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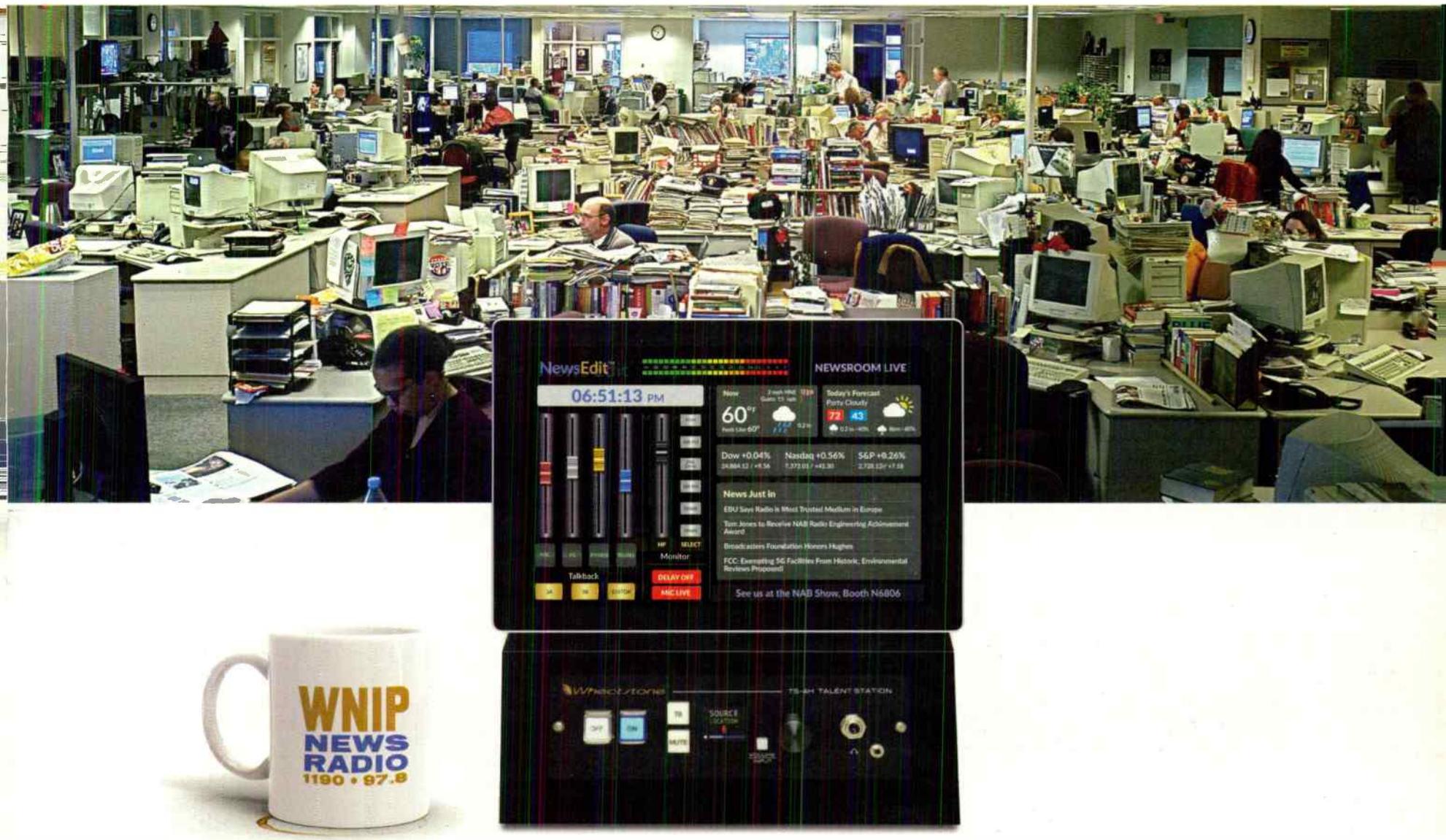

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Cover Story

The Accidental Multipath Tamer

by Jeffrey A. Keith, CPBE, NCE

Some of the greatest inventions were created by accident. Penicillin was discovered because some scientist forgot to clean up his workstation one night and returned the next morning to find the first antibiotic growing in a dirty Petri dish.

This is how a multipath solution came to be: by accident. Before the Multipath Limiter control feature was introduced into Wheatstone processors for reducing the adverse listening effects of multipath, it was actually designed to even out mono loudness.

The multipath controller algorithm began life at WMJI in Cleveland, OH in the 1990s, while I was the CE there. The station had great coverage as a grandfathered Class B (16 kW at 1128 feet). WMJI played oldies spanning several decades, and we'd noted drastic differences in loudness on mono radios as songs changed. I'd designed a stereo enhancer in the 80s and I knew how increased stereo separation affected mono loudness, so building a processing device for WMJI's air chain to even out mono loudness was a trivial design task. I even gave it a name: the MCC-1, or Mono Compatibility Controller.

After I placed the unit in the air chain, sales department staff who drove the market all day started asking me what I'd done to make the station "less scratchy." Mind you, this was a station that was well cared for and with a virtually perfect RF system (broadband transmitter, panel antenna, synchronous AM noise below 50 dB, etc.) and though our multipath was already less than other stations, with the MCC-1 in the chain it was essentially gone.

Over the following year, a repeatable correlation between the MCC-1 being in circuit and reduced multipath was observed. The effect on multipath wasn't a complete surprise, but it definitely wasn't what I'd designed the MCC-1 for!

Decades later and in countless markets where stations are using the Multipath Limiter in their Wheatstone FM processors, we're seeing the same kind of correlations I saw at WMJI.

One of the reasons this works is that most stereo receivers aggressively blend to mono during multipath, and that creates large fluctuations in volume as the width of the stereo sound field collapses. The wider the stereo image, the more obvious the sblending, and that's precisely why stereo enhancement earned the reputation of creating multipath. Stereo enhancement doesn't really create multipath, it just makes it seem worse when receiver blending squashes down a big and wide stereo sound field.

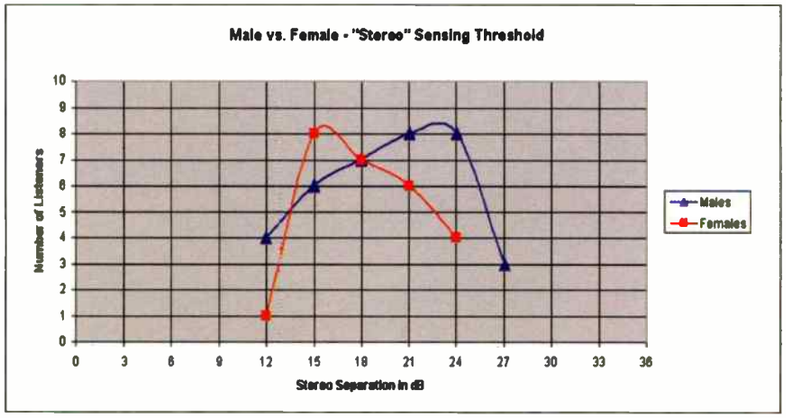
The Multipath Limiter's task is to manage incoming program material's L+R/L-R ratio under very specifically controlled conditions, and that in turn makes multipath-induced blending less noticeable to a listener. Because the algorithm intelligently fools the ear into believing it hears a full stereo signal, psychoacoustically-speaking, multipath is reduced and perceived coverage is improved.

Stereo Separation and Multipath

In the 90s,stereo enhancement was a well understood technique, What wasn't generally understood was how much the station's "electrical' stereo separation could be reduced before it negatively impacted listening enjoyment for those with stereo radios.

FM stations can easily achieve stereo separation well beyond 60-70 dB today, even though consumer receivers rarely achieve 40 dB to 45 dB in the mid frequencies. Fortunately, the human ear doesn't require all that separation for a positive stereo experience, something I confirmed with a listening test and 62 "normal radio listener" subjects. None considered themselves to be audiophiles, and not a single person needed more than 25 dB of stereo separation in order to believe they were hearing full and un-doctored stereo.

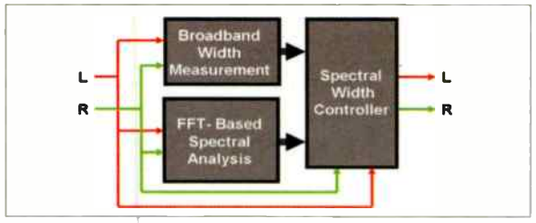
A few years later, after I'd moved on from WMJI, I learned of a paper by J.R. Stuart called, *The Psychoacoustics of Multichannel Sound.* Stuart had done extensive research on the perception of stereo separation, and the surprise for me was finding that stereo separation could be drastically reduced, with minimal impact on the listening experience – something that correlated quite well with my own admittedly very basic research, as shown in the graph below.



The idea behind the Multipath Controller is to attenuate the electrical stereo separation just enough to reduce its effects on multipath without interfering with the stereo listening perception, and this can get tricky because separation on program material is all over the map. Cutting stereo separation by a fixed 3 dB or 6 dB in order to blend it towards mono helps reduce multipath effects too, but it also compromises stereo on material with little separation to begin with.

For Country station 92.5 "The Wolf" in Denver, this was an unacceptable compromise. Sure, attenuating stereo separation for all programming might recover some listeners in The Wolf's listening area affected by multipath (92.5 broadcasts a rimshot signal into Denver from the base of the Rocky Mountains – it's a Class C1 with an antenna barely clearing the average terrain – the perfect storm for multipath!) but that could lose listeners in the areas it does reach, by taking stereo away from the listening experience.

The Multipath Limiter algorithm gave The Wolf (and many other stations) the best of both worlds because it manages stereo separation in relation to program content, and does it in a way that is imperceptible to the ear. The user simply sets the desired Multipath Limiter threshold using the processor's user interface, and from then on its operation is fully automatic.



One very important difference between a fixed amount of stereo blend and what the Multipath Limiter does, is that because the Multipath Limiter is continuously measuring the stereo separation of incoming programming, it also knows when stereo separation is below the user-set threshold – and knowing this it can (and does) increase stereo separation for program material which would otherwise be too narrow. Likewise, if the incoming program material is mono, the Multipath Limiter does nothing to it, waiting instead, until the audio is stereo before taking up the signal again. The end result is twofold: the perception of multipath is reduced, and the overall stereo listening experience is much more consistent across all program material.

It bears mentioning that while testing candidate DSP-based receiver chips to qualify one for our built-in, processor-based automatic FMHD diversity delay correction, we discovered a few quirks of newer DSP-based receivers that were not expected. First of all, they seem more prone to multipath effects even though they have quite complex mechanisms to supposedly minimize it.

Second, the majority lack the modulation headroom of older technology, rarely having more than 3dB headroom above 75kHz (100%) modulation. This more or less makes sense because when receiver designers refer to the "rules" to see how much headroom they need, 75kHz (100%) or 82.5kHz (110%) are the only maximums they ever see (over-modders beware!).

Third, when these chips try to decode a non-standard stereo multiplex signal (like single sideband) or a dirty MPX spectrum (think composite clipping), things can get real ugly, real fast. In fact one of the field observations we've repeatedly seen is that when single sideband seemed to reduce multipath, it often turned out that the DSP-radio simply shut down the L-R or severely rolled off its high frequency response in the presence of a "non-standard" MPX signal!

To combat some of these MPX signal behaviors, our FM processors have both a composite clipper and a look-ahead MPX limiter; the user can choose which algorithm works best for their scenario.

The bottom line is this: don't get nuts with modulation, keep the MPX spectrum clean, intelligently manage stereo separation, and prepare to be surprised at how much the perceived stereo coverage of your station goes up.

Jeff Keith, Senior Algorithm and Product Development Engineer for Wheatstone Audio Processing, has worked in the broadcast industry for nearly 50 years. An SBE Certified Professional Broadcast Engineer since 1991 and iNARTE certified Master RF Engineer since 1986, he is a long standing member of the Audio Engineering Society and IEEE. Keith holds senior memberships in the Society of Broadcast Engineers and International Association of Radio and Telecommunications Engineers.

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Studio Site

Is AoIP In Your Station's Mix?

Looking Back and Ahead at Audio-Over-Internet Protocol

by George Zahn

The burgeoning impact of AoIP (Audio over Internet Protocol) is found in more and more devices, including newer mixing consoles. For many smaller stations, AoIP may have seemed like a pipedream, or something to consider "down the road," but as more stations are networking over larger areas, AoIP can create some advantages, and it goes beyond consoles using AoIP, but now also microphone processors and more.

For the uninitiated, AoIP allows for high quality distribution of audio through the Internet, in some ways similar to the VoIP (Voice over Internet Protocol) used for telephone systems. Many organizations have replaced internal phone communications to VoIP over the last fifteen years to save money and increase flexibility.

VoIP versus AoIP

VoIP has been adapted to handle everything from consumer cell phone monitoring of front door cameras and speakers, to streamlining corporate telecommunications. The biggest limitations of VoIP is the audio and video quality, due to limited data going through the pipeline. VoIP was a great starting point, but radio needed more.

About fifteen years ago, the Telos Alliance, a collective of six major radio/TV brands, developed AoIP to allow for higher quality digital audio to be distributed over ethernet connections. This is a great way to accommodate audio being delivered over long distances without degradation of signal. Large snakes and bundles of cables and punch blocks could be replaced by simpler and streamlined Cat5e or Cat6 cables carrying audio as data.

AoIP and EoP (Audio over Ethernet) is based on the platform American Engineering Society open source AES67. This standard dates back to 2013. It has been almost universally adopted by technology manufacturers creating mixers and components for broadcast. AES67 has been described as a standard for conveying audio from one point to another, promoting interoperability. It has also become the audio component of video over IP.

