RF Safety for the Radio Amateur

- History
- RF Safety Objectives
- FCC Regulations
- RF Safety Calculator

Early History of RF Safety

1982: IEEE industry standard describes appropriate limits for human exposure to RF energy.

- FCC adopts RF safety regulations based on this standard.
- Unlike other services, the FCC exempted amateurs from any regulations regarding station evaluations.

More Standards on RF Safety

1991: IEEE decreased the maximum permissible levels of the 1982 standard and extended the frequency ranges considered.

1993: FCC proposal to include amateurs in RF safety regulations is introduced, but **not** acted upon.

Congress Gets Involved

1996: Telecommunications Act passed by Congress instructs the FCC to do a complete overhaul of RF safety regulations.

1996: FCC includes the Amateur Radio Service in the RF Safety Regulations, ending our exemption.

Ionizing vs. Non-Ionizing Radiation

- Ionizing radiation is responsible for "radiation sickness."
- RF is **non**-ionizing radiation.
- Non-ionizing radiation may have both thermal effects and athermal effects.
- RF Safety regulations concern only the thermal effects of non-ionizing radiation.

SAR and MPE

- The Specific Absorption Rate (SAR) measures the rate at which tissue absorbs RF energy.
- The Maximum Permissible Exposure (MPE) is based upon the SAR, and differs at various frequency ranges.
- The most stringent requirements are at 30 MHz to 300 MHz.

Exposure Environments

- A controlled environment is one in which people are aware of the RF and can control their exposure.
- An uncontrolled environment is one in which people would not normally be aware of the RF exposure.
- FCC Regulations treat these two environments differently.

MPE Limit

Controlled environment: 1.005 mW / cm^2

Uncontrolled environment: 0.205 mW / cm^2

Field strength decays with the square of distance.

FCC Regulations

- **All** Amateur stations **must** comply with MPE levels.
- Regulations allow us to consider duty cycle and average power in the calculations.
- A routine station evaluation is required of most amateur stations.
- Amateur stations are not required to file or record any paperwork.

FCC Regulations

While they must continue to be in compliance with MPE levels, stations using less than specified levels of PEP output, and mobile or portable stations using PTT, are exempt from routine station evaluations.

Frequencies in MHz	Peak Envelope Power in Watts
1.800 - 2.000	500
3.500 - 4.000	500
7.000 - 7.300	500
10.100 - 10.150	425
14.000 - 14.350	225
18.068 - 18.168	125
21.000 - 21.450	100
24.890 - 24.990	75
28.000 - 29.700	50
50.000 - 54.000	50
144.000 - 148.000	50
222.000 - 225.000	50
420.000 - 450.000	70
902.000 - 928.000	150
1240.000 - 1300.000	200
2300.000 and higher	250

How To Calculate Your Station's Power Density

- Download a worksheet from the FCC and do the calculations manually.
- Use a RF Safety calculator Windows program.
- Use a RF Safety calculator Web site such as http://hintlink.com/power_density.htm

Amateur Radio RF Safety Calculator

v1.2 (2015-08-18) by Paul Evans, VP9KF , Hintlink Technology

Calculate Radio Frequency Power Density

The average power at the antenna:
In watts

The antenna gain in dBi:
Enter 2.2 for dipoles; add 2.2 for antennas rated in dBd

The distance to the area of interest:
From the centre of the antenna, in feet

The frequency of operation:
In MHz

Ground Reflection Effects

In most cases, the ground reflection factor is needed to provide a truly worst-case estimate of the compliance distance in the main beam of the antenna. Including the ground reflection effects may yield more accurate results especially with very low antennas, non-directional antennas, and calculations below the main lobe of directional antennas.

Do you wish to include effects of ground reflections? (•) Yes ( ) No

Calculate RF Power Density | Reset Values

This is a main beam power density estimation program intended for use as part of a routine evaluation of RF safety compliance with FCC regulations. Amateur Radio operators licensed by the Federal Communications Commission of the United States of America are required to do a "routine evaluation" of the strength of the RF fields around their stations, subject to certain exemptions. These rules can be found in the FCC's ET Docket No. 93-62. More information can be found at the ARRL Website RF Safety page.

This program uses the formulas given in FCC OET Bulletin No. 65 to estimate power density in the main lobe of an antenna, with use of the EPA-recommended ground reflection factor as an option. This program is intended for approximate far-field calculations. It may overestimate the actual field strength of high-gain antennas in the near field (within several wavelengths of the antenna.) However, it may also underestimate the strength of fields that may be encountered in *hot spots* in the near field. No computer program can predict where wiring or reflective objects may create hot spots in your particular installation.

This is a World Wide Web front end for a public domain program written by W4/VP9KF using PHP. This program was derived from a public domain BASIC program written by Wayne Overbeck N6NB and published in the January, 1997 issue of *CQ VHF*, p. 33. Terms: GNU Licence.

Calculate Your Average Power

Operating Mode	Duty Factor
Morse code (CW)	40%
SSB phone	20%
FM	100%
RTTY/Digital	100%
AM	100%

Average Power =

Peak power at antenna X

Duty Factor of mode X

Percent of time transmitting

Time period:

30 minutes for uncontrolled

6 minutes for controlled

Calculate Radio Frequency Power Density

The average power at the antenna:
In watts
50

The antenna gain in dBi:
Enter 2.2 for dipoles; add 2.2 for antennas rated in dBd
4.4

The distance to the area of interest:
From the centre of the antenna, in feet
50

The frequency of operation:
In MHz
144

Ground Reflection Effects

In most cases, the ground reflection factor is needed to provide a truly worst-case estimate of the compliance distance in the main beam of the antenna. Including the ground reflection effects may yield more accurate results especially with very low antennas, non-directional antennas, and calculations below the main lobe of directional antennas.

Do you wish to include effects of ground reflections? (•) Yes ( ) No

Calculate RF Power Density | Reset Values

Calculation Results

Average Power at the Antenna	50 watts
Antenna Gain in dBi	4.4 dBi
Distance to the Area of Interest	50 feet 15.24 metres
Frequency of Operation	144 MHz
Are Ground Reflections Calculated?	Yes
Estimated RF Power Density	0.0121 mW/cm^2

	Controlled Environment	**Uncontrolled Environment**
Maximum Permissible Exposure (MPE)	1.005 mW/cm^2	0.205 mW/cm^2
Distance to Compliance From Centre of Antenna	5.5452 feet 1.6902 metres	12.3377 feet 3.7605 metres
Does the Area of Interest Appear to be in Compliance?	yes	yes

30 minute time window

Average Power may be lower

6 minute time window