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Modern VHF Signal Measurement Techniques at NPR Labs, Part II

A Measurement System to Measure HD Coverage Accurately

BY JOHN KEAN

The author is senior technologist at NPR Labs in Washington.

In the first half of this paper (Engineering Extra, Apr. 14), I discussed the need for an accurate antenna

WHITEPAPER

capable of repeatable measurements and presented the design of NPR Lab's transportable ground plane antenna. The article also described some early measurement techniques for VHF FM that set standards for quality, worth emulating today some 60 years later.

However, the old techniques used a series of local spot measurements that were collected along a common transmitter radial. These separate measurements were plotted on a signal strength vs. distance chart and fitted with curve.

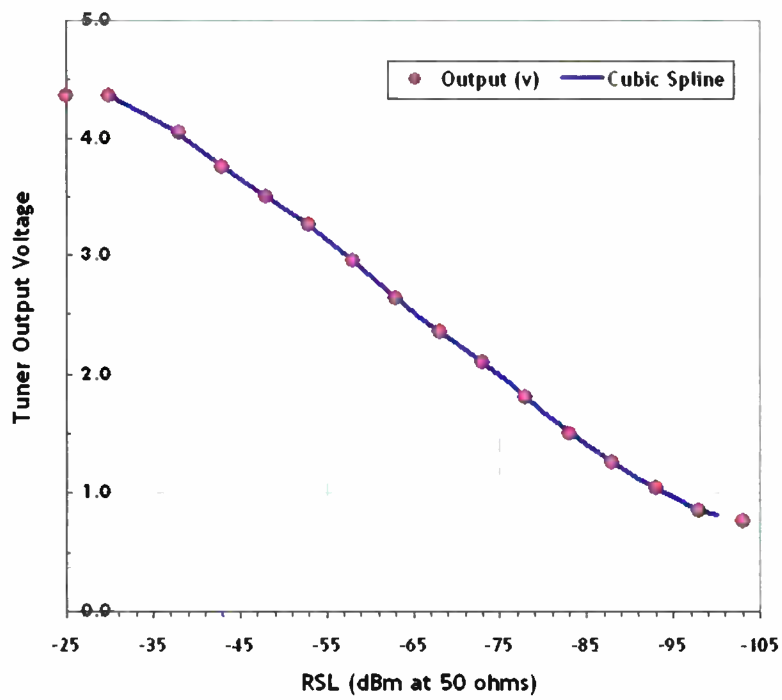

Fig.1: This chart shows Kenwood tuner DC output vs. RF signal input. With the calibrated groundplane antenna, a maximum input of –30 dBm is more than 80 dBu field strength. Signals or channel noise as low as 10 dBu are measurable.

The position and shape of the curve, relative to the FCC's signal propagation curve, indicated antenna radiation performance in a given direction and terrain effects at the coverage fringe. This approach though wasn't suited to "drive-test" studies over wide areas, which NPR needed in order to evaluate and compare HD Radio coverage to analog FM service.

Fortunately, we now have computers and software tools to help continuously collect and process the volume of data along hundreds of miles of roadway.

NPR Labs needed to carry out measurements of HD Radio signal coverage, specifically to determine how interference received from stations on first- and second-adjacent channels would affect digital reception. This required a customized measurement system. Drive test measurement adds some requirements that were not necessary in the original systems, especially in view of a tight schedule and limited budget. (See chart on page 8.)

The requirements were a tall order, as the middle column entries show. There was no commercially-available unit that met our requirements, so in NPR Labs tradition, we built our own field test unit. This unit provided all the features and performance summarized in the right column.

The following will describe how we set up the units for measurement, calibrate them and use them for field strength measurement.

NPR Labs had some early experience with the Kenwood KTC-HR100 "black box" tuner, as it was the first commercially-available HD Radio receiver.

(continued on page 8)

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CAP Implementation Guide Gives Glimpse to Future System

Greater Flexibility of Data Transmission Offers Possibility of Improvements

BY MICHAEL LECLAIR

Just before press time, I found myself scanning through the CAP Implementation Guide, an interesting document prepared by EAS equipment manufacturers. The group is known as ECIG — EAS CAP Industry Group. CAP, of course, stands for the Common Alerting Protocol, which has been adopted as a standard data protocol for a revised emergency notification system currently in the works.

The guide is being developed to assist manufacturers in developing equipment that can operate compatibly. The goal is to have CAP equipment that will deliver the right messages to the public no matter which manufacturer's system is used to send or receive messages. This is a worthy goal.

The new Emergency Alerting System under development is constrained by the need to operate within the existing EAS rules and SAME codes. CAP is a far more flexible and powerful system as it is based purely on data transmission, but ultimately it has to translate to something that works under the EAS system.

For example, the final "payload" of a radio emergency messaging system is an audio message. Under CAP, this audio message can be created from a text message using text-to-speech conversion, rather than relaying an analog audio file from sender to receivers, often over multiple generations. By generating the audio message from data, the quality can be maintained at a reasonable level even as the message is disseminated multiple times.

In my home state of Massachusetts, the Primary Entry Point for emergency alerts and monthly tests is an AM station with very broad reach, but the audio fidelity is noticeably lower than is typical on the many FM stations that then relay this alert. So this is a potential improvement. Done correctly, it also allows understandable messaging without having to find "announcer talent" amongst the state emergency management agencies.

ENCOURAGED BY POSSIBILITIES

The Guide provides the outlines of what could be possible in a new Emergency Alerting System. One of my pet peeves about the current EAS is its reliance on a daisy-chain of transmission. Typically, a single entry point station is used to generate the original alert or test, which is then relayed by other stations out to the public. In larger states, this can mean a significant delay before a message reaches the last radio station in the chain.

The capability of distributing emergency messaging via pure data transmission offers the possibility of building a system that does not require a daisy chain.

For example, the distribution of an emergency alert could now be accomplished via a relatively inexpensive path, such as the public Internet. All affected stations would receive the alert simultaneously, greatly speeding the distribution of an emergency alert at a fairly modest cost. An audio alert message could be placed at a website and downloaded automatically for playback from the receiver. A more hardened distribution system, such as satellite, would be an option where a higher reliability backbone is desired to supplement some or all of the chain.

One of the other great advantages of using alert distribution by a data path such as the Internet is the ability to conduct a "closed circuit" test of the system. Receivers can log all the relevant information, alert local engineering personnel and even respond back to the test sender with acknowledgement messages. To me, this offers the means to a large reduction of over-the-air testing, which we all dislike.

It may still be necessary to do the occasional "instructional" test to keep audiences educated on what an alert sounds like as well as to monitor actual system performance (similar to the existing Required Monthly Test) but weekly on-air tests potentially could be eliminated. That's an improvement that broadcasters could get behind.

KEEP IT SHORT

The CAP Implementation Guide also endorses a strict limit on message length of 1,800 characters maximum. This is important to make emergency messaging workable, both for direct display of the text message on advanced receivers or television systems and to keep the audio message within a two-minute length. Enforcing an efficient alert will contribute to the effectiveness of the system and reduce audience tune-out. The industry group recommends truncating audio messages of greater than 120 seconds, including those generated using text-to-speech conversion.

While the standard language for alert distribution is English, the CAP system supports audio messaging in multiple languages where this is desired. If a second, or even third, language version of an audio message is desired, the recommended operation is to have the receiver play the message in English, send the end-of-message data burst, and then play out any additional language messages immediately after the test concludes. This allows stations to select whether or not they wish to air alerts in more than one language based on their demographic service area, or to just stick with the English version.

STATE ACCESS

A new feature of CAP is a class of alerts known as "Governor's Must Carry." By creating a new class of messages that can be generated by local state agencies, the system has an input for local emergencies. That's an important feature of any new alerting system.

As most of you are aware, the EAS system is getting long in the tooth and is in need of updating to something more flexible and reliable. Discussions by government agencies have been under way for some time now, but many of the elements of the "new EAS" seem to be coming into place. From what I read in the Implementation Guide, some very good thinking has already taken place about how the future system could operate.

It's important for all of us to stay aware of these discussions and to help to develop a system we all can live with. We can even hold out some hope that it will provide a useful public service and possibly save lives. That's also a worthy goal.

THIS ISSUE

JUNE 9, 2010

Careful Planning Comes First in a Studio Move

A Cable Ladder Can Make Wiring Much Faster and Easier

BY CRIS ALEXANDER

In case you didn't know it, there is a recession on. With reduced top lines, radio station owners and managers are looking for ways to save money to preserve as much of their bottom lines as they can.

With rents down considerably in many markets, it can make a lot of sense to look for a new leasehold. Of course, the costs of relocation, including the often costly tenant finish of the raw space, must be factored into the move equation; but in these lean times, with landlords eager to fill their empty space with tenants, it's often possible to make a sweet deal.

I've observed several stations in my home market making such moves of late. Four of those stations are my responsibility, and at this writing we are well on our way to getting the new space ready to move the stations into. It's been awhile since I was personally involved in a new studio buildout, so the process has been a (re)learning experience for me.

This particular project is of a type that I have not undertaken in 23 years. In every other studio move I have done since 1987, we have built out the new space, purchased new cabinets and equipment, built out the new studios and moved into them.

This time, the cluster's studio equipment and cabinets are all too new to even consider replacing (and don't forget that there's a recession on!), so my challenge is to somehow move all the studio equipment from the old leasehold to the new in the shortest amount of time while keeping all four stations on the air. Piece of cake. Or maybe not.

PLAN TECHNICAL DETAILS

The key to any successful relocation project is careful planning.

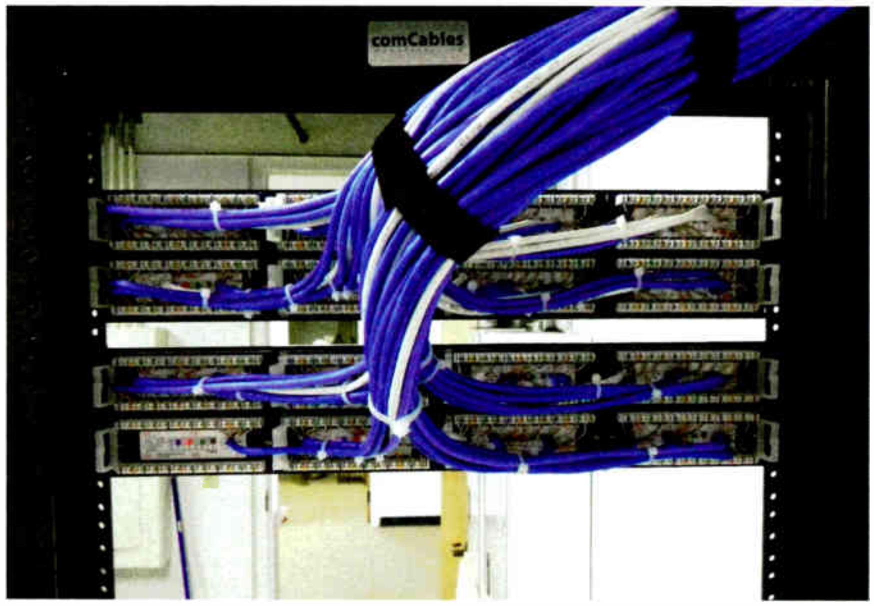
The planning for our new Denver facility started last fall. We sat down with the architects and discussed every detail of our proposed space. Within a few months, we had a final floor plan and a set of construction drawings that were approved in short order by the city's building department. Bids were solicited, a contract was awarded and walls started going up.

