

# Backscatter Journal

May—June, 2013 — 9<sup>th</sup> Issue

## TIPS FOR RECOVERING LOST COVERAGE

FCC-required narrowbanding brought the promise of expanded VHF/UHF licensable channels. For many it also brought a loss of net radio coverage. Simply reducing an analog FM transmitter's frequency deviation from 5KHz to 2.5KHz, and not likewise reducing the system's user radio receivers bandwidth, results in a 6db loss in system gain/coverage performance. A 6db loss is equal to cutting back one's transmitter power, for example, from 100 watts to only 25 watts!

Those who had purchased user radios and base/repeater stations within the past nine years have equipment whose receiver bandwidth could be narrowed. This feature of more modern equipment, in itself, allows a recovery of three of those six lost dbs.

So, the loss in system gain as a result of narrowbanding can range between 6db to 3db, depending upon the age of affected equipment and the attentiveness of the agency entrusted with the narrowbanding work.

How bad is a 6db loss? By now your unhappy radio users are letting you know exactly how bad it is! Fortunately, several techniques are available to recover lost system gain and coverage without tossing in the towel and moving to a new digital radio network. Let's explore a few possible solutions.

## MOBILE ANTENNA ENHANCEMENTS

One easy way to improve mobile radio performance focuses on the antenna itself. With respect to mobile units, simply relocating the antenna from the trunk lid to the roof will improve coverage by virtue of added elevation and by having the antenna generally centered about the vehicle's metallic structure. If your antenna is approximately 14-inches long (VHF) or in the area of 6-inches long (UHF), it is the typical quarter-wavelength type having a gain of unity (0db). By installing a somewhat longer 5/8-wavelength antenna, one can improve antenna gain by 1.5 to 2db.

Mobile antennas require the vehicle's metallic structure to provide what is termed a "virtual antenna" or essentially the other half of the visible antenna system. Unless the antenna is located in a relatively clear space whose encompassed circular area has a radius at least as great as the antenna itself, then the normally omnidirectional radiation pattern of the antenna will be distorted, thereby resulting in degraded mobile radio performance.

Also, pay close attention to the small diameter, RG-58 style coaxial cable used to interconnect the

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antenna to the radio. This cable is lossy at VHF/UHF so make sure the service technician trims down any excess cable and does not merely coil the as-supplied length up.

## BASE-REPEATER STATION ANTENNA SYSTEMS

In some cases, it is impractical to improve an agency's entire mobile radio fleet to recover coverage. In others, the system loss is more in line with the worse-case scenario, and further improvement is needed. Not to worry. It may be possible to install a higher gain antenna system at the main base/repeater site.

Enhancing antenna gain at UHF is relatively straightforward and—depending upon the system's coverage requirement—this change alone may recover sufficient system gain to yield pre-narrowbanding performance.

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UHF base station antennas having gain upward of 12db are common, which in many cases can represent a net 2 to 6db improvement relative to the antenna type being replaced. The potential for improvement is not as dramatic at VHF, since the physical antenna length of high gain base station antennas becomes significant. Yet, improvement is usually possible.

Additionally, if the transmission line length between the transmitter and antenna system is greater than 250 feet, it may prove beneficial to consider replacement with a lower loss (larger diameter) transmission line. For example, a 300-foot run of 1/2" diameter transmission line has a loss of 4.4db whereas a 7/8" diameter line of the same length has a loss of 2.5db, which would in itself net a near 2db system gain improvement.

As you can see, relatively straightforward hardware changes can yield significant performance recovery. Other configuration changes are possible as well.

## RECEIVER VOTING

In the course of assisting clients solve service-area coverage problems we often hear the complaint that while mobile coverage is good, portable coverage is poor to borderline line unacceptable. Radio system designers labor long hours to develop system configurations where coverage is reliable and consistent throughout a service-area, based on a user's equipment configuration and operational requirements. The objective through itera-

tive design is to achieve balanced coverage. A radio system is considered balanced when the talkout (base-to-user) and talkback (user-to-base) system gains/losses are equal, i.e., balanced, in both path directions.

