Changes to the FCC RF Exposure Rules 2021

By Robert S. Shank
KM6RSS

Outline

- Presenter Background
- FCC RF Exposure Rules History
- New Rules
- How Do I Comply?
- Resources
- Summary
- Questions

Presenter Background

Geologist, Mining, Maintenance, IT Consulting Engineer, Property Management (1974-Current)

- Amateur Radio Experience
  - July 2016 Received Technician, General and Amateur Extra License, Joined ARRL
  - June 2017 Joined VCARC, Amateur Radio Emergency Services (ARES), Volunteer Examiner (VE) for ARRL, GLAARG, Participated in VCARC Field Day
  - February 2018 Completed 6-month Qualification and Accepted into Auxiliary Communications Service (ACS) (Area 6 #1082)
  - May 2018- December 2019 VCARC past Vice President, President
  - June 2018 – Present VCARC Webmaster
  - July 2019 – Present VCARC Keyer Editor and Publisher
  - January 2020- Present VCARC At-Large Board Member

FCC RF Exposure Rules History

- Earlier Exposure Rules for Amateur Radio
  - August 1996 FCC Rule Announcement
    - New rules governing exposure to transmitted radiofrequency signals
    - These rules set new limits on the amount of RF energy people can be exposed to. They also require that some stations be evaluated to see if they are in compliance with the rules. Almost all existing amateur operation were already in compliance with the rules
    - The ARRL published the book “RF Exposure and You” (free on their website) which included “Categorical Exemption for Station Evaluation Worksheet” and instructions

FCC RF Exposure Rules History (cont.)

- Table 1 from August 1996 FCC RF Exposure Rule

TABLE 1.1

Wavelength Band	*Evaluation Required if Power* (watts) Exceeds:*
MF	
160 m	500
HF	
80 m	500
75 m	500
40 m	500
30 m	425
20 m	225
17 m	125
15 m	100
12 m	75
10 m	50
VHF (all bands)	50
UHF	
70 cm	70
33 cm	150
23 cm	200
13 cm	250
SHF (all bands)	250
EHF (all bands)	250
Repeater stations (all bands)	*non-building-mounted antennas*: height above ground level to lowest point of antenna < 10 m *and* power > 500 W ERP *building-mounted antennas*: power > 500 W ERP

*Power=PEP input to the antenna except, for repeater stations only, power exclusion is based on ERP (effective radiated power).

FCC RF Exposure Rules History (cont.)

- Table 3.1 from August 1996 FCC RF Exposure Rule

Table 3.1

Typical 60-Hz Magnetic Fields Near Amateur Radio Equipment and AC-Powered Household Appliances

Values are in milligauss.

Item	*Field*	*Distance*
Electric blanket	30-90	Surface
Microwave oven	10-100	Surface
	1-10	12"
IBM personal computer	5-10	Atop monitor
	0-1	15" from screen
Electric drill	500-2000	At handle
Hair dryer	200-2000	At handle
HF transceiver	10-100	Atop cabinet
	1-5	15" from front
1-kW RF amplifier	80-1000	Atop cabinet
	1-25	15" from front

(Source: measurements made by members of the ARRL RF Safety Committee)

FCC RF Exposure Rules History (cont.)

- Table 3.2 from August 1996 FCC RF Exposure Rule

Table 3.2

Typical RF Field Strengths Near Amateur Radio Antennas

A sampling of values as measured by the Federal Communications Commission and Environmental Protection Agency, 1990

Antenna Type	*Freq (MHz)*	*Power (W)*	*E Field (V/m)*	*Location*
Dipole in attic	14.15	100	7-100	In home
Discone in attic	146.5	250	10-27	In home
Half sloper	21.5	1000	50	1 m from base
Dipole at 7-13 ft	7.14	120	8-150	1-2 m from earth
Vertical	3.8	800	180	0.5 m from base
5-element Yagi at 60 ft	21.2	1000	10-20	In shack
			14	12 m from base
3-element Yagi at 25 ft	28.5	425	8-12	12 m from base
Inverted V at 22-46 ft	7.23	1400	5-27	Below antenna
Vertical on roof	14.11	140	6-9	In house
			35-100	At antenna tuner
Whip on auto roof	146.5	100	22-75	2 m antenna
			15-30	In vehicle
			90	Rear seat
5-element Yagi at 20 ft	50.1	500	37-50	10 m antenna

New Rules

- Start of New Rules began in 2013; April 1 2020 was latest publish date
- No Station is exempt from compliance with the FCC's rules and with the MPE limits
- Changes are not "major" but standardized across all FCC-managed frequencies
- Frequency, Maximum ERP (including feedline loss and antenna gain) and Distance are evaluation basis
- MPE (Maximum Permissible Exposure) and SAR (specific absorption rate) limits aren't changed
- All* Amateur Transmitting Equipment Must be Evaluated
  - Existing stations need to be "re-evaluated" by 05-03-2023
  - New or changed stations must comply immediately
- Controlled vs. uncontrolled (informed vs. uninformed) exposure values are different

New Rules (cont.)

- Exemptions don't apply to reactive near-field wavelength/2Π (or 0.16 wavelength) and require less calculations than a full exposure analysis

Frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1920\ R^2$
1.34-30	$3450\ R^2 / f^2$
30-300	$3.83\ R^2$
300-1500	$0.0128\ R^2\ f$
1500-100000	$19.2\ R^2$

- Hams are expected to conduct their own exposure analyses and do not have to submit results to the FCC unless asked (if someone complains about your station to the FCC, expect to be asked) Like me!!!

New Rules (cont.)

