The FCC's New RF-Exposure Regulations

By Ed Hare, W1RFI, ARRL Laboratory Supervisor

Excerpted from January 1997 *QST*

Every so often, an event gets the Amateur Radio community buzzing. On August 1, 1996, the FCC announced a significant rules change: Effective January 1, 1997, most radio services must comply with new requirements regulating human exposure to RF radiated fields. The new regulations include Amateur Radio; so, almost immediately, the telephones at ARRL Headquarters started ringing with members' questions. This overview accurately presents the best available information as *QST* goes to the printer. Sources for frequent updates appear under "Stay Tuned" at the end of this article.

Background

In 1982, the IEEE developed the C95.1-1982 Standard that described appropriate limits for human exposure to RF energy.[1] Medical researchers, engineers and industry developed this Standard. Shortly, the FCC wrote a set of regulations that required radio services to comply with the limits set in the Standard.

While the FCC was developing those early regulations, ARRL requested that the Amateur Radio Service be categorically exempt from any *specific* requirements under the regulations. We urged the FCC to rely upon the demonstrated technical competence of amateur operators and self-education as sufficient tools to ensure continued Amateur Radio safety. The FCC agreed, and we were categorically exempt from any specific requirement to perform a station evaluation under the old RF-exposure regulations.

The ARRL RF Safety Committee

To address what was then an emerging issue, in 1979 the ARRL Board of Directors formed the ARRL Bioeffects Committee. The ARRL Board has since reorganized this Committee as the ARRL RF Safety Committee. The committee consists of medical and research professionals. All of the current members hold Amateur Radio licenses.

Over the years, this committee has monitored developments in the medical and Standards communities and offered RF-safety input to the ARRL Board of Directors and Headquarters staff. Based on information in the Standards and other scientific studies, the committee wrote (and updates) an

extensive set of recommendations that appears in *The ARRL Handbook* and *The ARRL Antenna Book*.[2]

New Standards

In 1991, IEEE published a new Standard, C.95.1-1991. (See the sidebar "How the IEEE C95.1 Standard Was Developed.") This Standard decreased the maximum recommended RF exposures and extended the frequency range covered by the original Standard. This set the stage for the rule changes that currently affect Amateur Radio.

Enter the FCC

On April 8, 1993, the FCC released a Notice of Proposed Rulemaking (ET Docket 93-62), announcing that it intended to develop a new set of regulations for all services, based on the C95.1-1991 Standard. ARRL filed comments asking that the Amateur Radio Service exemption continue, relying on the continued technical expertise and education of amateurs. The Amateur Radio Health Group filed comments requesting that Amateur Radio be included in the new regulations, citing some instances where amateur installations could exceed the exposure levels in the Standard and noting that not all hams have read the educational material available on the topic. The FCC took no further action until the US Congress added a mandate to the Telecommunications Act of 1996 for FCC to complete its work on revisions to the RF-exposure regulations.

It surprised ARRL when the FCC shortcut the process, going from a general proposal for new regulations to completed text in one fell swoop. FCC announced the new regulations in the 96-326 Report and Order, "Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation." [3]

The Regulations

First, let's look at the regulations as they stand at press time. (Also, see the sidebar, "ARRL Petitions the FCC for Change.") The most important change is that hams must now evaluate their stations for compliance with the FCC's RF-exposure regulations. (We were previously exempt from the evaluation, not the regulations.) Some hams think that these regulations apply *only* to hams. That's not true. The regulations have always applied to a wide range of services.

Most amateur stations already meet the exposure limits described in the regulations, especially considering things like duty cycle and antenna patterns. Most hams need only understand some new regulations and perform a "routine analysis" of their station operation.

The regulations cover RF *exposure*, not RF *emission*. The regulations limit our signal strength in areas where it affects people.

