Helping Amateurs Interact with Neighbors Asking About Radio Transmissions

Developed by members of the RF Safety Committees from ARRL, RSGB, IRTS and SSA

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INTRODUCTION

Sometimes neighbors might show interest in knowing more about their exposure to your amateur radio signals (sometimes referred to as electromagnetic fields or EMFs) and might ask questions about your station. This guide is intended to provide useful information to you, based on regulations and scientific consensus, that can be helpful when responding to many of these questions. Radio amateurs who understand the facts, are usually better equipped to answer questions from the inquiring neighbor while maintaining a friendly relationship.

As a prerequisite to answering questions about your station, you should be aware of relevant regulations, have reviewed the design of your station, and confirmed that the radio waves emitted can't result in exposures above the regulatory levels. This puts you in an excellent position to answer questions about your station. If, however, you have not yet assessed compliance of your station when confronted by a neighbor, then you should be prepared to indicate that you will be doing so momentarily and will let your neighbor know the results when completed.

If you are responsible in this way and operate your station in compliance with the relevant regulations, then your station is safe.

Some key points in being responsibly prepared to respond to queries are:

- Be sure that the amateur radio station about which the neighbor has questions has been evaluated for EMF exposure compliance.
- Be prepared to offer the results of the evaluation to the neighbor.
- If the station has not been evaluated for compliance, be prepared to indicate that the licensee will evaluate it soon and will provide the results to the neighbor.
- Be able to contrast the relevant exposure limit to the maximum strengths of the amateur radio station.
- Be fluent with terminology for specifying units of RF exposure such as electric and magnetic field strengths and power density and averaging time.
- Be prepared to comment on the margin of safety inherent to the RF exposure limits.
- Have a point of contact with the local jurisdiction regulatory authority to provide to the neighbor if they have additional questions about exposure.

Having established that your station is compliant and hence safe, the rest of this document is in the form of several frequently asked questions (FAQs) that will help you in understanding why and how your conclusion on safety can be shared with others. Each FAQ includes an example answer that you can adapt to respond to the question in a way that you are comfortable with. Following the FAQs is some additional background material that can help you in thinking about how to respond to various inquiries. An extensive glossary of helpful terms and abbreviations is provided at the end.

FREQUENTLY ASKED QUESTIONS

Are radio amateurs required to comply with any government regulations for safety?

- Yes, radio amateurs must comply with relevant safety regulations, including for EMF exposure. The applicable EMF exposure regulations must be followed.

Background:

References to the regulations in different countries can be found at the end of this document.

Are amateur radio stations safe for me and my family?

Amateur radio stations are safe because….

- By law, radio amateurs like me must have a permission to operate issued by the government. (This permission is commonly in the form of a license.) To get such permission requires me to comply with strict national and international safety regulations and guidelines. These guidelines include a significant safety factor to help assure that exposure will never be harmful.
- I had to study many radio subjects, including safety, to pass the official exam before I got my permission (license) to transmit.
- My amateur radio station is designed and operated to comply with relevant safety regulations.
- When transmitting, radio waves emitted from the antenna travel around the world so that I can communicate with other radio amateurs. It all works just like the normal radios that have been used for listening to the news and music for over a hundred years. The fact that my amateur radio station complies with the radio exposure regulations ensures that the radio waves at your home are safe.

Background:

EMF exposure limits have been recommended by highly respected national and international organizations for decades. In Europe, they are published by ICNIRP [3]; in the USA by the IEEE [24]. Telecommunication regulatory agencies such as, for example, the FCC in the USA, Ofcom in the UK, ComReg in Ireland, and SSM in Sweden have implemented these recommendations into legal requirements that apply to amateurs and other users of transmitting equipment.

Around the world, scientists, engineers, biologists, and medical professionals continue literature surveillance on the topic to help ensure that the existing standards and guidelines are adequate for protecting health.

More can be read about it in official publications and statements by national and international health and safety organizations [4].

Do radio waves from an amateur station get into in my house?

- Just like broadcast radio and TV, some signals from my station are found everywhere including in nearby homes. However, my primary interest is transmitting radio signals a long distance away, not into nearby homes.
- The levels found in your home or on your property are below the relevant safety limits and usually significantly below those limits.

