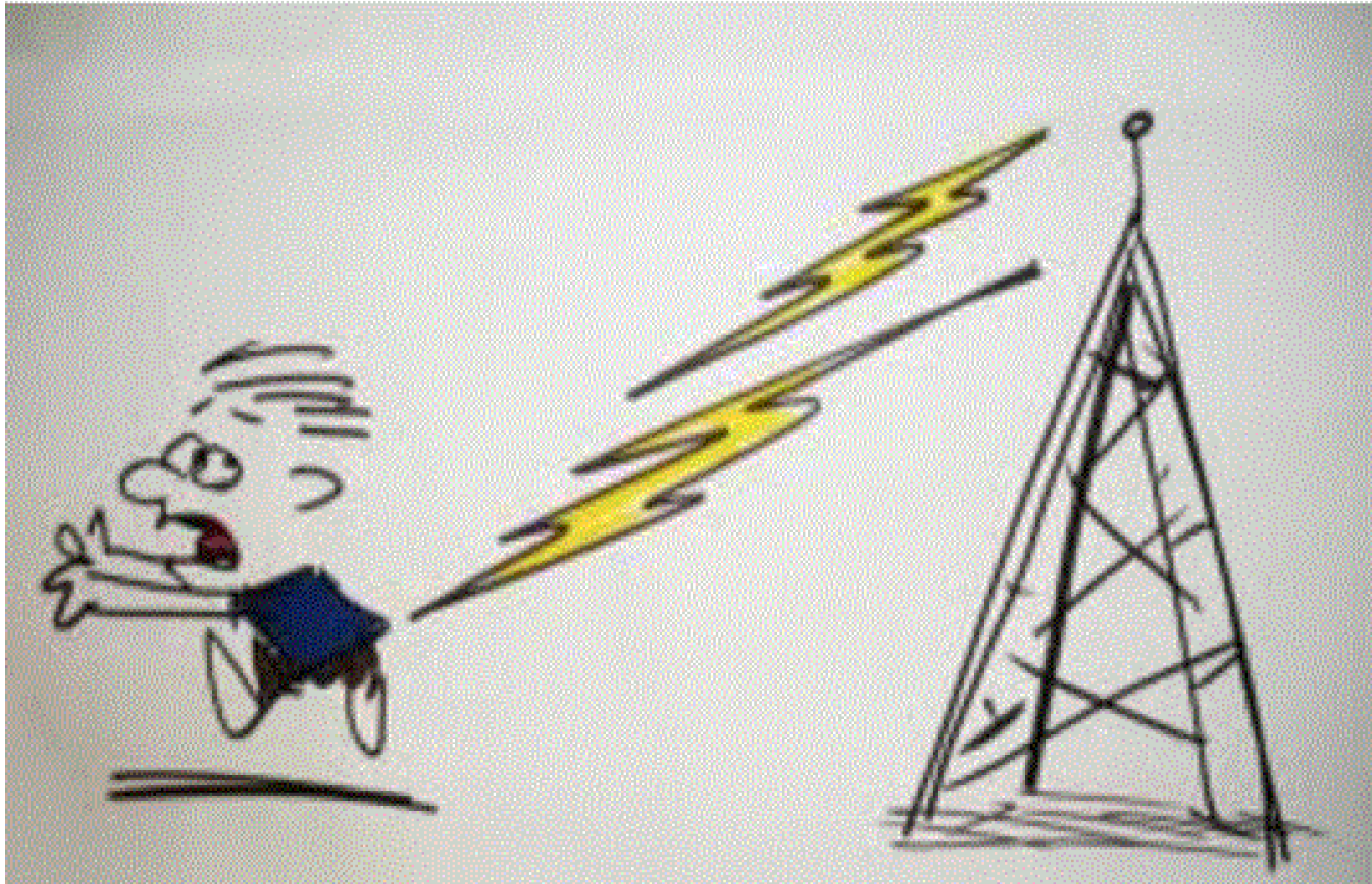


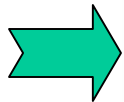
RF Safety





Radio Central Amateur Radio Club

- Home
- Renew On Line!
- Club Calendar
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- Newsletter
- Field Day
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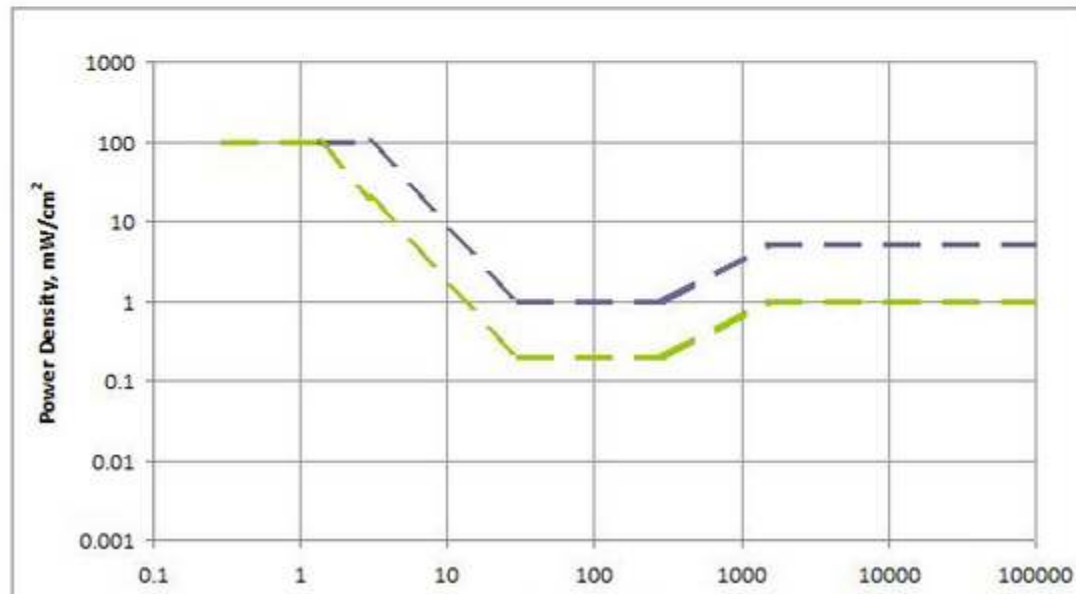


Radio Central's June Meeting will be a Virtual Zoom Meeting
Wednesday June 30, 2021 6:30 PM


Virtual Zoom Meeting:

RF Safety

Neil, KC2KY



Guest Book
Ham Links
Join RCARC
Club Presentations
About RCARC

- [LC Bandpass Filters for 20m, 30m, 40m by Stephen E. Sussman-Fort, F1LD, AB2EV](#)
[View with Adobe Acrobat...](#)
- [HRU 2019 Workshop: Fun with CW by Neil KC2KY](#) [View with Adobe Acrobat...](#)