How the user operates his radio equipment, and the equipment itself, often impacts system performance (balance) differently. For example, if a portable radio is side-mounted at waist level, the base-to-portable talkout signal path must overcome more body and obstruction losses than when the portable is elevated to head level. A more difficult profile would involve a waist-mounted radio operated with speaker/mic equipment. In that configuration, the talkback path described earlier would be subject to the same body/obstruction losses incurred by the talkout path. As a user-radio moves away from the base site, audio quality is gradually deteriorated by noise. As a result of the FM detection process, analog communications can be plagued by noise pops, dropouts and distortion at the outer edges of coverage.

Many VHF/UHF radio systems were originally designed at a time when portable, hand-carry radios were hugely expensive and unreliable as compared to mobile-mounted equipment. So, early systems were designed to coverage-support 100-watt mobile radios. The migration to low powered (5 watt) portable radio units onto systems design for mobile radio operation can result in huge reliability issues if original design is not revisited. For

analog systems, the installation of remote receiver sites and receiver-voter technology that works in concert with repeater/base stations can improve portable talkback audio quality by virtue of the reduced path distance to these receive-only sites. The effect is the same as if somehow the power level of the portable radio was increased well beyond the typical 5 watt level.

Voted receivers will not improve a system's ultimate coverage, as service-area is usually limited by base-site talkout losses. However, units operating within an area having the equivalent of DAQ-3 talkback audio quality and reliability would be improved to DAQ-3.4 or the higher DAQ-4 equivalent. A further positive effect of continuous receiver voting is to diminish, if not eliminate, the effects of multipath fading in a mobile radio environment. This is accomplished by virtue of space (site) diversity and the fact that the received signal arrives at multiple receiver sites via multiple propagation paths. Specifically, while a signal from a distant user radio may be momentarily faded or blocked at one site, it would likely be statistically stronger at another site or sites.

## BASE/REPEATER SITE NOISE LEVEL

Does your maintenance program include tower site noise floor determination? Few do, but this is a very critical test that must be performed regularly on VHF (albeit to a lesser extent, UHF) radio systems. Here's a simply example of why. If you are among the first to arrive at a wedding reception and the room is relatively quiet, it is very easy to converse with others at a normal

voice level. Yet, as the room fills with people it becomes increasingly harder to be heard. Once the band cranks up, you might have to yell just to get your neighbor's attention...now think radio.

Radio receivers are designed to detect signals as low as two-tenths of a microvolt...extremely small levels. Yet, the radio spectrum is plagued by normal atmospheric noise that is higher in average level at lower frequencies and becomes increasingly lower in level at higher frequencies.

So, one positive attribute of systems operated at 700/800MHz is the very low noise floor as compared to, for example, low band VHF systems where the noise floor might be higher by a factor of twenty or more. And lower radio frequencies, such as those VHF systems operated by many public safety agencies, are far more susceptible to electrical noise interference from a large host of electronic apparatus such as gas-discharge lighting, electric motors, automobile ignition systems, switching power supplies, computers and even plasma television screens!

Worse, the noise floor can be temporarily raised whenever close-proximity VHF/UHF base or repeater stations transmit, even though those stations may be somewhat removed in frequency from your repeater or base station's receive channel.

In our travels, we have identified and resolved a host of noise source issues which always result in improved system talkback performance. Make sure to include a noise floor effective sensitivity test within your radio maintenance program. Quiet is the name of the game.

## HOW HAS NARROWBANDING CHANGED YOUR RADIO SYSTEM?

Although the FCC's requirement for reduced bandwidth has been broadcast for many years, the real push to get it done really took root in the past 18 months. In our rebanding experience, TCS helped several clients resolve co/adjacent channel interference issues that had silently been degrading coverage. Since VHF/UHF technology is mature and many radio systems have been operational for decades, it sometimes takes a fresh set of eyes to objectively review a network...which often yields some unexpected surprises.