- Exemptions based on MPE table

Table 1. LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $|E|^2$, $|H|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $|E|^2$, $|H|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

How Do I Comply?

- Make a list all of your transmitter-connected equipment (transceiver, switches, attenuators/filters, feedline lengths, antenna type and manufacturer's data sheet on gain in dBi)
- Include in the list the bands you will be transmitting on
- Make formula-based calculations (see Stu AG6AG videos) or use website calculators (e.g. http://www.lakewashingtonhamclub.org/resources/rf-exposure-calculator/)

How Do I Comply (cont.)?

- Make formula-based calculations (“borrowed” from Stu AG6AG videos)

```
Reviewed: AG6AG
Date: 05/01/2021
Radio: Yaesu FT-3000D
Amplifier: Ameritron ALS-600
Tuner: Palstar AT2KD
Coax Type: RG-213/U
Antenna: Alpha Delta 10M - 80M  Fan Dipole

PEP Out Of Radio:
10M = 100W
12M = 100W
15M = 500W
20M = 500W
40M = 500W
60M = 100W
80M = 500W

Coax Length = 60 Ft.
Coax Loss (100 Ft.): 0.6 (All Bands)
Actual Loss = 0.36dBi

Antenna Gain:
All = 2.2dBi

ERP:
100W = 153W
500W = 763W
```

How Do I Comply (cont.)?

- Make formula-based calculations (“borrowed” from Stu AG6AG videos)

```
Duty Factored:
100W Duty Factor @ 40% = 61W
500W Duty Factor @ 40% = 305W

Ground Reflection Factor = 1.67^2
61W Factored = 156W
305W Factored = 781W

Controlled Distance = 4M
Uncontrolled Distance = 4M

Controlled
10M @ 156W PD = 0.078 < 1.020
12M @ 156W PD = 0.078 < 1.441
15M @ 781W PD = 0.388 < 1.956
17M @ 781W PD = 0.388 < 2.727
20M @ 781W PD = 0.388 < 4.371
40M @ 781W PD = 0.388 < 16.889
60M @ 156W PD = 0.078 < 30.807
80M @ 781W PD = 0.388 < 56.250
```

How Do I Comply (cont.)?

- Make formula-based calculations (“borrowed” from Stu AG6AG videos)

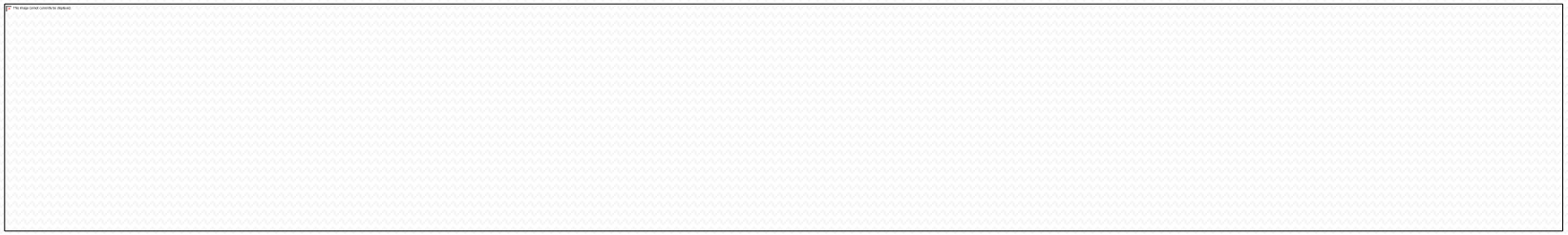
```
Power Density:
ERP(GR) / (4π X (Distance-cm²))

Max Power for Distance:
Max PD X (4π X (Distance-cm²))

Minimum Distance:
√((Power-mW / Max PD) / (4π))

Reflection:
(1.6)²

Controlled = 4.371
Uncontrolled = 0.874
```


```
Power Density:
ERP(GR) / (4π X (Distance-cm²))

Max Power for Distance:
Max PD X (4π X (Distance-cm²))

Minimum Distance:
√((Power-mW / Max PD) / (4π))

Reflection:
(1.6)²

Controlled = 4.371
Uncontrolled = 0.874
```


```
425W

2M
```

Resources

- http://www.arrl.org/files/file/Technology/RFsafetyCommittee/RF%20Exposure%20and%20You.pdf
- http://www.arrl.org/files/file/Technology/RFsafetyCommittee/RFXFAQ.pdf
- http://www.arrl.org/files/file/Technology/RFsafetyCommittee/28RFSafety.pdf
- Videos
  - “New FCC RF safety rules for ham radio” Ria's Shack ham radio https://www.youtube.com/watch?v=kyLDC-H8kb0
  - “FCC Implements New RF Safety Rules. How To Evaluate Your Amateur Radio Station RF Exposure Level” by Stuart Sheldon AG6AG (https://www.youtube.com/watch?v=ircLRVCbO_o), https://youtu.be/5vHIZ2dF2Qc
  - FCC Radio Frequency Exposure Rules (Dan Marler) https://vimeo.com/540342124
- Calculators
  - http://hintlink.com/power_density.php
  - http://www.lakewashingtonhamclub.org/resources/rf-exposure-calculator/



Summary

- No such thing as a blanket exemption
- Mobile and portable exemptions have been taken away
  - Mobile radio's antenna is > 20 cm away
    - Must evaluate MPE
  - Portable radio's antenna <20 cm away
    - Manufacturer provides SAR evaluation for equipment made ≥ 050321
  - List equipment and evaluate it in the bands-keep a record of the evaluation
- New Stations need to be evaluated by 05-03-2021
- Existing Stations need to be re-evaluated by 05-03-2023

Questions