- [HRU 2018 PC Test Equipment Work Shop by Neil, KC2KY](#) [View with Adobe Acrobat...](#)
- [Field Day 2017 by Neil, KC2KY](#) [View with Adobe Acrobat...](#)
- [RF Safety by Neil KC2KY](#) [Go To Presentation Page](#) 
- [A Slice of Raspberry Pi by Paul W2PB](#) [View with Adobe Acrobat...](#)

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RF Safety

KC2KY presentation, June 30, 2021

- [RF Safety, Neil, KC2KY](#) [View with Adobe Acrobat...](#)

Safety Standards

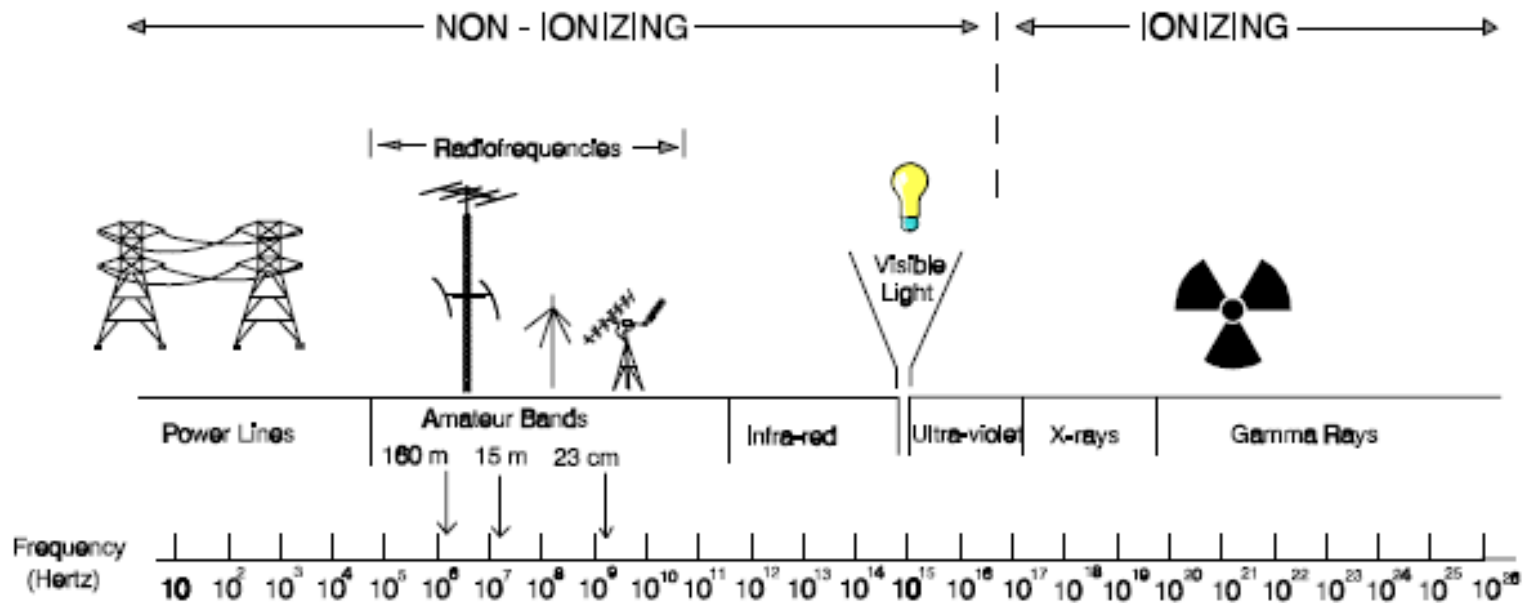
- [FCC Bulletin OET65 Supplement B](#) [View with Adobe Acrobat...](#)
- [ICNIRP \(International Commission on Non-Ionizing Radiation Protection\)](#) [View with Adobe Acrobat...](#)
- [IEEE C95.1](#) [View with Adobe Acrobat...](#)
- [Canadian Safety Code \(SC6\)](#) [View with Adobe Acrobat...](#)