Background:

Transmitting antennas produce radio waves around them. That is the purpose of an antenna, but each antenna has its own specific characteristics. The antenna's transmission pattern can increase signal strength in certain directions and reduce signals to and from other directions. Such directionality enhances the ability to communicate with far-away amateurs. This means that most amateur radio stations use antennas, like mine, that do produce transmissions that are directional, but the intended purpose of the directional antennas is not to cause intense radio waves in nearby homes. In fact, in many cases the amateur radio station signal strength in a nearby home is reduced depending on the pattern characteristic of the antenna. My main interest is in communicating effectively with a remote amateur station.

How much exposure am I getting from your amateur radio station?

- Not very much, and always less than permitted/regulated in accordance with exposure regulations. My purpose in using my amateur station is to communicate with people far away, or even on the other side of the world, rather than to "expose" people or objects close to my station.

- The actual level of exposure depends on a number of factors but decreases quickly with increasing distance from the antenna and the percentage of time during any half-hour period that the transmitter is actually operating. Unlike radio and TV broadcast stations, amateur signals are not present continuously and the average level is what is important for compliance with health protection limits.

- My station assessment shows that the highest exposure levels that could result from my station are below the regulatory limits.

Background:

To be credible, it is important that the radio amateur has assessed their station to the extent that they can claim to be compliant with their relevant regulations or exposure guidance. If an assessment shows that the exposure in publicly accessible areas could exceed the limits, mitigation measures must be implemented to eliminate this possibility.

Does exposure to your amateur radio transmissions need to be reduced?

- No, there is no need to further reduce the field strength of transmissions. I have assessed my radio station and shown its operation to be compliant with relevant EMF exposure regulations that are based on best science and engineering practices.

- Once safe, further reductions will not make exposures any safer.

- If you are still concerned about the exposure limits, remember that the limits have been agreed on to be reasonable by the majority of the world's scientific community .

Background:

See concepts section below.

CONCEPTS USEFUL IN COMMUNICATING ABOUT EXPOSURE TO AMATEUR RADIO SIGNALS

Regulations relative to electromagnetic fields (EMFs)

There are regulations that must be followed to help ensure no one is exposed to RF levels (radiofrequency fields) that are harmful. Radio amateurs are not responsible for the content of these regulations but are required to adhere to them like a broadcaster, wireless operator, or manufacturer does.

For amateur radio transmissions, various countries have different regulations that might range from a requirement that the amateur radio licensee simply be aware of specific EMF exposure regulations and abide by them to requirements that, on request by the regulator, the licensee is able to show an analysis or evaluation that demonstrates expected compliance of their station. [7], [8], [9], [11], [14], [15], [17], [18]

The regulations on exposure are very detailed and set limits on the maximum strengths as well as time- and spatially- averaged values of the radio waves at frequencies across the electromagnetic spectrum. These regulations assure sizable margins of safety so that exposure limits are always less than the exposure level above which established adverse health effects might occur. Internationally, a safety factor of 50 is applied for the general population, such as a neighbor, who may be unaware of potential EMF exposure. For workers and others who are subject to safety programs, a smaller safety factor of 10 is applied. When it comes to potential exposure of a neighbor, amateur radio licensees are required to abide by the more restrictive exposure limits that apply to members of the public.

EMF regulations in most countries are based on more than a half-century of scientific research by specialists in engineering, physics, biology, and medicine. These specialists continue to perform investigations and publish their findings in the scientific literature and continue their surveillance of that literature to identify new research findings that might influence refinements to the exposure limits and how compliance can be tested.

A number of information sources about exposure regulations and standards at the end of this document provide background that can help you formulate responses to inquiries about exposure to amateur radio signals.

Some basic RF field terminology

When discussing concerns over possible RF health effects, the concept of RF exposure can be confusing, particularly to those who are not familiar with radio waves. This is because of the different ways that RF fields can be characterized, and what might be perceived as arcane terminology associated with RF fields. Exposure to an RF field can be described in terms of the electric field strength (E, V/m), the magnetic field strength (H, A/m) and the plane wave equivalent power density (S, W/m^2 or mW/cm^2). These values are usually provided in any regulatory information related to limiting RF exposure of people. Further technical details on all these quantities is available [13], [25].

Should a discussion with your neighbor become entangled with various ways of expressing their exposure to your station, be sure that you can help the neighbor recognize that different units of measure can be used to describe exposure levels.