AoIP and STL

The concept of AoIP may still sound threatening, but you may be using this technology already without really knowing it. As stations dropped equalized, dedicated phone lines and RPU units for their STL, many have jumped over to devices such as TieLine's Bridge-IT, the GatesAir Intraplex, or the Comrex Bric-Link, among others for AoIP STL. Telos is even working on "IP Radios" that they say can vastly improve Internet reliability.

TieLine Bridge-IT

GatesAir Intraplex

On a much smaller scale, my station, WMKV, is in a large facility that has an auditorium and we had a basic connection installed between the auditorium and the station for special uses. One Cat5e allowed us to place a mixer in the auditorium and have the audio output terminate at the station, about 100 feet away. It became sort of a "dedicated equalized line" to use an old Telco phrase.

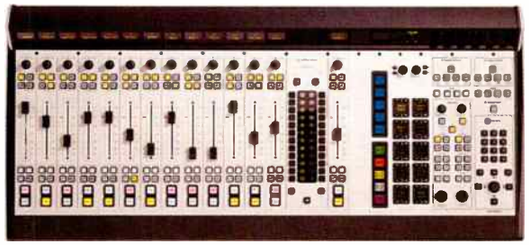
So if I'm a small station with just one location, how does AoIP or AoE help me? One simple way is utilizing voice talent from other cities or regions. Whereas ISDN encoders and decoders allow for studio quality audio connections and POTS ("Plain Old Telephone Service") CODEC units can get you very close, they can be expensive. If your console, or a processor in your studio, already can accommodate AoIP, you may well be able to get that connection more cheaply.

Comrex Bric-Link

Some will contend that in such circumstances, AoIP is only as good as your local Internet service when it comes to reliability. If you don't have a decent Internet service or you are using consumer grade Internet, quality can waver depending on the flow of data. Some say that's why ISDN is still more dependable. AoIP is now also part of sports broadcasting as field mixers, including JK Audio, Comrex, and Tie Line, are now featuring AoIP Codecs as well as ISDN and POTS.

Digital Bang for the Buck

As more stations cluster, AoIP allows for better and more diverse voice tracking along side some of the major radio conglomerates. It can also open up more lower cost options for interconnectivity in media for local stations and network sharing of audio content with minimal compression.



Axia Fusion Console

Among the mixing consoles that incorporate AoIP include offerings from Telos and their AXIA line (the Fusion line features as few as eight and as many as forty faders) which uses a central PowerStation to interconnect modules including the console, I/O interfaces for non AoIP devices, talk show manager, AES/EBU devices such as CD players, as well as microphones, speakers, satellite input, and other devices.

Wheatstone LX-24 Console

Furthermore, many of the AoIP systems allow for remote control of some basic studio operations through the same Internet that delivers the audio.

Wheatstone has a wide range of small to large consoles which are AoIP compatible. The LX-24, for example, allows for assignable inputs, hot-swappable modular components, and the same "remote" control via the Internet from anyplace with Internet access, using their proprietary software.

Arrakis is offering a line of interfaces and mixers that are all AoIP compatible. Arrakis and its Simple IP units with multiple mono or stereo inputs and outputs, to their ARC and MARC model mixers, uses Dante, a platform owned by the Australian company Audinate. Dante controls not just audio transfer but also control. It is compatible with AES67, a major move that happened about two years ago.

Arrakis Simple IP

Hybrid Technology

Other manufacturers that also are offering hybrid systems include Lawo, (including the Crystal and Sapphire), Logitek (including the Pilot, Mosaic, and Helix consoles), and Sierra Automated Systems (including the small Rubi through the larger Rubicon models).

Logitek Pilot Console

Each station is different, and our station has a couple of old warhorse Autogram analog Pacemaker consoles. We're discovering that replacement parts can be very hard to come by, and frankly, there's only so much cannibalization you can do without crippling a console altogether. One of the best things to do is to investigate before leaping into the market. Discuss performance with other managers and engineers whose stations are utilizing AoIP consoles and devices. It may be more affordable, and easier to install than you expect.

It may even be worth a road trip for a team from your station to see how the systems are implemented in other markets. Seeing is believing, and sometimes getting engineer, manager, and production supervisor on the same page can be done more easily out of the station building.

Plenty to "Process"

Here's another interesting facet of the AoIP phenomenon. Among components that are becoming more widely available, Wheatstone is offering the M4IP-USB. The device can be accessed by any point on your network, even studios in other cities, and the box offers four discreet channels of high fidelity audio processing. The device is also usable as a stand alone processor within a single studio or single station.

Each channel offers dynamics processing, a wide range of EQ functions, expander, de-esser, and high and low pass filters. It is AES67 compatible and allows you to send on one device that can be used from multiple locations. In short, AoIP is making many of us reconsider the audio chain of our youth.

Are you using AoIP in your plant or network? Let us know your take on the technology and how it's improved performance or efficiency or what you'd like to see changed in the technology.

George Zahn is a Peabody Award winning radio producer and Station Manager for WMKV-FM at Maple Knoll Communities in Springdale, Ohio. He is a regular contributor to ***Radio Guide*** *and welcomes your feedback. Share your stories with others by sending ideas and comments to: gzahn@mkcommunities.org*

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Chief Engineer

No More Ring Around the Transmitter

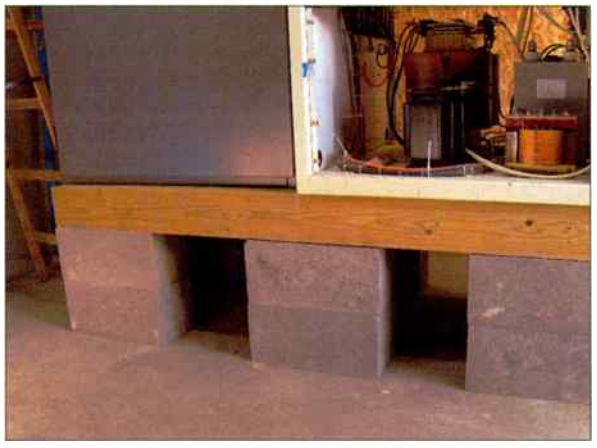
by Scott Schmeling

Dirty flood water ring, that is. (OK, raise your hand if you don't get the Wisk commercial reference!)

But, before we talk about that, I got a nice e-mail from Nels Wilson at KGBN in Caldwell, Idaho. Nels was writing about the RF contactor article *(Radio Guide Jan/Feb-18)*. He has a contactor he's been nursing along by cleaning and lubricating the shorting bar and finger contacts every month or so.

Talk about a small world, Nels grew up in Embarrass, Minnesota (about 85 miles north of Duluth – *almost* into Canada). But that's not all. I have a daughter and grandson living in Caldwell! I guarantee, Nels, that the next time we go to visit our daughter I will also visit KGBN. Thanks for the invitation, Nels.

OK, now to the subject at hand. The "ring around the transmitter" to which I referred was caused by flooding. On Thursday, September 23, 2010, we experienced the "100-year flood!" We lost a Harris FM20 which we replaced with a Nautel NV20. The following March we put that transmitter, and a Harris HT10, "on blocks" roughly 18-inches above the floor. Since that placed them above the high water mark, that certainly should have taken take care of it - we *thought!*



On September 22, 2016 (almost six years later, to the *day*) it flooded again! This time they called it the "500-year flood" (I called it the *six*-year flood!) The water was nearly 20 inches higher than the previous flood – well above the blocks the transmitters were sitting on. This time the HT10 was deemed not repairable.

Now we had a dilemma. It most certainly will flood again, and I couldn't raise the transmitters any higher without literally raising the roof. The decision was made to build a new building next to the current building. The new building would be built such that the floor will be considerably above the latest "high water mark."

Now, as we all know, moving a transmitter (though similar in size) is *nothing* like moving a freezer. In addition to moving the transmitter cabinet, we also have coax cables to *extend,* racks with STL's, remote control, and audio processing to move. And don't forget about the dehydrator (or nitrogen tanks) to pressurize the coax cables. Needless to say, a project like this takes a good amount of planning. Good friend and fellow engineer, Marv Olson (a name you've heard before) was brought in as well.

You could say the two buildings are sitting "nose-to-nose." For reference, the door of the old building is on the west end. In looking for a route for the cables, we decided to remove the exhaust fan above the door and make the opening large enough for all the cables and install wall feed-through panels and boots. The exhaust fan was moved to the new building.

The new building has a smaller footprint, but 12-foot ceilings. We installed Superstrut on the ceiling for cable supports. Most of the smaller coax's were 7/8 Heliax terminating in N-type Female connectors. It was our belief that a 7/8" flange connector would have slightly less loss. But more importantly, the flanges would give added strength at the "splice-point."

We cut several pieces of coax and installed connectors on *one* end. Then we put colored tape on both ends of each piece, as well as matching colored tape on the coax to which it would mate. Later, we labeled each line so there would be no confusion as to which line was for what. We also planned on a section of 3-inch conduit running the same path as the coax lines. The conduit is for any other cables that need to go between buildings.

There are four transmitters at this site: the NV20, a GatesAIR FAX50 3.5 kW, a Nautel VS 2.5 (backup), and a Nautel VS 1 (translator). All but the NV20 fit in one rack. The STL's, audio processing, and remote control are in another rack. Moving was done in two stages. The two racks were moved first (late in the evening for minimal down time). The NV20 was saved for later. Therefore, composite, control, and metering lines had to be run from the new to the old building. We also ran a length of 25-pair *telephone* cable to use for ... telephone ... and generator and tower light status, as well as those lines to the NV20.

With phase one of the moving project complete, we could take a breath and do a little more planning for the NV20 move. Our very first decision was to use a *moving company!* They have the experience and the tools. Not to mention *they* are much stronger than Marv and I are!

One nice thing about having everything else moved over already was that we could use the VS 2.5 backup while the NV20 was being moved. That means we could make the move during *daylight* and not have to rush – we all *liked* that idea!

When the NV20 moving day came, Marv and I were there, the movers and the electricians arrived, and shortly after morning drive, we switched to the backup and started disconnecting everything on the NV20. We also removed all eight RF Modules and 20 power supplies. By doing this we reduced the weight to something over 400 pounds – much easier to handle.

The actual *move* went pretty much without a hitch (great planning!). With the transmitter sitting in place, we went to work Re-connecting everything. Not to over-simplify, but we were ready to switch back five hours after going to backup.

The move wasn't without issues. Two of the larger lines had slight pressure leaks (which we found and fixed) and the NV20 showed higher than normal internal temperatures. That was because the air conditioning wasn't in yet. In fact, we had an exhaust fan but nothing to allow air *into* the building ... but we're workin' on it. I'm learning the differences in spec's between *open* and *closed* ventilation systems. Open – being filtered fresh outside air being forced into the building and warm air being exhausted out. Closed – being air cooled and recirculated by an air conditioning system. I'm planning a hybrid – *closed* as the primary with an *open* as a backup.

I've already discovered one advantage to the move: I no longer have to stand on a platform or ladder to see the NV20 touchscreen!

I guess that's it for now. Until next time ... keep it between 90 and 105!

Scott Schmeling is the Chief Engineer for Minnesota Valley Broadcasting. You may email him at: scottschmeling@radiomankato.com

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FCC Focus

2018 and Its First EEO Audit

New Procedures: Old Problems – Don't Get Caught Off Guard!

by Gregg P. Skall – Womble Bond Dickinson (US) LLP

On February 26, the Media Bureau issued its first Equal Employment Opportunity ("EEO") audit of 2018 to randomly selected radio and television stations. There are two significant changes that 2018 brings to this procedure that could catch broadcasters off guard.

FCC Steps Into Cyberspace!

First, broadcasters must note that this is the first EEO audit since the on-line public file rule has become effective for *all* radio and television stations. The second significant difference is that this new 2018 audit marks the FCC's next step into the world of Internet-dependent communications. Be warned that the Commission is now conducting all correspondence electronically. The U.S. Post Office is gone, gone, gone! No more mailed letters; so don't look for FCC notices in the mailbox. Beginning with this audit, all communications between the FCC EEO staff and broadcast licensees will be accomplished either by email or by filing responses in the FCC hosted on-line public file.

Where Do I File?

The Commission has created an EEO audits folder in all broadcast stations' on-line public files. Look for it under *Equal Employment Opportunity records – additional documents – EEO audits, investigations and complaints.* The February 2018 EEO audit letter instructs broadcaster respondents that their responses must be uploaded to that FCC on-line public file; they are *not* to be filed with the secretary or sent directly to the EEO staff, as in past years.

E-Mail Addresses:

By the way; since the commission is now sending the official correspondence by e-mail, it is also important that every broadcaster be sure to validate its current email address with the Commission and in the contact records it maintains for the station. You can no longer rely on your FCC contact rep, typically your law firm, to get a copy and notify you. The Commission is not sending copies to the station's attorney of record or other contact representative. In already *pending matters* Commission's rules require that notices also be sent to the station's attorney, and if direct communication occurs with the party, a copy must be mailed to the attorney. But an EEO audit is apparently not considered by the Commission to be a *pending* matter to which that rule applies, as copies of the recent EEO audit letters were not sent to the FCC contact representatives.

Not Your Same Old Audit Letter!

So be alert, and should you receive an EEO audit letter, notice also that there are some new features. As in the past, employment units of fewer than five employees are exempted from the audit, however, exempt employment units must now respond with a list of the unit's full-time employees, identified by job title (without names) and the number of hours each is regularly assigned to work per week.

Document, Document, Document!

An area where even compliant stations regularly fall short in an EEO audit is documentation. In particular, many stations do good in complying with the EEO rule requirements, but fall short by not retaining sufficient documentation of their Prong 3, supplemental outreach efforts. From the beginning, the Commission has repeatedly emphasized that *if you can't document it, it did not happen!* While stations often participate in more than the required supplemental outreach activities, in my experience, too often, they don't think to secure and maintain adequate documentation to verify their participation.