In our travels, we've discovered an assortment of issues: improperly set receiver-voter levels; bad antennas; off-frequency base stations; excessively lossy transmission lines; horribly filthy tower sites. The list was mind-boggling. In one instance we found a defective channel assignment where a neighboring repeater output frequency was assigned dead-on to an adjacent area's repeater input frequency. That poor receiver's first RF amplifier/mixer didn't stand a chance!

So, how has narrowbanding affected you? We would like to know your experiences, pro and con. Please send your comments to: [narrowbanding@tusaconsulting.com](mailto:narrowbanding@tusaconsulting.com). We will publish the results in our next Backscatter Journal.

## HURRICANE PREP CHECKLIST

Hurricane season started this month, and the season is predicted. In our experience, radio systems fail in hurricanes due to three reasons: damaged antennas; loss of electrical power and loss of site connectivity.

Now is the time to have your radio network's antenna and transmission line components inspected by a reputable tower firm. Have them ensure all attachment hardware is properly torqued and that any suspect hardware replaced. It is a good idea to sweep test each transmission line to determine integrity of connectors.

With respect to microwave antennas, make sure each is properly on-path and level. If your microwave antennas do not have dual stiff-arm supports, get them installed NOW.

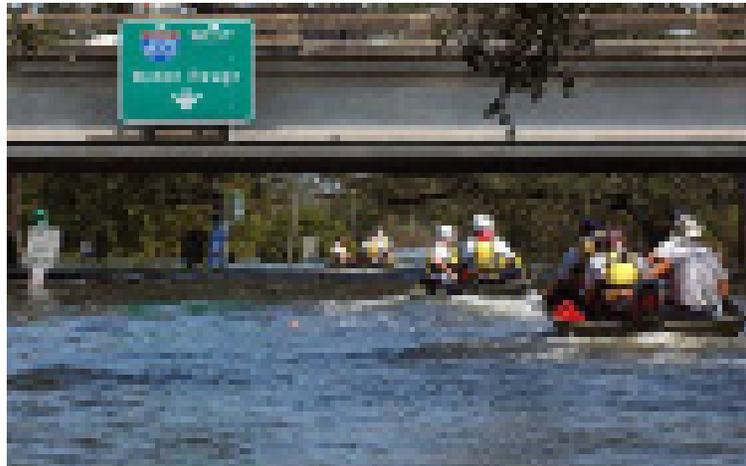
Some tower sites seem to become jungles with the passage of



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time....particularly rental tower sites. If, at your sites, you see trees encroaching on power company right of ways, get rid of them. Restringing downed power lines takes time and it would be pretty embarrassing if the downed line was just outside your site's equipment shelter.

Have all generators in the radio system serviced and load tested. That means putting the transfer switch to good use and running each site for several hours on generator power. Then, reassess and fix accordingly. If the battery,



radiator and belts have not been serviced within the past, do so. Pin hole cooling system leaks will eventually shut any generator down and extended power outages are frequent in the aftermath of large storms.

It is always good practice to pre-position fuel service, generator repair and tower service companies on an emergency response retainer. Make certain your radio system vendors (radio, microwave, consultants, etc.) have ready access to your jurisdictional area to affect emergency repairs and to provide technical support. Give them clear instructions: "If things look seriously bad, don't wait for us to call because we most likely can't just show up!"

Finally, provide online or written instructions to key users on how to utilize those interoperability resources already resident within their radio networks. Because these resources are rarely used, few know what they do, or worse, how to use them.

Clearly, the wrong time to try learning how to call for help via an interoperability link is when the water starts rising.

## GETTIN' ON THE GOOD SIDE

I don't know how it happened, but suddenly the dreaded sixtieth birthday came and went. In Tusa's early days, getting older was a good thing...it meant engaging a professional career in radio engineering, getting into a new business, learning new things and carving a niche out of life. Today, it also means something else:

Turning 60 means you've nudged out onto the **wrong side** of Life's Bell Curve.