Maximum Permissible Exposure (MPE)

The regulations have specific MPE requirements for radiated electric fields, magnetic fields and power density. (See Table 1.) MPEs are derived from the Specific Absorption Rate (SAR) at which tissue absorbs RF energy, usually expressed in watts per kilogram (W/kg). The FCC MPEs are not based strictly on IEEE C95.1, but rather on a hybrid between that Standard and one developed by the National Council on Radiation Protection and Measurements (NCRP),[4] a body commissioned to develop recommendations for federal agencies.

From a safe SAR, the Standards and regulations set MPEs that vary with frequency. The most stringent requirements are from 30 to 300 MHz because various human-body resonances fall in that frequency range.

MPEs assume continuous-duty and operation. The regulations, however, allow us to average the total power over 6 minutes for controlled environments and 30 minutes for uncontrolled environments. This average considers both the duty factor of the operating mode and the actual on and off times over the worst-case averaging period.

Exposure "Environments"

The regulations define two primary RF-exposure environments: "controlled/occupational" and "uncontrolled/general public." In a "controlled" RF environment people know that RF is present and can take steps to control their exposure. These are primarily occupational environments, but the FCC includes amateurs and their immediate households (families). This applies to areas where you control access. The limits for controlled environments are evaluated differently (less stringent) than those for uncontrolled environments.

"Uncontrolled" RF environments are those open to the general-public, where persons would normally be unaware of exposure to RF energy. This applies to all property near your station where you don't control public access: sidewalks, roads, neighboring homes and properties that might have some degree of public access.

The regulations require amateurs to evaluate their stations for both controlled and uncontrolled exposure areas.

Categorical Exclusions

All Amateur Radio stations must comply with the MPE limits, regardless of power, operating mode or station configuration. (Even Ed Hare's 10-mW station must comply.--*Ed*.) However, the FCC presumes that certain stations are safe without an evaluation. Those are:

- Amateur stations using a transmitter power of less than 50 W PEP at the transmitter output terminal.
- Mobile or portable stations using a transmitter with push-to-talk control.

Paperwork

Other than a short certification on Form 610 station applications, the regulations do not normally require hams to file proof of evaluation with the FCC. The Commission recommends, however, that each amateur keep a record of the station evaluation procedure and its results, in case questions arise.

Examinations

The regulations add five questions on the topic of RF exposure to each Amateur Radio examination for Novice, Technician and General class licenses. The Question Pool Committee (QPC) is addressing this in the normal cycle of changes to the question pools. The Novice and Technician pools were released on December 1, 1996. (ARRL has asked the FCC to extend the deadline for the General Class question pool to its normal cycle, December 1, 1997.)

This entire matter has very much been a moving target, with changes forthcoming from every direction. I commend all QPC members, including the ARRL/VEC, for their diligent work to meet the tight deadlines imposed by these regulations.

Routine Station Evaluation

The regulations require amateur operators, whose stations are not categorically excluded, to perform a routine analysis of compliance with the MPE limits. The FCC is relying on the demonstrated technical skill of Amateur Radio operators to evaluate their own stations.

The FCC regulations do not require field-strength measurements. Measurements are one way to perform an analysis, but they're very tricky. With calibrated equipment and skilled measuring techniques, ±2 dB error is pretty good. In untrained hands, errors exceeding 10 dB are likely. A ham who elects to make measurements will need calibrated equipment (including probes) and knowledge of its use. Many factors can confound measurements in the near field.

Most evaluations will be comparisons against typical charts to be developed by the FCC, relatively straightforward calculations of worst-case scenarios or computer modeling of near-field signal strength. The FCC encourages flexibility in the analysis, and will accept any technically valid approach. Once an Amateur Radio operator determines that a station complies, operation may proceed. There's no need for FCC approval before operating.

FCC Office of Engineering and Technology "Bulletin 65"

To help hams perform the routine evaluation, the FCC is revising an existing document: *Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation* (also known as "OET Bulletin 65.")

