any area where people may be exposed, including yourself and/or members of your household is greater than these distances, the formulas in the FCC rules can be used to determine if you are exempt from the need to evaluate your station.

The near-field boundary can be calculated from the formula:

$$\text{Near field boundary in feet} = 156.8 / \text{Frequency MHz}$$

The following table shows the near-field boundary for different frequencies in the HF range:

Band	Near-field distance
160m	87.1 feet
80m	44.8 feet
40m	22.4 feet
20m	11.2 feet
10m	5.6 feet

THREE WAYS YOU CAN EVALUATE YOUR STATION

If you are required to or want to do an evaluation below are some suggested methods.

CALCULATIONS

There are three basic ways to evaluate your station. The easiest is to use an on-line RF safety calculator available at the following link:

<http://www.lakewashingtonhamclub.org/resources/rf-exposure-calculator/>

For uncontrolled exposure (general public), the RF-exposure limits are based on average power over a 30-minute period. This would be used for neighbors and other people that do not know whether RF energy is present and do not know much about its safety implications. There is another exposure category called "controlled exposure" that would apply to you as a licensed amateur operator and to members of your household if they have been provided with some information and training about RF exposure, which you can provide to them. This higher level of exposure is based on a 6-minute exposure-time period. You can also apply the uncontrolled exposure limits to you and your family if you find that easier.

You can determine average power for calculation purposes, but the easiest first estimate is to use the calculator and use your transmit PEP in the calculation, without feed-line losses. For a simple example, let's assume you are running a 100-watt PEP, 29.7-MHz transmitter to a 3-element Yagi with a gain of 7.5 dBi. Enter these values into the calculator and include the ground-reflection factor to account for ground gain and other scatterers. In this example case, the program will tell you that if people are located more than 11.0 feet for controlled exposure or 24.6 feet for uncontrolled exposure, diagonally from any part of the antenna, the exposure will be below the limits.

If people may come closer to your antenna than that, you may want to employ a more granular approach employing average power instead of your maximum transmit power.

To calculate average power use the following formula:

Average Power (W) = Transmitter power * mode duty factor * operating time duty factor

The duty factors are expressed numerically. For FM or digital transmissions use a duty factor of 100%, or 1.0 in the formula. For SSB, use 20% for unprocessed audio and 40% for heavily processed audio as a very conservative estimate, numerically expressed as 0.2 and 0.4 respectfully. For CW, use 0.4.

For the operating-time duty factor, determine the *maximum* percentage of time you might be transmitting in any 30-minute window for uncontrolled exposure, again expressed numerically. This is typically 10 minutes transmitting and 10 minutes listening and 10 minutes transmitting for most amateur operation, or an operating duty factor of 0.67. Use a 6-minute window for controlled exposure, which will typically be 100% (1.0) in 6 minutes for most amateur operation.

This simple calculator applies for any distances that are greater than the near-field boundary limit.

ANTENNA MODELING

If areas where people may be exposed to your RF signal are closer than the near-field boundary described earlier in the document, you may need to use other evaluation methods, such as antenna modeling. A free demo version of the EZNEC antenna modeling program is available from this URL:

<https://www.eznec.com/demoinfo.htm>.

The free version can do near-field calculations for most common antenna types. The information in the book, *RF Exposure and You*, also available for free download from the link provided earlier in this FAQ document, contains near-field models of most antenna types at different heights.

For regions within the near-field boundary, the easiest way to calculate exposure is to use antenna modeling. NEC-based antenna modeling programs can do near-field modeling to accurately predict electric and magnetic fields, which can be compared to the limits described in the FCC rules. This is described in much more detail in the book, *RF Exposure and You*, available for download from the ARRL RF Exposure web page described earlier. The book also contains many pages of charts describing the result of many antenna models that ARRL ran to obtain compliance distances.

MEASUREMENTS

Amateurs with calibrated equipment can make measurements, although it is not likely that most amateurs will do this. A description of measurement techniques is also described in the book, ***RF Exposure and You***, available for download at a URL listed above.