Handy Tools

- [W0JEC MPE Calculator](#) [Link to W0JEC's page](#)
- [On Line MPE Calculator](#) [Link to VP9KF's On Line Calculator's page](#)
- [KC2KY's RF Safety Excel Sheet](#) [Download](#)

Non Ionizing Radiation

Also Known As RF



Known RF Exposure Effects on Health

Thermal Effects - heating of body tissue, fairly well understood

Effects are non-cumulative

Areas of particular concern are the eyes and testes - human body does not cool these areas efficiently.

Resonant frequency of an adult human whole body ranges from 35 MHz to about 80 MHz.

Adult human head is resonant at about 400 MHz

Small child's head: about 700MHz.

RF Exposure Effects on Health, Continued

Non-thermal effects - cancer, leukemia, immuno-deficiency, etc.

Far less understood than thermal effects.

Some studies show an elevated risk factor of 1.5x to 2x others indicate no association at all.

Compare that to a 10x elevated cancer risk factor for a 1-pack per day smoker.

There is no conclusive proof of risk, but no proof that the risk does not exist, so athermal risks remain a controversial topic.

New FCC Rules As Of May 2021

Maximum Exposure Limits Have Not Changed

Rules as to Who is Exempt from Having to Do a Safety Assessment have Changed

If you are not exempt you need to do an assessment before May, 2023

If you make a change to your station (new antenna, more power, improved coax) that would affect RF Exposure, you may have to do a new assessment

So How do I Know Whether I have to Do an Assessment of My Station?

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

From the ARRL RF Safety Web Page

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

It's just as easy to do the assessment as it is to calculate whether you can get out of doing it!

Safe Exposure Levels

How much is safe? Several factors are involved:

Transmitter power

Antenna Gain

Coax Loss

Duty Cycle

Average Key-Up Time

Distance from Antenna

Standards are a wonderful thing – Everyone has one!