It's not that hard to get adequate documentation at the time of the event, but it can be time-consuming and sometimes impossible to get it a year or two after the fact. The Commission is not terribly picky about what you keep to document supplemental outreach: it can take the form of thank you letters from schools, students or civic associations, flyers or notices of the event that display the station logo, interview notices from a job fair or any other similar correspondence or document. The important point is that, although almost any type of documentation would be deemed satisfactory by the staff, you must maintain it and have it available for an audit.

Similarly, when hiring for a full-time position (30 hours a week or more), busy broadcasters sometimes forget to keep documentation of the broad outreach used to advertise employment opportunities. While the axiom "if it's not documented, it didn't happen" remains true, with this audit, the Commission has made it easier for stations to demonstrate their broad outreach in this audit. While the Commission requires dated copies of all advertisement, bulletins, letters, faxes, emails or other communications announcing the position, in this audit the employment unit may send one copy of each notice with a list of the sources to which it was sent, rather than providing copies of every notice. The station must make an affirmative statement to indicate whether it retains copies of all the notices. On-air ads can be documented with a single log sheet showing when the ad aired and a statement as to the other times it aired instead of providing multiple log sheets.

Ideas for Prong 3

Depending on the size of the market, employment units must perform two or four Prong 3, supplemental outreach efforts every two years, measured from the filing of the station license renewal. When the employment unit has performed more than four initiatives, the audited station needs to document only four and then only summarize the rest and be ready, if asked, to provide more information on request.

The Commission made it easy for stations to decide what qualifies as a supplemental outreach initiative. In the original rulemaking, it offered a menu of items that it would accept.

Last year, the Commission made the job of Prong 1 outreach even easier, declaring that broad outreach in hiring may be achieved solely with *Internet notice,* provided certain standards are met. Years ago, in response to a lawsuit, the Commission changed its EEO approach from requiring specific racial and gender diversity in the employment unit to one of requiring "broad outreach" to achieve inclusiveness. However, in the belief that the Internet was new and would not reliably reach the poor or many minorities, it rejected the suggestion that broad outreach could be achieved solely through the use of the Internet. Last year, and some 15 years later, the Commission announced its reassessment of that conclusion. Finding that Internet usage has become sufficiently widespread, broadcasters can now use the Internet as a sole recruitment source to meet the "wide dissemination" requirement of its rules.

In reaching its conclusion, the Commission's found that the number of Internet connections in the U.S. has surpassed the U.S. population and that computer access has become so ubiquitous that it can reasonably be assumed that an Internet job posting will be readily available to all segments of the community. The ruling also relied on a 2015 Pew Research Center study reporting that 90% of Americans who had looked for work in the preceding two years used on-line resources for their job search and 84% of them submitted their job applications on-line. Compared to newspapers, the Commission found that the generally free or cost effective use of Internet postings would assist in even broader outreach than costly print advertising and that employers can automate the process of posting jobs on-line. Thus, the Commission found that on-line job postings were now likely to achieve the largest number of people possible *if posted on a widely available site.*

That last caveat is important because the staff will continue to examine the specifics of each case to ascertain whether the posting of a full-time job vacancy *actually achieved* wide dissemination. Broadcaster employment units *must be prepared to show* that the sources achieved broad outreach; how many sources were used no longer matters, provided broad outreach can be documented.

Also be cautioned that the unit must continue to "use recruitment sources for *each* full-time vacancy sufficient in its reasonable, good faith judgment to widely disseminate information concerning the vacancy." Therefore, broadcasters are free to select the number and type of recruitment sources they use, and may even use a single on-line Internet posting, provided the posting appears on a website that is so widely used that it can reasonably be expected to achieve broad outreach and wide dissemination. So, the choice of websites and Internet outreach remain very important and must continue to be done thoughtfully with FCC policy goals in mind.

The Random Audit Program:

So back to: *Be Prepared!* The FCC is committed to reaching every broadcast station sooner or later. Audits use a completely random selection process and the odds are that your station will be audited sooner or later. Be prepared and know the rules. The audit letters do change from time to time and now you can no longer rely on the U.S. mail or your attorney for notification. There should be a person in charge of EEO compliance in every station or employment unit and make certain that your current e-mail address is the one on record with the FCC.

This column is provided for general information purposes only and should not be relied upon as legal advice pertaining to any specific factual situation. Legal decisions should be made only after proper consultation with a legal professional of your choosing.

Gregg Skall is a partner of the law firm Womble Carlyle Sandridge & Rice, LLC. He frequently lectures on FCC rules and regulations, represents several state broadcaster associations and individual broadcasters and other parties before the Federal Communications Commission in their commercial business dealings. Prior to private practice, Mr. Skall served as the Chief Counsel for the National Telecommunications and Information Administration and General Counsel to the White House Office of Telecommunications Policy.

Tips From the Field

A Diode Became a Resistor

by Michael Bradford

When the main Continental 816-R2, 20 kW transmitter turned itself off for no apparent reason on a bright, sunny afternoon, I was pleasantly surprised when the on-air jock actually used the remote control to turn on the auxiliary transmitter before calling me. I can't remember how many times at this and other stations, the jock would call first before following the nice printed instructions mounted in the control room meant to save time and get back on the air as fast as possible.

As my wife and I arrived at the transmitter shack, it was interesting to note that the main transmitter tally system indicated no overloads, open doors, reduced air flow, tripped breakers or missing voltages. I turned on the blower for the dummy load and noted the "OK" LED was lit. I hit the filament switch and the blower came up to speed with no problem. The air flow indicator was normal, the other interlocks and "ready" LEDs were normal, and the transmitter turned on just fine feeding the dummy load. As I was checking the multimeter positions for various meter readings, I noticed the 28 Volt supply reading was going down slowly. When it reached about 17 Volts, a relay somewhere in the control chain dropped and the transmitter turned off. No "fault" LEDs, no loud bangs, no sparks and no other indication of trouble.

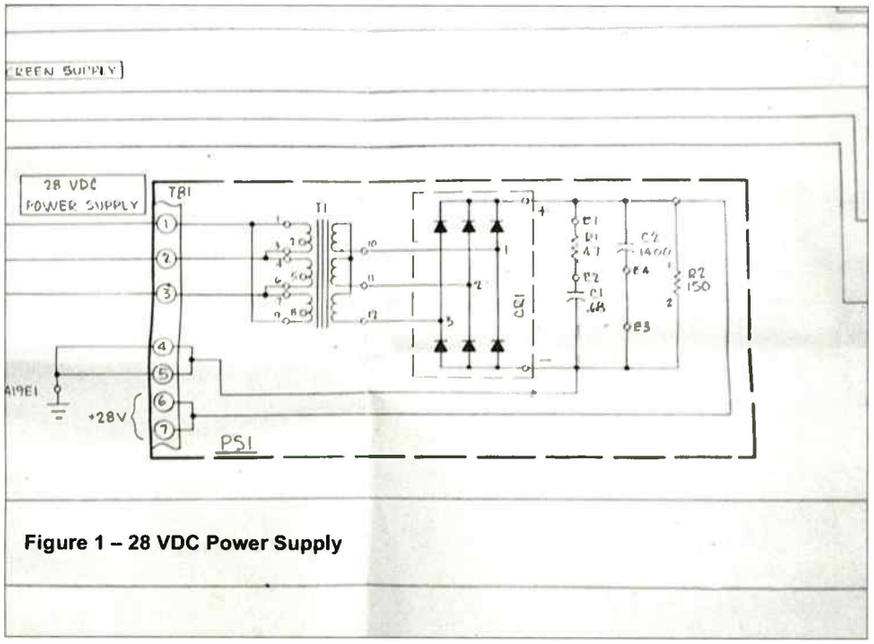

Figure 1 – 28 VDC Power Supply

I unfolded the schematic and began checking out the control ladder for any leads. The 28 Volt supply (**Figure 1**) is a basic analog assembly with enough amperage to handle all the auxiliary relays and sub-assemblies easily. I suspected it had a bad filter cap or a blown diode. I turned the transmitter off and used the grounding stick to discharge any remaining high voltage.

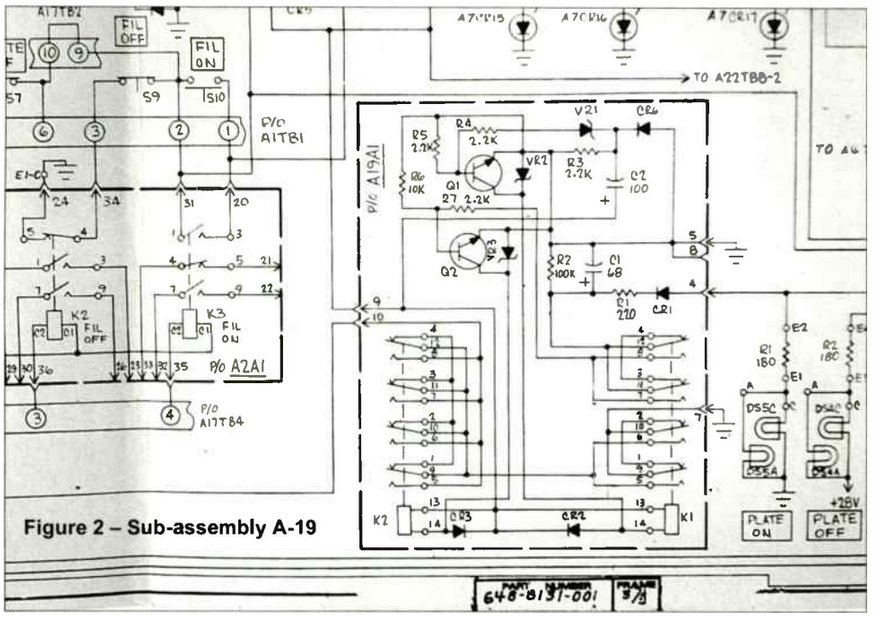

Figure 2 – Sub-assembly A-19

Then I turned all the primary power breakers "off" and removed the wire connectors for the input and output wiring on the power supply. The plan was to place the assembly on the bench and get a closer look.

In any case, with the auxiliary transmitter on-line, there was no need to rush and no need to get up, like so many previous emergencies that had happened, at 3:00 in the morning.

When on the bench, I attached a temporary 120 VAC feed and used my trusty Simpson 360 meter to monitor the output – all was perfect with no load and, after the required cup of coffee and some thought, I found the output was still 28 VDC. I connected a 100 Ohm 200 Watt resistor to the 28 Volt output with jumpers and noted no change in the output and just a nice, warm resistor.

I turned the 120 VAC breaker that feeds the power supply "on" and installed a simple one RU rack shelf backwards and upside down on the outside of the transmitter front panel to support the power supply. In this fashion, I could measure the voltage as I connected the output wires, without worry of the power supply taking a dive onto the floor. One of three wires connected and no trouble. Second wire installed and no problem. As I installed the third wire, the Simpson showed the output voltage going down slowly. As all the wires in the Continental are numbered, it was easy to locate them and their destination on the schematic. The third wire went from the power supply to sub-assembly A-19 (**Figure 2**).

An inspection of this assembly showed no burned spots, no loose connections or indication of overheating – no charred resistors or melted barrier strip connections or other signs of faulty components. I noted the "snubber" diodes across the relay coils in this assembly on the schematic, and tried to locate them to check them out. They were nowhere to be found on the sub-assembly! I thought there might be a relay with a shorted coil, so I removed them one-at-a-time; the relays checked out just fine compared to the coil resistance in a spare relay. I decided to remove the 28 Volt wires at the terminal screws on the relay sockets, in case I had a bad socket. Voila! As I removed the first relay connection I noted the Simpson reading jump up to the full 28 Volts. Now I was puzzled; I had already checked the relays and this socket had no visible indication of over heating or such ... what next?

I decided to remove the socket for further investigation and as I turned it over in my hand, I spotted a diode across the coil connections hidden underneath the socket assembly – the "snubber" diode I couldn't find before. I connected the Simpson and it read the same resistance in both directions. This wasn't a diode anymore!

I happened to have a baggy of general purpose diodes in my tool box and had a replacement installed under the socket in a few minutes. After re-installing the socket and wiring and securing all the other power supply connections and mounting screws, I turned the transmitter filaments back on and watched the panel-mounted multimeter reading for the 28 Volt supply; it was rock steady after ten minutes.

I turned the transmitter on into the dummy load and it ran flawlessly for an hour. I switched the "main" back on-line and tweaked the tuning and loading controls on the Continental and all appeared normal.

I wrote out a description of the whole project and my procedure and put the document into the binder with the transmitter manual and previous notes. I always go through this regimen in case I need to refresh my own memory or in case a fellow engineer comes along in the future and has a similar issue.

Time to finish off the last coffee in the Thermos and the last graham cracker with frosting my wife brought along just in case I got hungry. What engineer do you know who doesn't get hungry after working for a few hours at the transmitter shack? Be safe at all times and never close your toolbox lid without latching it!

