

# Understanding the Changes to the FCC RF Exposure Rules

Learn whether these changes affect your station, and how you can easily evaluate it to comply with FCC regulations.

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On May 3, 2021, the new FCC rules regarding exposure to RF energy went into effect. Stations operating under the exemptions included in the old rules must comply with the rules changes by May 3, 2023. This article provides a historical background on the amateur rules for RF exposure, as well as information about the exposure limits, other requirements for amateur stations, and changes to how many amateurs can continue to be exempt from the requirement to evaluate their stations.

## Recent Changes to the Rules

When the FCC first introduced regulations about human exposure to RF energy in 1996, amateur radio was included. The first RF exposure rules set limits for human exposure to radio transmitters. Although these limits applied to amateur radio, amateurs were not required to evaluate their stations.

In 2020, the FCC finalized significant changes to the rules. Under the new rules, amateur stations are still required to comply with the exposure limits, but more amateur stations are required to conduct a “routine station evaluation” to determine that their station complies with the limits for human exposure. In the old rules, there were numerous exemptions from this requirement based on frequency of operation, power level, and the type of operating being done. Mobile and handheld portable transmitters that used push-to-talk (PTT) were exempt from the need to evaluate, as were most repeater stations. These service-specific exemptions were replaced in the new rules with simple formula-based methods of determining whether a particular station needs to be evaluated.

## Determining If Your Station Needs an Evaluation

If you performed an evaluation of your station under the old rules, you don’t need to do so again, unless you make a change that could increase the amount

of RF energy present near your station, such as increasing transmitter power, changing your antenna type, or using a new band or operating mode. If you don’t make these kinds of changes, you may continue to operate.

If your station was exempt from evaluation under the old rules, you’ll need to either assess your station or use the exemption formula to determine whether or not it needs to be evaluated under the new rules. Those with stations in this category have until May 3, 2023, to complete the evaluation.

Table 1 shows the formulas you can use to determine whether you’re exempt from needing to do an evaluation. This table cannot be used for exposure distances  $< \lambda/2\pi$  or for distances closer than 20 centimeters.

Table 1 — Single RF Sources Subject to Routine Environmental Evaluation under MPE-Based Exemptions,  $R \geq \lambda/2\pi$

Transmitter Frequency	Threshold Effective Radiated Power (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 – 1500	$0.0128 R^2f$
1500 – 100000	$19.2 R^2$

Note: Transmitter frequency is in MHz, threshold ERP is in watts, R is in meters, and frequency (f) is in MHz.

Using Table 1 for the frequency (f in MHz) and separation distance (R in meters) at which the RF source operates, single RF sources are exempt if the ERP (in watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, the separation distance in meters (R) must be at least  $\lambda/2\pi$ , where  $\lambda$  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.

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## RF Exposure Calculator

**The FCC's New RF-Exposure Regulations**

The FCC has adopted guidelines and procedures for evaluating environmental effects of RF emissions. The new guidelines incorporate two tiers of exposure limits based on whether exposure occurs in an occupational or "controlled" situation or whether the general population is exposed or exposure is in an "uncontrolled" situation. In addition to guidelines for evaluating fixed transmitters, the FCC adopted limits for evaluating exposure from mobile and portable devices, such as cellular telephones and personal communications devices.

**ARRL RF Safety Committee**

To use the RF Exposure Calculator, fill-in the form below with your operating power, antenna gain, and the operating frequency. Depending on how far above ground the RF source is located, you might want to consider ground reflections — and then click "Calculate".

**What's New About the FCC's New RF-Exposure Regulations?**

You may need to run the calculator multiple times to get a complete picture of your situation, i.e. take into account the antenna's lobes and directionality.

[Click here to get \(more\) info.](#)

**Parameters**

- Power at Antenna: (Need help with this?)  (watts)
- Mode duty cycle:  ▼
- Transmit duty cycle: (time transmitting)  
You transmit for  minutes then receive for  minutes (and repeat).
- Antenna Gain (dBi):
- Operating Frequency (MHz):

Include Effects of Ground Reflections

If you would like to receive future announcements of any FCC news related to RF-exposure or the requirements for amateurs to evaluate their stations, you may optionally provide an email address.

Email Address:  (optional)

Comments:  (optional)

Results for a controlled environment:

**Figure 1** — This simple RF calculator can do most evaluations in 1 minute or less. To use this calculator, visit [www.arrl.org/rf-exposure-calculator](http://www.arrl.org/rf-exposure-calculator).

Regarding the RF exposure rules, the FCC has clarified that effective radiated power (ERP) is the gain of an antenna compared to the gain of a half-wave dipole at the same location. For example, if you're operating 28.5 MHz and the closest place where people might be exposed (including you and your family) is 12 meters diagonally to any part of your antenna, then the maximum ERP you can use by this formula is 611.5 W. If you're running 100 W to a dipole, then your station is exempt from evaluation on this band. If you run 500 W to a Yagi antenna with a gain of 5.35 dBd (if the gain of the antenna is specified in dBi, convert this to dBd by subtracting 2.15 dB), your ERP would be 1713.8 W, so you would not be exempt on this band for that power and antenna configuration. If this was a new installation, in order to put that station into operation you would need to do an evaluation, reduce power, locate your antenna farther away from people, or control access to areas that were this close to the antenna.

