Ensuring Compliance with FCC RF Safety Rules

By Robert E. Johnson

Although it has been more than seven years since the FCC implemented its rules governing the protection of workers and the general public from exposure to RF energy, the issue often remains well down the list of concerns facing owners and operators of cellular, public safety, paging, and land mobile systems. Nonetheless, it is the responsibility of every system owner or operator to comply with these rules or face significant penalties if an FCC inspection reveals non-compliance. The FCC has demonstrated its intention to enforce the rules, has already fined several violators, and has new narrowband measurement tools that make evaluation possible at collocated sites without the need to notify their owners. Fortunately, these same narrowband measurement tools make the task of evaluating a site's electromagnetic (EM) environment easier for owners and operators as well.

Figure 1. With this many emitters at a single site, measuring the contribution of each one would require cooperation from all organizations represented there, a highly unlikely event and the impetus for development of narrowband instruments.

Today there are conservatively hundreds of sites throughout the U.S. that are not fully in compliance with the rules, and many more at which RF measurements have not recently been made. The reasons for this range from simply ignoring the issue altogether, to the increased complexity of the rules, and the difficulty of making measurements at co-located sites. The latter excuse was until relatively recently the most defensible, at least for co-located sites where measurements of multiple emitters owned and operated by different organizations were difficult if not impossible to perform. Those who have in the past chosen to ignore the issue believing that chances of a random inspection were remote, may be in for a rude awakening today. While it is true that for many years previous FCC RF safety rules went largely unenforced, this situation has changed, to which the bank accounts of several broadcasters can attest.

As for the rules themselves and the measurements they require, they are indeed more complex than their predecessors. Making electromagnetic (EM) field measurements until the early 1980s was comparatively simple. Standards during this time specified a single MPE level for all frequencies, so antennas (probes) employed by EM measurement systems were equally sensitive at all frequencies and rather simple. To make the measurements, a technician or engineer simply measured the total field strength at various places around the site, and assuming the total was below that mandated by the current applicable standard, compliance was assumed.

If the total field strength was above the specified maximum level, the accepted procedure was a “last on-first off” affair, a matter of seniority. That is, the most recent company to add its transmitter to the site was deemed the “problem” and had to remedy the situation. This could mean that the company had to uproot its transmitting facilities are find another location. Of course, since there were fewer multi-emitter sites at that time, only one organization -- the sole occupant of the site – would be affected.

Later in the 1980s, standards became frequency-dependent, reflecting the fact that the human body absorbs radiation more readily at some frequencies than others. This complicated the measurement process because a more complex “shaped” probe was required whose sensitivity mirrored the requirements of a particular standard. For example, many standards and guidances then (as now) set E-field MPE limits at 614 V/m (100 mW/cm^2) below 1 MHz, and 61.4 V/m (1.0 mW/cm^2) from 30 to 300 MHz – a difference of 20 dB or 100 times the power at the higher frequencies. To accommodate this, shaped probes are 100 times more sensitive in the 100 MHz region than at 1 MHz.

In the latest standards, there are two sets of maximum permissible exposure (MPE) limits instead of one, and there is the ominous “5% rule” to contend with. Moreover, the ability to determine compliance is compounded by today’s proliferation of sites with multiple emitters, each owned by different organizations. However, the introduction of narrowband measurement equipment allows the required measurements to be made regardless of how many services are located at a site. These instruments complement the standard broadband types that were previously the only type available. Nevertheless, broadband instruments may still be a viable option in some cases, so it is important to know when to use each one.