By late April, the tenant finish was just about complete. That meant it was time for the technical infrastructure buildout to start.

A lot of planning went into that part of the project as well. Conduit runs, NEMA box placement, power distribution, telephone and Internet wiring were carefully thought out. A "home run" of 2-inch EMT conduit was installed between each control room and the TOC, the "Technical Operations Center" (we used to call it the engineering room). A run of 2-inch EMT went to the telephone/electrical room, and a run of 4-inch EMT was installed to provide roof access for coax cables and the like.

Space is tight, so the rack budget was critical. We are downsizing from seven racks to four. The racks selected were Middle Atlantic WRK-series open-frame units. Side panels were purchased for the two end racks, and each rack has a locking back door. A top plate containing a thermostatically-controlled fan and a removable wiring access plate was provided for each rack. The four units were bolted together and to the floor. A 1.25 kVA rack-mount UPS will

(continued on page 6)



Patch panels were used to terminate all phone and LAN wiring.

			ADI-2001 Slot #3		Block #1	SDI-2001 Slot #4			
Source/Destination	Pos#	Wire	Signal	Color	Color	Signal	Wire	Pos#	Source/Destination
KLTT ASERV-1 L	1A	H	Channel 1 (Stereo-1 Left) In	Brn	Brn	Channel 1 (Stereo 1 Left) In	H	26A	KLTT ASERV-2 L
D9M	1B	L					L	26B	D9M
	2A	S					S	27A	
KLTT ASERV-1 R	2B	S	Channel 2 (Stereo 1 Right) In	Red	Red	Channel 2 (Stereo 1 Right) In	S	27B	KLTT ASERV-2 R
D9M	3A	H					H	28A	
	3B	L					L	28B	D9M
	4A	H	Channel 3 (Stereo 2 Left) In	Org	Org	Channel 3 (Stereo 2 Left) In	H	29A	
	4B	L					L	29B	
	5A	S					S	30A	
	5B	S	Channel 4 (Stereo 2 Right) In	Yel	Yel	Channel 4 (Stereo 2 Right) In	S	30B	
	6A	H					H	31A	
	6B	L					L	31B	
	7A	H	Channel 5 (Stereo 3 Left) In	Grn	Grn	Channel 5 (Stereo 3 Left) In	H	32A	
	7B	L					L	32B	
	8A	S					S	33A	
	8B	S	Channel 6 (Stereo 3 Right) In	Blu	Blu	Channel 6 (Stereo 3 Right) In	S	33B	
	9A	H					H	34A	
	9B	L					L	34B	
	10A	H	Channel 7 (Stereo 4 Left) In	Vio	Vio	Channel 7 (Stereo 4 Left) In	H	35A	
	10B	L					L	35B	
	11A	S					S	36A	
	11B	S	Channel 8 (Stereo 4 Right) In	Gry	Gry	Channel 8 (Stereo 4 Right) In	S	36B	
	12A	H					H	37A	
	12B	L					L	37B	
	13A	H	Channel 9 (Stereo 5 Left) In	Brn	Brn	Channel 9 (Stereo 5 Left) In	H	38A	TRN-1
	13B	L					L	38B	(From DA 1 L)
	14A	S					S	39A	
	14B	S	Channel 10 (Stereo 5 Right) In	Red	Red	Channel 10 (Stereo 5 Right) In	S	39B	TRN-3/WW
	15A	H					H	40A	(From DA-1 R Bridged)
	15B	L					L	40B	
CRC-1	16A	H	Channel 11 (Stereo 6 Left) In	Org	Org	Channel 11 (Stereo 6 Left) In	H	41A	
(From KLZ Intraplex)	16B	L					L	41B	
	17A	S					S	42A	
CRC-2	17B	S	Channel 12 (Stereo 6 Right) In	Yel	Yel	Channel 12 (Stereo 6 Right) In	S	42B	
(From KLZ Intraplex)	18A	H					H	43A	
	18B	L					L	43B	
Sangean Receiver L	19A	H	Channel 13 (Stereo 7 Left) In	Grn	Grn	Channel 13 (Stereo 7 Left) In	H	44A	
	19B	L					L	44B	
	20A	S					S	45A	
Sangean Receiver R	20B	S	Channel 14 (Stereo 7 Right) In	Blu	Blu	Channel 14 (Stereo 7 Right) In	S	45B	GABNET
	21A	H					H	46A	(KLZ Intraplex)
	21B	L					L	46B	
	22A	H	Channel 15 (Stereo 8 Left) In	Vio	Vio	Channel 15 (Stereo 8 Left) In	H	47A	
	22B	L					L	47B	
	23A	S					S	48A	
	23B	S	Channel 16 (Stereo 8 Right) In	Gry	Gry	Channel 16 (Stereo 8 Right) In	S	48B	Ramsey
	24A	H					H	49A	(From DA 5 L)
	24B	L					L	49B	
	25A							50A	
	25B							50B	

Color-coded documentation helps to keep things organized during installation and provides a record of the baseline installation.

MOVE

(continued from page 4)

be installed in each rack with the UPS feeding two full-length power strips, one on each side.

I decided early on to use a cable ladder system for all the wiring within the TOC. We did this at a transmitter site installation last year and it made a believer out of me. The cable ladder system eliminates at least one insulation displacement block in each rack and greatly simplifies the facility wiring. The cable ladder provides a neat, secure and convenient path for all the wiring between each rack, the blocks feeding the studios, the telephone/LAN rack and the conduits feeding electrical room and roof.

For this type of work, a CAD program is a must. For years I used AutoCAD, but over a decade ago switched to TurboCAD, a feature-packed program that does everything I need it to. All the rack and cable ladder system were laid out in TurboCAD and the plotted plans were given to the general contractor. From those he had no issues putting everything together exactly as we wanted.

In fact, we used TurboCAD to plan the entire facility. Because it will import and export AutoCAD files, I was able to swap drawing files with the architect seamlessly.

Cable ladders greatly simplify the wiring task.

The CBC-Denver facility has at its core two vital organs: a Wheatstone bridge router and an RCS NexGen digital media system. The bridge router is the audio "engine" for the entire facility, and NexGen provides virtually all the audio and programming. These elements are common to all four stations, so there will be no moving one station at a time — it's all or nothing!

And so it is that we have to have the TOC ready for all the equipment. There won't be time to move the equipment, install it in the racks at the new location and then wire it up. The wiring has to all be in place on moving day so that we can move each item, put it in the racks, plug it in and turn it on. The Wheatstone bridge router and NexGen system have got to be working at the new locale within hours of their removal at the old location.

When we first installed the Wheatstone bridge router system a few years ago, we had to integrate it into the existing analog audio scheme, converting to AES to the degree possible at the time and slowly evolving into a nearly all-digital facility since. This was a learning process, and while I won't say that big mistakes were made along the way, we certainly could have done a few things better.

Starting fresh in a new location would

seem to be the ideal time to fix these things, but after much consideration I decided that we simply don't have time. We will, in essence, relocate the bridge router system configured exactly as it is now. That way we know that it should work, we know *how* it should work and we will not have to spend a lot of time troubleshooting configuration issues within the system.

If we don't make any wiring errors we should be able to unplug the system at the old facility and plug it in at the new and be off to the races. I'll have to let you know how that works out.

THE RIGHT TOOLS

There are lots of project planning software tools on the market to help with projects like this, and I have some in my library. In this case, however, I opted to use a tried-and-true software tool, Microsoft Excel, to plan the project.

A color-coded spreadsheet was created for each wiring block in the facility. Each line contains the signal source or destination, block location, wire designation (high, low or shield) and signal name. The individual block spreadsheets were assembled into a single workbook with a tab for each block.

From these spreadsheets we created wires with the proper termination on one end along with a Kroy wire label under clear heat shrink tubing. The other end of each wire was left unterminated and was marked with a piece of painter's tape with the signal name written on it. As each wire was installed from the proper location in the designated rack, it was routed through the cable ladder system to the correct Krone block, cut to length, affixed with a label under heat shrink and punched down.

We're using hook and loop fastener wire ties to bundle the wires and secure them to the cable ladder. This will allow for future wiring changes while keeping things neat and secure. We actually got this idea from our phone guy, who used the ties to bundle the huge trunk of Cat-5e wires coming from all over the facility to the bank of patch panels we'll use to route phone and LAN signals.

We're going to follow a similar plan for each of the studios. With the bridge router system, there's not a lot of signal wiring in the studios, but we still have to tie local sources and destinations — CD players, NexGen workstations, phone hybrids, mics and headphone amps — to the "satellite" router located in each studio (called a "satellite" router because it operates as a "satellite" to the main bridge router). All the signal cables will be pre-made with connectors and wire labels installed. When the cabinets and equipment are installed in each studio, wiring will be a simple matter of plugging in each device, routing the wire, cutting it to length, affixing a label and punching it down.

When the time for The Big Move comes, I plan to bring in the troops, market CEs from some of our other facilities who are proficient with Wheatstone, NexGen and other systems. I can hand each the wiring spreadsheets for their assigned rooms and they can complete those rooms without supervision.

We're about done with all the TOC wiring and we're starting now on all the studio pre-wiring. I am confident that we will make our move date in July.

Cris Alexander is director of engineering at Crawford Broadcasting Company and a past recipient of SBE's Broadcast Engineer of the Year Award.

Amanda Alexander terminates a studio 25-pair cable.

MEASUREMENT

(continued from page 1)

Although a complete tuner, the box required a Kenwood in-dash head unit to provide the tuning controls, display and loudspeaker amplifier. We used one in NPR's "Tomorrow Radio" drive test work in 2002, to record coverage in a number of cities around the country. We used a proprietary computer interface to connect to the tuner, and the interface required proprietary software to record the data. While it worked well, the reception status and GPS data logs were kept in separate files, and no information was available for field strengths, which we determined was necessary to build a model for HD Radio coverage prediction.

