Safety Guide

by Richard Strickland

RFR Safety 101

RF radiation (RFR) and the issue of safety when working near RFR has been getting an increasing amount of press. Although the Federal Communications Commission (FCC) has not fined a large number of licensees, some of its most recent enforcement actions can be considered landmark cases.

These precedent-setting cases include:

• The first action involving personal injury to a tower climber.

• The first action involving multiple licensees that collectively generated enough energy on the ground to exceed the commission's Maximum Permissible Exposure (MPE) limits for General Population/Uncontrolled exposure.

• The commission's recent issuance of a Notice of Apparent Liability for Forfeiture (NAL) to a television station with a proposed fine of $25,000 - after establishing a $10,000 fine as the standard for RF radiation violations. A separate NAL involving another licensee at the same site has a proposed fine of $20,000.

These examples illustrate the three main reasons why you need to understand the safety issues of RFR:

1. Personal Safety: Minimize the risk to all personnel: employees, contractors, and visitors.

2. Regulatory Compliance: Comply with all FCC, OSHA, and local regulations.

3. Liability: Minimize liability risk.

RF RADIATION AND BIOLOGY

It is a well-documented fact that RF radiation can cause body tissue to heat. This fact became obvious during World War II with the widespread deployment of radar.

Research began in the 1950s, and by the 1970s the concept of Specific Absorption Rate (SAR) was developed to explain and quantify how RF energy is absorbed by the human body. SAR is measured in Watts per kilogram of body mass.

At its simplest, it turns out that the SAR level is essentially a function of how good an antenna you make. The major factors are frequency, your height, polarization versus your position, and whether or not you are grounded.

A "standard" man, defined as an individual that is 1.75 meters tall (about 5 feet, 9 inches for the metrically-challenged), is resonant at about 85 MHz providing that he is not grounded. Thus, a standard man makes a great Channel 6 television antenna! The average woman, who is somewhat shorter, makes a great FM radio antenna!

The other biological effect that is a concern and also impacts the standards and regulations is electrostimulation – RF shocks and burns. People who work around AM radio stations are usually quite familiar with this problem. Electrostimulation risks guide the standards below 30 MHz, while SAR is the basis of all the major worldwide standards at higher frequencies.

The heating effects of RF energy should be evaluated based on time-averaged exposure. Most of the major worldwide standards average exposure over six minutes. This is based on human physiology and studies done for heating, ventilation, and air-conditioning. The human body can deal with short-term extremes of heat and cold, but after about six minutes the internal thermal-regulatory system loses the ability to deal with the extremes.

FCC ISSUES

The FCC Regulations provide for two sets of MPE limits, one for Occupational/Controlled (occupational) exposure and one for General Population/Uncontrolled (i.e. public) exposure.

The MPE limits are frequency dependent, with the greatest restrictions occurring in the human resonance region, in which humans absorb the most energy, from 30 MHz to 300 MHz. The public limits are only one-fifth of the occupational limits for all frequencies above 3 MHz.

A common misconception is that the so-called "Public Limits" apply only to the "general public." Nothing could be further from the truth! Although this area could be the subject of an entire article, the basics are that a *controlled* environment is an area covered by an RF safety program.

As part of such an RF safety program, qualified workers are allowed to enter controlled areas. Qualified workers, per the FCC Regulations, are *fully aware* and able to *exercise control*. Fully aware workers have received both written and verbal instruction in the area of RF safety and are able to exercise control over their exposure by using appropriate equipment such as RF personal monitors and RF protective garments.

On the other hand, the various tradespeople who might visit a rooftop RF environment – HVAC, elevator repair, window washer, building maintenance, and even some electronics types – cannot possibly be classified as fully aware and able to exercise control. In fact, it is very difficult to control an entire roof, much more so than to control a simple tower.

This is important to realize because it will influence the types and locations of signs that you should use.

"CONTROLLED" AREAS

Environmental health and safety professionals define a "controlled" environment as an area or workplace *controlled* by a safety program for a particular hazard. For example, if safety glasses are required in a machine shop, workers have received training, there is a written safety program, and the policy is enforced for employees, contractors, and visitors, then that would be considered a controlled environment for eye hazards.

Note that the official titles for the two FCC exposure scenarios involve the terms controlled and uncontrolled exposure. This is why the FCC allows time-averaging for Occupational/Controlled exposure but does not allow time-averaging for General Population/Uncontrolled exposure.

This comes into play at sites such as Mt. Wilson outside of Los Angeles. The RF field levels on the public road used to exceed the public limits. Broadcasters tried to argue that the time-averaged exposure would be less than the MPE limits since people would only be in the high field area for a brief period while driving. But the FCC's position is that since the environment is not controlled – nobody is controlling what the public does in this area – then nothing would stop somebody from stopping the car, getting out, and having a picnic.

