

RF RADIATION SAFETY CONSIDERATIONS FOR THE CANADIAN AMATEUR

Norm Rashleigh, VE3LC
RAC Vice-President Industrial Liaison

There is an increased perception by members of the public that Radio Frequency (RF) radiation is causing them harm. The sources range from the use of cellphones, RF from computers and WiFi, to the siting of cell towers in residential areas.

The less than complete reporting of these concerns by the media does little to allay public worry. As a consequence, Radio Amateurs with towers and conspicuous antenna installations are becoming a target as something to be feared in neighbourhoods.

With the release of Industry Canada's Client Procedure Circular for "Radiocommunications and Broadcasting Antenna Systems" (CPC 2-0-03), which is obligatory to follow for Amateurs who are erecting a tower and antenna system at a height greater than 15 metres, a consultation process is necessary with Industry Canada, the Land Use Authority (LUA) and your close-in neighbours. The particulars about the installation must be stated in the notice of consultation that includes the subject of RF safety of the proposed installation. Indeed, Industry Canada may call for a complete evaluation of new or existing Amateur installations if there are any RF safety concerns raised by the public.

If you were called on to demonstrate the RF safety based on Health Canada's Safety Code 6, what would you do? This happened recently to an Amateur in Saskatoon and the game plan was not obvious. Industry Canada's response was to seek the services of a professional to do a study and prepare a report. This all resulted when the Amateur erected a new tower with an HF beam and a neighbour complained and raised a concern about an RF radiation hazard.

Of course, very high intensity RF fields are something to worry about and can cause harm to living things. This is caused by the heating effect that we are all familiar with when we cook food in a microwave oven. There may be other long-term risks to health as well, but none have been proven.

When it comes to RF Safety of emissions, however, Amateurs are governed by the same rules as other radio services. This is brought to our attention by reading Section 14 of document "Standards for the

Operation of Radio Stations in the Amateur Radio Service" (RBR-4) where it states that Amateurs must respect environmental considerations in the "Client Procedures Circular" (CPC 2-0-03) when erecting towers and the placement of antennas. In the CPC 2-0-03 document, Section 7.1 states:

"It is the responsibility of proponents and operators of installations (radio) to ensure that all radiocommunication and broadcasting installations comply with Safety Code 6 at all times."

It further states:

"Compliance with Safety Code 6 is an ongoing obligation. At any time, antenna system operators may be required, as directed by Industry Canada, to demonstrate compliance with Safety Code 6 by (i) providing detailed calculations, and/or (ii) conducting site surveys and, where necessary, by implementing corrective measures."

SAFETY CODE 6

Safety Code 6 is a Health Canada document entitled "Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz". This document sets forth the Canadian limits that are considered safe for RF field intensity as averaged over a 6-minute period of time. The limits imposed by

Safety Code 6 are essentially the same as imposed in the USA and stated in FCC document OET Bulletin 65. Both the Canadian and the US standards categorize the limits based on "controlled" and "uncontrolled" environments. There is a stricter limit for RF exposure in the "Uncontrolled" environment as opposed to the "Controlled" environment.

The Controlled exposure limits are for those that have control over their RF environment, such as RF workers or operators of 2-way radio, as a matter of their occupation or avocation. The uncontrolled environment, with its stricter exposure limits, is for the General Public where they do not necessarily have control of the RF sources in their midst. Although not categorically stated in the Canadian rules, in the United States the limits or exposure for Radio Amateurs operators and their family is based on a "Controlled" environment, but across the Amateur's property line, the stricter limits for an "Uncontrolled" environment come into play. In addition, a controlled environment should not be accessible by the General Public which means that Amateurs should have fences if their emissions do not meet the stricter limits.