Fortunately, a little "reverse engineering" of the black box yielded a breakthrough. The voltage at a certain point on the receiver board provided a near-linear presentation of the input signal power over a 70 dB range! Fig. 1 shows the DC output voltage vs. FM RF input referenced to 50 ohms, from –25 dBm down to –104 dBm.

There was no commercially-available unit that met our requirements, so in NPR Labs tradition, we built our own field test unit.

It's apparent that the signal voltage flat-tops above –30 dBm, and there is a slight curve at the lowest signal powers. The voltage would be fine as is, but we extend the range of accuracy by using a cubic spline formula to track the curves. When attached to our ground plane antenna, this results in an accurate measurement from approximately 80 dBuV to nearly 10 dBuV. While the upper limit would prevent measurement at higher field strengths closer to test stations, we have focused on lower field strengths that are pertinent to station interference and which correlate nicely to the native range. If we needed measurements at higher signal levels, we inserted a fixed 50-ohm pad into the antenna line.

The Kenwood tuner provides only the signal strength of the analog host FM station, but the frequency difference between the FM carrier and each digital subcarrier group is less than 150 kHz. At FM Band frequencies this difference is less than 0.17 percent (0.15/88.1 = 0.0017), which causes a high correlation of fading between the analog and digital signals. Consequently, a station's analog FM field strength is an accurate "proxy" for the station's digital field strength. This condition would not apply to stations that have different analog and digital antenna radiation patterns, but we avoided this type of station in our nationwide measurement campaign used to develop a prediction model for HD Radio reception.

Comparison of Available Systems and NPR Labs' Requirements

REQUIREMENT	'OLD' SYSTEM APPROACH	SYSTEM SOLUTION
Continuous recording of RF signal strength	Strip charts may record for long periods, but manual derivation of local median signals (every 100-200 meters) over long distances would be grueling	Digital sampling with large storage direct to memory card, permitting hours of non-stop recording
Large RF dynamic range from the signal recording system, to support variations in distance as well as log-normal fading effects	Common field strength receivers have wide range capability by changing the input RF attenuator, but this interrupts the signal and attenuator settings must be tracked	Selection of a receiver with >60 dB of linear signal measurement range (70 dB with slope compensation); a 12-bit A/D converter providing >70 dB of recording depth
Ability to simultaneously record field strength on multiple channels	Achieved by building multiple systems	Compact receivers that fit into one cabinet
High selectivity (ability to simultaneously record a desired channel a nearer first-adjacent channel signals)	Usually not a consideration for spot measurements	Upgraded 10.7 MHz IF filters to support measurement of desired signal >25 dB below a first-adjacent station signal, based on analog-to-analog interference
Ability to log HD Radio reception	All field strength receivers at the time were analog-only	Receiver provides digital/analog Blend Line to digital recorder, sharing tuner for signal strength
Compact and portable	A challenge for a multiple-channel system with separate cabinets	Two boxes fit in the backseat of any size vehicle; GPS interface for latitude, longitude and time integrated to digital logging

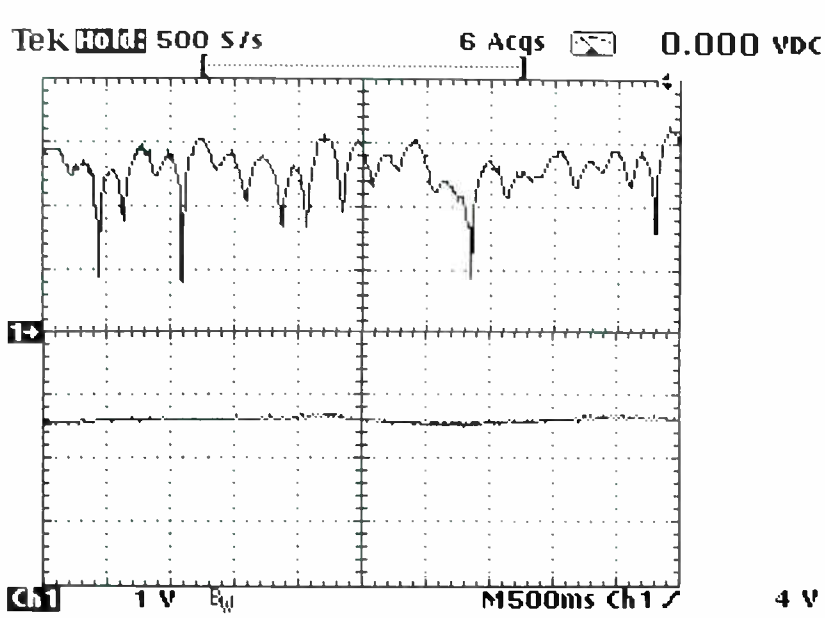


Fig. 2: Dual-trace oscillograph of the tuner's unfiltered output voltage (upper half) with fast fading from lab's Rayleigh simulator. Peak-to-peak RF range is approximately 25 dB. The lower trace shows the DC output after low-pass filtering. The average voltage is preserved, but the variations are greatly reduced.

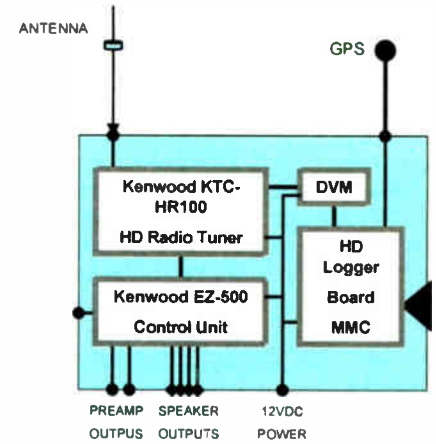


Fig. 3: Simplified diagram of the NPR Labs Field Test Unit, containing the Kenwood KTC-HR100 FM/AM/HD Radio tuner and EZ-500 control unit. The G-Dyno logger board with its MMC card socket is connected to the tuner through the low-pass filter (not shown). A digital voltmeter displays the DC signal line. A 12 volt sealed lead-acid battery, also not shown, provides backup against power interruptions and portable operation.

FAST FADES

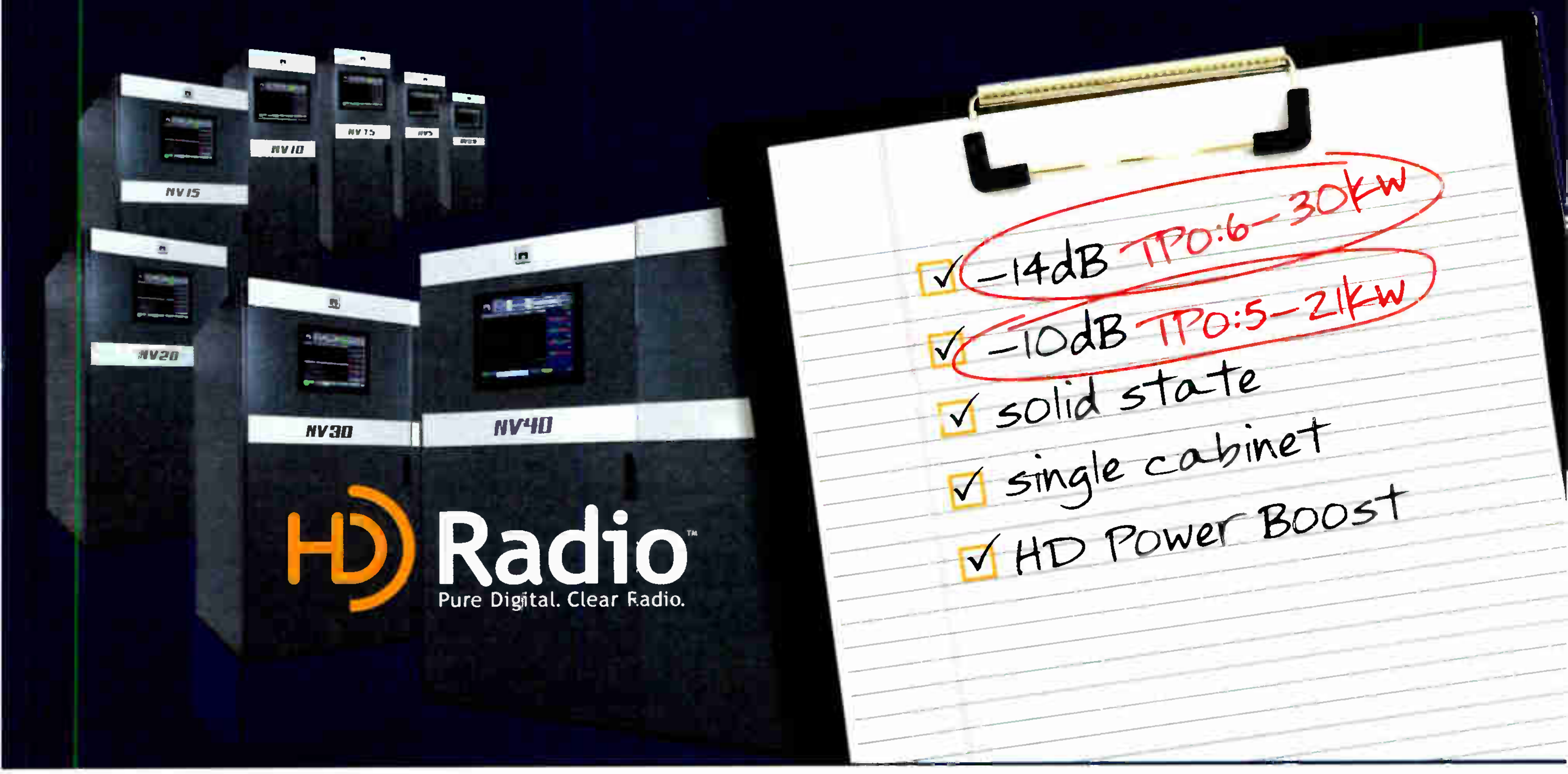
Another important consideration in drive-test measurement of VHF signals is fast fading, which is caused by reflections from the foreground surface near the vehicle, distant hills or mountains, buildings, etc. The multipath causes the mobile signal to vary large amounts, often more than 20 dB, within the span of one wavelength (about 3 meters at FM frequencies). This effect dominates the variation in field strengths over the short distances that we refer to as the "local mean field strength." These distances for "local mean field strength" may be 100 to 300 meters, and correlate to the cell sizes we use in our computer predictions of field strength. While we could potentially sample at high rates to quantize this fast fading, then average the results, this process requires a lot of data storage and post-processing, which is wasteful when the local mean field is what we want.

