EMCAB-2: DOES IT MEAN QRP OPERATION FOR CANADIAN AMATEUR URBANITES?

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In the March/April 2011 issue of TCA, I presented a discussion about RF Safety and Safety Code 6. This was one of the environmental considerations that should be part of the notification and consultation process when considering a radio station and tower installation according to Industry Canada document **CPC-2-0-03** entitled "**Radiocommunication and Broadcasting Antenna Systems**". According to the same Client Procedures Circular (CPC), the following is also stated in **Section 7.2**:

Radio Frequency Immunity:

"All radiocommunications and broadcasting proponents and existing spectrum users are to ensure that their installations are designed and operated in accordance with Industry Canada's immunity criteria as outlined in EMCAB-2 [1] in order to minimize the malfunctioning of electronic equipment in the local surroundings."

The EMCAB -2 document sets the Radio Frequency field strength levels that, when measured in the environment of the equipment suffering interference, determines fault and responsibility for the interference. In the words of the Industry Canada document:

"If the level of the transmitted signal exceeds the applicable field strength value on the premises of the affected equipment, it will be deemed that the transmission is the cause of the problem. If the field strength is less than the applicable value, the affected equipment's lack of immunity will be judged the cause."

Type of Equipment	Field Strength Criterion in volts/metre (V/M)
Broadcasting Receivers	1.83
Associated Equipment	1.83
Radio-Sensitive Equipment	3.16

Unfortunately, for the Radio Amateur this is a potentially onerous policy because of the relatively low threshold levels where the fault swings against the radio transmitter operator. EMCAB-2 seems to be uniquely Canadian and sets the criteria as shown in the above table.

There are two levels set forth by Industry Canada dependent on the type of equipment that may suffer interference. The term "Broadcasting Receivers" seems clear enough in definition. However, according to the EMCAB-2 document, the term "Associated Equipment" applies to other home entertainment equipment that includes: Video Recorders; Audio Tape Recorders; Cable Television Broadcasting Converters; Audio Amplifiers and Compact Disc Players; and equipment that may or may not have a broadcast receiving component.

The term "Radio Sensitive" equipment covers all other equipment that does not have association with broadcast receiving; this may include home alarm systems, telephone sets, electronic control for home heating and air conditioning, and so on. This list evolves constantly as new applications for electronic controlled apparatus are applied into everyday living.

As a comparison to the Safety Code 6 [2] field intensity levels, we note in the following table the very large difference to those of EMCAB-2 which is several orders of magnitude less. In addition, note that the EMCAB-2 levels do not change with frequency as do the levels for Safety Code 6.

ANOTHER CPC DOCUMENT TO PAY ATTENTION TO

As a companion document to EMCAB-2, Industry Canada subsequently released **CPC-3-14-01** [3] entitled "**Determinations of Harmful Interference with Respect to Radio-Sensitive Equipment**"; this is also recommended reading for Canadian Amateurs. In this document, Industry Canada discusses their policy with respect to determination and intervention on Radio Sensitive Equipment interference matters.

In **CPC-3-14-01**, the Department states it ***"fully expects complainants and operators of radio transmitters to cooperate with each other to resolve radio-sensitive equipment problems."***

This may mean trying to increase equipment immunity by way of adding chokes and filters and/or modifying the radio station antenna configuration or decreasing transmitter power. The document also states: ***"Radio operators are encouraged to work with complainants in resolving problems without recourse to the Department."***

Amateur Band	Safety Code 6 RF Field Level Criterion for safety of the General Public as averaged over 6 minutes Units = volts/metre	EMCAB-2 RF Field Level Criterion for Interference Immunity for Broadcast Receivers Units = volts/metre	EMCAB-2 RF Field Level Criterion for Interference Immunity for Radio-Sensitive Equipment Units = volts/metre	Difference in Columns 2 & 3 Units = dB (rounded)	Difference in Columns 2 & 4 Units = dB (rounded)
160 metres	155	1.83	3.16	39	34
80 metres	80	1.83	3.16	33	28
40 metres & 30 metres	40	1.83	3.16	27	22
20 to 1.25 metres	28	1.83	3.16	23	19
70 centimetres	33	1.83	3.16	25	20

As a last resort, Industry Canada may decide to make a determination of harmful interference based on the field strength values identified in EMCAB-2. If it is determined there is excessive field strength from the radio transmissions, Industry Canada states the operator may be imposed ***"such terms and conditions that include, but are not limited to, limiting the user's radiated power, hours of operation or choice of operating frequencies. In extreme cases, it may result in suspension or revocation of the user's authorization."***

AMOUNT OF TRANSMIT POWER WHILE BEING COMPLIANT WITH EMCAB-2?

What does all this mean in terms of the amount of power an Amateur station can run and still have reasonable assurance the amount will not exceed the RF Field intensity levels of EMCAB-2 for which the Amateur operator station is judged responsible for broadcast receiver interference?