Michael Bradford began his career at WCCW in 1962, A CPBE since 1984, and currently a contract engineer, you may reach him at: mbradford@triton.net

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Transmission Guide

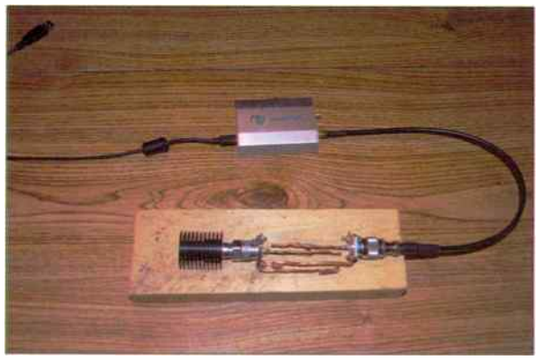
A Home Brew Isocoupler for 950 MHz

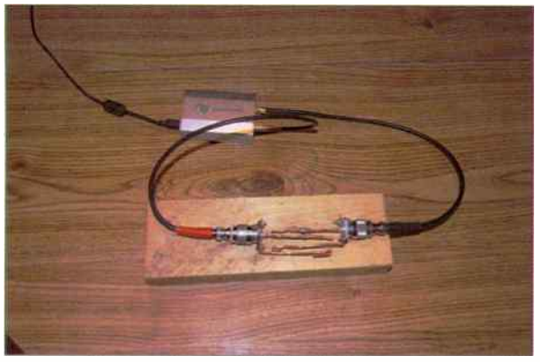
by Bob Reit, CBT

One of my clients needed to mount a STL transmitting antenna on a series fed AM tower and got sticker shock when he received the isocoupler quotes. The four week factory lead time did not help either. Like most managers, he wanted the project completed "now!" My response was, "It can't be that complicated, it's just a couple of coupled loops of wire in a watertight enclosure." So I set out to build my own.

Using my PocketVNA, dummy load and some chassis mount N connectors I set out to build one using coupled loops. This attempt did not work so well, I could not get a good match or reasonable insertion loss through the coupler.

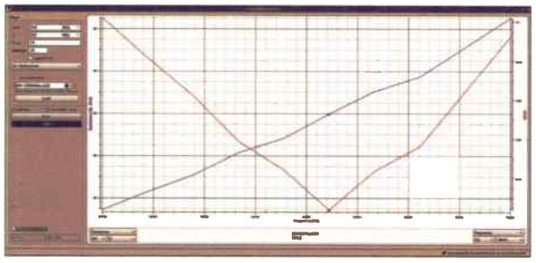
As the Perl monks say, "There is more than one way to do it." My second breadboard attempt is shown below, with the PocketVNA setups to measure SWR and insertion loss.

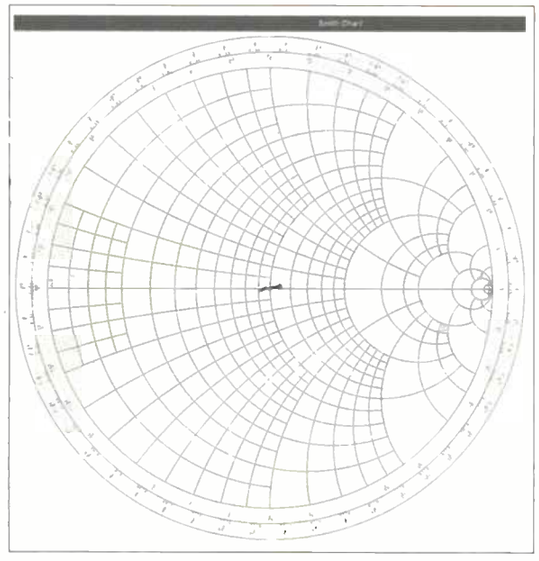




It is simply #12 solid copper wire, 1/4 wave long soldered to the center conductors, as well as another set of 1/4 wave wires from the flanges. The two connectors are arranged such that the wires are parallel to each other and spaced about 1/2 inch apart This was much better. By adjusting the distance between the connectors and trimming the length of the wires, I was able to get the SWR down to 1.01:1 from 947.0 to 949.4 MHz and the insertion loss down to 1.0 dB.

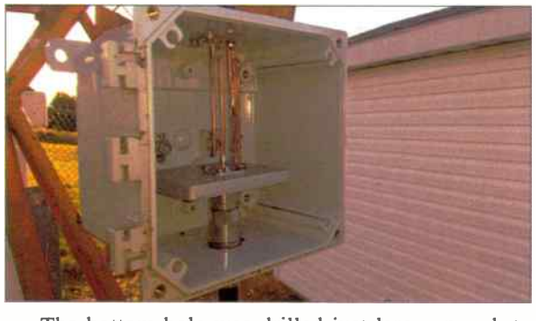
The adjustments for best SWR and minimum insertion loss interact, and it got old fast to change the two PocketVNA setups, so final adjustment was done with a spare STL transmitter feeding the coupler to my Bird Thruline wattmeter into a 20 Watt 50 Ohm dummy load. That way I could watch the Bird at the same time as the reflected power meter on the STL transmitter without having to change the setup.





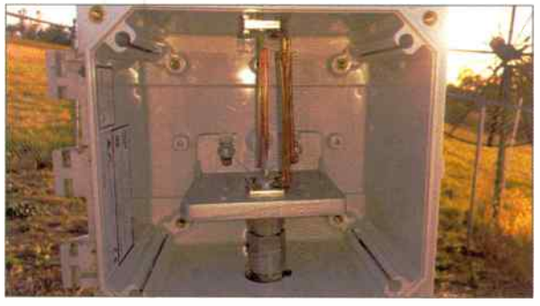
Another design concern was the possibility of the coupler arcing over on modulation peaks. For this 2 kW station, it was not a problem. The ball gap at the base of the tower is set to one-half the spacing of my coupler wires, so if something is going to arc, the ball gap would arc first.

To make the coupler weatherproof it was enclosed in an outdoor PVC Junction box. I had the aluminum bracket shown left over from another project, the slots in it allowed for final coupling adjustment. The top connector was mounted directly to the box and waterproofed with rubber mastic tape.



The bottom hole was drilled just large enough to allow the cable connector through and sealed with ductseal. A 1/4 inch hole was also drilled in the bottom to allow the box to "breathe" to prevent condensation. The final version worked better by doubling up the outer conductor wires to make them thicker.

The most expensive part of this project was the twenty dollar junction box. The N connectors cost eight dollars each and everything else I had lying around. If you had to buy everything new for this project I could not see it going over fifty dollars.



Performance of the completed outdoor coupler is as good as the prototype. 1.01 SWR and 1.0 dB insertion loss. Not as good as the 0.5 dB loss of a commercial coupler, but our path has enough fade margin where the extra 0.5 dB of loss doesn't matter.

This coupler has been in operation for over a year now with no problems. Some who have reviewed my design expressed concern about no DC continuity at the connectors like coupled loops would have, but it has never been an issue even during Summertime thunderstorm season.

Bob Reite operates his contract engineering firm, Telecentral Electronics, Inc. servicing radio stations in Pennsylvania and New York state and may be contacted at br@telcen.com

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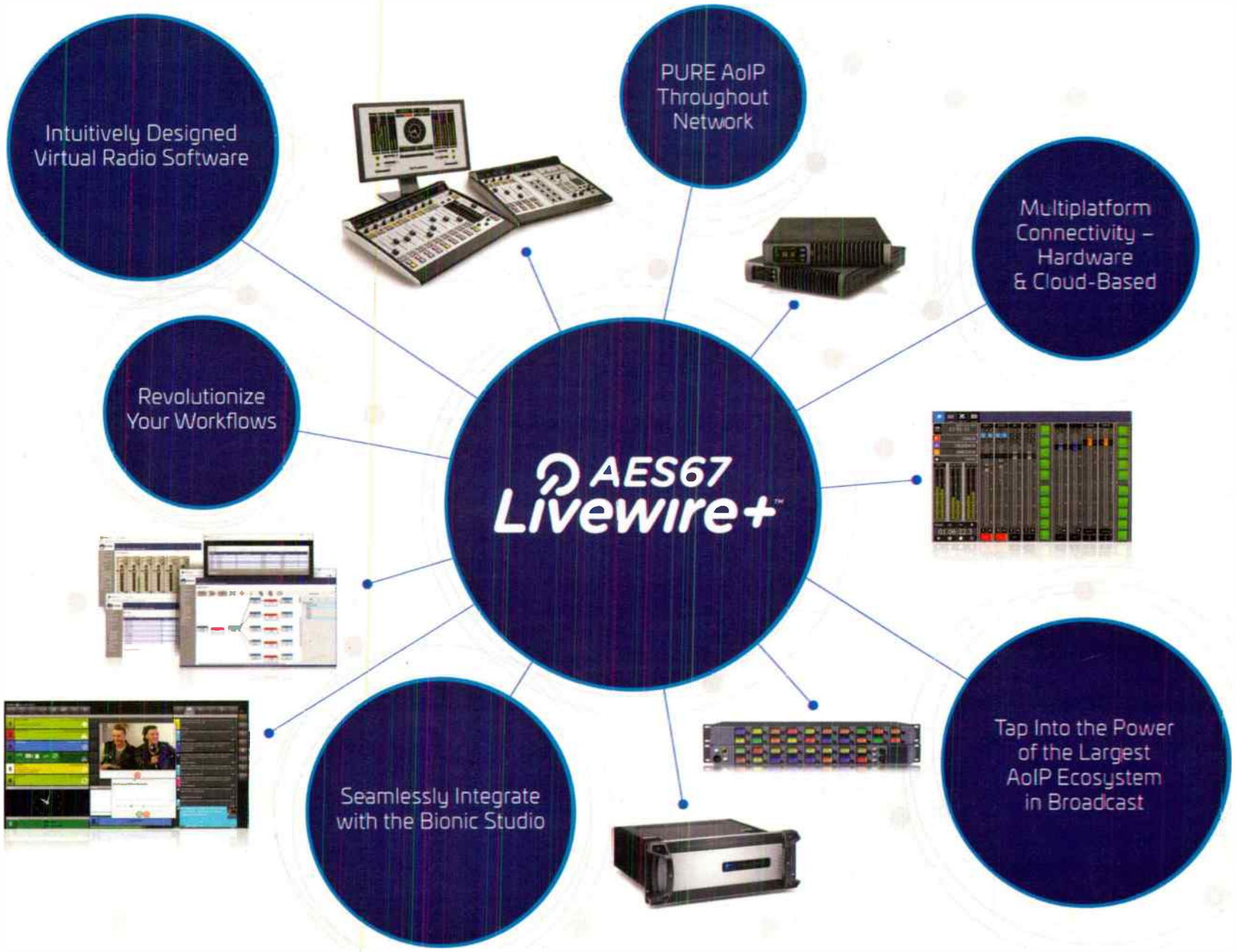

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Transmitter Site

A Tale of Parts

by Jim Turvaville

In my previous writing, I've reported that my hands-on times are less these days, but with a couple of maintenance contracts still to my name, that does come along every now and then. I recently had an experience which bears sharing, and hopefully will be worthy of your read.

The call was to a 5 kW, FM tube-type transmitter which would not turn on without the proverbial "Boom!" happening upon the application of the High Voltage contactor. Some "slash and burn" troubleshooting by both myself and the corporate engineers found two different issues; howbeit they may have really been related. First, I found we had a shorted high voltage rectifier that, when disconnected, failed to bring about the customary blowing of the breaker on the wall. This model had 4 of the long bricks instead of the long rows of diodes in a "stack," so the smart and efficient repair involved just replacing all four of them at the same time.

Once that was completed, we found that the high voltage choke was also shorted and a replacement was ordered. Aside from being 65 pounds and less than one cubic foot in volume, there are also not many handy ways to pick it up – and not need a visit to your chiropractor shortly thereafter. But the biggest obstacle was the 200 pound, high voltage plate transformer which was in the way of getting to the choke. Here is a front and an inside side view of that location. **(See Figure 1 and Figure 2)**


Figure 1

The guys who assembled this beast at the factory most certainly had done so prior to some of the internal parts being installed – particularly the PA cavity and most likely the entire side panel of the transmitter. In this install, there is a 4 inch, solid concrete wall on the right, and an equipment rack on the left, so the front panel was my only option. The conclusion was that the high voltage transformer had to be removed in order to access the choke, so some careful tactics got under way.

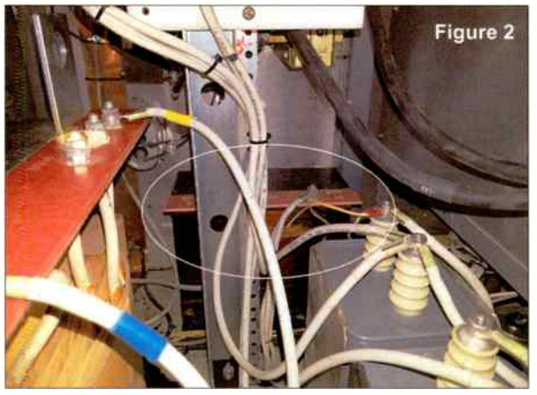
Figure 2

I always fall back to not trusting my memory, taking several pictures on my phone of the entire assembly, as well as close up shots of the wiring connections. As you know, one can also use the flash function on the phone camera to "see" into dark and tight spaces to find out what you're up to on the project. That's how I found the compliment and location of bolts holding both large iron parts to the floor of the transmitter cabinet. Fortunately, each was held down only with a bolt in each corner **(as seen in Figure 4)** and I happened to be carrying the required socket, extension, u-joint adaptor and ratchet for the job.

Not only did I take careful video notes of the wiring, before disconnecting anything, I used my trusty 10-roll set of colored tape to conspicuously mark the wires and the terminals to which they were attached. Here is the plate transformer and choke wiring before being disconnected. **(See Figure 3 and Figure 4)**

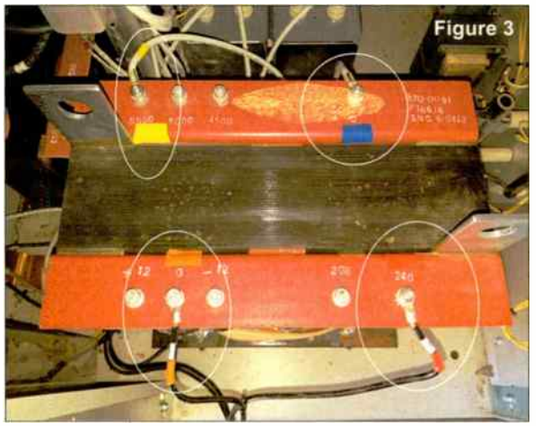
Figure 3

I had the advantage of a nice section of rubber mat (remember where that came from?) on the floor in front of the transmitter, so disconnecting the large plate transformer and removing the chassis bolts let me just rotate it and walk it out of the cabinet onto the floor mat with minimal physical strain. At no point was it required for me to actually try and lift the entire weight, or this project could not have been attempted solo. Once the main transformer was out of the way, I could label and then remove the four bolts holding in the choke, and also walk it out of the cabinet onto the rubber mat where it then could be actually lifted and swapped out.