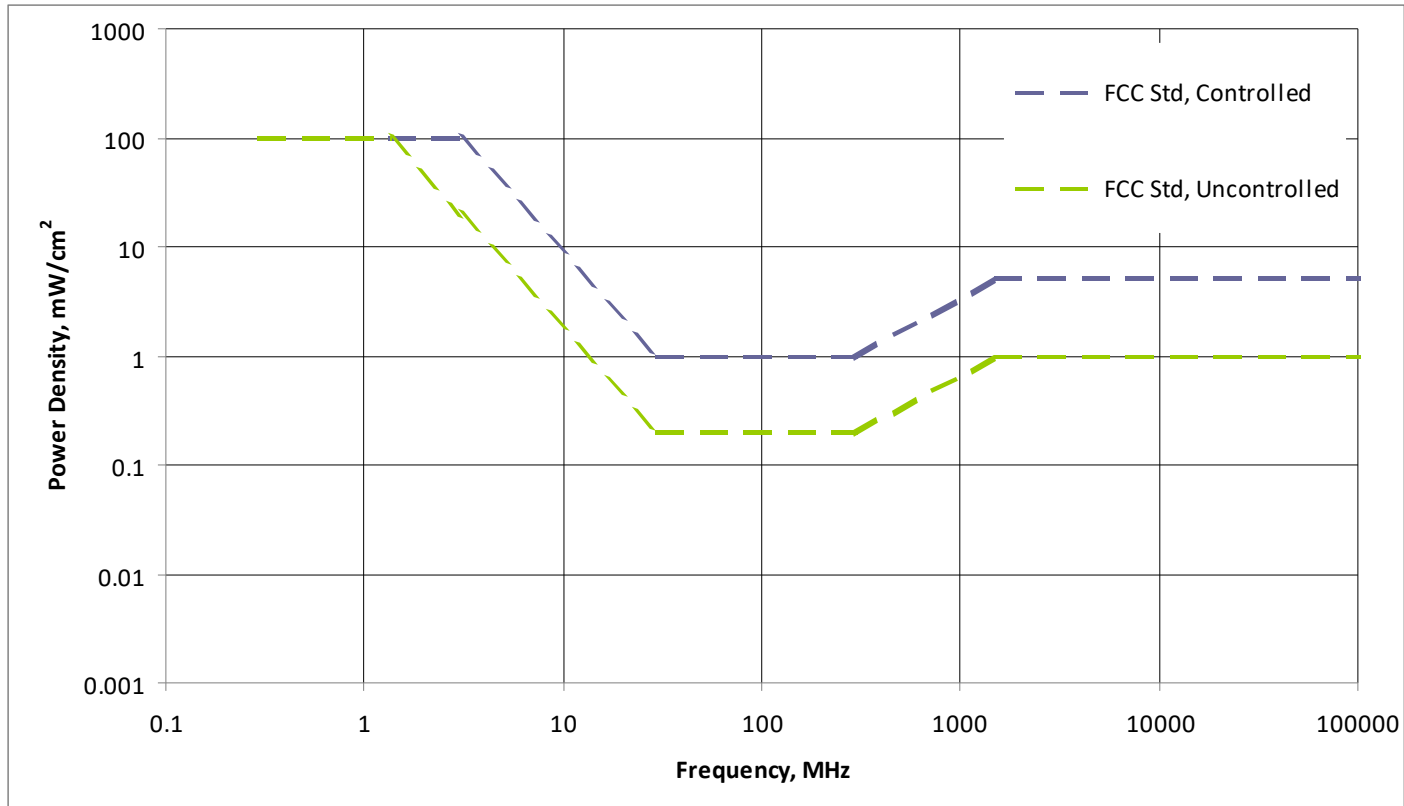
FCC OET65

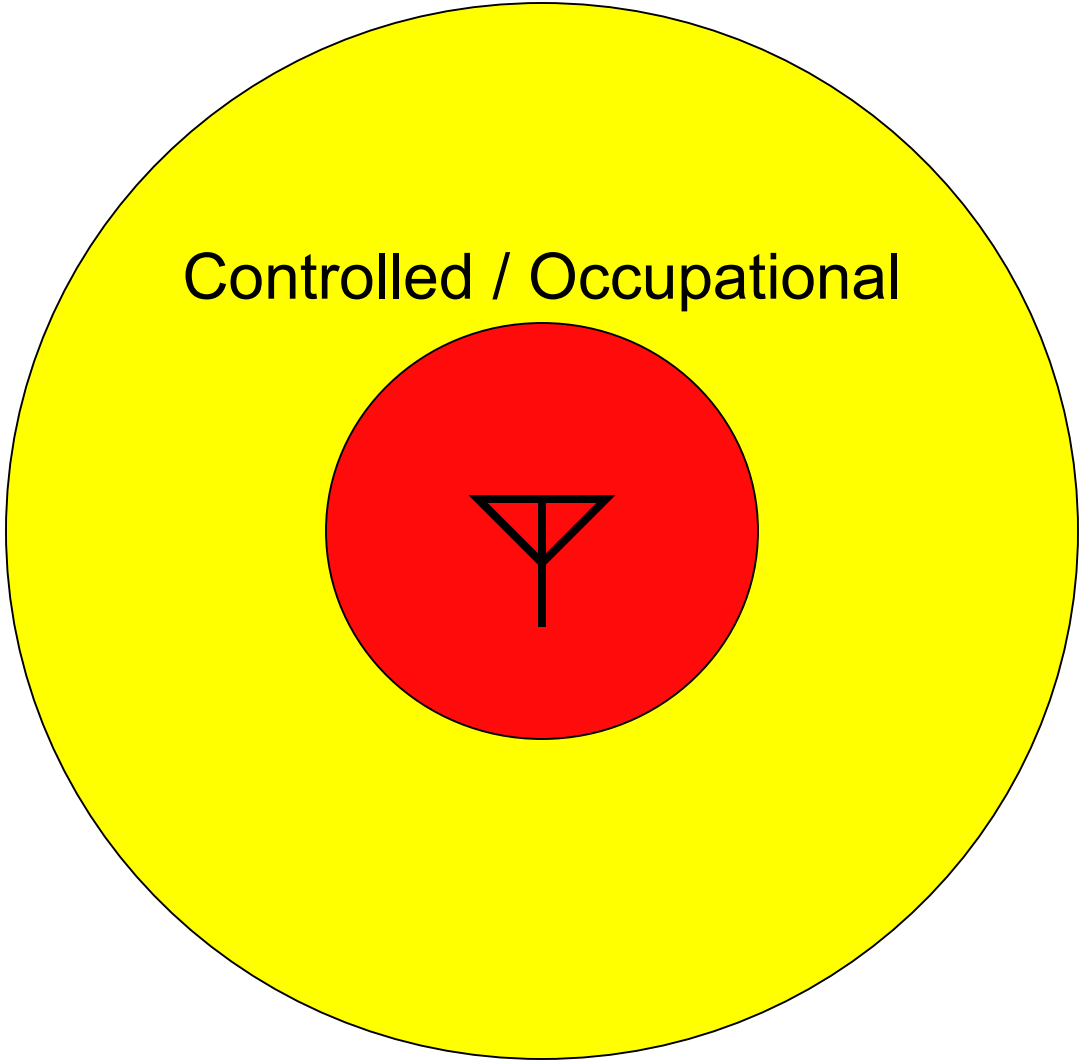
IEEE C95.1

Canadian Safety Code SC-6

ICNIRP (International Commission on Non-Ionizing Radiation Protection)