If you run 100 W on 3.5 MHz to any antenna, you need to do an evaluation in all cases if the exposure occurs at a distance of 13.6 meters or less, because this would be within the near-field distance defined by  $\lambda/2\pi$ .

If you have to do an evaluation, there's no need to panic. In most cases, you can do a simple calculation using an online RF calculator.

To perform an evaluation, you're going to compare the power density and field strength of your antenna to the limits in the FCC rules. Table 2 shows the limits for the amount of RF exposure that can occur from the operation of any transmitter in any radio service.

The FCC has determined that amateur radio operators and the members of their households can be evaluated to the higher (Controlled) exposure limits if the amateur has provided them with RF safety instruction and training. (The FCC was not specific as to what this training shall be.)

Exposure must meet all three limits — power density, electric field, and magnetic field strength. The limits are for exposure averaging over 30 minutes for Uncontrolled and 6 minutes for Controlled. To obtain this average exposure, evaluators should determine the average power of the transmitter being evaluated, using mode duty factors and the on/off duty cycle of the transmitter over the averaging period.

## Using RF Calculators

The easiest way to do an evaluation is to use ARRL's RF exposure calculator at [www.arrl.org/rf-exposure-calculator](http://www.arrl.org/rf-exposure-calculator) (see Figure 1). The calculator will take your average power, the frequency you're using, your antenna gain, and your operating mode to calculate the minimum compliance distance from any part of your antenna. At this distance, the power density, E-field, and H-field all meet the FCC's limits.

You can calculate your average power by inputting the mode with the highest duty factor you intend to use and telling the calculator about your on/off operating times. You should use the "worst case" that you might ever be using when people may be exposed by the signals from your antenna. For example, if you might transmit a carrier for 10 minutes to adjust your station at full power, you should select 100% as your mode duty factor. Even if you usually transmit for only 1 – 2 minutes then listen, but you might occasionally transmit for 20 minutes in a single transmission, you should enter that worst-case scenario into the calculator.

Table 2 — Limits for Maximum Permissible Exposure (MPE)				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minutes)
<b>(A) Limits for Occupational/Controlled Exposure</b>				
0.3 – 3.0	614	1.63	*(100)	≤ 6
3.0 – 30	1842/f	4.89/f	*(900/f <sup>2</sup> )	< 6
30 – 300	61.4	0.163	1.0	< 6
300 – 1500			f/300	< 6
1500 – 100000			5	< 6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3 – 1.34	614	1.63	*(100)	< 30
1.34 – 30	824/f	2.19/f	*(180/f <sup>2</sup> )	< 30
30 – 300	27.5	0.073	0.2	< 30
300 – 1500			f/1500	< 30
1500 – 100000			1.0	< 30
f = frequency in MHz and * = plane-wave equivalent power density				

If the distance where people may be exposed is greater than the distance the calculator estimates, your evaluation is complete.

Once you do this evaluation on each band and mode you might use, you have done what the rules require. On HF, the upper bands have lower limits, so if you're using a tribander antenna on 29.7 MHz and you pass, you'll also pass on the lower bands using that same antenna. Likewise, if you pass at a 100% duty factor, you'll also pass if you use a mode with the same duty factor and power level, while using the same antenna.

### Other Means of Evaluation

While the calculator is the easiest way, it's a conservative calculation, so it often overestimates the signal from your antenna. If you don't "pass," you can use other, more accurate ways to calculate the signals from your station.

For example, you can use antenna modeling to predict the field strength from your station. How this is done involves a lengthy explanation, but you can enter the dimensions of your antenna and use the near-field calculator built into most antenna-modeling programs. Although it's beyond the capabilities of most amateurs, the FCC would also permit you to make measurements of field strength. To do this accurately requires a calibrated antenna and measuring instrument. The small handheld electromagnetic field (EMF) meters that are available generally don't give good results.

### Mitigation

If you don't pass, the FCC gives you a lot of flexibility in the ways you can mitigate and control exposure. You can use a different frequency and operating mode. You can also control where your antenna points. For example, if you model your antenna and find that you may exceed the limits in a neighbor's home (if you point the antenna in that direction), you could choose not to point your antenna at your neighbor's home while someone may be inside. You can also lower power under circumstances where human exposure may occur, closer than the distances you calculated. (You will have to repeat the

calculation with your lower power level when you do this, to ensure that it meets the limits.)

### Completing Your Evaluation

The good news is that there's no paperwork. When you complete your evaluation, you've fulfilled the rules requirement. Unless specifically requested by an agent of the FCC, you aren't required to submit any paperwork to them. However, it's a good idea for you to keep a copy of your evaluations in your station records.

### More Information

In addition to this article, there's a lot of good information available at <http://arrl.org/rf-exposure>. Additionally, my book, *RF Exposure and You*, is available at [www.arrl.org/files/file/Technology/RFsafety Committee/RF+Exposure+and+You.pdf](http://www.arrl.org/files/file/Technology/RFsafety%20Committee/RF+Exposure+and+You.pdf).

If, after utilizing these resources, you still have questions about how to apply the information to your particular station configuration, you can email the ARRL Lab at [tis@arrl.org](mailto:tis@arrl.org). Include your name, call sign, and as much information about your station as you can and one of the ARRL Lab engineers will help you.

Table data provided by [www.fcc.gov](http://www.fcc.gov).

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