RF exposure is also an issue for the Occupational Safety and Health Administration (OSHA), just as for any other risk. There is an expectation that a company will have a program in place to manage these hazards. This means that you need a written policy, and your workers must receive training.

RESPONSIBILITIES AND LIABILITIES

Licensees have responsibilities and liabilities from several aspects:

• As a licensee, regardless of where the emitter is located - your own property or a shared site.

• As an employer.

• As a company that hires contractors.

• As a company that has visitors.

Furthermore, in terms of compliance, licensees must:

• Comply with FCC Regulations for public areas.

• Comply with FCC Regulations regarding employees and contractors.

• Comply with OSHA Regulations regarding employees.

These are the reasons why you need to pay attention. In practice, doing the things described in the following paragraphs should satisfy all of these needs in a way that both makes sense and does not cost you a fortune.

ACHIEVING COMPLIANCE

How do you comply with regulations, minimize liability, and prevent overexposure? Use this simple checklist as a guide and you will be in very good shape:

1. Determine where the potential hazards are located.

2. Quantify the magnitude of RF fields on the ground and in other areas that are easily accessible.

3. Establish rules for access to areas where significant RF field levels may exist.

4. Restrict access to towers and other areas with significant RF field levels.

5. Install *appropriate* RF safety signs and physical barriers.

6. Train your workers.

7. Document all of the above.

There are several ways to determine the magnitude of RF fields. These include:

• Calculating ground levels at simple sites with a small number of antennas. Calculations are conservative, and if everything is clearly below the public MPE limits, you should be fine. Formulas are given in FCC Bulletin OET-65.

• Measuring complex sites and sites where calculations indicate there may be a problem.

• Making sure that anyone who climbs a tower is protected, since there is limited value to making measurements on towers.

• Documenting all of the above.

THE RIGHT SIGNS

Installing the correct RF safety signs is an important aspect of achieving compliance, reducing liability exposure, and reducing risk to personnel.

At first glance it seems to be simple – just install a few signs around the site, everybody will be satisfied, and you can move on to doing something really important. Unfortunately, this wrong viewpoint appears to be the prevailing attitude at many of the broadcast and wireless sites that I visit to conduct RF safety surveys.

The purpose of RF safety signs is to *communicate useful information!* Therefore, if you install the wrong sign or even the correct sign in the wrong location, the message will be wrong. In addition, if you install signs and do not control access in accordance with the information contained on the sign, you have inadvertently communicated something else – that the signs are meaningless!

QUANTIFYING THE HAZARD

The three most common signs that I use relate to RF field levels. The message panel of these "NOTICE," "CAUTION," and "WARNING" signs all start with "Beyond this point: Radio frequency fields at this site..." with the remainder of each message declaring a different field level. It is important to know and understand the differences:

• NOTICE – the RF field may exceed the FCC general public exposure limit.

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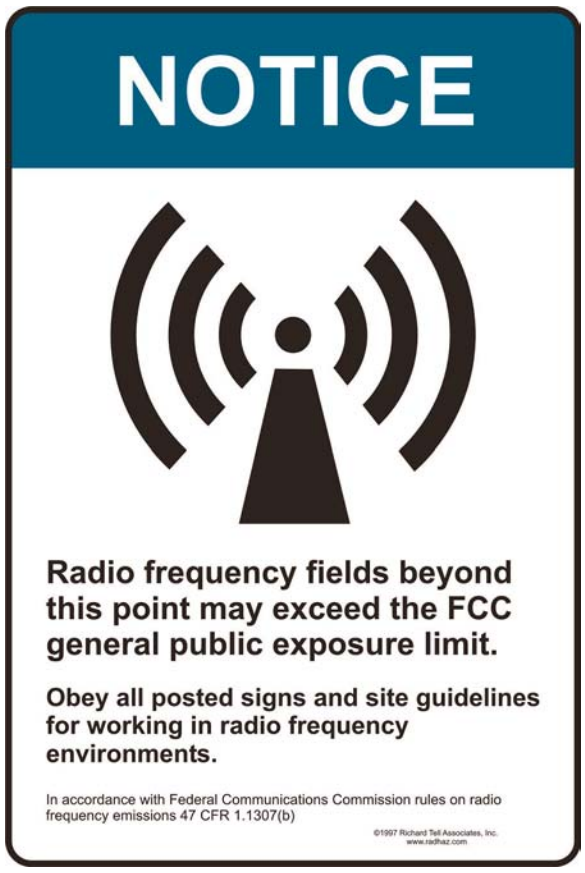

A "Notice" sign indicates potential RFR exposure.