FCC Exposure Limits





Uncontrolled / General Public

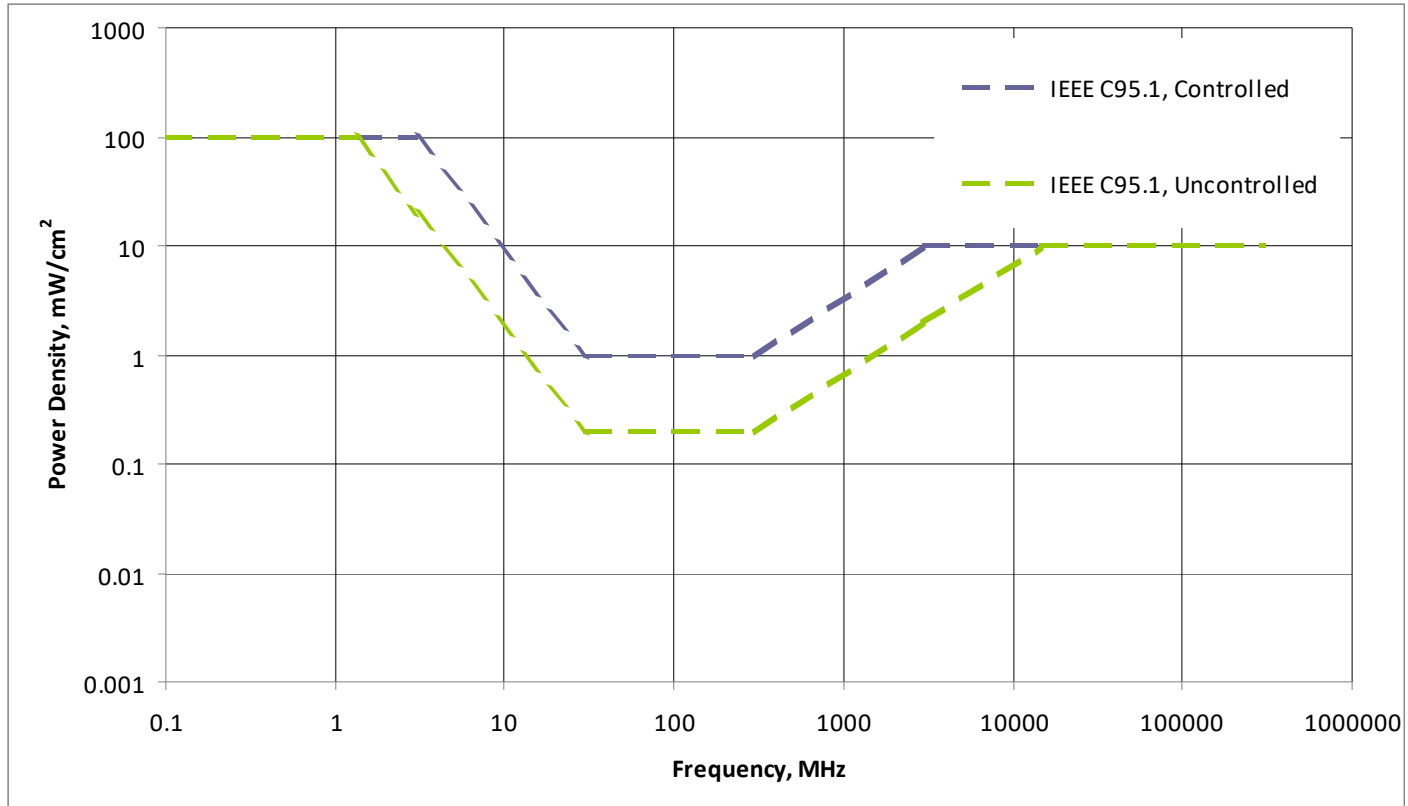
Other Standards

IEEE c95.1

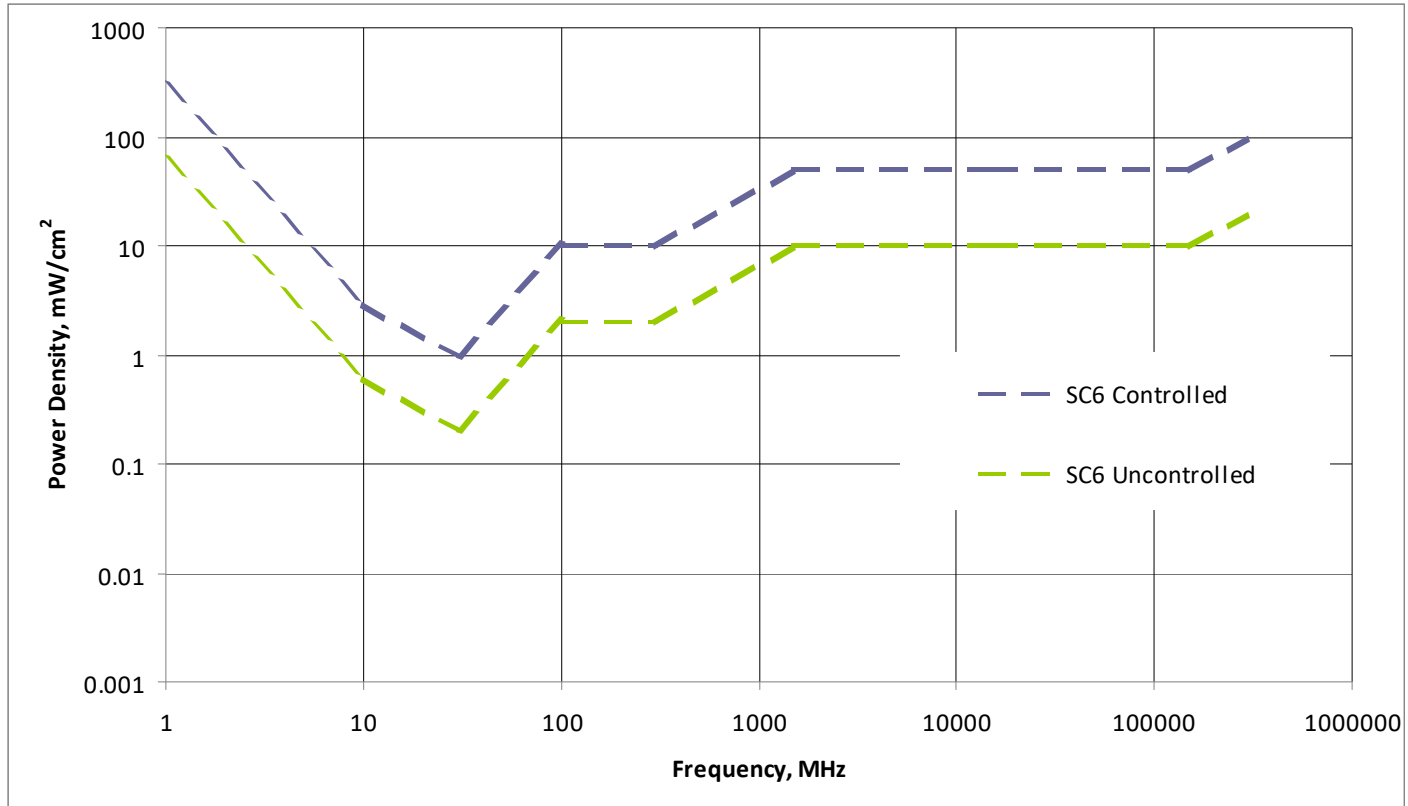
Canadian Safety Code 6 (SC6)