To reduce the sampling rate and storage of fast fading, we filter the signal in real time, using a four-pole low-pass filter having a 1 Hz cutoff. This is imple-

(continued on page 10)

more -14dB more -10dB

more of your bases covered



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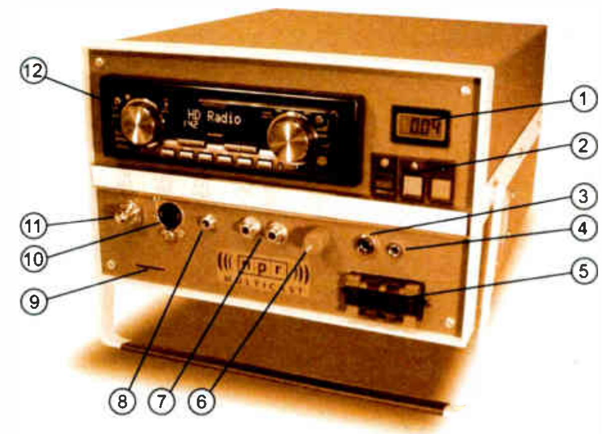
MEASUREMENT

(continued from page 8)

mented with conventional op-amp ICs with a Butterworth characteristic. Fig. 2 shows a dual-trace oscilloscope photo of the DC voltage before filtering, using a mobile signal generated by the lab's HP-11759C RF channel simulator. In the upper trace, familiar rounded peaks and sharp signal drops are representative of fast fading, which is also termed Raleigh fading, from the statistical probability distribution of fast fading. In the lower trace of Fig. 2, after the low pass filter, fast fading is almost gone and only the slower fading is left. The slower fading would reveal the effects of terrain shielding and land cover on signal strength that we are attempting to measure. The slow fading is referred to



1. Digital Volt Meter (for real-time Received Signal Level and power supply status)
2. Controls and Indicators (from left to right) Main Power Switch, Logger Power Button, Logger Start/Stop Button
3. 1/4" Headphone Out
4. 1/8" Headphone Out
5. Terminal Block for External Loudspeakers (4 x 20W)
6. Headphone Level Control
7. Preamp-Level Stereo Output Jacks
8. Power Input Jack
9. MMC Card Slot
10. Global Positioning System (GPS) Jack
11. FM Antenna Input Jack
12. Kenwood EZ-500 Receiver Head Unit (controls internal KTC-HR100MC tuner)

Fig. 4: The main Field Test Unit's features.

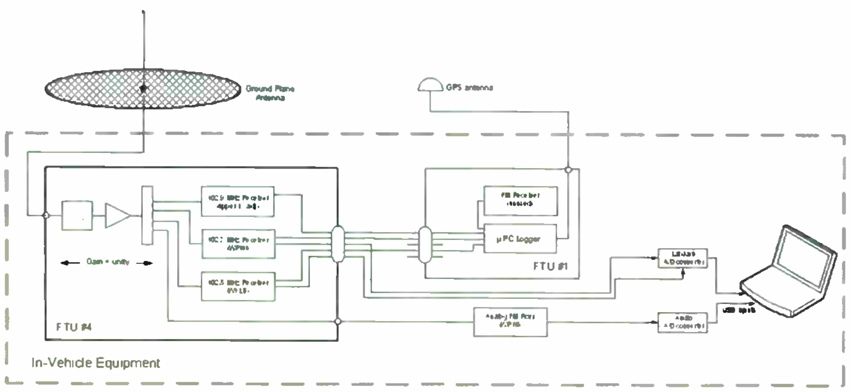


Fig. 5: The multichannel RF logging system used a standard Field Test Unit (FTU #1), equipped with a triple-input connector to interface with a second unit (FTU #4), modified to contain a total of three KTC-HR100 tuners. This unit also contains an 88–108 MHz bandpass filter, high dynamic range RF amplifier and four-port RF splitter. For NPR Labs' recent HD Radio interference field tests, the three tuners were set to the desired channel and upper and lower first-adjacent channels, while the fourth RF output was fed to an OEM car radio, tuned to the desired channel, for analog audio recordings.

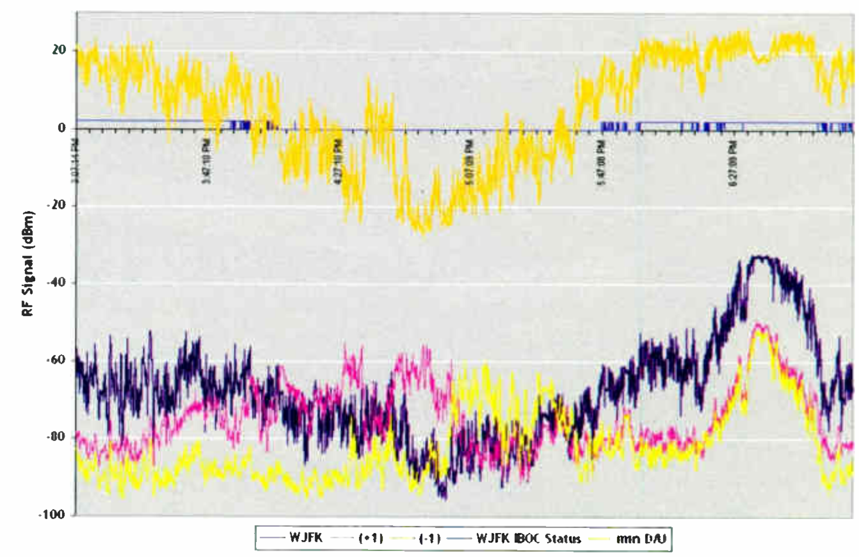


Fig. 6: Signal power measurements in dBm from four hours of drive-testing outside Washington and in Maryland and northern Virginia for station WJFK(FM), a Class B on 106.7 MHz in Manassas, Va. WJFK's signal is shown in dark blue trace along the bottom. Signals from WWEG, a Class B on 106.5 MHz in Myersville, Md., and WWMX, a Class B in Baltimore on 106.9 MHz are recorded in yellow and magenta, respectively. A desired-to-undesired signal ratio between WJFK and WWEG or WWMX, whichever is higher, is calculated and displayed as "min D/U" in gold, near the top of the chart. IBOC digital reception status is shown as the lighter blue trace near the 0 dB line; a "high" indicates digital reception and a "low" indicates no digital reception. Over most the route, the station signals vary independently, with WJFK's digital reception dropping near the middle portion of the route. While the "min D/U" is an approximate indicator of successful IBOC reception, computer analysis of the numeric data presented here showed that a more complex relationship between the absolute level of WJFK and its ratio to both station signals was needed to determine whether IBOC would be received.

as log-normal fading, again getting its name from the statistical distribution of the signals over large geographic areas.

The log-normal fading, representing the local mean field strengths we wish to capture, is sampled by a microcomputer logger inside the Field Test Unit's cabinet. We wanted a logging device with removable flash memory storage, to provide a simple, self-contained measurement system and to avoid connecting laptops and running custom software. Finding the right logger wasn't easy, when it had to combine a compact analog-to-digital sampler with integrated GPS capability. We finally located a company based in Scotland that makes a computer logger for race cars, called the "G-Dyno Plus." The logger is only 3 by 6 inches and has seven A/D input channels. It also has four binary digital input channels, which made it perfect to record the Kenwood tuner's digital blend line. The G-Dyno logger required software modifications by the manufacturer to change the sampling rate (we chose 4 Hz) and the output data format to we needed for signal post-processing.

The logger stores the RF signal values, digital receive status, UTC time stamps and GPS latitude and longitude to an MMC memory card (similar to SD cards).

A simplified diagram for the field test unit is shown in Fig. 3. Inside the field test unit cabinet, the logger board is connected to the Kenwood KTC-HR100 "black box" tuner, which supplies the RF level and digital receive status signals. The connector for the external GPS unit and control buttons are brought to the front panel of the cabinet. The Kenwood EZ-500 control unit, mounted on the cabinet front, is connected to the tuner and provides a variety of audio outputs. Fig. 4 is a photo of the basic field test unit, pointing out the front-panel controls and connections.

MULTIPLE CHANNELS

To develop a model to predict the coverage of HD Radio (NPR Labs completed this model and has a patent pending), we realized that the original field test units' single channel wasn't enough.

We were estimating the field strength of the HD Radio signal by measuring the FM Host carrier (something that is well-correlated with the signal level of both sidebands, due to their close frequency adjacency). However, HD Radio employs two separate sidebands approximately 100 to 200 kHz from the FM carrier, squarely in the channels of upper and lower first-adjacent stations. To understand the behavior of HD Radio in the real world, we needed four receivers: one to provide field strength data on the desired host FM channel, one to determine the digital reception status and two to capture signal strength data on the lower first-adjacent channel and the upper first-adjacent channel.

The small size of the Kenwood black box tuners offered the opportunity to combine the three tuners, which collect the signal strengths of the host FM and upper and lower channels, into one separate cabinet. Rather than use three bulky head units, Kenwood offered a small tuner control that was no larger than a candy bar. (The auxiliary cabinet containing three tuners with the small tuner controls can be seen in the inset photo in the first article.)

Fig. 5 shows an actual diagram of the in-vehicle system used in 2009 for a series of over-the-air interference studies involving first-adjacent digital stations with analog FM reception. The left box is a field test unit containing a high-performance 88–108 MHz bandpass filter, a low-noise high dynamic range amplifier, and a precision four-port RF splitter. Three of the ports feed the three receivers in the auxiliary cabinet, which are connected through a multi-wire cable to the logger in basic field test, shown in the center. The fourth RF output was fed to an analog mobile FM receiver in this particular test for audio recording of off-air reception.

Returning to the system's use for IBOC reception studies, a drive-test of WJFK(FM), Manassas, Va., a Class B commercial station on 106.7 MHz near Washington, is shown in Fig. 6. The graph illustrates approximately four hours of drive-test measurement on highways and arterials in southern Maryland and northern Virginia. This figure shows the signal power in dBm for WJFK (which operated in hybrid digital at –20 dBc at the time) as the dark blue line near the bottom of the chart. Note that even with the low-pass filtering, the log-normal fading causes substantial signal variation when viewed over longer periods.

WJFK has a first-adjacent neighbor, WWMX, a Class B on 106.5 MHz in Baltimore, and another first-adjacent neighbor, WWEG, a Class B on 106.9 MHz in Myersville, approximately 60 miles west of Baltimore and 50 miles northeast of WJFK.

WWMX's signal is shown in yellow (–1 channel) and WWEG is shown in magenta (+1 channel). It's apparent that the three signals can track differently in strength along the routes, depending on the distances and various terrain effects from each station. Signal powers varied from a high of approximately –30 dBm, where WJFK's signal began to flat top, to lows close to –100 dBm. Where WJFK's signal rises significantly, WWMX's and WWEG's signals rise too. This is due to 25 dB crosstalk from first-adjacent signals in the tuners. However, this level of measurement isolation was sufficient to collect all the data we needed to develop the HD Radio coverage prediction model.