Passing this major mile-market signals retirement is on the near horizon. And, for us radio jockeys an eventual one-way, no-cost reunification with the Ionosphere. Just lovely, isn't it? So while those early years had a more personal purpose, perhaps now is the time for us seasoned veterans to start gettin' on the good side and making a lasting difference through mentoring.

Yes, our Industry is seeing major shifts from analog to digital technologies, yet at its fundamental roots it



is still Radio. So, who is going to take our place as the mid1960s-70s generation begins to retire and fade away? Have you done anything recently to encourage today's generation to study radio or electronics? How are young people just graduating and entering the field

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of radio communications to gain the practical, hands-on experience that transcends dry textbook fundamentals?

If you are a Baby Boomer, recall in our time when we first entered the workforce. Then, radio systems were hardware-intensive, were all analog and were susceptible to various forms of interference and degraded audio quality. The test gear of that period could very accurately measure the various technical parameters so essential to radio network operations, but it lacked the computational capability to assess data. We had to interpret the data collected and, through on-the-fly research or past experience, quickly “noodle” out solutions that worked and were cost-effective.

Those are the lessons not well taught in today's schools and the responsibility for passing those fundamental processes and experiences along rests with us

## QUIET BEFORE THE STORM?

The FCC's deadline for narrowbanding passed on January 1st. A majority of Part 90 Licensees had met the challenge and satisfied their obligation for change several ways.

Some replaced or retuned VHF/UHF equipment or took this as an opportunity to embrace Project-25 digital technology and constructed replacement 700/800MHz systems. Others, who started late but were committed to rule compliance, asked for FCC rule waivers to complete funded narrowband or upgrade technologies. A relatively smaller group elected to do nothing.

Discounting those who have migrated to higher frequency bands and simply neglected to cancel their unused system licenses, some

felt the rules don't apply to them and believed they would be able to hide under the FCC's “radar screen.” In our view, that isn't a particularly bright move for several reasons. As the dust settles in granting the various rule waiver requests that were filed in the waning days of Year 2012, the Commission's attention will most certainly shift toward field enforcement. Some of the laggards will be flushed out as frequency coordinators start granting new licenses via the new narrowband channel plan.

The result will be lots of interference to wideband system operators. If they fail to clear out, FCC enforcement will make it happen with lightning quick speed.

Eventually though, the Commission will aggressively target those

as a community. I urge you to write articles about technical problems solved as well as inspirational discussions on how to successfully grow and operate technology-based businesses. No knock against universities, but many instructors there lack frontline experience in making a payroll, finding customers, designing products, growing a small business or meeting client needs and expectations.