The following tables are taken from Safety Code 6 and show the limits for Controlled and Uncontrolled environments in Electric and Magnetic Field Strength as well as Power Density:

Exposure Limits for RF and Microwave Exposed Workers

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m ²)	5 Averaging Time (min)
0.003-1	600	4.9		6
1-10	600/f	4.9/f		6
10-30	60	4.9/f		6
30-300	60	0.163	10*	6
300-1 500	3.54 f ^{0.5}	0.0094 f ^{0.5}	f/30	6
1 500-15 000	137	0.364	50	6
15 000-150 000	137	0.364	50	616 000 / f ^{1.2}
150 000-300 000	0.354 f ^{0.5}	9.4 x 10 ⁻⁴ f ^{0.5}	3.33 x 10 ⁻⁴ f	616 000 / f ^{1.2}

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, *f*, is in MHz.
 2. A power density of 10 W/m² is equivalent to 1 mW/cm².
 3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (µT) or 12.57 milligauss (mG).

Exposure Limits for Persons Not Classified As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m ²)	5 Averaging Time (min)
0.003-1	280	2.19		6
1-10	280/f	2.19/f		6
10-30	28	2.19/f		6
30-300	28	0.073	2*	6
300-1 500	1.585f ^{0.5}	0.0042f ^{0.5}	f/150	6
1 500-15 000	61.4	0.163	10	6
15 000-150 000	61.4	0.163	10	616 000 / f ^{1.2}
150 000-300 000	0.158f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616 000 / f ^{1.2}

* Power density limit is applicable at frequencies greater than 100 MHz.

- Notes: 1. Frequency, *f*, is in MHz.
 2. A power density of 10 W/m² is equivalent to 1 mW/cm².
 3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

FCC Table that sets limits for Transmitter Power to allow exemption of American Amateurs from RF Safety evaluation

BAND WAVELENGTH	TRANSMIT POWER (WATTS)
MF BAND	
160m	500
HF BANDS	
80m	500
40m	500
30m	425
20m	225
17m	125
15m	100
12m	75
10m	50
VHF (all bands)	50
UHF BANDS	
70cm	70
33cm	150
23cm	200
13cm	250
	250
SHF (all bands)	250
EHF (all bands)	250

For frequencies below 100 MHz, the limits are specified in terms of electric ("E") and magnetic ("H") field strengths. In the near-field distance to the antenna (i.e., within 1-2 wavelengths of the antenna), the way the fields behave is very complex and is not easy to model or solve by calculations. For this reason, evaluations normally have to be dependent on actual "E" and/or "H" field measurements. These measurements can be

complex in themselves requiring a good and comprehensive methodology with well-calibrated equipment that is usually beyond the practice and affordability of most Amateur Radio operators. The other difficulty in performing a comprehensive Safety Code 6 evaluation of an Amateur Radio station is that each different band, antenna and mode which is used should be evaluated independently to be thorough about the full activities of the station.

In the US, the FCC allows American Amateurs exemption from RF safety evaluations providing transmit power does not exceed the limits in the following table. This table can be found in the FCC OET 65 document. Unfortunately, no such table exists in the Canadian Amateur Radio rules at the present time. This is something Radio Amateurs of Canada intends to take to Industry Canada for consideration for inclusion into the Canadian rules. Such a change would make it easy for both Industry Canada and Canadian Amateurs to determine compliance for 90% of Amateur station installations. Indeed, such a table already exists for the deployment of AM Broadcasting stations as seen in Industry Canada document "BRP-1".

AMATEUR PORTABLE OPERATION

Portable radios are typically operated in the very near-field of the operator. When using a handheld portable, the radio and antenna system can be within a centimetre of the person and are typically used close to the operator's face and one of the most sensitive parts of the anatomy to heating is the eye. Most Amateur portables can operate at 5 or 6 watts, a significant amount of power that can easily illuminate a fluorescent tube held nearby as the photo below demonstrates.



Amateur portable and mobile equipment is not unlike equipment used in other services. One big difference, however, is that equipment for other services must meet standards for certification governed by specific "Radio Standard Specifications" (RSS) issued by Industry Canada. Amateur equipment, however, is exempt from these requirements. For instance, the standard that is required for all Land Mobile equipment is RSS 119. Most RSS standards call for compliance to the

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requirements of yet another document "Radio Frequency Exposure Compliance of Radio Frequency Apparatus – All Frequency Bands" (RSS 102).