Figure 4

The entire process took a bit over an hour, and since the station was operating on a backup transmitter, this could be done during daylight hours and at a time which was not freezing cold in the building.

I'm reminded of a story that I've related many times before, but it's quite appropriate at this juncture. Seems there were three surgeons who were at a medical convention, discussing their experiences with various different kinds of patients. The first said that he preferred to operate on Accountants, since when you opened them up all of the parts were numbered. The second proclaimed his preference was to operate on librarians, since all of their parts were in alphabetical order. The third surgeon then announced he had them all beat, as his preference was to always operate on Engineers. After all, when you're done and you have parts left over, *they don't mind.*

Sure enough, I will relate that this project had parts left over. **(See Figure 5)**


Figure 5

While that high voltage choke was probably installed at the factory before the PA cavity, and most likely the left side panel of the cabinet was installed, there simply was no physical way to see or to hold the bolt, lock washer and flat washer for the back two cabinet base screws. I had lost the two flat washers in the removal process anyway, so I just tightened the two accessible bolts a bit extra and reported to corporate that there were just going to be a couple of parts not replaced per factory spec. The DOE reminded me that if that choke came loose in the cabinet and started to move around, we'd have much bigger problems on our hands than just two bolts and washers. I agreed.

Jim "Turbo" Turvaville is semi-retired from 39 years in full-time Radio Engineering and lives in Rural Wheeler County Texas in a "tiny house" where he maintains a small clientele of stations under his Turbo Technical Services (www.jimturbo.net) operation providing FCC application preparation and field work.

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Tower Topics

Making Radio Waves – Not Metal Waves

by Barry Mishkind

Most of the time, after a tower site is constructed, it is assumed it will "just be there" for as long as the station needs it. However, that is sort of like buying a car and never changing the oil or tires. Eventually something not very good will happen. Good maintenance prevents that.

As part of the quarterly lighting system inspections – and a quarterly routine even for stations without tower lights – it is a very good idea to take the time to check the towers themselves for structural and electrical integrity.

Otherwise, on your next trip to the tower site, you might find a site like this: The RF is supposed to make waves – not the antenna! As can be seen, two guy wires were lost on this tower. The resulting pressures can be seen to have created some structural issues, to say the least. The cause – a failed guy anchor – means other guys may be at risk. And as this tower is part of a multi-tower directional array, repair can become quite a project.

Towers (and anchors) Do Age Too

Something most engineers know, but few managers truly appreciate, is that towers are not forever. True, towers that are properly maintained will last quite a while. There are towers around that have stood for 80 years. But they have been carefully monitored. On the other hand, some "young" towers can deteriorate very quickly.

A poorly installed or poorly maintained tower can – and will – fail or develop problems, making it dangerous or impossible to climb. (Here is a good example!) Then you run into the bureaucracy.

In a sort of "worst case scenario," it even may turn out the local zoning people will not permit a replacement tower, ruling the original was "nonconforming" when it was built. One station in Florida fought with local zoning for over 18 months about a tower too dangerous to climb. The station was under pressure to replace a beacon that had failed but no one would climb the existing tower. The zoning board was not willing to allow a replacement tower. Before long, the Enforcement Bureau showed up and started fining the station for not having the beacon operational. Such are those times that cause great hair loss!

Be Proactive

The truth is, however, that far too many stations either forget to check on the condition of their towers regularly or, worse, fail to set money aside for this important maintenance issue. Eventually, this sort of neglect catches up with them.

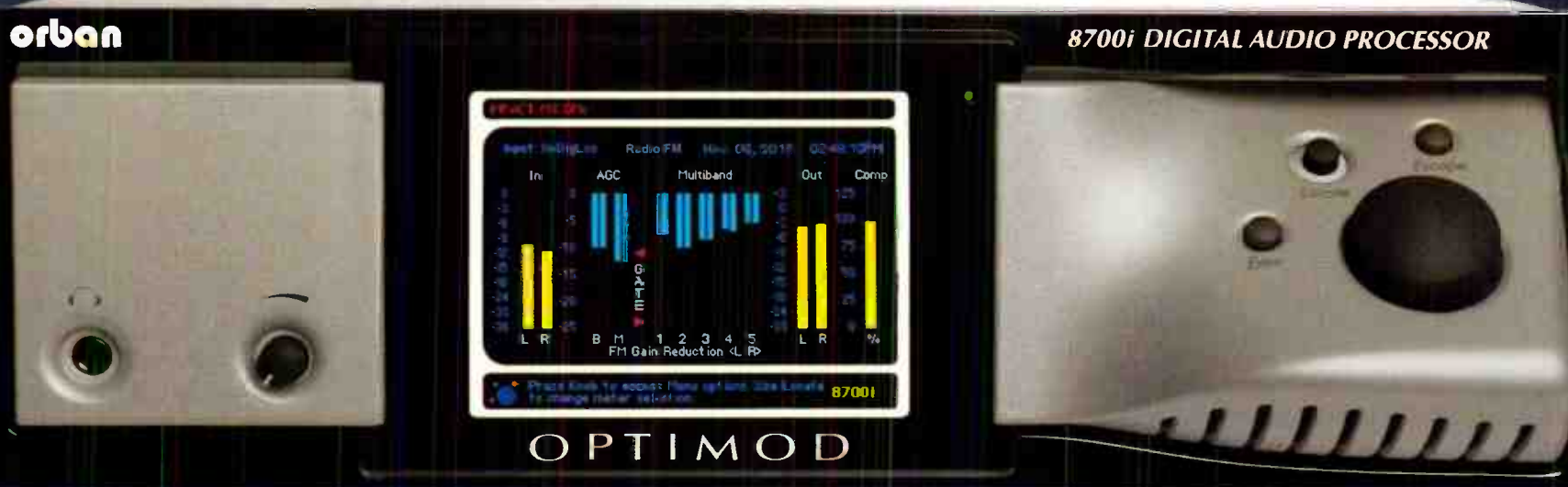
Depending upon the type of tower, and the painting and lighting requirements, it is important to be proactive, regularly inspecting each tower and looking for evidence of signs of wear and fatigue: fading paint, loose connections and clamps, blocked weep holes, broken insulators, broken or loose guy wires, guy wire tension, etc.

Such an inspection should take the time and effort to look below ground level for corroded guy anchors, exposed and/or broken ground wires, evidence of burrowing animals that could cause failure of those anchors, the transmission coax, electrical and control lines, etc.

As a real world example, notice this guy anchor. There are some things that are done properly, including the

(Continued on Page 22)

Forge a Sound They Won't Forget



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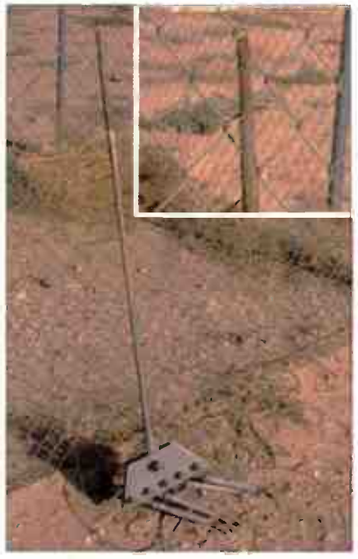
– Continued from Page 20 –

insulators and the loop to prevent tower vibrations from affecting the turnbuckles.

However, there is a common – but potentially fatal – problem with the anchor itself. Notice how it goes right into the ground. This permits electrolytic destruction of the anchor leading to failure.



In fact, at the particular transmitter site shown, one of the guy anchors did fail (see picture at right) not only taking that tower down, but also slamming into an adjacent tower, killing it. It took over a year and a half for the station to recover fully.

On the right, in the inset, you can also see a close-up of the point of failure on the guy anchor.

The metal had deteriorated so badly that a strong local wind was all it took to snap the guy anchor and kill two towers.

Some folks have used various methods to try to control the electrolysis, including various metal cathodes, which "sacrifice" themselves rather than the guy anchor itself.

There is a more direct method which, if properly prepared and the right chemical additives are introduced, will protect the anchor on a longer time span.

This is to encase the anchor in concrete. The downside is that if the installation is not done properly, it is much harder to see if a dangerous condition is developing.

Sealing the Anchor

Perhaps a better way to ensure the long-term survival of the anchor is using a concrete pedestal. The engineer who repaired the earlier damage to the site shown used that approach. After replacing the anchors with ones encased in concrete and installing a "figure 8" safety loop to keep any casual visitors (or vandals) from fooling with the tensioning, the original tower withstood even the microburst that took down two of its neighbors – much better

Do Not Rely On Others

Some stations do budget for and schedule a periodic inspection by a respected tower crew. That is good if it can be arranged, and their report will document the condition of the tower site and offer recommendations of what work must be done and what maintenance can wait.

Tower crews will come with equipment a station may not have on hand, such as tension meters, surveyors' transits (to check orientation, alignment, etc), official paint color charts, digital and infrared cameras, etc.

However, this should not replace a program of periodic inspections by station personnel.

For example, it does not take a tower crew to find and cover exposed copper or notice broken insulators or other problems. Perhaps the GM might be motivated to ask some of the station staff to help – a Saturday Pizza Party might even bring the staff together.

And even without a tension meter, it is not too difficult to pull on a guy wire and see if it is excessively loose or dig around a guy anchor and inspect its condition.

Overall, the sooner such problems are found, the easier they are to fix.

Get the Best Advice

Work with the company that provides tower services to you. Let them help you to understand the type of metal in your tower and how to keep its surface in good shape. They can suggest possible areas where you might need to take steps now to prevent problems later, with the tower and/or the local zoning board.

All in all, the object is to make radio waves, not tower waves.

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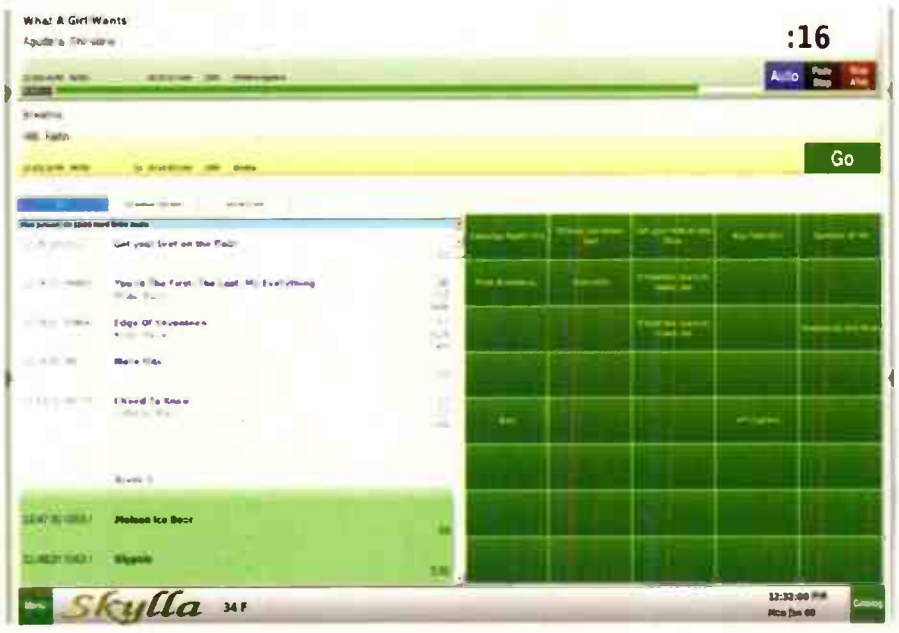

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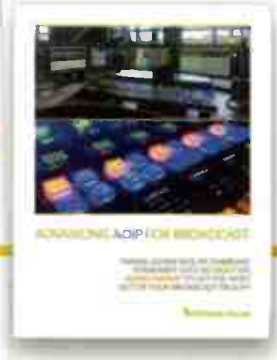

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Breathing New Life Into an Old Computer

Getting around the Windows obsolescence situation!

by Tommy Gray – CPBE, CBNE

I have no doubt that most of us have at least one or more perfectly good computers around, that we don't use much anymore, because either they will not run Windows 10, or you simply got tired of putting up with all the mandatory intrusion into your computing experience. For about two years now, I have been migrating all the computers in my office over to Linux to replace or supplement Windows™ on older computers. The primary computer I now use for my office machine is, ironically, a machine I had retired some time ago when XP was replaced and Microsoft dropped support. The first thing that happened to it was that the maker of the Antivirus program I was using dropped XP support. For a while I found one that worked but according to the reviews was not as good as the one I had been using. This was just the first in a long line of frustrations that started adding up.

I even bought a Windows 8 laptop to replace it with, as I felt I needed something I didn't have to constantly worry about losing support for. Every time I looked at the high dollar boat anchor over in the case by the wall, I got ticked off severely. I paid a chunk for that nice Dell machine, and now I could not safely use it. I saw the handwriting on the wall and decided that my best solution was probably to eventually migrate all my machines over to Windows 8 or higher. Then the reviews started coming in and all the problems with the later versions started showing up, as usual with any new Microsoft OS. Never wanting to be on the "Bleeding Edge" of technology with regard to a computer I made my living with, I waited for the eventual and inevitable patches to come down.