Two more traces of data are presented on Fig. 6. A "max D/U" is shown in gold, representing the worst (lowest) desired-to-undesired signal ratio between WJFK and WWMX or WWEG are shown. It's apparent that during the middle of the drive that WJFK's signal becomes weaker than both stations' signals, putting the gold trace below –20 dB. Near the beginning and end of the drive, the D/U ratios are nearer to +20 dB.

The last trace to view is in bright blue, near the "0 dB" level, presenting the digital receive status of WJFK's HD Radio signal. A "high" line state indicates digital reception and a "low" (0) state indicates no digital reception. There is a rough correlation between the signal level of WJFK and its D/U ratio, to WJFK's digital reception. However, our analysis of thousands of miles of signal reception data revealed that a more complex relationship was involved with these three signals for a prediction model of HD Radio reception. While we can't reveal the details while the patent is pending, at any given location the model considers the field strength of the digital signal as well as the ratios of the digital signal to each first-adjacent channel analog FM signal. The effects of second-adjacent channel FM signals are considered as a secondary factor.

We used this instrumentation for extensive drive-test measurements with 10 other public radio stations across the United States. The additional data led us to the development of a comprehensive model for HD Radio coverage that considers the digital signal level and the levels of upper and lower first- and second-adjacent signals. We are grateful to have the opportunity to develop the multichannel FM signal measurement system, which has provided public radio with a great deal of information on signal propagation and station coverage.

Comment on this or any other article to rwee@nbmedia.com.

Tower Lighting Options Grow

New Solar-Powered, LED Lights Help Save Costs While Meeting Aviation Obstruction Rules

BY MEENAKSHI SINGHVI

Aviation obstruction lights are high-medium-, or low-intensity lighting devices installed atop high-rise structures, buildings and towers and used as collision avoidance measures.

The governments of most countries require aviation obstruction lights on all high towers and on low towers near airports, because towers are hazards to aircraft. Such devices make the structure much more visible to passing aircraft, and are usually used at night, although in some countries they are used during daytime, too.

Aviation lights need to be of sufficient brightness in order to be visible for miles around the structure.

For broadcasters, high-rise towers are a vital part of the transmitting system, so proper understanding of tower lighting system is essential.

In general, tower lighting systems require several sets of lights, depending on the height and location of the tower, along with connection to the mains power supply. In addition, medium-wave broadcasters require some form of isolation system, such as an Austin transformer, on self-radiating towers.

Earlier, incandescent filament bulbs were standard for tower lighting, but nowadays LED-based and solar-powered LED-based aviation obstruction lights are very popular.

These lights have replaced older incandescent filament and neon bulbs for several reasons. An additional benefit for broadcasters is that solar-powered LED aviation obstruction lights can eliminate the need for power cabling and Austin transformers on self-radiating towers.

CATEGORIES OF LIGHTS

Aviation obstruction lights are broadly divided into three types: aviation red obstruction lights for structures less than 200 feet (61 meters) above ground level (AGL); medium-intensity flashing white obstruction lights for structures between 200 feet and 500 feet (153 meters) AGL; and high-intensity flashing white obstruction lights for structures with a height exceeding 500 feet AGL. A mix of these types of lights may be required, depending upon the tower.

Aviation obstruction lights must meet all specifications of the International Civil Aviation Organization (ICAO). Since rules can vary from nation to nation, additional approvals from other organizations may be required. In the United States, the Federal Aviation Administration is responsible for implementing aviation safety regulations.

Any structure that exceeds 200 feet AGL generally needs to be marked/lighted according to FAA regulations. There are many factors that can affect obstruction marking requirements, such as weather, terrain, proximity to airports, etc.

Tower lighting can be red or white; specific colors may be mandated based on the tower size and location.

For red lighting systems, the tower must be painted in alternating sections of orange and white paint to provide maximum daytime visibility; red lights are for night-time use only. In the case of white or dual (red-white) lighting systems, the need for painting the tower may be eliminated.

A tower or any high-rise structure may be lighted by low-, medium- or high-intensity obstacle lights or a combination of such lights.

Multiple light units may be used to achieve a horizontal coverage of 360 degrees around the tower or structure. The "beam spread" of a light is defined as the angle between the two directions in a plane for which the intensity is equal to 50 percent of the minimum specified peak beam effective intensity.

Towers taller than 200 feet may also require lighting at intermediate points along the tower. The color and placement requirements can vary based on tower height. The presence of guy wires may also affect how a tower must be marked.

In addition to structure size, the type or combination of types of lights that must be used can vary based upon the time of day. Their type of signaling (fixed or flashing) and brightness also can vary. FAA Advisory Circular AC 70/7460-1K outlines the specific obstruction marking requirements.

TYPES OF LIGHTS

Traditionally, red lamps use incandescent filament bulbs or neon bulbs, which have a relatively short lifespan.

Nowadays, LED-based and solar LED-based lights are becoming quite popular.

Advances in light-emitting diode technology are creating new applications and increased acceptability of LEDs for mainstream applications. Until recently, LEDs were considered appropriate only for indication or decorative purposes, but LEDs are now gaining acceptance for signaling, down lights, floodlights, street lights and aviation obstruction lights.

LED light is increasingly superseding incandescent bulbs and neon lights, particularly for applications where the bulb can be difficult to replace, because an LED light source can offer a longer life, energy savings, equal or better light characteristics and years of maintenance-free operation and a quantifiable return on investment.

LEDs are common on broadcasting towers, mobile towers, wind turbines and high-rise buildings. Technical specifications of these lights are based on the number and type of LEDs used, and are usually defined in terms of lux produced. LED-based obstruction lights are available for all intensity types and categories.

In addition to being long lasting (LEDs can remain in service for a decade or more), LED technology is quite efficient at converting electrical energy into light energy while generating very little heat. LEDs are 90 percent more energy efficient than the incandescent bulb.

Also, since LEDs give off hardly any heat, they are safe to handle and there are no UV or infrared rays. They also are clearly visible in sunlight, without any time lag.

Unlike conventional light sources such as fluorescent and high-intensity discharge bulbs that use mercury to generate light, LED lighting uses no mercury, thus eliminating issues surrounding disposal of hazardous substances.

	AOL Using Filament Bulbs	AOL With Neon Spiral	AOL With LED Lights	AOL With Solar Panel & LED
Original Equipment Cost	Very Low	Medium	Medium	High
Cabling Costs	High	High	High	None
RF Isolation	Required	Required	Required	Not Required
Power Panels	Required	Required	Required	Not Required
Maintenance	Bulb Replacement Required	Bulb Replacement Required	None	Battery Replacement Required
Bulb Life	1,000 hours	5,000 hours	100,000 hours	100,000 hours
Power Consumption	Very High	High	Low	None External

Table 1: Comparison of Various Lights for Aviation Obstruction Lighting

(continued on page 14)

MINSTRUMENT MATRIX

Sophisticated Minstruments from NTI give you comprehensive test capability... and these flexible audio instruments fit in the palm of your hand

DL1 Digilyzer
Digital Audio Analyzer

A handheld digital audio analyzer with the measurement power & functions of more expensive instruments, the DL1 Digilyzer analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as embedded digital audio. In addition, the DL1 functions as a smart monitor and digital level meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you connect to an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a comprehensive event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp
- Audio scope mode

DR2 Digirator
Digital Audio Generator

The DR2 Digirator not only generates digital audio in stereo & surround, it is a channel transparency and delay tester as well, all condensed into a handheld package. Delivering performance & functionality challenging any digital audio generator made today, it produces all common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bit. The Digirator features a multi-format sync-input allowing the instrument to be synchronized to video and audio signals. In addition to standard two-channel digital audio, the DR2 can source a comprehensive set of surround signals.

- AES3, SPDIF, TOSLink, ADAT outputs
- 24 bit 2 channel digital audio up to 192 kHz SR
- Sine wave with stepped & continuous sweeps; White & Pink Noise; Polarity & Delay test signals
- Dolby D, D+, E, Pro-Logic II, DTS and DTS-HR surround signals
- Channel Transparency measurement
- I/O Delay Measurement
- Sync to AES3, DARS, word clock & video black burst
- User-generated test signal files

AL1 Acoustilyzer
Acoustics, Audio & Intelligibility Analyzer

The AL1 Acoustilyzer features extensive acoustical measurement capabilities as well as analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

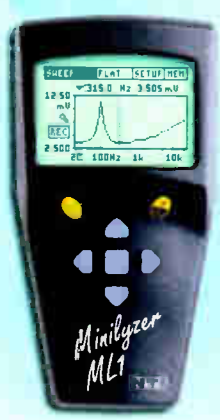
- Real Time Analyzer
- Reverb Time (RT60)
- Delay measurements
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- Automatic Distortion analyzer (THD+N)
- Frequency, RMS Level, Polarity measurements
- Requires optional MiniSPL microphone
- Includes MiniLINK USB interface & Windows PC software for storing tests and PC transfer

MR-PRO Minirator
High performance Analog Audio Generator + Impedance/Phantom/Cable measurements

The MR-PRO Minirator is the senior partner to the MR2 below, with added features and higher performance. Both generators feature an ergonomic instrument package & operation, balanced and unbalanced outputs, and a full range of signals.

- High (+18 dBu) output level & <-96 dB residual THD
- Sine waves & programmable swept (chirp) and stepped sweeps
- Pink & white noise
- Polarity & delay test signals
- User-generated custom test signals & generator setups
- Impedance measurement of the connected device
- Phantom power voltage measurement
- Cable tester and signal balance measurement
- Protective shock jacket

ML1 Minilyzer
Analog Audio Analyzer



The ML1 Minilyzer is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand. The comprehensive feature set includes standard measurements of level, frequency and THD+N, plus VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external response sweeps generated by a Minirator or other external generator.

Add the optional MiniLINK USB computer interface and Windows-based software and you may store all tests on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

MiniLINK

- Measure Level, Frequency, Polarity
- Automatic THD+N and individual harmonic distortion measurements k2 – k5
- VU + PPM meter/monitor
- 1/3 octave analyzer
- Requires optional MiniSPL microphone for SPL & acoustic RTA measurements
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

MR2 Minirator
Analog Audio Generator

The MR2 pocket-sized analog audio generator is the successor to the legendary MR1 Minirator. It is the behind-the-scenes star of thousands of live performances, recordings and remote feeds.