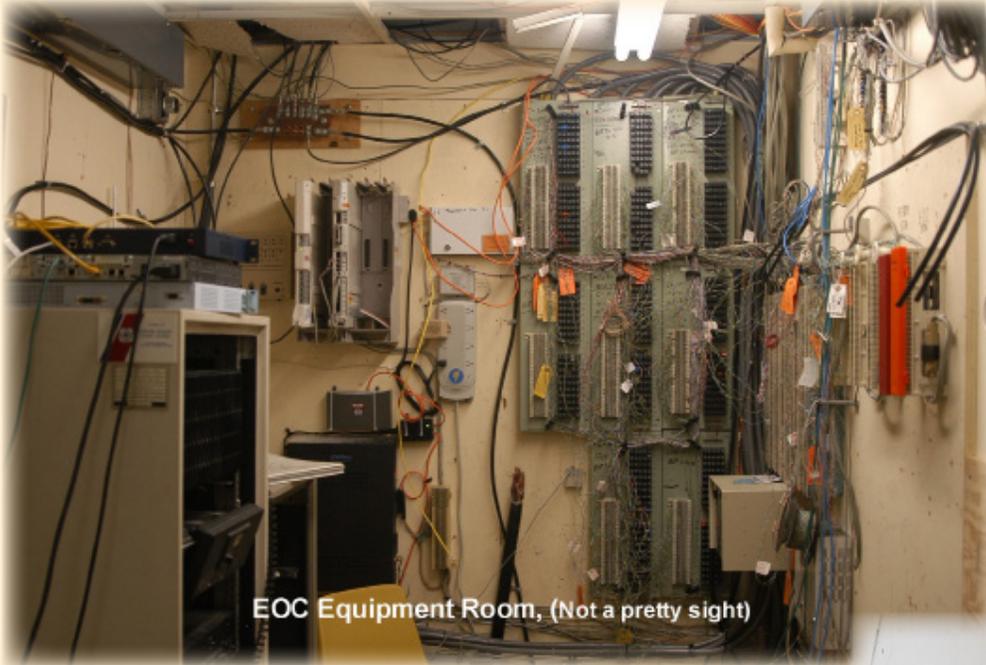
My mentor, Wes Schum, gave me a most precious gift by allowing a gateway into his life's experiences, with no strings attached. Perhaps someone did the same for you? If so, repay that favor by mentoring others. The reality is that the years are steadily gaining on us and it is past time (for me, in particular) to start gettin' on the good side! How about you?

who haven't modified their licenses and that, in itself, will root out a number of errant operations.

Some believe the commission won't have the stomach to shut down public safety agencies operating in non-compliance; arguing that the Commission has never levied a fine to a public safety licensee. These folks are very wrong - on both counts. Why anyone would risk getting their name and face plastered on their local TV news and Internet for a “Bandwidth Rap” is senseless. So, if your agency falls into the non-compliance category, please get to work and conform to the new bandwidth requirements. It's important.

## TCS HALL OF SHAME: HOW IS THIS POSSIBLE??

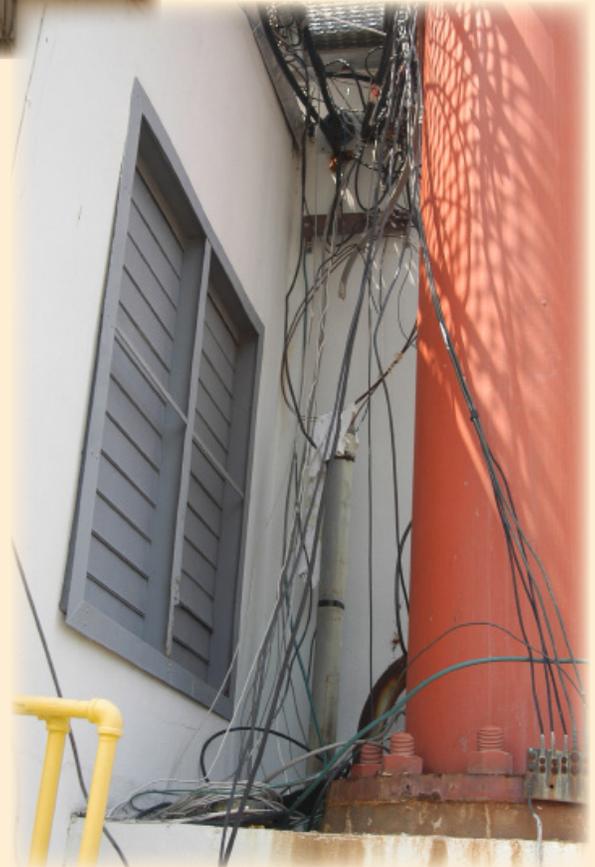
As hard as it is to fathom, a commercial firm was actually paid to plan, execute and maintain this wiring job of extraordinarily low quality. Sadly, this is the back room of an Emergency Operations Center that will remain nameless.



EOC Equipment Room, (Not a pretty sight)

**But wait, there's more...**

**Behold this fine example of  
single-point grounding!**



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