Well I waited, and they did (come down that is). The only problem was that each patch had its own set of new issues and it seemed that I was spending all my time just keeping my machines running and patched.

Where to Go From Here?

I had programmed in Linux many years back and was not that happy with it. I knew though, that the community would keep working at it until there were several great distros out there to choose from (all of which were free, BTW). I once wrote a Linux clone of one of the major radio automation systems for a manufacturer, and ran it on SuSE™. It looked good, but never performed, at that time, as good as its Windows™ counterpart. I also tried Red Hat™ and most of the other main line versions, and none of them set the woods on fire at the time. Now if you needed a mail server, you had a winner in them hands down, but for an everyday run-of-the-mill workstation, unless you were a techie, forget it. Bottom line is that I, once again, abandoned Linux for the second time in several years.

When Microsoft started talking about dropping Windows 7, and the patches for 8 went to 8.1, and then they dropped updates for two new mini laptops and a very expensive Windows tablet I had bought, that was the last straw. I was ready to tie a rope to all those new Windows computers and drop them into the lake three times, cutting the rope after number two! To keep my favorite Windows machines running and to avoid all the Ransomware, and Malware that was out there, I pulled the network cables out of them and only plugged them in when I absolutely had to. I started only doing email on my cell, which was not the best thing in the world but was safe and reliable, and with me everywhere I went.

I was sitting in the office one afternoon and started looking at that ever-growing pile of once awesome computers now collecting dust, and told myself this had to stop. I loved those machines and this was killing me. I reached over and got one of them, connected it up to my KVM switch and a network cable, and proceeded to pull out a USB drive to get the latest version of Linux out there to load onto it. I was determined, though, to keep the Windows side running for all that expensive software that was on it.

Backing Up a Tad

I had done my homework as to where to start with a Linux that was not only easy enough to use for everyone around here, but also continued to give a Windows style experience for all the die hards. Linux is just like Chocolate, Vanilla, and Strawberry! Everyone likes something different. My criteria for which to use was that it make the

(Continued on Page 28)

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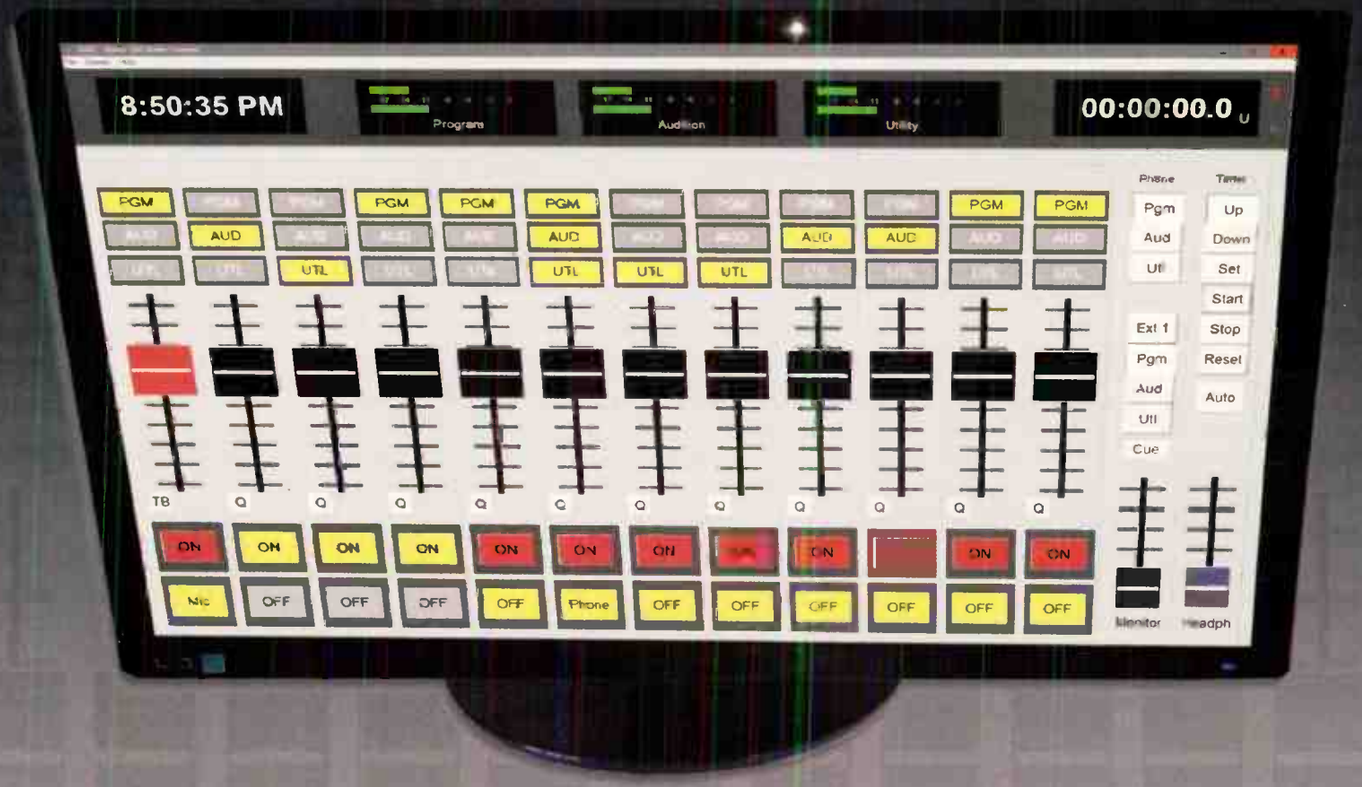

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– Continued from Page 26 –

transition from Windows to Linux almost invisible, and seamless, without having to do a lot of command line operations to install software, etc. I had settled, after playing with it for about a month, on Linux Mint Cinnamon. The Software Manager built into it accomplished a couple of things. It made installing software safe and easy, and updates were a breeze. It (Linux Mint Cinnamon) also looked very close to Windows.

Bite the Bullet!

I made the informed decision that this would be my new Linux machine. Just to be safe, I cloned the hard drive with my trusty copy of "HDClone Pro™" I had used for year, to assure I would not lose anything if something went awry. I then took out the original drive and filed it away for safekeeping. When I installed the newly cloned drive in the machine, I booted up Windows just to make sure everything was still intact, and it was. Next, I took the USB drive, went to the Linux Mint Cinnamon home page, and downloaded the ISO for the latest distro for the older 32 bit laptop and copied it to the flash drive (the 64 bit is there as well and I got a copy for another computer at the same time on a second drive). I then went into the BIOS and set the USB as the first boot device, and shut down the machine. I then restarted in Linux Mint Cinnamon from the flash drive.

Once there, I clicked on the desktop icon that says "Install Linux Mint" and got started.

When the install was up and running, I chose the option to "Install Alongside Windows" and let her rip! In a few minutes it said the install was finished (after making a few choices as to drive size, location, etc.) and it prompted me to remove the USB drive and restart. Upon restart, the Grub boot manager screen popped up, giving me the option to run Linux Mint Cinnamon or my old Windows XP. I chose Linux and everything came up beautifully.

It's Alive!

When I powered up, Linux came up and ran just fine and showed me a desktop that looked just like a Windows machine of some type. The install had found all my hardware, networks (including WiFi), and even my wireless mouse, and printers! Everything came up running fine with the exception of a couple of things I had to get a driver for – but that was easy. It also came with LibreOffice, which had virtually every tool in the typical Microsoft Office™ suite and did not require me to go out to the cloud to load and run it. And it also did not require me to buy it! It was totally free just like the OS.

I created a few documents of the various types that I normally use, and there were virtually no differences from Office™. Now, not to make it sound like this was my first experience with Linux, because it wasn't. It was just my easiest and best to date. *BTW: LibreOffice will also run on Windows and, again, is free!*

Icing on the Cake!

Later, I installed WINE so that I could run some of my basic Windows programs on Linux without restarting – they ran fine, and just as fast as ever. (Not every windows application will run this way, but a great many will). For those that won't, just restart into Windows.

Now, the machine was as fast as my newer fully loaded Windows 10 laptop, which was originally Win 8.1, but was forcefully upgraded to 10, and slowed down by about 30%. After that update, it required me to wait on it frequently while it tried to update. By the way, the updates failed about as often as they succeeded and had to be redone! I have been running this machine now for about a year in its current configuration and it has been several months since I have used the Windows OS on it at all. The programs I used most often easily ran under Linux, so there has been no need to restart in Windows very often.

The bottom line is that I *love* Linux Mint Cinnamon and have now migrated all 8 machines here in the office over to it, and have had *zero* problems! Updates are a breeze and only take just a few minutes. When all the talk came out about Spectre and Meltdown, Linux put out a patched kernel and the update went smoothly through the normal update feature of the OS. I would strongly suggest if you have a Windows machine you like, and don't want to surrender to the mandatory M'soft intrusions, you might want to seriously consider biting the bullet and installing Linux Mint Cinnamon alongside your Windows install and keep it just for those things you can't do otherwise. (Clone your drive first, to keep it in case you have a problem, which is highly unlikely!)

Continued Next Time!

Tommy Gray is a retired veteran broadcast engineer currently staying busy doing engineering in the gulf south, through "Broadcast Engineering & Technology LLC", a Louisiana based Consulting and Contract Engineering Firm, serving the US. www.BEandT.com

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Facility Focus

Dealing With Lightning – Part 2

by Sam Wallington

Unless we want to move our radio stations to the north or south pole, the areas on the planet with the least lightning, we have to learn to live with it as peacefully as possible. While we can't completely eliminate the possibility of lightning causing damage to our equipment, we can certainly improve the odds. Last time *(see page 30 of the January-February 2018 issue of Radio Guide)* we talked about how to protect our equipment when lightning gets into the radio station's systems. In this issue, we'll talk about minimizing the chance of it getting into the system. Like last time, I will use a story to lead the way.

Howie N. Dent lived beneath a bowling ball factory. Many days, he would hear bowling balls rumbling around upstairs, and every so often, one would come crashing through the ceiling and into his apartment. He'd been lucky: He had only been hit personally once (a glancing blow off his right shoulder), but his television and computer hadn't fared so well – he had needed to repair or replace both at least twice.

One day, Howie decided he'd had enough. Using a ladder and flashlight, he explored every corner of his ceiling, but failed to understand how the bowling balls were able to get through. A couple hours later, he gave up finding any openings. There simply weren't any obvious holes large enough to allow one of the TV-crushing spheres through, and yet somehow they still came. He decided to try a different tactic. He went to the hardware store, then built a sort of lean-to shelter over his TV. Then he waited.

Sure enough, a couple days later, he heard the rumblings of bowling balls overhead, and after half-an-hour or so, one came crashing through the ceiling, right over his TV. Boom! It landed on the lean-to, and crashed onto the floor, narrowly missing Howie's foot. His invention had worked! Though the bowling ball still crashed into his place, he had successfully diverted it, preserving his TV.

Excited now, Howie let his creativity take over. More trips to the hardware store, and a few days of hammering and wrenching, and he had built a fairly complex array of large funnels and pipes. The funnels were positioned over his delicate equipment (and over his bed!) to help ensure the bowling balls would be captured before falling. Attached to the bottom of each funnel was a large pipe, which then turned and went through the outside wall to the garden. He sat back and waited for the next onslaught.

Rumbling, rumbling, CRASH! A bowling ball came through the ceiling above his computer. It was immediately captured by the funnel. He could hear it rolling round and round, circling the drain, until it dropped into the pipe. BANG! The bowling ball broke through the duct and crashed onto the floor, landing on Howie's big toe. "Owie!" yelled Howie.

Once the pain subsided, Howie thought for a bit. He had put a 90-degree turn in the duct after it connected to the funnel in order to route it toward the garden. Apparently the bowling ball had too much energy even then, and simply broke through the pipe. After another visit to the hardware store, he replaced all the 90-degree bends with slow, sweeping turns (fortunately, he had very tall ceilings, so he could still easily walk around his apartment). A little paint even made his creation artistic!

Next time the bowling balls rumbled from above, he waited a safe distance from the ducting to watch what happened. CRASH! A bowling ball banged into the funnel, then blasted into the duct. Success! The ball noisily rattled through the duct and was safely deposited in the garden. No broken equipment ... and no owie!

Our world is different than Howie's, but in a sense, we all live under a bowling ball factory – we just call it "lightning." Regardless, we can learn from his story. We can't always predict when and where lightning will strike, but we can take steps to help keep it from taking out our electronics – or us! Essentially, as Howie learned, we need to catch the lightning before it causes damage, and put it somewhere safe.

Lightning obeys certain rules, just like bowling balls obey the laws of gravity and inertia and so on. Lightning "wants" to connect to ground as quickly and efficiently as possible. Our job is to help it do that, while avoiding our equipment, using the tools at our disposal.

A lightning rod is like Howie's funnels, capturing the energy of the lightning bolt and, using electrical cable (like Howie's ducts), routing that energy into the ground. Just like Howie couldn't use a tiny tube, because the bowling ball would overwhelm it, we must use large-gauge cable to ensure we can handle the large amount of current present in lightning.

(Continued on Page 32)

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– Continued from Page 30 –

Howie's ducts ended somewhere near the ground, but because lightning is seeking the easiest path to ground, we must create a very good electrical connection with the ground. How we do that varies with the type of soil we have available. If the soil is very conductive (and good for connecting electrically to metal), we can connect to a ground ring made up of a few eight- or ten-foot metallic rods driven into the ground and bonded together with large-gauge cable. If, instead, the ground is not conducive to a good connection, we may have to use more expensive electrolytic/chemical-based ground systems that artificially improve the connection to ground.

We also have to take care how we route the cable. Like Howie's bowling balls, lightning does not like to turn sharp corners on the way to ground. Sharply bending the cable will cause the lightning to leave the confines of the cable and continue its downward path without our guidance. Because that sharp bend isn't the easiest path to ground, the lightning will take another path – perhaps through our transmitter. By carefully keeping the radius of the bends in our grounding conductors as large as possible, we help the lightning "choose" to follow our path instead of another.