- Intuitive operation via thumbwheel and "short-cut" buttons
- New higher output level (+8 dBu) & low distortion
- Programmable Swept (chirp) and Stepped sweeps
- Sine waves
- Pink & White noise
- Polarity & Delay test signals
- Illuminated Mute button

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The Advance That Has Led Us Backwards

We've Become Slaves to Our Automation System Technology in Too Many Ways

BY GUY WIRE

The 2010 NAB Show has come and gone. By most accounts, this year was a significant improvement over the past several conventions. Traffic was up, buyers were serious and vendors were busier. The industry appears to be turning around with renewed hope of better things yet to come.

I usually do an NAB recap piece after the show each year, citing all the Cool Stuff and promising new products and technologies that caught my eye. My colleagues at Radio World have already handled that pretty well. After leaving NAB this year, I kept thinking about one particular paper given during Monday's afternoon radio tech session that exposed a largely unacknowledged reality, one that has literally crippled the product of radio and our business.

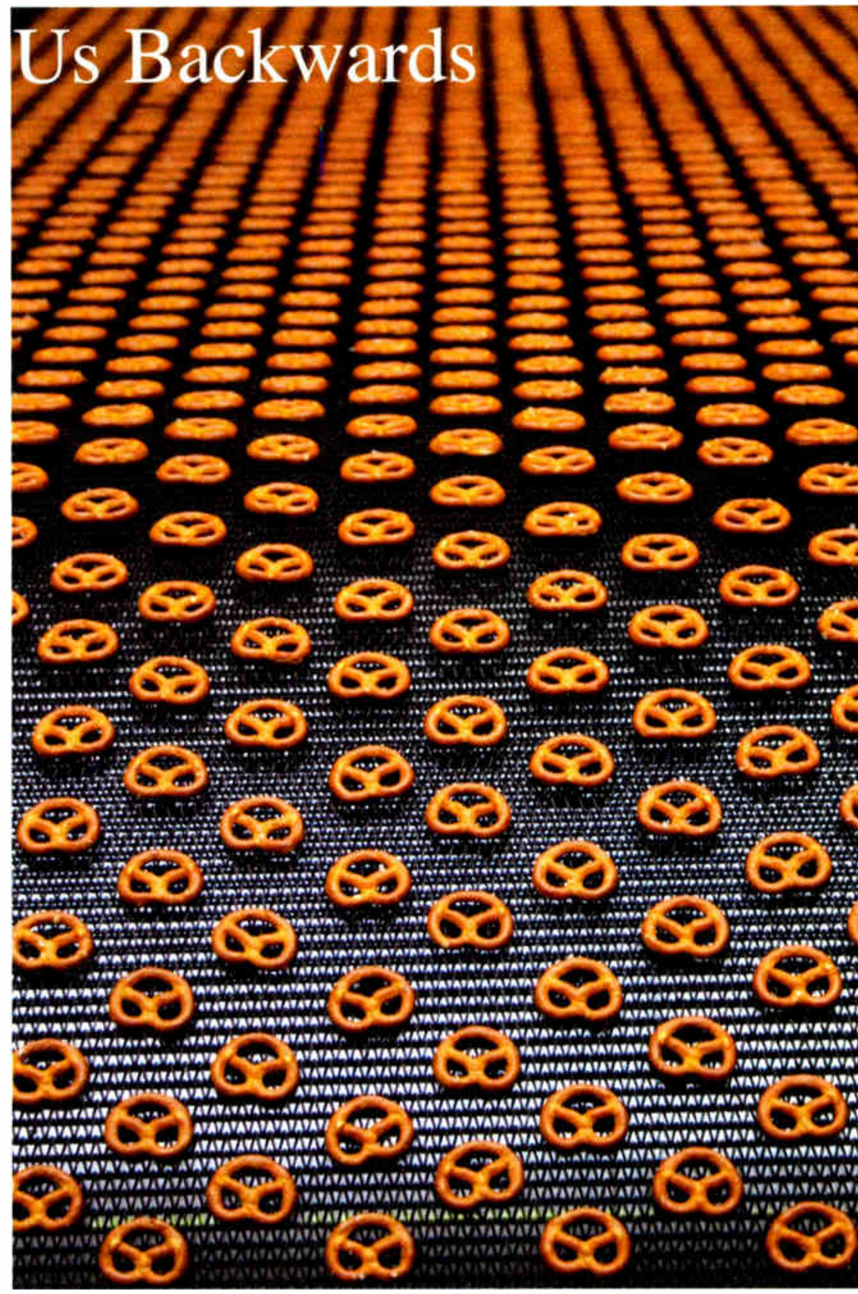
RADIO'S MALAISE

Pat Campion, director of product development for ENCO Systems, presented a discussion titled "Beyond Automation: Intelligent Software Design for Live-Assist Applications." He started by warning the audience he was taking great risk that he might not have a job after saying what he wanted to say about radio automation systems. Not just about his own company's products, but about those of all his competitors. That quickly got everyone's undivided attention.

Campion asserted that computer-based automation systems should be blamed for a part of what is wrong with radio today. Without reservation, I totally agree.

Twenty or thirty years ago — before consolidation, computers and the Internet changed our business forever — only the background music stations dared to use clunky automation systems. They all featured various kinds of Rube Goldberg-inspired tape rotation and play-out systems. Virtually every popular station with live announcers used carts and CDs to deliver their recorded content.

I can remember many top-rated jocks and morning shows of that era having huge walls and carousels filled with carts, carefully categorized and labeled. When they wanted a special bit or effect, they knew right where to grab and load it for quick execution. Dead air was practically nonexistent. Real live jocks knew how to fill and buy time cleverly without liner cards when they had to. Radio still had a sense of fun, impulsive creativity and unpredictability back then.



iStockphoto/zoran mircetic

Automation is a cost-saver, in radio and most businesses. That's great if the goal is to produce a homogenized product in large quantities, but Guy Wire says automated and live-assist technology has had unintended consequences.

Then came the big technology advancement. PCs and networks brought a promising and seductive amount of flexibility and efficiency to both production and on-air execution. As user interfaces, digital audio platforms and drive storage capacity all improved, loading everything destined for the airchain became easy if not preferable.

GIVE WAY TO THE 'BETTER WAY'

Fewer people could now do more of the work. Shows could be fully automated with voice-tracked announcers making it all sound "live." The game became how well we could fool the audience.

Consolidated owners and managers figured out the financial advantages of this marvelous new way of doing radio even faster than programmers. Except for drive times, live announcers were jettisoned. Radio quickly became more sterile, homogenized and predictable. I don't have to belabor the fine points of that ugly little truth.

Today's radio automation systems admittedly do a lot of things pretty well. But they also inflict a lot of unintended consequences.

Playing a log of events in sequence and reliably stopping and restarting on command is not too hard. Implementing a good search and change function for live-assist operators to quickly find and swap or add elements on the fly is more challenging.

Some do this chore better than others. Those that don't measure up frustrate

LED LIGHTS

(continued from page 12)

LEDs are also reliable and rugged; they contain no fragile filaments or glass. LEDs are solid-state devices and are less affected by the demands of harsh and hazardous environments. Finally, the usable life of LED bulbs is limited by lumen depreciation, not failure.

Lumen depreciation is the main concern with LED bulbs as their luminous intensity can significantly decrease over time. However, many manufacturers compensate for this by offering lights with initial luminous intensity much greater than required by FAA and ICAO specifications.

LEDs can also be heat-sensitive, and excessive heat buildup can shorten their usable lifespan.

SOLAR LED-BASED LIGHTS

The combination of a new generation of LED lights with very low power consumption and the falling costs of solar panels made it practical for LED-based obstruction lights to work on solar energy. This kind of system consists one solar panel, a backup battery, high-intensity LED lights and a control circuit.

In fact, this arrangement is very economical compared to other aircraft obstruction lighting (AOL) systems (see Table 1, page 12). These lights are suited for all types of tower, and avoid the necessity of laying mains power supply cables on the tower. Also, in case of self-radiating medium-wave towers, the costs of Austin isolation transformers are also saved.

Among the other benefits of solar-powered LED-based obstruction lights are that each light operates independently; and accident or failure may affect one light, but it will not affect the others.

Also, with automatic sensors no manual intervention is required to turn the lights on or off. Solar lights can be designed to provide illumination automatically from dusk to dawn. Each system can charge itself, storing and producing electricity even on overcast days.

In addition to the light itself, solar-powered LED-based obstruction lights do require a few additional basic "modules" for operation.

A solar, or photovoltaic to use the formal term, module converts sunlight into electricity that can be used immediately or stored in a battery for use during the night. The type of battery being used is lead-acid, maintenance-free type, which is designed to be fully charged and discharged over and over again without causing damage.

Also necessary is a DC-to-AC inverter to convert direct current from the battery into alternating current to run AC appliances. If the LED lights are able to work on DC, then there is no need for converter.

Setting up a solar-powered LED-based obstruction lighting system does require some care, especially in positioning the solar panels to ensure maximum power generation.

Also, if a DC-to-AC inverter is used, remember that a 240 V inverter loses about 30 percent of the power during the conversion process. Using 12 V DC-based systems eliminates this power loss.

It is also important to check the life of the batteries, number of batteries and their charging capacity.

Meenakshi Singhvi is station engineer for All India Radio in Ahmedabad, Gujarat, India.

This article was adapted from a piece published in the June 2010 international edition of Radio World.

READER'S FORUM

OFF BY A DASH OR TWO

I enjoy the "Radio World Engineering Extra" and found the article on Page 1 of the April 14 issue ("Modern VHF Signal Measurement Techniques at NPR Labs") to be most interesting. But your broadcast history is off a bit.

The Detroit station where the measurements were done in 1950 is WWJ-TV, not "WJZ(TV)". In 1950, WWJ-TV was the station using Channel 4 in Detroit. WJZ-TV operated on Channel 7 in New York City at the time. It is now WABC-TV, having adopted that call sign in March, 1953.

Also, the call sign has a hyphen in it. The use of "(TV)" or "(FM)" is for call signs that do not have the -FM or -TV suffix as part of the call sign. Hence, in New York, WJZ was the AM station on 770 kHz (now WABC), WJZ-FM was the FM station on 95.5 MHz — now WPLJ(FM) — and WJZ-TV was the television station on Channel 7. But WGHF(FM) was the FM station on 101.9 MHz and WQXR-FM was on 96.3 MHz. The latter station had the suffix because there was a WQXR on the AM band. The historic WJZ call letters now reside in Baltimore. Westinghouse changed the call letters of WAAM(TV) to WJZ-TV in 1957 upon acquiring that station. CBS, which now owns WJZ-TV, changed the call letters of its WJFK and WQSR(FM) to WJZ and WJZ-FM, respectively.

Philip E. Galasso
Chief Engineer
Citadel Wilkes-Barre/Scranton
Wilkes-Barre, Pa.