The glossary at the end of this document includes many terms that are found in scientific and engineering documents.

Know your station before you talk about it

You must have a properly performed exposure assessment before talking to your neighbor [12].

The assessment must show that your station is operated in compliance with the regulatory limits, hence, is deemed to be safe. You can choose to share the assessment with your neighbor.

Proximity of the transmitting antenna relative to a neighbor's home and its height above ground affect potential exposure.

Prepare to explain what amateur radio is about

When interacting with neighbors, you should offer to answer any questions about your station and respond to any interest that the neighbor might have about amateur radio in general.

Amateur radio has many facets, and it is useful to stand back and look at the hobby from an outsider's perspective and see what might help a neighbor respect the hobby. It can be helpful if any discussion that might ensue addresses some of the following thoughts:

- What is amateur radio?
- How does amateur radio work?
- What is radio frequency?
- How does amateur radio use radio frequencies for communication?
- Are there different types of amateur radio stations?
- Amateur radio provides communications in emergencies.

Your national amateur radio society will have material to help you cover these points ([20], [21], [22], [23]).

Things to consider when engaging

Effective interaction with another person depends importantly on the state of mind of you and that individual, any past relationship with the person, and the level of knowledge that both you and your neighbor have. A level of trust and empathy needs to be established, so that what you tell your neighbor can be seen as trustworthy.

If confronting a neighbor who is angry, acknowledge their concern. Explain that you understand that they are worried that the signals from your station might be harmful and that you want to explain what you know about why your signals are not harmful. But, first, give your neighbor a chance to express their concerns. Don't talk down to them and never assume an attitude of superiority.

When confronted by someone who has preformed strong beliefs on the subject of EMF health effects, it's best not to argue. Some individuals may not accept the idea that exposure regulations offer sufficient protection. In this case, there is generally little benefit in entering into an argument. For instance, the person may believe they have "researched" the matter fully; in such cases explaining that they are misinformed will likely be problematic and is best avoided. Nonetheless, helping your neighbor to understand that the existing exposure regulations are based on a wide scientific consensus is an important point to convey. To such people you might respond:

"As an amateur radio operator, I trust the regulations and the supporting science that keep me and my family safe, and which also keep you and your family safe."

There are a number of example reputable information sources at the end of this document including guidance on risk communication [19].

There are reputable sources of information but also beware of unreliable information

There are numerous reputable agencies that have reviewed and interpreted the scientific evidence relating to exposure to EMF. Several such references are listed at the end of this article. The main conclusion of these reviews is that if the levels of exposure to RF fields are below defined limits, then such exposures should be regarded as "safe". This position has been expressed by almost 100 health and safety organizations/agencies around the world [4].

Unfortunately, some individuals and organizations have selectively interpreted information in a way that is intended to alarm people and raise concerns that there are or may be health impacts from very low-level exposure to RF energy. However, these viewpoints have failed to convince the health and safety organizations that have united around the present guidelines.

It is also worthy of note that some of these information sources are associated (directly or indirectly) with some product that is being sold and which it is claimed will mitigate a "problem." It is therefore challenging to discern between Internet hype and the best understanding of a complex situation. Insight to whether these claims are valid can sometimes be gained by considering: *If the asserted health "problem" didn't exist, would there be any market for the product*? Then consider if any claim of "independence" in the "scientific proof" of the health "problem" makes sense, or might it be an enticement to buy a product from them?

Belief vs understanding - what does "safe" mean?

Science is about questioning and testing. It aims to come up with theories and then seeks ways to test them. As such, good scientific studies commonly present conclusions that include an expression of uncertainty in the findings that may lead to statements such as, "*more work needed*", "*next investigation should look at*..." etc. It is important to note that in scientific discourse these reservations are regarded as sensible and proportionate and do not detract from the major conclusions of the study.

In complete contrast, in everyday life, most people just want to know the answer as simply and concisely as possible and find it challenging to deal with uncertainty. Any idea communicated with confidence and lack of doubt is readily perceived as being accurate and is often believed to be the "truth" – irrespective of the scientific basis. This is how misinformation and oversimplification can result in a widespread belief that something is factual when the real evidence is to the contrary or nuanced.

Radio amateurs must understand that the current EMF exposure limits are the result of exhaustive scientific investigations and analyses over several decades. However, as already noted above, the conclusions of scientific reports generally express some level of uncertainty. Because of that, and based on the scientific consensus, regulations include a considerable safety factor. Essentially, regulations give assurance that amateur radio is safe beyond any reasonable doubt.