Moving beyond Howie's strange life, there are technologies that claim to capture and ground lightning energy before it builds up enough to cause a lightning strike. These systems are like lightning rods – they are grounded and mounted atop a structure – but they vary by having multiple sharp points. Some are like a small plate with sharp cutouts, like a throwing star but with the tips bent upward. Others are like a bottle brush, with hundreds of needle-like points protruding from a central conductor. Either way, the idea is that the sharp points "connect" to the sky, bleeding off the energy between cloud and ground before it builds enough to cause a lightning strike.

Lightning Dissipater Array – www.lbagroup.com

Opinions vary about these cloud-bleeding systems. Some say they don't work, and others swear by them. My own experience is positive. On one occasion, I was working inside a transmitter building for many hours, and a thunderstorm rolled in without my knowledge (yes, I should have checked the forecast!). When I finally finished my work and stepped outside, I could see and hear lightning in every direction, but none of it was within about 1-2 miles of the tower protected by one of these systems. Proof? No. Evidence? Yes. (For the record, I immediately left the site, as even the best of these systems doesn't claim 100% success!)

There are several other lessons we can gain from Howie's story. First, reducing the chance of lightning damage will require effort and money. Sometimes the money only becomes available as the result of a significant lightning strike that takes the station off the air in a very expensive way. Of course, it is always best to be proactive, designing and installing the lightning protection system as part of initial construction. The second lesson is that, despite our best efforts, we will not succeed in keeping every potential lightning event out of our equipment, but each event should be a learning opportunity. Instead of shrugging our shoulders and giving in to the "inevitability" of lightning damage, we should try to determine exactly what happened and take newly-informed steps to try to prevent a future recurrence. How did the lightning travel? Did it use our system for a while, but "break out" before reaching ground? Did it bypass our preparations entirely? Is our ground connection really a good connection? Third (though implied) is that our lightning protection systems will require maintenance and repair. At least annually, we should check the components of the system to catch and resolve corrosion or other damage that would hinder the system's ability to manage a lightning event.

These articles are a brief introduction to the concepts of lightning protection. Beyond Wannabe's and Howie's stories, there are many other pieces to a complete approach to lightning protection, such as surge suppression, integrating conductive building materials (like steel beams or fence posts) into the ground system, and dealing with lightning coming from sources at least partially beyond our control (such as telephone and power lines). Also, determining soil quality, measuring the system's connection to ground, and designing an appropriate system are beyond the scope of this article. Most tower and antenna manufacturers can provide information or consultants to provide the details.

Next issue, we will put what we have talked about here into practice, and I will introduce you to a resource or two, so you can continue learning about protecting your stations from lightning damage.

Sam Wallington is VP of Engineering for Educational Media Foundation, and has 34 years of experience in broadcast engineering. He can be reached at swallington@kloveair1.com

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Power Principles

Battery Power 2018

by Wiely Boswell

Power from rechargeable batteries today is now wide spread. From the smallest Bluetooth speaker to the 60 kW generator, batteries are maintenance items. Lithium are now on the scene, and making the news catching on fire. Let's start with the old reliable flooded cell car battery that has been around for 70+ years. They started in farm houses as a jar with lead plates in an acid solution and you would rebuild them as necessary.

A typical cell voltage is 2.25-2.27 VDC. A six cell car battery produces 13.6 VDC. During charge, as with an engine alternator, the battery is taken to 14.6 Volts or higher, using the maximum current output if necessary. Total alternator output would be accessory load current plus battery charge current. Intelligence in the charge circuit, in the alternator or car computer, will make the initial voltage go higher for a period. It is about balancing the charge state of each cell. To make sure all the cells in series are at full charge, an equalizing voltage is applied for a brief period and will ramp down to float voltage with an intelligent charge circuit. A 24 Volt circuit, as in a large generator or a small UPS, will have two 12 Volt batteries in series; the two batteries should be equal. This is where a voltage test is possible. Typical inter-cell voltage checks can not be made due to the lack of access. The advantage of higher voltage strings is the same power output will require 1/2 the current.

High discharge currents are rough on batteries. So the balance of cells in series is important. **Figure 1** shows a standard generator battery maintainer. The unit is AC line regulated to maintain constant secondary voltage independent of line voltage swings. (It's a good idea for transmitter tube filaments also.) Main switch on Float, is the normal operating position and the unit is manually switched to High on a routine basis for 10-15 minutes.

Figure 1

When switched to High, charge voltage increases and thus current will increase. The current will roll off as cells are equalized and battery voltage increases. The preferred method is to have a timer control the equalize cycle time, with switch back to float. Excessive overcharging will result in continual gassing and the cells will deplete electrolyte. Distilled water is added to cells and no plates should be exposed to air. A lot of batteries now are called maintenance-free and do not allow access to cell electrolyte, yet they still use water. They do use less water because they use a calcium alloy instead of antimony alloy in the construction of the lead plates. Calcium also strengthens the lead plates used in larger industrial batteries.

Cells have a specification of minimum voltage to which a cell should be discharged. Below this value, plates become seriously, chemically eroded and charging will not be able to capture all the plating. It will seriously reduce battery life and result in possible cell failure.

A dangerous situation is a high resistance cell failure. Sometimes a car battery will run headlights fine, voltage looks good, but it will not have enough power to crank engine – yet *sometimes* it may start. Power normally gets delivered into the starter motor, which has the highest resistance of the series circuit. When a cell resistance becomes greater than the starter motor, most of the current goes into the cell. This amounts to all the other cells' power going into the failed cell. The cell will boil so violently the vent cap may not release fast enough, and the cell top can blow off of the cell. *Been there, done that!* My car starter solenoid was easily accessed on the fender well for test starting and was mounted right by the battery. It was easy to test-start by shorting the coil to +12V and resulted in a section of battery blowing off!

The electrolyte can be a gel instead of a liquid. There is a family of sealed-gel batteries, that can be mounted in any position except upside down. **Figure 2** shows the charging voltage range/charge current based on application on the side of a typical UPS gel cell. You can see how different standby use is from cyclic use, and how wide the

(Continued on Page 36)

Power Principles

– Continued from Page 34 –

recommended range varies A battery that remains in standby most of it life is recommended to be floated at a higher voltage.

Figure 2

Constant Voltage Charge	Voltage Regulation	Initial Current
Standby Use	13.6-13.8V	1.2A
Cyclic Use	14.5-14.9V	2.4A

Replace Battery Every 3-5 Years
Do Not Short Circuit
Avoid Total Discharging(Damage is done to battery below 10.5V)
Do not charge In A Sealed Container
Limited Warranty Applies

The current demand is really rough on UPS batteries. A two battery, 24 VDC UPS battery string, supporting a 200 Watt load, will use 8 Amps and 400 Watts will pull 16 amps. That is why they will not run for a long time. Internally, the battery will become hot. To a UPS battery, a short power hit is like starting a car and a long power outage is like starting your car until it will not turn over. The resulting heat is not good for batteries. Then when the AC power comes back on, the UPS charges its battery as hard as it can, which continues to heat it up. It is worth noting here that Li-ion packs have their temperature actively monitored and a hot battery will not allow charging.

The expected life of UPS batteries will vary greatly on the number of backup events, battery loading, length of loss events, and average environmental temperature. Experience shows you should change a battery set every three years and monitor for battery leakage and/or poor connections. Consider that the connections may carry a large current and the string is fused at approximately 60 Amps, but depends on string voltage and unit wattage. The battery spade terminals need to be correct size with a tight fit. A terminal connection which overheats can result in terminal seal corrosion/leakage. If the UPS warns you with an alarm, it can just drop at any time. Various units perform periodic self tests in different ways and each model handles battery problems differently. How they come back up to normal operation, after a prolonged AC power outage, is also a function to consider. It needs to come back up on its own when AC power is restored. It is always a great ironical event when a device meant to prevent power outages causes one.

A gel cell is considered a valve-regulated, lead acid (VRLA) type battery. An absorbent gas mat (AGM) type battery is similar. The idea here is that the gases produced during charging recombine into the plates or the "mat" and no venting occurs. However they are never to be in a sealed container or closed environment, because of explosive gas concentrations. Heavy over charging can still force venting (valve). When this happens the electrolyte is depleted and will never be replaced. The battery dries out, the electrolyte gets below the plates, and cell self-discharge increases and can eventually short.

Consider the scenario of a UPS going all the way dead, AC power comes back, and starts a current-limited voltage regulated charge. The unit charges the batteries as hard as it can and then backs off when a certain voltage plan is reached. Let's assume one cell shorts and will not charge up. The string will never reach voltage and the remaining cells will be overcharged, get hot, swell up and/or bust open – making it really hard to even get the batteries out. So proactively, every three years or less, change them out.

The same physical size gel cell can have different amp-hour (Ah) ratings. Simply put, a 1.0 Ah rating is the ability to maintain a minimum specified voltage while providing 1 Amp for 1 hour. It is not this simple, and discharge rate is a big factor. It might produce 1/4 Amp for four hours but not 1 Amp for 1 hour. The specs on the battery will reveal Ah vs. discharge rate. You can find higher Ah gel cells (9 Ah vs. 7 Ah) to go in a UPS, but it can be how they calculate Ah, or perhaps they cram more plate area into the same size battery. Either way, it may not be a better battery choice.

In lithium technology, cell balance is everything. **Figure 3** shows a Riobi 18 Volt tool battery with integrated charge electronics. The battery is expertly charged by monitoring every cell in the string. The circuitry monitors voltages and charge current that follows the Li-ion charge procedure. It will also shut the battery down when a minimum discharge voltage is reached. If the battery becomes too hot from being discharged hard (such as powering a grinder) the charger will indicate hi temp and not begin charge. More to follow on Lithium batteries. Any questions or comments? Let me know.

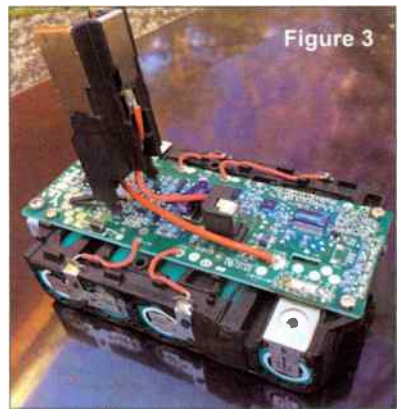


Figure 3

Wiely Boswell is Chief Engineer of Faith Broadcasting, Montgomery, AL; CBRE,CBNE, and SBE 118 Chairman. He may be contacted at: Wiely@faithradio.org

In the Field

It's All About Transmitters

by Steve Callahan

Yes, at a radio station, it's all about transmitters. It's the one thing that makes a radio station different from just any old business. We all have our favorite brand or model of transmitter, but when was the last time you truly enjoyed installing a transmitter?

When you manage to convince the station owner or manager to purchase a new transmitter, the real work begins. You've got a string of decisions to make. It's up to you to select the right model, power level and features that will suit the station now, and for maybe the next 20 years into the future.

I got called to a 5 kW AM station one day, with the request that I install a new 5 kW solid state transmitter to replace an older tube model. So I wisely visited the site first, to take a look to see how deep the water was before I dove in. As I approached the tower, I noticed that a crate containing the new transmitter was sitting in the middle of the transmitter building's parking lot and had probably been there for a few weeks. One could only hope that the crate was capable of sealing out the recent rain and snow. I opened the door to the transmitter building and it was so full of older transmitters and junk that I could barely make it to the front of the phasor. I don't know what the owner was thinking when he didn't specify inside delivery and why he didn't just flip a coin to see which of his burned out transmitters would be left in the parking lot in place of his brand new one.

I was in Maine once and was at a small, local AM station, with an FM construction permit, that I was considering buying. I visited the studios and offices in a cute little house with the AM tower out back. The seller and I got in his car and we headed to the FM tower site – or so I thought. We drove out of town and ended up in a field. No tower and no transmitter building, just an old RCA 5 kW FM tube transmitter in the middle of that field. There was no blue plastic tarp over it for protection from the harsh Maine winter, just a blue and black RCA transmitter that had been in the field way too long. I passed on buying that station but looking back, it would have been a challenge in more than one way.

I was working on a 50,000 kW AM RCA Ampliphase transmitter years ago. My job that night was to upgrade the power supply by installing diode rectifier stacks instead of the rectifier tubs full of suspicious PCB-type oil. Simply, an Ampliphase is two transmitters combined in phase and that's certainly a challenge when you're using tubes in all of the lower amplifier stages. The final tube was so large and heavy that you needed a winch on a wheeled platform (like a little tow truck), to hook under the two handles on the side of the tube and then use the winch to lift the tube out of the socket which was held in the socket by gravity

RCA Ampliphase Transmitter
www.deemajo.net/museum

This particular transmitter also had the habit of repeatedly blowing up the plate contactor relay which was pretty big and was hung in an inconvenient place on a wall. Replacing the rectifiers was really sort of fun and I got to work standing up inside the transmitter cabinet. which was a first for me.