Ed. Note: Some years ago, after debate, Radio World adopted an editorial style rule of identifying all broadcast licenses on first reference with the suffix AM, FM or TV in parentheses. Thus the station licensed as KIIS-FM is written here as KIIS(FM) on first reference and KIIS subsequently. We acknowledge that this was heresy to some devoted radio call sign fans.

SOLAR-POWERED LEDS IN INDIA

AHMEDABAD, INDIA — In July 2008, while attending to a fault of cabling and lights on the medium-wave mast at All India Radio Ahmedabad's Bareja high-power transmission site, it was observed that the Austin transformer at the site was also faulty.

IN THE FIELD

Looking at the exorbitant replacement cost of this transformer and cabling, the station decided to explore the other alternatives for obstruction lighting on the tower.

During its search, AIR Ahmedabad came across an excellent option: compact solar-powered LED aviation obstruction lights.

The solar-powered lights consist of a backup battery panel, high-intensity LED lights and control circuitry — all enclosed in a suitably designed compact iron-clad box.

The solar panel is rigidly attached to the box, making it a single module. With the help of clamps, the entire unit can be mounted on the mast or tower.

A setup like this had not previously been used on a live mast carrying RF voltage in excess of tens of thousands of volts. Some personnel were skeptical that the systems might burn out due to the high RF field, and the effect of a high-intensity RF field on the storage batteries was also not known.

As an experiment, one solar-powered LED aviation obstruction light was mounted on the mast at 3 meters above ground level (10 feet AGL); utmost care was taken to observe various safety precautions. This exercise was done during daylight hours.

When the transmitter was switched on, no abnormality was noticed in the lighting unit, and all the parameters of the transmitter were also found to be normal.

We waited until dark to see the working of solar switch, which was included for automated dusk-to-dawn operation.

It was a happy moment for the staff to see that lamp easily switched on. All parameters of the transmitter, again, were found to be normal.

After the transmission, the module was inspected thoroughly for any arcing or other signs of damage; all of the components were found in healthy condition.

The working of the test unit was closely monitored for about one month before it was moved to its permanent location atop the 175 meter (575 foot) mast.

Subsequently, four more solar-powered LED lights were installed on the medium-wave mast, and one on the STL towers. These lights have worked satisfactorily since their installation.

— Meenakshi Singhvi

the jock and degrade his performance. It's probably why we see many stations still hanging onto Instant Replays and similar external devices to handle quickly-needed audio clips.

Every system out there has its own unique strengths and weaknesses. If operators don't learn how to properly use all of the features and also how to overcome all of the foibles of their system, the air sound suffers.

TECHNOLOGY SEDUCTION

Automated live-assist radio has lulled a lot of jocks out of being creative and compelling, into a less effective frame of mind. Either they become lazy and inattentive, letting the machine do most of the work as programmed, or they spend most of their mental energy just feeding the monster and tracking the system, making sure all the spots play and the songs and sweepers segue properly.

Shouldn't they really be concentrating on making their next live break the best and most engaging it can possibly be for their listeners?

Too many programmers have been seduced by the power of automation giving them "more control and consistency." Too many capable and creative jocks have been largely muzzled into liner card readers and generic voice-trackers. Programmers using the smothering control of automated air content have squeezed the life out of the people who talk to us over the radio every day. Most have no real choices of what to air or even what to say. The PPM imperative to play the tunes and shut up is only making it worse.

There is no honest way to spin this into something positive. It's been literally devastating to the radio music industry. Air talent that doesn't cooperate can be easily replaced with a voice-tracked box. The pendulum has swung too far in the direction of control and away from creativity. We've lost perhaps an entire generation of great live jocks who might have been, save for the damage inflicted by automation systems.

A sage and venerable icon jock recently told me his show would immediately improve if we got rid of the automation and brought back only carts and CDs. If only we could resurrect those triple-stack cart decks tossed into a dumpster years ago. But I digress.

REGAINING CONTROL

Campion's paper takes on the inadequacies of radio automation headfirst, identifying unexploited opportunities and areas needing improvement. His current focus at ENCO is developing enhancements that make the job of the live-assist jock easier and more efficient, so that person *can* concentrate on doing a better show. That means spending a minimum amount of time and effort finding and preparing his chosen content. It also means harnessing the resources of the Internet to enrich that content.

Good live-assist automation performance depends not only on flexible, well-written and resilient programming but also on smart execution by the operators. Any system can only do what those who design it, set it up, program it and run it, expect it to do. An expensive, fully developed feature-rich system that is misused will sound just as clunky or defective as a more limited, less developed or buggy system.

Pat ended his presentation by challenging every station programmer and engineer to evaluate how well their automation company is delivering everything they need to achieve the air sound they want. If it's missing key ingredients or not executing their needs reliably, they should be all over that automation company to correct the flaws and make it acceptable. If that doesn't happen, fire that company (even if it's ENCO) and find one that can and will deliver.

Congratulations, Pat Campion. That's refreshing and courageous. If we ever needed something to jump-start better programming and air sound execution in radio today, this is it. We've become slaves to our automation system technology in too many ways, letting it dictate what we can and cannot do in an increasingly demanding and competitive media space. It's time we retake full control and insist that it deliver the results we truly want and deserve.

As an engineer, I do admire the engineering genius and beauty of these machines and realize that computer-based digital audio playout systems have been one of the most important technical innovations for our business in my lifetime. They have made radio technically more reliable and higher quality in many ways that were impossible before.

But in my heart, I worry that when I install one of these systems to automate a station, I am cutting out another piece of the soul of our industry and throwing it in the trash. We could end up like Neo in the Matrix. The dark side of this technology is that the patient dies in the real world. We might just need an Oracle to save us.

Guy Wire is the pseudonym for a veteran broadcast radio engineer.

The Equipment Measurements Question

When Must You Show Compliance of Your Transmitter to Technical Standards?

Do You Measure Up?

Question posed in the Apr. 14 issue
(Exam level: CBRE)

This Sunday night you are going to install a new HDFM exciter, which also generates the composite stereo signal. Are you required to do performance measurements?

a. No, as long as there is no change in modulation level.
b. Yes, because you're a professional and you want to know that the station is measured perfect no matter that the program director says his "golden ears" are better than your test gear.
c. No, there is no FCC mandate to do this, and anyway performance is set by the manufacturer's checkout.
d. Yes, under the general guidelines of 77.12966 b.3 any equipment change requires performance measurements.
e. Yes, 47 CFR 73.1590(a)(4) requires performance measurements when a stereo generator is first installed.

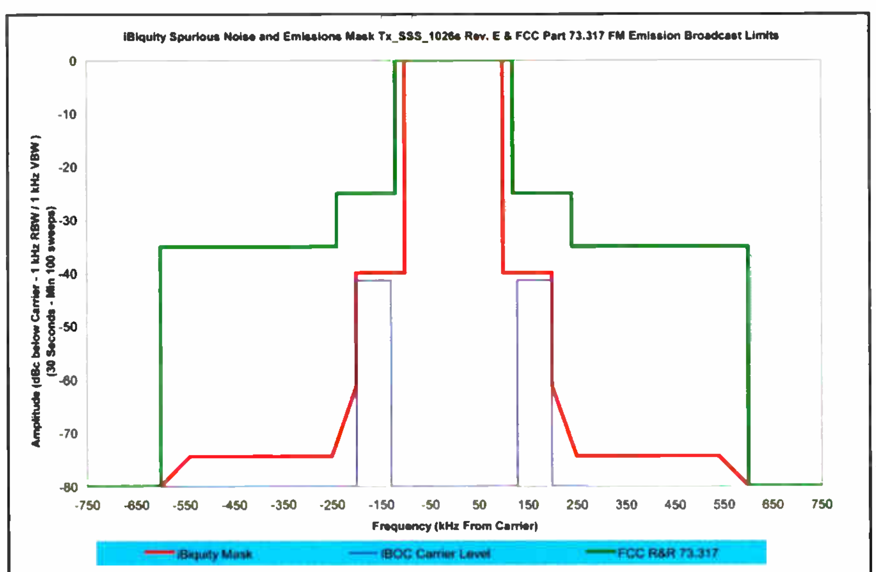
BY CHARLES S. FITCH

To help you get in the SBE certification exam taking frame of mind, Radio World Engineering Extra poses a typical question in each column. Although similar in style and content to the exam questions, these are not from past exams nor will they be on future exams in this exact form.

Today's question, shown in the box, serves two purposes: First, to once again remind you that the SBE exams are open book. You are allowed to take related reference material with you. Second, to remind you that you should carefully select and be acquainted with your reference choices before the exam. The exam room is no place to familiarize oneself with material that is several hundred pages long.

Questions on operating practices and the related FCC regulations make up around 25 percent of the usual testing content of the Certified Broadcast Radio Engineer exam, and this proportion reflects the importance that compliance to these regulations represents as a part of our professional performance. Questions on safety, technical problems and related theory round out the question areas on the CBRE exam.

In the main, the FCC regulation questions you'll encounter test you for two qualities: Are you familiar with the structure and organization of these regulations? And do you know, or can you readily access, the specific information in them?



Emissions mask for FM showing both the standard FCC mask in green and the HD Radio mask in red. Equipment performance measurements check for signal emissions outside these limits which can potentially interfere with other stations.

Image courtesy iBiquity

We've discussed effective general test-taking strategies and how you can quickly dismiss many answers on their face. Even a general knowledge can eliminate many of the choices, so use this to your advantage.

Quickly reading over the possible answers for the question we've posed this issue should make you jaundiced of answer (d) immediately. Overall, the focus of the FCC is to enforce rules and regulations unique to this agency, which mainly is contained in 47 CFR (Volume 47 of the Consolidated Federal Regulations) and, if you've been at this long enough, you know there is no Part 77.

All of 47 CFR, even in tiny print, covers an entire bookshelf. Most of the specific regulations for broadcasting are contained in Part 73 for what used to be known as "main station" and Part 74 for what had been known as "auxiliary support services" such as translators and remote pickup links. The two sections have become blurred now as LPFM and translators for AM stations compete on an equal basis with more traditional "main stations."

For instance, here in Hartford, there is a fill-in translator (Part 74) with a signal better than most Class A FMs. Since it carries the HD2 signal of the Class B main station, most listeners think that it's just another full-power FM station (like those in Part 73).

Since only one choice has a specific reference in Part 73 for a main facility issue, a quick check of the rule shows its perfect relevance to the question, and there is the answer. Answer (e) is correct.

1590 (a) The licensee of each AM, FM, TV and Class A TV station, except licensees of Class D non-commercial educational FM stations authorized to operate with 10 watts or less output power, must make equipment performance measurements for each main transmitter as follows:

(4) Installation of FM subcarrier or stereophonic transmission equipment pursuant to § 73.295, § 73.297, § 73.593 or § 73.597.