At press time, Bulletin 65 is not complete. The ARRL and others have been offering specific comments to the FCC, after reviewing the first draft. There has been considerable discussion about what the document should contain. So far, all parties agree on two points: The material should be easy

to use, and there should be more than the three pages devoted to Amateur Radio in the draft copy! The ARRL has gathered a group of technically astute volunteers to help staff and the RF Safety Committee select the most useful course of action. When the document is complete, another article will discuss the details of Bulletin 65.

Stay Tuned ...

This article accurately presents the best available information as *QST* goes to the printer. (Every time we got to "where it's at"--it moved.) You can get frequent updates from *The ARRL Letter*, W1AW bulletins and our RF-Safety Resource page as new information develops. If the FCC grants our several Petitions for Reconsideration, we will have ample time to update ARRL publications and write additional *QST* articles to give you the specific information and tools you'll need to comply with the regulations.

Notes

[1] IEEE C95.1-1982 has been superseded by IEEE C95.1-1991. Copies are available from IEEE Sales Office, 445 Hoes Ln, PO Box 1331, Piscataway, NJ 08855-1331; tel 800-678-4333; fax 908-981-9667; e-mail customer.service@ieee.org; Web

[2] ARRL publications are available from your local ARRL dealer or directly from ARRL. Mail orders to Pub Sales Dept, ARRL, 225 Main St, Newington, CT 06111-1494. You can call us toll-free at 888-277-5289; fax your order to 860-594-0303; or send e-mail to pubsales@arrl.org. Check out the full ARRL publications line.

[3] These are available electronically on the FCC's Office of Engineering and Technology Web page. Contact the FCC's Int'l Transcription Service 1270 Fairfield Rd, Gettysburg, PA 17325; tel 717-337-1433 for paper copies. Note: FCC documents may refer to ANSI/IEEE C95.1-1991 as C95.1-1992.

[4] NCRP Report No. 86, "Biological Effects and Exposure Criteria for Radio Frequency Electro-magnetic Fields," ISBN 0-913392-80-4. National Council on Radiation Protection
and Measurements, 7910 Woodmont Ave, Bethesda, MD 20814; tel 301-657-2652, fax 301-907-8768, e-mail ncrp@ncrp.com; Web http://www.ncrp.com/

Table 1--Maximum Permissible Exposure (MPE) Limits

Controlled Exposure (6-Minute Average)			***Uncontrolled Exposure (30-Minute Average)***		
Frequency	*Electric Field*	*Magnetic Field*	*Power Density*	*Electric Field*	*Magnetic Field*	*Power Density*

Range (MHz)	*Strength (V/m)*	*Strength (A/m)*	*(mW/cm^2)*	*Strength (V/m)*	*Strength (A/m)*	*(mW/cm^2)*
0.3-3.0	614	1.63	(100)*			
3.0-30	1842/f	4.89/f	($900/f^2$)*			
0.3-1.34				614	1.63	(100)*
1.34-30				824/f	2.19/f	($180/f^2$)*
30-300	61.4	0.163	1.0	27.5	0.073	0.2
300-1500	--	--	f/300	--	--	f/1500
1,500-100,000	--	--	5	--	--	1.0

f = frequency, in MHz.

* = Plane-wave equivalent power. (This means the equivalent far-field strength that would have the E- or H-field component calculated or measured. It does not apply well in the near field of an antenna.)

-- = Not specified.

How the IEEE C95.1 Standard Was Developed

I recently attended a one-day seminar conducted by the Chairperson of IEEE Standards Coordinating Committee 28, Non-Ionizing Radiation Hazards (SCC-28). This group has developed a number of IEEE Standards that relate to exposure to electromagnetic fields from 3 kHz to 300 GHz. This seminar educated engineers about the Standard and its development.

SCC-28 now has about 120 active members. About 200 more follow the Committee's work (including ARRL). SCC-28 is about 70% researchers, with others from various organizations and industry.

SCC-28 considers a large number of input sources and research papers. It evaluates these against scientific criteria. For example, they exclude papers that do not include measured RF field levels. The result included about 120 papers.

SCC-28 considered the topics and conclusions in these papers and combined them with the substantial collective knowledge of their learned membership. Finally, they reached a consensus that a standard for exposure could be set and did so.