One transmitter manufacturer which is no longer with us is Sparta/Bauer. I had the opportunity of working at a 1 kW AM daytime station with the famous Bauer 707 tube transmitter as it's one and only transmitter. Yes, this is the transmitter that Sparta/Bauer had a Kelly

(Continued on Page 40)

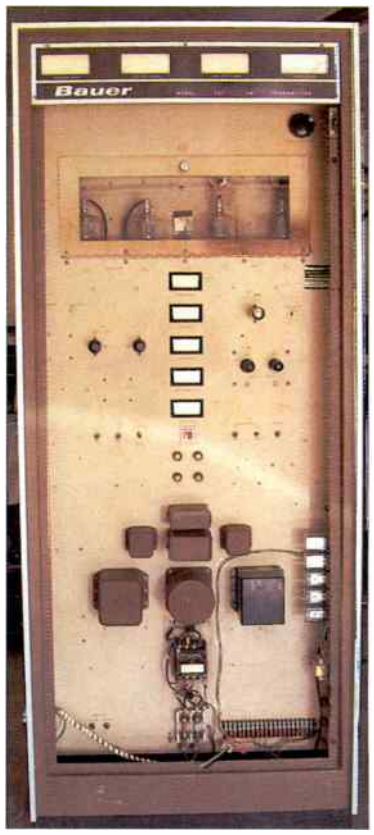
In the Field

– Continued from Page 38 –

Girl assemble part-by-part on the show floor at an NAB convention to demonstrate how simple it would be for us engineers to maintain. A friend of mine was performing an annual audio proof on the transmitter, because you had to do those back in the 70's, and it took two people to accomplish. The audio response of this particular Bauer 707 was way, way off of the FCC response curves. We tried a new set of tubes and then we checked and rechecked each and every stage of that transmitter and wished that we had a Kelly Girl handy to tell us what the problem was. While reading the transmitter's manual for the millionth time that night, I found a picture on the last page of manual showing the transmitter's internal components from the rear of the transmitter through the open door. My friend and I stared in disbelief that the modulation transformer in the picture looked nothing like the modulation transformer at our feet.

He then remembered that another AM daytimer an hour up the road also had a Bauer 707 transmitter and that he was willing to drive up and take a look and then "borrow" the modulation transformer if it looked like the one in the picture. He came back with the now correct-looking modulation transformer which we temporarily installed and used to finish the audio proof. We then reinstalled the mystery transformer and he returned the loaner transformer just in time for the other station's sign-on. I'm sure that the FCC's statute of limitations has long expired on our actions that night.

When I worked in the sunny state of Florida, I inherited a brand new, never-turned-on, 60 kilowatt, single tube, Continental FM transmitter. Surprisingly, this is the only one of its kind that I have ever seen. It replaced two combined, 25 kilowatt McMartin tube transmitters with the wood grain contact paper on the front. The Continental was a monster – it was big and foreboding. It had an internal serpentine output filter that was loaded with arc detectors that would shut the transmitter down immediately in the event of an arc in the filter. Fortunately, I didn't hang around that employment long enough to see if that protection circuit worked or not.



Bauer 707 Transmitter
www.arizona-am.net/PHOENIX/W8QBG/Bauer/index.html

Just recently, I had the most enjoyable transmitter installation experience that I've had in a long time. I was tasked with replacing a very worn out 1980's vintage FM tube transmitter so I selected an Elenos 2 kW FM transmitter. I'd seen that they have tens of thousands of transmitters all around the world, in some very tough environments, so I had great hopes for this transmitter.

Elenos Indium 2 kW Transmitter

Installation couldn't have been simpler. It actually took longer to open the shipping box than it did to get the transmitter connected and on-the-air. It was a snap to connect the output coax, the ground strap, the 220 Volt power and the composite from the STL receiver. A quick adjustment of the operating frequency and output power via the front panel, and it came right up to the target power level. A minor tweak of the composite input level and we were on the air and sounding good. After correcting a couple of documentation errors in the manual, the remote control was plugged in and the job was done. The old refrigerator-sized transmitter had officially been replaced by a 2 kW transmitter that I had carried to the tower site under my arm.

Show your own transmitter some respect by visiting it on regular basis. It'll pay you back with years of faithful service.

Steve Callahan, CBRE, AMD, is the owner of WVBF, Middleboro, Mass. Email at: wvbf1530@yahoo.com

The Easter Bunny Visits Small Market Radio

by Roger Paskvan

In small markets, the community is everything and the public perception of your station is of utmost importance. In today's ever changing world, finding a safe place for you community's Halloween and Easter egg events can become a major challenge.

This situation presented itself to a client of mine in a small eastern North Dakota town. The city council actually came to the radio station and asked them if they would provide an Easter promotion event, open to the general public. The idea sounded good and the station personnel went to work to put together a dynamite promotion involving Peter Rabbit and a great Easter egg hunt.

The biggest problem was finding a suitable place to hold the event that wouldn't cost a lot to rent. The original promotion was held at one of the city parks but later migrated to the local high school lawn. Remember in this part of the U.S.A., April can be full of surprises including that late season snow storm, the day before the great event.

On the morning of the Easter egg promotion, the staff hides about 500 plastic eggs that have been filled with candy. Although anyone can attend, only children under ten can look for the eggs and fill their bags. Parents, of course, show up with their kids which is good PR for any station. The presence of a local Peter Rabbit mascot completes the mood for the day.

The big event opens at 10 a.m. with the station jocks promoting the hunt on the PA system. Kids are organized into several groups, then let go for egg hunting, giving some organization to the event. Everyone has a great time and it's fun for the whole family.

At the end of the Easter egg hunt, prizes are awarded to the kids with the most eggs, that include a few children's bicycles. For the very young, the parents go around with their child to assist. Eventually, tickets were just put in a bin and drawn for prizes by the station staff.

The Easter egg hunt has been in play for over 15 years and the small market community looks forward to this event every April. At the close of the Easter egg hunt, the station sets up its traditional lunch to thank everyone. Free hot dogs or hamburgers cooked by the station staff tops off the festivities. The food is donated or traded by area grocery stores and a drink is provided by the area bottlers. The meal is topped off with free cookies from a local bakery. This promotion draws about five hundred people, which includes kids, Moms and Dads every year.

From a station standpoint, the event is wrapped around an Easter promotion sales package for area merchants to advertise and participate. Signage and promotion materials are displayed on the day of the event for participating sponsors. It a good time and a fun day for not only the families but the local merchants that serve the community.

Over the years, the eggs have been stuffed with candy as most requested by the kids, and the hiding of the eggs has been reduced to just laying them on the ground. The contest becomes how many eggs the average five year old can pick up and put in their bag. Snow just adds to the fun since the eggs are buried in the white stuff and the kids love digging for them.

An Easter egg hunt – what a good idea for your small market station image and positive PR for the community you serve. Easter is just around the corner, why not give it a try and put some extra cash into your spring sales this year.

Roger Paskvan is a Professor of Mass Communications at Bemidji State University, Bemidji, MN. You may contact him at: rpaskvan@bemidjistate.edu

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	5.0 kW	1998	Nautel FM5, *Solid State*
	10.0 kW	1988	BE FM10A - Dual 5 kW
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	20.0 kW	1990	Continental 816R2, *SS IPA, New Final*
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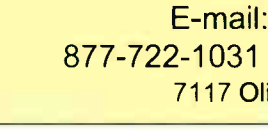

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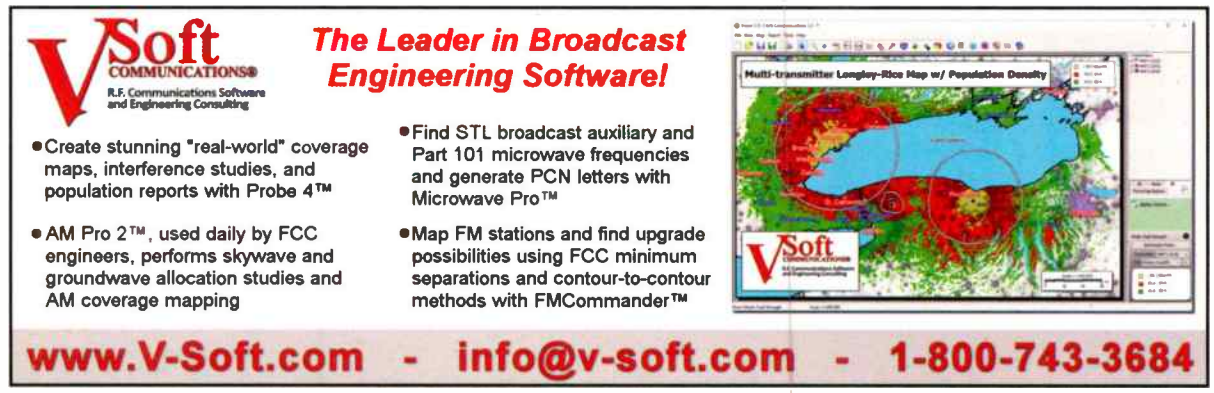

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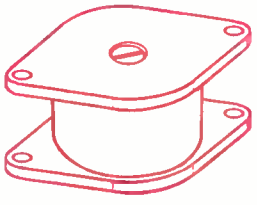

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Service Guide Radio Equipment Products and Services

Gear Guide

Graham Studios

by Ron Erickson

Radio station furniture is different from anything else you could use to set equipment on. Nothing else works as well and I should know – because over the years I've built a number of studios in various radio stations and some owners try everything to cut corners. I've tried modified computer desks, fixing up garage sale furniture and in one instance, an owner wanted to use plywood with two by fours for legs. (I walked away from that "opportunity.") I've worked for more than one station that traded advertising for custom furniture from a local cabinet shop. Craftsmen that could make your kitchen or bathroom cabinets look like a million dollars told me they understood what I was asking for; only to discover after delivery that we were not on the same page.

There was one memorable "custom furniture" trade out. The studio was to be a showplace and I had a deadline to get it operational. After taking delivery from the local cabinet maker, I discovered that the equipment pods were just a little too tight for the 19" gear to mount into. This meant we needed to have the furniture re-made and wait for another two to four weeks – or "trim" the metal rack ears on everything in order to get the studio built in the time allowed. The owner said trim the ears ... so that's what I did. I can absolutely tell you, no alternative works as well as *real* broadcast furniture.

Many of you know me from my company, Erickson Broadcast Sales, aka: "EBS," a combined engineering, equipment sales and integrating company. We created and trademarked pre-wired *"Radio Station Kits,"* a number of which have shipped to places like Nigeria, The Seychelle Islands, Nunavit Canada and many other locations around the world. To build a pre-wired studio/station kit, we needed to start with furniture designed for broadcast. Plus we needed broadcast furniture that shipped flat and assembled easily. You see, we use the underside of the desktop as the surface where our wire harness is attached, allowing for mostly hidden custom length wires with the right connectors that are routed to each audio source.

Other cables go from the distribution amps for production inputs and program line outputs. The equipment complement that we installed varied with station format and whatever else the customer requested. In order to insure that our kits could assemble in about four hours with simple hand tools, I turned to Rod Graham, the founder of Graham-Studios Furniture. He showed me how easy it was to build his furniture. Rod also helped us develop templates for pre-drilled holes, to help make our pre-wired kits even easier to assemble. EBS credits the success of our station and studio kits to Graham-Studios furniture. For the budget minded small station or production room, the Graham-Studios *"Radio Desk"* could be just what you need. The basic *"Radio Desk"* has room for rack mounted gear below the desktop. This deck features a sweeping end curve for a second announcer or on air guest and a smaller curved cutout is where the DJ/Announcer sits to operate the control console. For more equipment mounting space, a desktop pod can be added as shown.

Basic Radio Desk

Radio Desk With Pod

Like all of Graham-Studios Furniture designs, the *Radio Desks* are available in right hand (6R-RD) or left hand (5L-RD) versions. They also come in an "L" version with one or two lower equipment racks extending off of the shown EQ Rack Space. (See Graham-Studios website for more options.) All of the studio furniture from Graham-Studios is designed to ship in either crates or boxes and assembles easily. They even have access slots for audio and power wiring (see **Figure 1**).

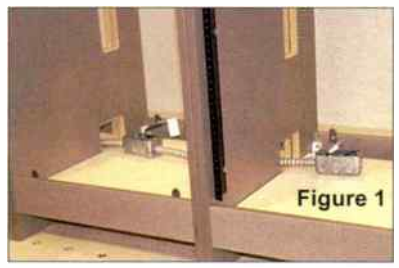

Figure 1

For larger, more impressive facilities, Graham-Studios offers many more designs and configurations. For example, The *"Radius Curve"* desk expands into several different design configurations. It comes with a second side table top with plenty of room for two guests along with the console operator/talent. Order it as a full "U" design with a tabletop pod and you have enough room for guests as well as double racks under the desktop and a rack pod on top. The rack pod is shown on a riser which can also be trimmed at an angle to create an optional back-leaning pod at no additional charge. All furniture from Graham-Studios can be scaled to the size of the room also at no additional cost.

Radius Curve

The top-of-the-line furniture from Graham-Studios is the Modulux. It can be ordered with deluxe hardwood trim, a punch block cabinet, matching bases and toe kicks – and like all their furniture, may be ordered in your choice of colors.

Radius Curve U

Modulux 2

Graham-Studios is now owned by father & son, George and Jason Neil, who purchased the company from Rod Graham. They are continuing to build, in my opinion, some of the best and most affordable broadcast furniture in the industry. You should visit their web site for more photos and information: www.graham-studios.com

Ron Erickson may be reached at ronerickson@gmx.com or by calling 541-460-0249.

Final Stage

RADIO ROUNDUP

The Radio Guide Event Register

Email your dates and info to: ***radio@rconnect.com***

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www.nabshow.com

Texas Association of Broadcsters (TAB)
August 1-2, 2018
Marriot Downtown, Austin, Texas
www.tab.org/convention-and-trade-show

2018 Nebraska Broadcasters Assn. Convention
August 15-16, 2018
Embassy Suites, LaVista, NE
http://ne-ba.org/news_and_events-convention.asp

NAB Radio Show
September 25-28, 2018
Orlando, Florida
www.radioshowweb.com

WBA Broadcasters Clinic
October 16-18, 2018
Madison Marriot West, Middleton, Wisconsin
www.wi-broadcasters.org/events/broadcasters-clinic

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http://oab.org/engineering/obec/

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