Gone are the days of hauling all that backbreaking test equipment up to the transmitter site such as this classic total harmonic distortion analyzer.

A mea culpa: Careful readers of this column will probably have noted that the regulation overall paragraph identifier "a" was missing in last issue's question printing. We printed 47 CFR 1590(4). I'm certain this probably caused our sedulous editor many sleepless nights as he tried to conjure up from the gray cells what was wrong with the answer selections.

Performance measurements should also be conducted for the following:

- The initial installation of a new or replacement transmitter
- Any modification made under 73.1690
- Installation of an AM or FM basic/standard and/or a new HD generator/exciter
- When specifically instructed by other rules or as a function of your FCC authorization.

In general, just about any component change in the system that could affect frequency stability, modulation envelope or adherence to regulation standards needs to be "proofed."

The elaborate proof of performance requirements of the past covering audio

response and distortion have been eliminated from Part 73. The common logic at present is that the competitive environment will take care of these issues. If a station really wants the most audience, the best sound, the greatest coverage, they will maximize the related technical performance because operating optimally is in ownership's best interest.

The remaining "proof issues" are spectral purity concerns. Your quest to be the best should not take you outside of your assigned channel either from over modulation and/or from spurious signals caused by non-linearities in your plant's operation. For the most part, these tests take on the form of spectrum analyzer reviews of occupied bandwidth.

The one and only occupied bandwidth test that must be made periodically within a mandated period of time is the AM occupied bandwidth measurement required annually. Each test must be made within 14 months of the previous. Overall the specifications for this are in 73.44 but if you're running HDAM, you'll need to at least meet the spurious requirements as well as staying under the HDAM IBOC mask that includes the adjacent channel digital sidebands.

FM occupied bandwidth is described by specifications in 47 CFR 73.317 for "traditional" FM but, as above for AM, you'll use the HDFM IBOC mask for the sidebands in the adjacent channels on either side.

Missed some Certification Corners or want to review them for your next exam? See the "Certification" tab under Columns at radioworld.com.

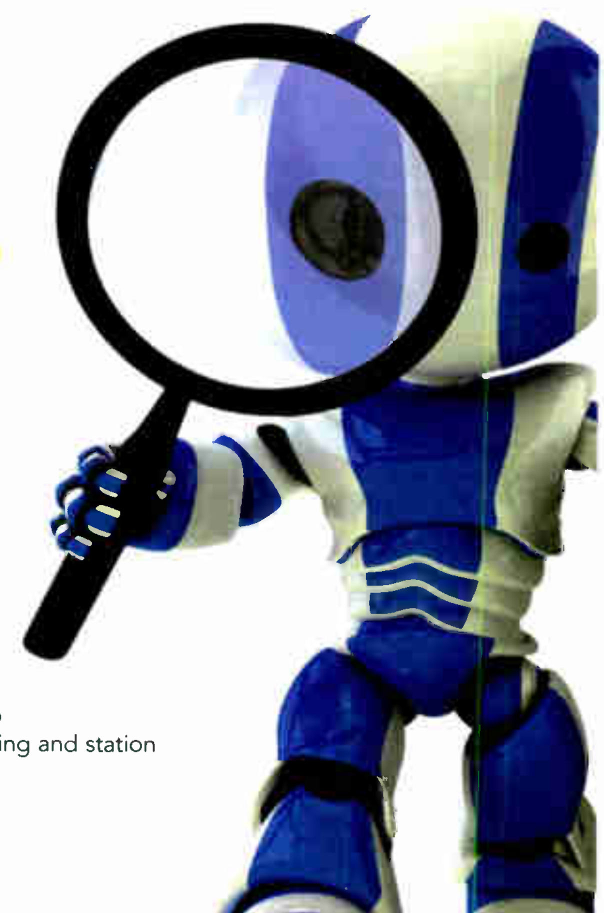
What's the Ratio, Kenneth?

Question for next time

(Exam level: CBRE)

At 100 percent AM modulation, what is the ratio of peak antenna current to unmodulated current?

a. 16 to 1
b. 8 to 1
c. 4 to 1
d. 2 to 1
e. 1 to 1



Emotions as Engineering Glue

Would the World Really Turn if We Were All Like Mr. Spock?

BY BARRY BLESSER

For most professionals, the idea of emotions in the workplace is viewed as a disrupting influence on the ability to get work done efficiently.

We have all observed angry voices, fist pounding, abrasive augments, passionate rigidity and even sexual flirtations. I have never heard anyone argue that these manifestations of emotions should be tolerated in the workplace. One executive once told me that emotions and psychology should be left at home.

Engineers are especially hostile to the idea that emotions have utility in the workplace, believing instead that this profession must be based on logic, reason, inference, deduction and the hard cold facts of observable reality.

In the 1960s, the science fiction television series "Star Trek" introduced us to the character Mr. Spock, who was half human and half Vulcan. He continued in the more recent feature movies as the prototype of a typical engineer. The character embodies the essence of logic, literalness and reasoning, thereby becoming the most famous symbol of what I call "anti-emotionalism." As if to highlight the weakness of human emotions, Mr. Spock said: "Nowhere am I so desperately needed as among a shipload of illogical humans."

Could this view of emotions be totally wrong? I will attempt to demonstrate that life as we know it stops if emotions are removed. Fortunately, people cannot suppress emotions.

iStockphoto/Mark Stay

NO EMOTION, NO FUNCTION

To begin, we need to look at what neuroscience research tells us about emotional substrates in the brain.

Emotions have been said to exist as part of the limbic system, which includes the amygdala and other connected substrates. Occasionally, a patient shows up for medical treatment with those parts of the brain having been damaged by accident or disease. These cases illustrate what happens to a person without emotions. On the one hand, they appear normal but when examined more carefully, the consequences of the injury become clear.

Such people have difficulty driving a car, but not because they lack the cognitive and motor skills to control the vehicle; rather they simply do not care if the car is heading towards a child playing in the middle of the road.

In one case a scientist reported that it took him more than four hours to get dressed in the morning. He could see all of his choices in the closet but he had no means to make a decision. Should he wear a blue sock on his right foot and a red sock on his left foot? He simply did not care because all of the choices were equivalent without emotions. Every possible combination of clothing could be considered as a choice. This is the real Mr. Spock: non-functioning.

How then can we reconcile the common view of emotions as being negative with the medical reality that we cannot do even the simplest task without them?

Consider first that the word "emotional" is reserved for those cases where the emotions are inappropriately intense and correspondingly destructive, like an adult tantrum. I call such extremes emotional hijacking; too much of a good thing becomes destructive.

Because emotions are like water to a fish — all around us — we lack a vocabulary for the emotional water that we swim in. Ordinary emotions are simply the answer to the question: "Why do you care?"

PERSONAL CURRENCY

Let us consider an engineering meeting discussing a particular technical problem that needs to be addressed. Everyone has an opinion, and each of these opinions is an individual's unique answer to the previous question. "I care because…." Publically, everyone may state that we all care because it is good for the broadcast station to have the issue addressed. However, each individual has a private reason for caring.

Here are some possible reasons why an individual might care. He wants to prove to his father that he made the right career choice. He wants to show he is intelligent because he is trying to raise his self-respect. He wants recognition to get a raise so that he can send his daughter to college. He wants the younger engineers to see him as still having value. He wants his choice to dominate the discussion as retribution for a previous insult. He is trying to compensate for an inferiority complex because he never went to college. He views life as a competitive sport with winners and losers. He wants to impress the cute new female engineer so that he can ask her out on a date.

> **Engineers** are especially hostile to the idea that emotions have utility in the workplace.

These answers can dominate each individual consciously or unconsciously. I call the answers a person's personal currency. We get paid in emotional currency in addition to our regular paycheck. Management studies have consistently shown that financial compensation is rather low on the criterion for job satisfaction even though many of us think that is the largest motivator. It is not. Our personal currency is the driving force because it answers the question about why we care about something.

This discussion is not intended to be academic. There are meaningful implications to your engineering depart-

(continued on page 21)

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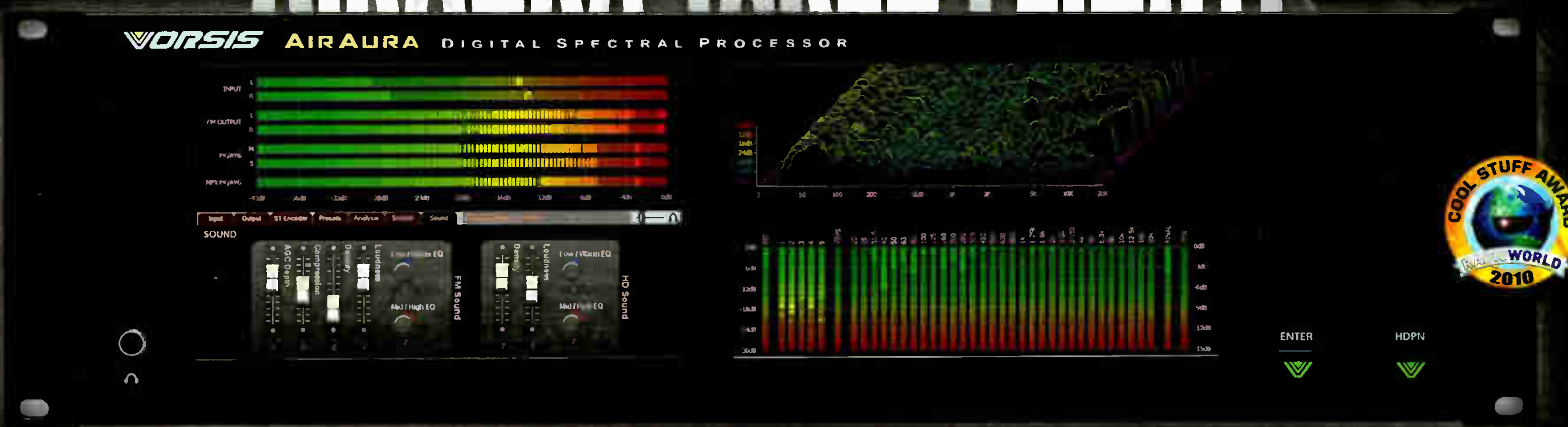

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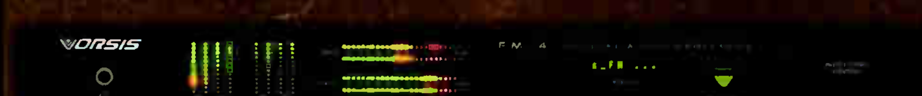

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