By Lawrence Behr, NCE

TECH REPORT

Medium Wave Broadcasting—A Different View of EMC

Today it is the general disposition of the EMC community to deal with microwave frequencies and milliwatts of power. Some engineers are not even aware that there exists all about them a realm—where power is measured in tens or hundreds of kilowatts and frequencies in the kilohertz—that has been dealing with EMC for nearly 100 years.

Welcome to the world of AM medium wave broadcasting! Those stations that you hear between 530 and 1710 kHz when you drive to work are really quite imposing transmitter plants where many aspects of EMC and radio frequency safety are dealt with. Consider that there are some 5000 AM stations in the US.

Encountering ERPs Approaching 50,000,000 Watts

These stations can transmit with up to 50,000 watts carrier power, using as many as twelve antenna towers, which may be 500 feet or more in height, and occupy dozens of acres of land!

On the international scene, many broadcasters operate with power outputs exceeding 1,000,000 watts. For these stations, peak effective radiated powers may approach 50,000,000 watts, or +97 dBm, for those relating on the WiFi level.

New Scales of EMC/EMI, Spurious Emissions, Arcs & Sparks

So, what EMC dreams does a broadcast engineer have at night? Well, pretty much the same as those of you designing an automotive system or a WiFi PCMIA card – with a few extras. Broadcast engineers have to deal with FCC approvals, spurious emissions, lightning protection and interference.

They also have product safety concerns. With mains voltages of 220 volts up, DC operating voltages in the 10's of kilovolts, and RF voltages that can easily arc several feet when provoked, there are real concerns over the safety of personnel and keeping the transmitter plant from reducing both itself and its humanoids to cinders.

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Considering that even the most modest transmitter somewhat equals the power of an arc welder, one can get a better perspective of the forces involved!

Even interference and spurious emissions assume a new scale. While much of the EMC community thinks in terms of emission limitations at a few meters, a broadcast engineer's emission horizon can go out for miles.

Because the ionosphere can reflect medium wave signals very efficiently at night, even a few watts can cause interference to stations hundreds of miles away.

Elaborate multi-tower antenna systems are used to control this unwanted energy. These arrays may be expected to maintaining sidelobe suppressions to within a few tenths of a dB at a pattern depth of as much as 40 dB and gains of 10 dB or more.

The design performance of some of these vast arrays rivals that of higher frequency laboratory antennas and it is all done with massive lumped circuit networks!

EMC Features of Lumped Circuit Antenna Tuning System

Figure 1 *(next page)* shows a lumped circuit antenna tuning system for a 100,000 watt medium wave system near 1000 kHz. It displays a number of features of interest from an EMC standpoint.

In this case, the building is an integral part of the system. The wide use of copper and aluminum to provide shielding on the floor, walls, and ceiling will be noted.

In addition, many of the large copper inductors and vacuum capacitors are filter circuits to block antenna induced RF currents from nearby trans-

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FIGURE 1: *High Power MW Antenna Tuning Unit*

mitters, thus minimizing intermodulation products in the transmitter powering this system.

Radio frequency safety is an important consideration, as evidenced by the metal mesh operator's cage. Operating voltages on these components reach 35,000 volts and currents of hundreds of amps. Extensive protective inter-

FIGURE 2: *10 Kw AM Triplexer Installation*

locks and grounding switches are incorporated for maintenance personnel safety.

Unique Triplex Installation

Figure 2 shows a unique installation of three antenna tuning units and filters in a triplex configuration feeding three different 10,000 watt medium wave transmissions onto a single antenna.

Each tuning unit complex contains filters that provide 60 to 90 dB rejection of intermodulation products generated by its transmitter from the others, and also provides over 40 dB of load isolation.

The tuning units feed a proprietary "CombiPole" tower antenna that incorporates, independently, impedance adjustable feeds for each frequency.

This system has a special property: Grounding any feedpoint permits "cold" downstream maintenance, without affecting the transmissions on the other channels!

Regulatory Emissions Mask

In the United States, Part 73 of the FCC Rules governs spurious emissions from transmitters, including incidental intermodulation from systems like those above.

Although transmitters require authorization through the FCC verification process, subsequent modification and system integration are subject to the control of the operator.

Among the most important regulatory tools is the emissions mask, shown in **Figure 3** as it would apply to a 50,000 watt transmitter.

Station licensees are required to periodically verify that their emissions comply with these requirements to minimize radiated interference.

In addition, because of their extensive interference potential, the FCC requires that AM stations respond to any complaints of interference in their "blanket areas" which constitute their 1000 mV/m signal contours. The extent of this blanket contour may be a few hundred feet for a 250 watt station, and over a mile for a 50,000 watt station.