• CAUTION – the RF field may exceed FCC Rules for human exposure.

• WARNING – the RF field exceeds FCC Rules for human exposure.

Perhaps the sign that I recommend most often is one that I refer to as a "Tower CAUTION" sign. The message panel on this sign states "On this tower: Radio frequency fields near some antennas may exceed FCC Rules for human exposure."

A "Caution" sign alerts RFR may be over the human limit.

There are also other commonly used RF safety signs that include those warning of the burn hazards from touching a hot AM tower or hot guy wires.

CORRECT SIGN FOR EACH LOCATION

Used correctly, NOTICE signs should identify all areas where the RF field levels may exceed the public limits, but are below the human or occupational limits. Officially, only qualified workers should be allowed past this point, although this is a gray area. Many treat the NOTICE sign as a pre-warning.

A CAUTION sign is meant to identify an area that has RF field levels that generally exceed the public limits with a few isolated hot spots that exceed the human or occupational limits. Only qualified workers, workers who are *fully aware* and able to *exercise control*, should be allowed to enter these areas.

Used correctly, a WARNING sign identifies areas where the RF field levels exceed the human or occupational limits. One should never enter such areas without shutting systems off and/or reducing power, and having equipment such as a personal RF monitor to verify that the field levels have been reduced below the human limits.

A "Danger" sign alerts workers to potential burns from RF voltage.

It is important to remember that AM radio sites present an additional potential danger and are a sore spot with FCC inspectors. AM sites should have both RF field level signs and DANGER signs that warn of the serious potential for RF burns should one contact the tower or feed line. Furthermore, in addition to fencing to keep intruders from climbing the tower, AM fencing should prevent intruders from touching the tower.

TIME-AVERAGING

Many broadcasters seem to have the wrong idea about time-averaging. Yes, the heating effects take some time to do any harm but it is a short interval. RF energy, which is a form of non-ionizing radiation, does not accumulate like the ionizing radiation in the form of X-rays, gamma rays, and cosmic rays. It is a threshold effect that takes a few minutes to have an impact.

You may see custom signs indicating the time limits that a worker can spend in a given area, based on the RFR. These signs are *never* a good idea for two reasons:

• The FCC does not allow time-averaging for areas that must comply with the public MPE limits.

• It depends entirely too much on human behavior.

For example, if the field levels are 300 percent of the occupational MPE limit, it is both biologically and legally OK to have the person remain in the field for two minutes (one third of six minutes) providing there is no substantial exposure for the next four minutes. But this is a risky approach that no safety professional would ever condone because it unnecessarily increases the risk.

It is far better to treat the MPE limits as absolutes and reserve time-averaging for analyzing an exposure incident.

MEASUREMENTS

If you have a simple site and calculations made in accordance with Bulletin OET-65 indicate that the field levels are well below the MPE limit, then measurements may not be needed.

An accurate RF survey of the transmission site – one that will actually do you some good and satisfy the FCC requirements – can be a very good investment. And if nothing changes at the site, there is little reason to repeat the survey. But if things change on site because of a new licensee, a different antenna, or new structures that could result in reflections, a new survey is indicated.

This survey should include the areas around the tower(s) and inside the transmitter building itself. It is a good idea to check the areas around the tube(s) for leaks. Even solid-state amplifiers can leak due to bad connections. It is particularly important to check around equipment at AM stations. Some phasors and tuning circuits can have very high RF fields around them.

The survey should be conducted by someone who knows what they are doing and uses appropriate and accurate survey equipment. This survey normally takes some time to do properly; it is not just a matter of holding up a meter and taking a quick reading.

A MEANINGFUL SURVEY

It is important to "seek out" pockets of high RFR and document them carefully. The technique used varies with the magnitude of the fields.

I usually move my arm holding the probe in windmill fashion while trying to cover the largest volume of space. When I find a spatial peak field that is a significant percentage of the MPE limit, I stop and make a series of spatially-averaged measurements. The FCC bases its exposure limits on spatially-averaged exposure although it has not yet defined where and how to make such measurements.

The report should then clearly define what was measured, under what conditions, by whom, their qualifications, and the spatially-averaged field levels in terms of percent of the public MPE limits.

Of course, the subject of measurements – which specific equipment, the measuring techniques, how much accuracy can be attained and with how much error, etc. – is a big topic and cannot be completely covered in this overview article.

This completes your RFR Safety 101 course. If you are interested in continuing your education with higher-level courses, you can find more information on the web including at www.rfsafetysolutions.com.

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