Well, as a very rough determination, we can apply the formula for the amount RF Field Strength potential difference in free-space between two points, 1 metre apart, designated as (**E**) in volts(rms)/metre; this from a radiating source knowing the Power (**P**) of the transmitter in watts, knowing the linear Numeric Gain (**G**) of the antenna (not in dB) and knowing the distance from the radiating antenna in metres (**D**). Note that the gain of the antenna (**G**) is referenced to an isotropic radiator having a Numeric Gain of 1.

As is typically the case, antenna gain is often given in dBi (referenced to an isotropic radiator), but may also be presented as dBd (referenced to a dipole). Note that 2.15 dBi = 0 dBd and, therefore, when determining the value of (**G**), the base dB reference may have to be changed before conversion to linear (numeric) gain for the purpose of applying the formula below. Also, the gain of the antenna should include any losses between the transmitter and antenna such as feedline loss.

The formula is as follows:

$$E = \frac{\sqrt{30 \times P \times G}}{D}$$ [4]

This is an accepted equation by the International Telecommunication Union (ITU) derived from first principles.

For determining the antenna system Numeric Gain (**G**), apply the notion that every doubling (or halving) of the Numeric Gain equates to approximately 3 dB with a base of 0 dBi = a Numeric Gain of 1. Therefore, 3 dBi = a Numeric Gain of 2; 6 dBi = a Numeric Gain of 4; 10 dBi = a Numeric Gain of 10; and 13 dBi = a Numeric Gain of 20 and so on.

The preceding formula does not take into consideration ground reflections which will likely not apply to close-in situations for the low frequency bands. In addition, calculations of this type should only be used in the far-field at least 2 wavelengths away from the source of radiation. Notwithstanding, it is accepted that the far-field may not be fully developed for at least 5 to 7 wavelengths from the source.

So let's apply the formula to a likely situation of an Amateur station using a 7 dBi Ringo Ranger 2 metre antenna at rooftop level. There is approximately 3 dB of feedline and connector loss and the transmitter is operated at 50 watts. With the feedline loss, the effective gain of the antenna is now reduced to 4 dBi; this equates to a Numeric Gain of 2.5. The next door neighbour's house is a two-story dwelling and is less than 15 metres away from the Amateur antenna.

For the sake of this determination, we will consider an example in the far-field of radiation on the 2 metre band. The neighbour complains of clicking and blockage of function on their computer speakers when the Amateur is transmitting on FM. Because it is FM, no modulation recovery is noticed. The computer workstation is located on the second floor of the neighbour's house, just below the height of the Amateur's antenna. Based on the EMCAB-2 document criteria, is the Amateur at fault or is it a lack of RF immunity of the computer speakers?

Let's apply the formula to determine the Field intensity in volts(rms)/metre:

$$E = \frac{\sqrt{30 \times 50 \times 2.5}}{15} =$$

4.09 volts per metre

In this example, the prediction suggests the Amateur's transmission is creating a field in excess of the EMCAB-2 criteria for radio-sensitive equipment and if Industry Canada is called in to access blame based on their "measurements", typically across the Amateur's property line, the Amateur may be cited and ordered to reduce power or adjust the configuration of the station or even to cease operation.

In another example, an Amateur uses a modest beam antenna on 20 metres with 5 dBi gain including feedline losses. The Amateur typically runs 100 watts of RF power. What distance is his zone of compliance where the field intensity is not likely to exceed the EMCAB-2 criteria for Broadcast receivers, 1.83 volts/metre?

Using the formula:

$$D = \frac{\sqrt{30 \times P \times G}}{E}$$

Then:

$$D = \frac{\sqrt{30 \times 100 \times 3.2}}{1.83} =$$

53.54 metres or approximately 176 feet

This determination should be reasonably accurate as the distance calculated is more than 2 wavelengths on the 20 metre band and therefore considered in the far-field from the radiation source.

In both of the examples presented, the Amateur is running only modest power that is the typical output of most VHF and HF Amateur transceivers.

INDUSTRY CANADA MEASUREMENT METHODOLOGY

Although we have provided an equation for determining RF Field Strength, it is based on simple free-space propagation and may only give a ballpark figure. Actual measurements are necessary to make an accurate determination of field strength and may vary considerably from point to point in the environment in question.

Generally, if Industry Canada is called in to make measurements, they should follow a defined Internal Procedure that defines the methodology and instrumentation. Such measurements in high profile and complex situations may be carried out by contracted engineering practitioners.

To provide guidelines in the methodology for RF Field Strength measurements, Industry Canada has released document **GL-01** [5], entitled **"Guidelines for the Measurement of Radio Frequency Fields at Frequencies from 3 kHz to 300 GHz".** This document can also be applied to measurements to determine Safety Code 6 compliance.