Determining RF field strengths.

Amateur station EMF evaluations are generally not based on measurements because reliable test equipment is very expensive and requires training to be used properly. Most evaluations are based on a computer assessment in which theoretical estimates of EMF levels are obtained using various assumptions. These calculations are carried out in a conservative way to help ensure that the exposure limits are not exceeded.

Whether you or your neighbor want to perform measurements of EMF levels, it is important to be aware that less expensive instruments that may not be used properly usually lead to unreliable results.

REFERENCES

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[4] IEEE: IEEE list of statements from 92 national/international health agencies: Statements from Governments and Expert Panels Concerning Health Effects and Safe Exposure Levels of Radiofrequency Energy (2010-2022). Institute of Electrical and Electronics Engineers. https://www.ices-emfsafety.org/publications/expert-reviews/

[5] ITU: International Telecommunications Union EMF guide: https://www.itu.int/en/ITU-T/emf/Documents/Introduction%20to%20the%20ITU%20EMF%20Guide%20%2817%2012%2014%29.pdf

[6] WHO: World Health Organization international EMF project https://www.who.int/initiatives/the-international-emf-project

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[19] Risk communication website (Peter M. Sandman) https://psandman.com/

[20] USA – ARRL: website https://www.arrl.org/

[21] UK – RSGB: website https://rsgb.org/

[22] Ireland – IRTS: website https://www.irts.ie/

[23] Sweden – SSA: website https://www.ssa.se/

[24] IEEE – EMF standards available free of charge (subject to sign up) via “GET program” e.g., IEEE Std C95.1™-2019, IEEE Std C95.3™-2021, IEEE Std C95.7™-2022 https://ieeexplore.ieee.org/browse/standards/get-program/page/series?id=82

[25] FCC Office of Engineering and Technology, Bulletin No. 65, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields”, and Supplement B, “Additional Information for Amateur Radio Stations” These documents are available by clicking on the appropriate links at https://www.fcc.gov/general/oet-bulletins-line

GLOSSARY of TERMS and ABBREVIATIONS

BR: basic restriction, a term used for the maximum permitted exposure in terms of SAR from a transmitted signal as a function of frequency. Expressed in physical quantities that are related to established adverse health effects of RF.

ComReg: Commission for Communications Regulation, Telecommunication Regulation Ireland.

DRL: dosimetric reference level, a term used for the maximum safe energy absorption rate (e.g., SAR).

EMF: Electromagnetic Field, also called “RF” and “Microwaves” for amateur radio use. The means by which energy is transmitted from your antenna, some of which can be absorbed in people.

emissions (transmissions): Radiated radio frequency energy from a transmitting source, commonly associated with the radio signal transmitted from an amateur radio station antenna. Radiated RF energy might originate from the element(s) of the antenna, the antenna transmission line feeding the antenna or parts of the transmitter output circuitry including antenna tuners.

ERL: exposure reference level, a term used for maximum permitted exposure from a transmitted signal as a function of frequency. Describes quantities (such as field strengths) that are more easily evaluated than the DRL to provide a more-practical means of demonstrating compliance with the guidelines.

established adverse health effect: An effect detrimental to the health of an individual due to exposure to an electric, magnetic, or electromagnetic field, or to induced or contact currents, with the following characteristics:

1. It is supported by the weight of the evidence of that effect in studies published in the scientific literature.
2. The effect has been demonstrated by independent laboratories.
3. There is consensus in the scientific community that the effect occurs for the specified exposure conditions.

exposure: The state of being in the presence of electric, magnetic, or electromagnetic fields, or in contact with a current or voltage source.

exposure limit: A maximum value of electric, magnetic, electromagnetic field strength (power density), or SAR that is established for protection against established adverse health effects. RF exposure limits are sometimes published as recommended guidelines (non-compulsory) and are sometimes incorporated in official regulations issued by various telecommunications and/or health authorities. RF exposure limits typically provide significant margins of safety against established adverse health effects. RF exposure limits commonly distinguish between more stringent limits for the general population and less stringent limits for those who are subject to a safety program such as workers involved in an occupational task. RF exposure limits are generally expressed in terms of RF field strengths (power densities) with specific characteristics relative to their average over certain times and their average over body dimensions.