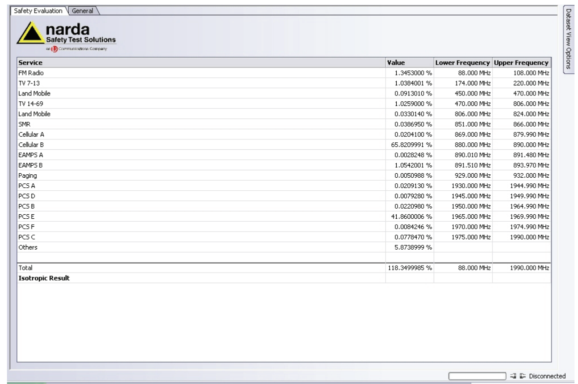
Enter the Telecommunications Act

The Telecommunications Act of 1996 mandated among other things that the FCC create new rules regulating RF emissions. This resulted in the commission creating the current rules in 1997, which were modified in 2003 to better reflect the potential harm from specific types of devices, eliminating some altogether. The new FCC rules are based on the IEEE (formerly ANSI) standard and National Council on Radiation Protection and Measurements (NCRP) guidelines, and make compliance the responsibility of every service operating at a site. This requirement effectively was the death knell spelled of the "last on, first off" solution. Today, if the total measured EM field anywhere at the site exceeds the level specified by the FCC rules, *all* emitters that contribute 5% of more to the total are required to become participants in the remedy. The two tiers of exposure limits are called "controlled/occupational" (for sites with effective RF safety controls) and "general population/uncontrolled", the latter being five times more stringent than the former.

Broadband measurement equipment gathers energy over a broad range of spectrum and computes a single value, which is the aggregate field strength generated by the site. It also provides the percentage of an applicable standard this level represents. The instruments themselves cannot identify the contribution of each emitter at a collocated site, although by selectively turning off all transmitters at the site, turning them on one by one, and measuring their emissions, this result can be obtained. As will be explained later, this is a key factor in why narrowband instruments were created. Collocated sites (like the one shown in Figure 1, for example) make measurements exceedingly difficult because only the owner of its emitters has the authority to turn them on or off, rather than a single entity. Obviously, if one operator decides to determines its levels of emissions (and compliance with the rules), is it highly unlikely that all other operators at the site would be willing to shut down their equipment for hours while the measurements are performed. In addition, if public safety agencies transmit from the site, this is not even an option.

The narrowband solution

The introduction of the SRM-3000 selective radiation meter (Figure 2a) by Narda in 2004 solved this problem by capturing signals over a much narrower spectral region with much greater sensitivity, measuring their field strength, and recording and displaying the strength of each one along with its corresponding contribution (in percent) to the total allowable by the FCC rules (Figure 2b). This instrument also allows all emitters at the site to be identified, which is often more difficult than it might seem because multiple antennas may be obscured behind a radome, each one transmitting at a different frequency. The instrument makes it possible for a system operator to evaluate a site’s compliance and its contribution to the total without turning off a single transmitter and without the need to notify other occupants. The FCC has begun to employ these instruments, which makes it far easier for their agents to conduct measurements – unannounced.



Service	Value	Lower Frequency	Upper Frequency
FM Radio	1.3453000 %	88.000 MHz	108.000 MHz
TV 7-13	1.0384001 %	174.000 MHz	220.000 MHz
Land Mobile	0.0913010 %	450.000 MHz	470.000 MHz
TV 14-69	1.0259000 %	470.000 MHz	806.000 MHz
Land Mobile	0.0330140 %	806.000 MHz	824.000 MHz
SMR	0.0386950 %	851.000 MHz	866.000 MHz
Cellular A	0.0204100 %	869.000 MHz	879.990 MHz
Cellular B	65.8209991 %	880.000 MHz	890.000 MHz
EAMPS A	0.0028248 %	890.010 MHz	891.480 MHz
EAMPS B	1.0542001 %	891.510 MHz	893.970 MHz
Paging	0.0050988 %	929.000 MHz	932.000 MHz
PCS A	0.0209130 %	1930.000 MHz	1944.990 MHz
PCS D	0.0079280 %	1945.000 MHz	1949.990 MHz
PCS B	0.0220980 %	1950.000 MHz	1964.990 MHz
PCS E	41.8600006 %	1965.000 MHz	1969.990 MHz
PCS F	0.0084246 %	1970.000 MHz	1974.990 MHz
PCS C	0.0778470 %	1975.000 MHz	1990.000 MHz
Others	5.8738999 %		
Total	118.3499985 %	88.000 MHz	1990.000 MHz
Isotropic Result			

Figure 2. The SRM-3000 selective radiation meter (a) solves the problem of making EM measurements at collocated sites and shows the strength of each signal separately (b).