ICNIRP (International Commission on Non-Ionizing
Radiation Protection)

IEEE c95.1

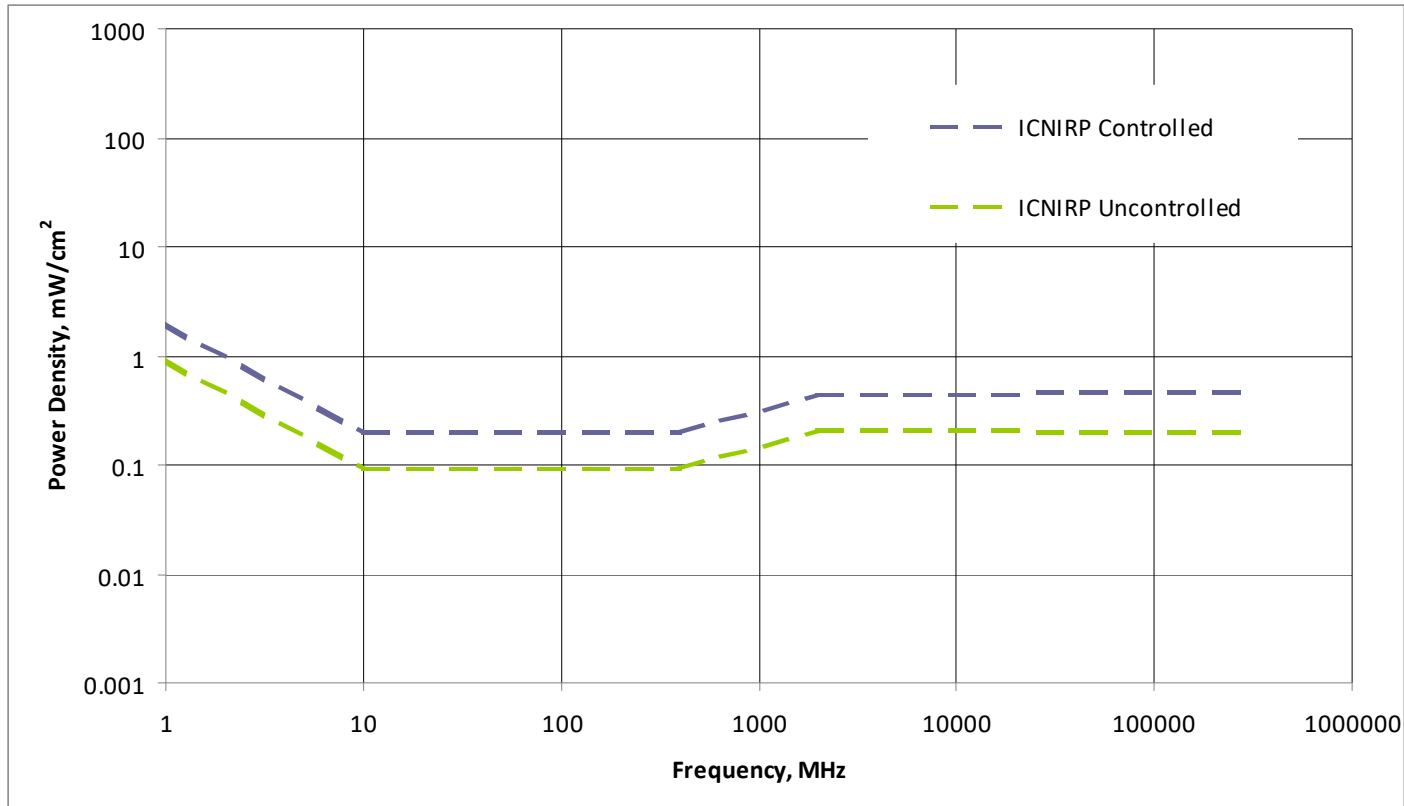


Canadian Safety Code 6 (SC6)



ICNIRP

(International Commission on Non-Ionizing Radiation Protection)



Assessing RF levels in Your Shack

Get a copy of FCC OET-65 Supplement B

1. Direct Measurement
 - a. Equipment can be expensive but some club members have access
 - b. Most commercial instruments (Including Nardalert S3) are calibrated for “Occupational” (controlled environment) MPE limits. In most cases we’re interested in uncontrolled environment limits.

2. Analysis / Calculation
 - a. W0JEC MPE Calculator
 - b. On Line Web Based MPE Calculator
http://hintlink.com/power_density.php
 - c. Excel Spread sheet created by KC2KY

W0JEC MPE Calculator

W0JEC Maximum Permissible RF Exposure Calculator, V 1.5

Enter Antenna and Operating Data

Enter type of antenna. Select the closest description from those shown. If none fits, select "Other Antenna Type"

[Click to Enter Antenna Type](#)

Select the transmission line used from the types listed below.