FCC: Federal Communications Commission, the USA regulatory authority for telecommunications.

ICES: International Committee on Electromagnetic Safety, a independent committee of the IEEE Standards Association that develops scientific and science-based standards for protection from non-ionizing radiation.

ICNIRP: International Commission on Non-Ionizing Radiation Protection, an independent organization providing scientific information and science-based advice on protection from non-ionizing radiations.

ionizing radiation: EMF that has enough energy to force electrons out of their orbits, leading to chemical changes that can be dangerous to life. The ability to ionize molecules is based solely on frequency, with ionizing EMF at frequencies at and above those of the high end of the ultraviolet light spectrum (UV-C, approximately 2000 THz).

literature surveillance: The process of reviewing scientific literature in terms of reported research findings that relate to biological and/or health effects of electromagnetic fields. Literature surveillance is an important aspect of maintaining RF exposure standards/guidelines/regulations to reflect the most recent insights on established adverse health effects.

margin of safety: A common way to talk about safety. It is provided by means of safety factors (see later). However, the actual exposure of a person to the RF emissions of an amateur radio station will typically imply a margin of safety far greater than the safety factor since their exposure is very likely much less than the exposure limit.

microwaves: RF, typically in the low GHz frequency range.

MPE: Maximum Permissible Exposure, the USA regulatory specification of an exposure limit for RF fields. The exposure limit is a function of frequency and is based on averaging over time and space.

nonionizing radiation: EMF that does not have enough energy to cause changes to chemical structures. All frequencies used by radio amateurs are nonionizing. This type of radiation usually causes harm to humans by generating more heat than the body can deal with, either as the whole body or at local points within the body. Heat generation from EMF is proportional to SAR.

Ofcom: The Office of Communications, the UK communications regulator, overseeing the broadcasting, telecommunications and postal industries including amateur radio stations.

PTS: The Swedish Post and Telecom Authority, roughly equivalent to the FCC, Ofcom and ComReg.

radiation: Another word used for EMF. It refers to the property of this energy that causes it to move from one place to another. This term is sometimes incorrectly equated with the dangerous energy (see ionizing radiation) that is the product of a nuclear explosion.

RF: radio frequency, frequencies useful for radio transmission (includes all amateur frequencies). Also colloquially used by radio amateurs as an alternative term EMF.

radio waves: A type of electromagnetic field (EMF) with radio frequencies (RF) that results from the propagation of RF energy. Radio waves can be characterized by their frequency (or wavelength) and strength (expressed as electric or magnetic field strength or power density).

reference level: Term used by ICNIRP to describe quantities (such as field strengths) that are more easily evaluated than the basic restrictions to provide a more-practical means of demonstrating compliance with the guidelines.

re-radiation: The creation of an EMF in the close vicinity of a conductive object immersed in an EMF. The re-radiation comes about because of RF currents being induced in the conductive object from the incident EMF. While the strength of the re-radiated field (EMF) can be very strong near the surface of the conductor, it cannot carry more energy than is present in the incident EMF.

RF fields: The component of radio waves typically consisting of electric, magnetic and/or electromagnetic fields.

safe exposure: Exposure below the safe exposure limits will not harm a person. This is based on the results of over six decades of research that has been standardized in two recommended limits for safe

exposure, the IEEE standard, IEEE C95.1-2019 and ICNIRP-2020 Guidelines. Safe exposure can take place for an unlimited amount of time without harming humans.

safety factor: A factor related to how many times an exposure limit is set below the level that might cause an established adverse health effect. The factor accounts for variability in animal research, the possible effects of more stressful environmental conditions and uncertainties associated with extrapolating from research on animals to potential effects in humans. The public exposure limit generally includes a safety factor of 50, assuring a significant overall margin of safety.

safety program: An organized system of policies, procedures, practices, and plans designed to help ensure compliance with exposure limits associated with electric, magnetic, and electromagnetic fields; contact voltage; and contact and induced currents.

SAR: Specific Absorption Rate, the rate at which incident electromagnetic energy is absorbed in a person's body. Since it is complex to determine, equivalent frequency dependent exposure levels of the external RF fields (i.e., exposure levels that produce the same SAR in the body) have been determined (such as ERL and MPE). Measured in units of W/kg or mW/g.