For portable radio equipment, because of the near-field usage application, the only way to effectively evaluate RF safety is by using a SAR (Specific Absorption Rate) test. Fortunately for Amateur equipment, it is exempt from these RSS certification requirements by Industry Canada. If such testing and certification was imposed, it would likely add considerably to the cost of Amateur gear.

Although Amateur portable equipment is exempt from SAR testing, it is worth noting that such testing for RSS 102 certification is based on a distance separation from one's face of 2.5 centimetres and a transmit/receive duty cycle of no more than 50% in any 6-minute period. It is probably wise to operate the radio within such limitations.

As a matter of interest, Safety Code 6 and RSS 102 call for limiting the heating effects of near-field RF radiation on simulated body tissue according to the tables provided in the box at the right.

RADIO FREQUENCY SAFETY CALCULATORS

There are several RF Safety Calculators that can be found by a Google search on the Internet. All of the calculators I have discovered use the same formulas for the determination of Power Density and all are based on plane wave far-field evaluations.

The calculators are typically based on formulas that can be found in FCC document OET 65. If these calculators are applied to near-field situations, the result should be very conservative.

One nice calculator presentation can be found at www.wirelessconnections.net/calcs/rfsafety.asp.

SAR Limits, General Public / Uncontrolled Environment

Body Region	Average SAR (W/kg)	Averaging Time (minutes)	Mass Average (g)
Whole Body	0.08	6	Whole Body
Localized Head and Trunk	1.6	6	1
Localized Limbs	4	6	10

SAR Limits, Occupational Use / Controlled Environment

Body Region	Average SAR (W/kg)	Averaging Time (minutes)	Mass Average (g)
Whole Body	0.4	6	Whole Body
Localized Head and Trunk	8	6	1
Localized Limbs	20	6	10

CONCLUSIONS

Most Amateur Radio installations and operations using modest power levels and a low gain antenna should pose no concern when it comes to RF safety. Nevertheless, under the current rules imposed by Industry Canada, Amateurs may be called upon to show proof that their installations conform to the limits of RF exposure permissible to the General Public, especially if a neighbour complains about a new or existing antenna installation. As a consequence, all Canadian Amateurs should be well aware of the contents of Canada's Safety Code 6 and other related documents I have listed below for reference. In addition, to play it safe when using handheld VHF and UHF portables, keep the TX time to less than 3 minutes in any 6-minute period and the radio antenna at least 2.5 cm from your head.

REFERENCES

These references are typically available by a search on the Internet.

1. Health Canada: Safety Code 6 – Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Radio from 3 kHz to 300 GHz
2. Industry Canada: GL-02 – Guidelines for the Protection of the General Public in Compliance with Safety Code 6
3. Industry Canada: RBR-4 – Standards for the Operation of Radio Stations in the Amateur Radio Service
4. Industry Canada; CPC-2-0-03 – Radiocommunications and Broadcasting Antenna Systems
5. FCC: OET 65 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

6. FCC: OET 65, Supplement B – Same as 5 above but with "Additional Information for Amateur Radio Stations"

7. Industry Canada: RSS 102 – Radio Frequency (RF) Exposure Compliance of Radiocommunications Apparatus (All Frequency Bands)

- ARRL hard copy publication: *RF Exposure and You*, by Ed Hare, W1RFI
- *CQ Magazine*, November 2010, Article by W5YI – "Complying with the FCC's RF Safety Regulations"

POSTSCRIPT

Hot off the Press: The following reference material has just been released by Industry Canada (February 15, 2011) and has otherwise not been mentioned or considered in this article. These documents are well worth review by Amateurs involved in matters of Safety Code 6 evaluation.

TN-329 – "Safety Code 6 (SC6) Measurement Procedures (Uncontrolled Environment): The purpose of this technical note is to describe measurement procedures for different types of radiocommunication and broadcasting installations when verifying compliance with the "uncontrolled environment" (public exposure) limits as set out in SC6.

TN-261 – *Safety Code 6 (SC6) Radio Frequency Exposure Compliance Evaluation Template (Uncontrolled Environment Exposure Limits)*

The purpose of this document is to provide an evaluation tool to quickly assess the radio frequency (RF) exposure compliance of simple antenna sites.

Both of these new documents are available at www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01751.html.

TCA