[Click to Enter Coax Type](#)

Enter Transmission Line Length, feet

Enter Transmitter power (Avg. or Max. PEP), watts

Enter Frequency of Operation, MHz

The effects of ground reflection must be taken into consideration for most if not all antenna configurations and transmitter power levels in order to arrive at valid results when calculating near field power density. Do you wish to include ground effects? Yes No

Estimated distances that must be maintained from your transmitting antenna (in feet) in order to meet FCC power density limits for Maximum Permissible Exposure (MPE):

	Controlled Environment	Uncontrolled Environment
SSB w/o Processor (20% duty cycle)	<input type="text"/>	<input type="text"/>
Conversational CW (40% duty cycle)	<input type="text"/>	<input type="text"/>
SSB w/Heavy Processor (50% duty cycle)	<input type="text"/>	<input type="text"/>
FM/FSK/PSK/RTTY/AFSK/SSTV (100% duty cycle)	<input type="text"/>	<input type="text"/>
WORST CASE (100% duty cycle), w/o transmission line attenuation, w/ground reflection effects	<input type="text"/>	<input type="text"/>

Antenna and Operating Data can be changed by clicking on the data boxes. MPE results must then be recalculated.

Online RF Safety Calculator

Amateur Radio RF Safety Calculator

Calculation Results

Average Power at the Antenna	100 watts
Antenna Gain in dBi	8 dBi
Distance to the Area of Interest	25 feet 7.62 metres
Frequency of Operation	14 MHz
Are Ground Reflections Calculated?	Yes
Estimated RF Power Density	0.2214 mW/cm ²

	Controlled Environment	Uncontrolled Environment
Maximum Permissible Exposure (MPE)	4.5968 mW/cm ²	0.9234 mW/cm ²
Distance to Compliance From Centre of Antenna	5.5392 feet 1.6883 metres	12.3242 feet 3.7564 metres
Does the Area of Interest Appear to be in Compliance?	yes	yes

Interpretation of Results

1. The power value entered into these calculations should be the average power seen at the antenna and not Peak Envelope Power (PEP). You should also consider feedline loss in calculating your average power at the antenna.
2. If you wish to estimate the power density at a point below the main lobe of a directional antenna, and if the antenna's vertical pattern is known, recalculate using the antenna's gain in the relevant direction.
3. Please also consult FCC OET Bulletin 65 Supplement B, the Amateur Radio supplement to FCC OET Bulletin 65. It contains a thorough discussion of the RF Safety regulations as they apply to amateur stations and contains numerous charts, tables, worksheets and other data to help determine station compliance.

[Perform another computation](#)

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http://hintlink.com/power_density.php

KC2KY's Excel Spread Sheet

What's my RF Exposure Level?											
Freq, MHz	P Max, watts	Duty Cycle	Feedline Loss, dB	Antenna Gain, dbi	Ground Reflection?	Height, ft	Distance, ft	P*G, Watts	Exposure (mW/cm ²)	Limit (uncotrolled)	Compliant?
1.8	500	27%	1	0	y	15	0	274.5198379	0.104470488	55.56	Yes
3.5	500	27%	1	0	y	15	0	274.5198379	0.104470488	14.69	Yes
5	50	27%	1	0	y	15	0	27.45198379	0.010447049	7.2	Yes
7	500	27%	1	0	y	15	0	274.5198379	0.104470488	3.67	Yes
10	100	27%	1	0	y	15	0	54.90396758	0.020894098	1.8	Yes
14	500	27%	0.4	3	y	22	0	628.8886167	0.11125788	0.92	Yes
18	100	27%	0.4	3	y	22	0	125.7777233	0.022251576	0.56	Yes
21	500	27%	0.4	3	y	22	0	628.8886167	0.11125788	0.41	Yes
24	100	27%	0.4	3	y	22	0	125.7777233	0.022251576	0.31	Yes
29	500	27%	0.4	3	y	22	0	628.8886167	0.11125788	0.21	Yes
50	100	27%	0.4	3	y	22	0	125.7777233	0.022251576	0.2	Yes
144	25	50%	1.4	3	y	22	0	46.25407266	0.008182896	0.2	Yes
432	25	50%	2.5	3	y	22	0	35.90459054	0.006351949	0.29	Yes
900	0.01	50%	0	0	y	25	0	0.0128	1.75361E-06	0.6	Yes
1296	0.01	50%	0	0	y	25	0	0.0128	1.75361E-06	0.86	Yes