An SAR (see the text of this article) of 4 W/kg determines the final Standard. This is the approximate level at which several animal species demonstrate temporary difficulty in performing complex tasks. (For example, a monkey trained to push a button six times to get a banana decided, when exposed to a 4-W/kg field, that he didn't want a banana. With removal of the field, he soon decided he was hungry, after all). The Committee deems these to be thermal effects. Human volunteers exposed to such fields usually asked, "Who turned on the sun?" They felt warm.

The Committee applied a safety factor of 10, setting an SAR of 0.4 W/kg for controlled/occupational exposure and an additional safety factor of 5 (SAR = 0.08 W/kg) for uncontrolled exposure. The MPEs in the Standard and regulations account for how much energy the human body absorbs over different frequency ranges.

Some have suggested that this whole topic is unfounded--there are no adverse effects of RF energy. Several ARRL committees and other technical experts advise us that these Standards are realistic and we should heed them. I serve on two US standards bodies, and have participated in others. I know how difficult it is to find common ground in a large group. Given that 120 members of SCC-28 agreed upon this Standard, it is almost certainly based on sound scientific principles. -- *Ed Hare, W1RFI*

ARRL Petitions the FCC for Change

No one, including ARRL, had an opportunity to comment on the specific regulations announced by the FCC. The regulations are significantly different from what the FCC proposed in the original Notice of Proposed Rulemaking. The FCC simply did not follow the "rules to make the rules." This lack of due process forms a significant part of several Petitions for Reconsideration.

There are petitions "on the plate" from industry and the amateur community. When the regulations were first announced, ARRL filed an emergency petition for relief from an implementation error that required question pools revision well before the effective date of the regulations.

Then our Laboratory staff, RF Safety Committee and outside experts pored over the 180+ page Report and Order (see note 3). We found many errors and flaws in the requirements as written.

The 50-W threshold for categorical exclusion is arbitrary: While the MPEs vary with frequency, the 50-W level does not. We ask that the 50-W level be increased at some frequencies, consistent with the MPEs. Some other services have exclusions when the antenna location is 10 meters from areas of exposure. At HF, 150 W to any antenna would be unconditionally safe when the antenna is 10 meters from areas of exposure--with a significant safety margin. We asked the FCC to add these criteria to the 50-W criterion already in the regulations.

We did not ask for any change to the 50-W criterion at VHF and higher, because some station and antenna configurations could result in fields that exceed the MPEs.

We considered higher limits, for HF, with a greater antenna separation. A safety margin similar to that for the 150-W scenario would require a rather great distance at some frequencies. We backed off this path because it might be misinterpreted. Local officials might assume that the worst-case distance for such high-power stations should apply to all amateur stations.

Part of the ARRL's petition for reconsideration asks the FCC to preempt local regulation of RF exposure. The congressional mandate to the FCC included the requirement to develop preemption of local regulation of RF exposure resulting from the operation of radios in the Personal

Communications Services (of which we're not). In order to do so, they needed the federal RF-exposure regulations. The result is that the Amateur Radio Service bears the burden of these new regulations without the benefits of preemption.

As the FCC and amateur communities wrestled with understanding the requirements and rewriting Bulletin 65, it became apparent that neither the FCC nor the amateur community could meet the January 1, 1997, implementation date. If the FCC manages to complete Bulletin 65 by the target date of December 1, 1996, that would give amateurs only four weeks to obtain it, read it, understand it, perform the needed calculations and take steps to correct any problems. For example, if a ham wants to move a tower, it could require zoning approval and other paperwork. In some areas of the country, winter would prevent completion.

At their October meeting, the ARRL Board of Directors voted to ask the FCC to extend the implementation date by one year. The ARRL then joined the growing number of organizations and individuals seeking relief from the short deadlines for these regulations. At press time, there has been no decision on any of the petitions for reconsideration before the FCC (although this may have all been decided by the time you read this). -- *Ed Hare, W1RFI*