It also provides information in seconds that previously required hours if it could be obtained at all. Finally, interference from extremely low frequency (ELF) emitters is often a concern when broadband instruments are used to evaluate systems located on “existing verticality” such as power distribution poles and towers. This occurs because broadband equipment employs high-impedance probes that are susceptible to the intense E-field energy generated by power distribution lines. In contrast, the narrowband SRM-3000 employs low-impedance probes that are immune to ELF energy.

That said, narrowband instruments are also more expensive than broadband types, and in some cases provide more information than is actually necessary to establish compliance. When only one (or even a few) emitters operate at a site, a broadband instrument can provide a viable solution from both performance and cost perspectives. Thanks largely to advances in digital semiconductor technology, the latest broadband instruments, such as Narda’s NBM-550 and NBM-520 (Figure 3), have far greater capabilities and user features than their predecessors.

Figure 3. The NBM-550 radiation meter represents the latest generation of broadband instruments and incorporates spatial as well as time averaging, the ability to export measurement results to Excel or other spreadsheets, and can be fitted with a GPS receiver that verifies where each measurement was made.

They can perform spatial as well as time averaging, output their results to Excel or other spreadsheets, and are supported (as is the SRM-3000) by software that allows RF safety officers or anyone responsible for FCC compliance to easily provide a complete measurement report. Some broadband models even include an instrument-mounted GPS receiver that verifies where each measurement was made within several meters, which the software integrates into the report. So with two types of instruments to choose from, the question becomes which one to use in a particular situation.

Some typical examples

If there is only one emitter at a site, a broadband instrument such as the NBM-550 is obviously the most cost-effective choice because control of the transmitter rests with a single organization and its frequency is known. A broadband instrument may even be acceptable when there are several emitters at a site. For example, a site may have five emitters owned or controlled by a single organization, so their specifications – especially service types and operating frequencies – are known, and the authority to selectively turn each one on and off probably resides with a single person or group. With the ability to control the operation of all emitters, the owner might be able to employ a broadband instrument.

In other cases, particularly “multi-emitter-multi-operator” situations, a narrowband instrument is really the only practical choice. At a five-emitter site, where each emitter is owned and operated by a different organization, there can be several important unknowns, such as the type of service and frequency of operation. In some cases, the owners and operators of these systems also may not be known. Even once information is be obtained, it will generally be extremely difficult or even impossible for a single organization to gain the authority to turn all transmitters on an off for measurement purposes. A narrowband instrument thus makes it possible for any organization wishing to know its contribution and the contributions of others at the site to quickly evaluate compliance.

In short, every broadcast organization is required by law to comply with FCC RF safety rules, and there is for the first time a greater chance that violators will be penalized. Narrowband instruments make it much easier for system operators at densely-populated sites to determine compliance with these rules. However, single-transmitter sites and those with several emitters each controlled by a single entity may still be well served by broadband instruments. The ultimate decision is always site-specific, which makes it important to fully understand the compliance and measurement process, and when necessary to employ the services of one of the many organizations throughout the U.S. that specialize in RF safety.

Robert E. Johnson is director of instrument products at Narda RF Safety Test Solutions. Robert has spent over 20 years involved in RF safety products and standards. He is presently a member of the AIHA, IEEE and ASSE and has performed hundreds of RF safety classes for thousands of students. He can be reached at bob.johnson@l-3com.com.