Reradiation Effects of Cell Towers

Unfortunately, the precisely calibrated antenna patterns of many AM stations are subject to disruption by signal reradiation from nearby conductive objects like poles and towers. This has become a serious problem with the proliferation of cellular towers across the land in recent years.

In this case, the FCC requires the licensees using the reradiating objects to eliminate their effect. This is commonly done through application of a detuning system such as shown in **Figure 4** *(next page)*. A network and cage of wires permits the phasing of the tower currents to be controlled in a cancellation mode. Suppressions of unwanted currents on the order of 40 dB are possible with careful design.

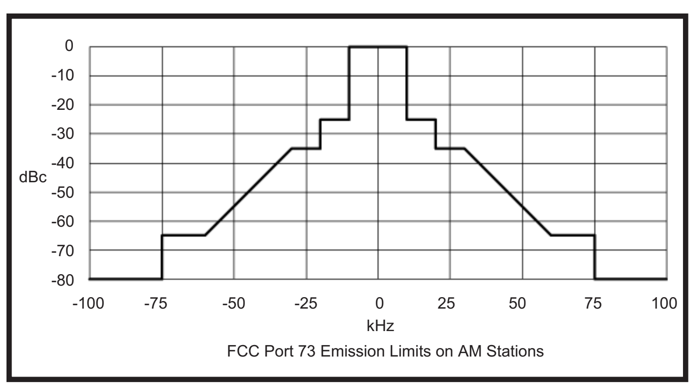

FIGURE 3: *FCC Emissions Mask*

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FIGURE 4: *Cell Tower Detuning System*

On occasion, a tower may reradiate signals from several stations simultaneously, leading to a requirement for a highly complex filtering system.

Normally operating at low power levels, detuning systems in high fields may need to handle many kilowatts of coupled energy, and may also give rise to personnel RF safety issues and special remediation conditions to satisfy OSHA workplace safety requirements.

Co-location of Medium Wave and Cellular Antennas—A New Reality

Every year thousands of new towers are built to support cellular telephone antennas. At the same time, thousands of AM antenna towers of convenient cellular height already dot the urban landscape, with room for, but empty of, additional antennas!

Why hasn't this seemingly obvious marriage of resources and requirements generally occurred? Blame the perception, for many years a sound one, that the characteristics of AM antennas like high voltages and pattern stability are far out of sync with the characteristics of the cellular antenna system.

Fortunately, approaches have been developed to overcome these problems and to permit economical collocation of medium wave and cellular antennas.

Figure 5 shows one such application where a coaxial cable-fed cellular antenna system is able to share space on a 10,000 watt AM tower with no degradation of either system while maintaining RF and high voltage safety protection.

Further advancing the collocation potential of these towers, a new system has come to market that permits "hot" tower mounted transmission systems using Cat-5 and other non-RF cables, such as are employed in WiFi and WiMax technologies.

New IBOC Digital Broadcasting Technology

This article has spoken mostly of some "heavy metal" aspects of current medium wave broadcast practice. There are many more stories to be told, but space is too short.

Among them, a new technology called IBOC, "In-Band On-Channel", digital broadcasting has just been approved by the FCC and is being deployed throughout the US.

In a remarkable feat of development, a broadband digital signal has been compatibly introduced into the amplitude modulated broadcast channel to provide FM quality stereo simultaneously with a conventional analog broadcast, using the same transmitter and antenna.

EMCers—Consider an AM Engineering Career!

This IBOC technology, among other evolving technologies aimed at using more of the limited spectrum, requires new attention to interference, bandwidth, and transmitter linearity. At the same time, AM broadcasters are constantly seeking more powerful systems, with concomitant safety and compatibility requirements.

So, if you are burned out on anechoic chambers and microchips, make the acquaintance of an AM engineer (a local chapter of the Society of Broadcast Engineers "SBE" is a good place to start) and see how the other half lives – just don't get too close to the RF! Ω

FIGURE 5: *Cellular Collocation System On AM* Tower

About the Author - Lawrence Behr, NCE

A NARTE Director since 1994, Lawrence Behr is a NARTE Certified EMC engineer and a NARTE Master Engineer. As CEO and President of LBA Group, Inc., he provides expert engineering telecommunications services to clientele worldwide. He has more than 30 years experience in broadcast and mobile communications engineering and in all aspects of management and marketing in the telecommunications industry. He has served as an expert witness relative to broadcast regulation, propagation and allocation before the FCC and the Federal Courts. Recognized as a pioneer in wireless cable and broadcast technologies, Mr. Behr has presented numerous papers for conferences and symposia sponsored by SBE, NAB, IEEE, CIRT and others. He is a former Commissioner for North Carolina's Agency for Public Communications, and is a panel member for the USC Center for Futures Research (100 US Telecommunications experts). Lawrence is also a member of SBE, SCTE, AFCEA, a pilot, and Extra Class ham operator K4JRZ.