In addition, more specific to carrying out measures for EMCAB-2, Industry Canada has an Internal Procedure Circular (IPC) **IPC-3-14-01** [6] which is not readily available to the general public, but it should be available to interested parties through an "access for information request" to your local Industry Canada office.

This document provides a detailed procedure for conducting field strength testing using a grid of measurements making the determination based on the mean of the measurements plus adding the standard deviation between the measurement values. The procedure specifies that the measurements may be made "inside" or "outside" the premises depending on circumstances. A slightly different procedure and grid pattern is specified for each. It is interesting that all the examples given in the IPC document relate to HF Amateur Radio frequencies.

COMMENTARY

In releasing EMCAB-2 back in 1994, the Department took the position they would not impose any significant level of RF interference tolerance on common electronic equipment. Such interference energy is typically conducted into the equipment by associated external wiring acting as an antenna. The battle against the EMCAB-2 levels as being too low was fought years ago by RAC through its representation at the Radio Advisory Board of Canada (RABC). At the time, Ralph Cameron, VE3BBM, served as the Chairman of the RABC's Electro-Magnetic Compatibility (EMC) Committee and the proposed EMCAB-2 document was foremost on the agenda.

The only salvation nowadays is the majority of the domestic equipment is digital and, therefore, must be certified under Industry Canada document **ICES-003** [7] (entitled **"Interference-Causing Equipment Standard"** for **"Digital Apparatus"**) protecting against excessive conducted and radiated RF outbound interference. Such protection, in the form of ferrite RF chokes applied to equipment input and output cables, provides the benefit that the equipment is likely to be more tolerant to higher RF Fields than those specified by EMCAB-2 by virtue of much improved conduction suppression. Nevertheless, **ICES-003** applies to "Digital Equipment" and does little for equipment that is solely analog.

CONCLUSION

As you can see from the scenarios presented in this article, Amateurs who are living on small residential lots may not be able to run much more than 5 or 10 watts QRP without running the risk of exceeding the field intensity criteria set out in EMCAB-2 – and therefore may cause interference to a neighbour's electronic organ or other overly radio-sensitive equipment. This is especially likely when limited space requires that the Amateur's antenna wires must be tied down to fences on the property line.

Of course, tall towers would provide a solution by keeping RF fields up and out of the way of susceptible equipment but that has its own set of other problems with municipalities and evokes the provisions of **CPC 2-0-03**. Perhaps the best way to avoid causing interference when operating increased power is to buy a nice rural property with no neighbours nearby and everybody will be happy – except possibly the family members that live with you.

REFERENCES

[1] *Industry Canada EMCAB-2 document entitled "Criteria for Resolution of Immunity Complaints Involving Fundamental Emissions of Radiocommunications Transmitters": <www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01005.html>*

[2] *Health Canada Safety Code 6 document entitled "Limits of Human Exposure to Radiofrequency Electromagnetic Field in the Frequency Range from 3 kHz to 300 GHz": <http://aolab.phys.dal.ca/~tomduck/ temp/safety_code_6.pdf>*

[3] *Industry Canada, CPC-3-14-01, entitled "Determinations of Harmful Interference with Respect to Radio-Sensitive Equipment": <www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01383.html>*

[4] *ITU-R Recommendation P.525-2 document entitled "Calculation of Attenuation in Free-Space": <www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.525-2-199408-I!!PDF-E.pdf>*

[5] *Industry Canada, GL-01, entitled "Guidelines for the Measurement of Radio Frequency Fields at Frequencies from 3 kHz to 300 GHz": <www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01451.html>*

[6] *Industry Canada, IPC-3-14-01, entitled "Determinations of Harmful Interference with Respect to Radio Sensitive Equipment (RSE)". This document is not published on the Internet but should be available from Industry Canada through an access for information request.*

[7] *Industry Canada, ICES-003, entitled "Interference-Causing Equipment Standard" for "Digital Apparatus": <www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/ices003e.pdf/$FILE/ices003e.pdf>*

ABOUT THE AUTHOR

Norm Rashleigh obtained his Amateur Radio Certificate in 1963 holding the call sign VE3DVF which he still holds today. A year later, he obtained his Advanced Amateur Certificate.

Since 1990, he has held VE3LC which was formerly held by Maurice Haycock, a famous and accomplished Canadian geologist, Arctic explorer and painter (www.haycock.ca). Norm is now retired following a 36-year career in mobile radio engineering with CN Telecommunications and the RCMP where he was a promoter of Amateur Radio to engineering work-term students.

Norm's Amateur Radio interests have been an eclectic mix of all the hobby offers. Currently, he can be found participating in contests operating QRP CW. Norm is married to Ginette and has two adult children.

Norm is a member of the ARRL, the QCWA (chapter 70) and RAC where he presently serves as the Vice-President Industrial Liaison. He is also an advisor to The Canadian Amateur magazine.

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