NAB Radio TechCheck

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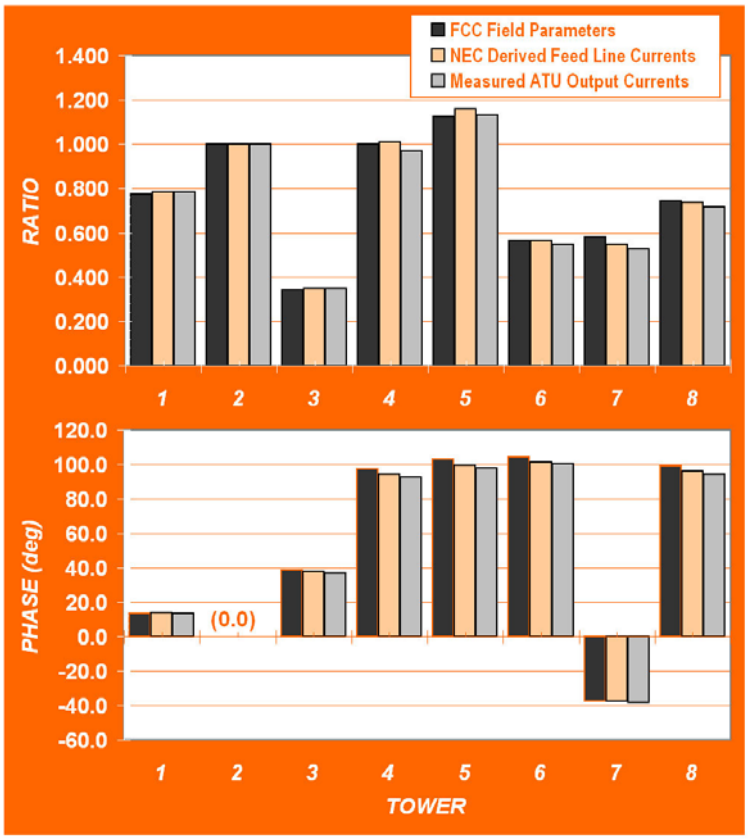
AM Directional Antenna Modeling – a Case Study

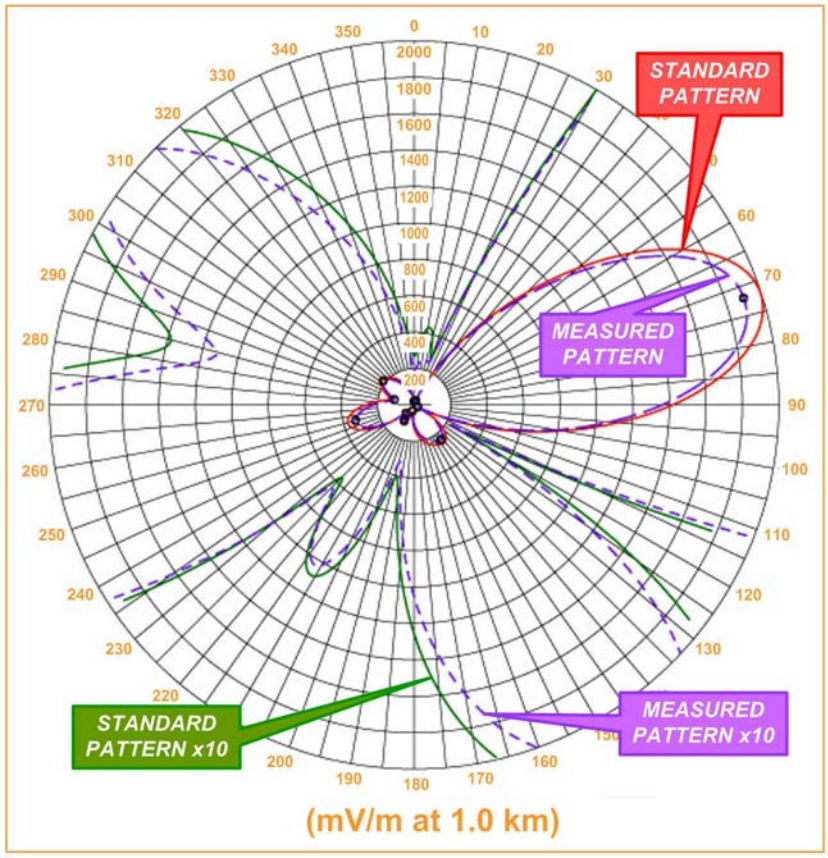
AM broadcasters will soon be allowed to use computer modeling (in conjunction with sampling system verification) for performance verification of AM directional antennas (DAs; see the October 6, 2008 issue of *Radio TechCheck* for additional information on the new rules recently adopted by the FCC). An interesting case study comparing computer modeling to actual measurements was included in a paper given at the IEEE Broadcast Symposium, held earlier this month in Alexandria, Va. Entitled "Review and Analysis of Medium Wave Directional Antenna Sample Systems," this paper was co-authored by Steven S. Lockwood, P.E., Carl T. Jones, Jr., P.E., and Matthew W. Folkert.

Mr. Lockwood and Mr. Jones co-presented this material to the Symposium attendees. Mr. Lockwood focused on Medium Wave (MW) directional antenna sample systems, while Mr. Jones discussed the modeling of an eight-tower AM directional array (see photo) which utilizes toroidal current transformers (TCTs) for sampling. This array is located adjacent to the Florida Everglades, far away from any significant re-radiating structures that could potentially distort the directional pattern, and as such represents a nearly-ideal opportunity to do a comparison of computer modeling and measured performance values. These towers are of equal height, uniform cross-section, base insulated, and supported by non-conducting, Phillystran guy cables. According to Mr. Jones, since the tower (electrical) heights at the station's operating frequency are 73.4 degrees, they are well within the tower height range where TCT-based sampling works extremely well.



For this study, an antenna system model was developed using NEC-4 computer code that had been specially modified to incorporate an algorithm that derives base drive voltages from radiated field parameters. Once all construction was completed at the site, impedance measurements were performed at the base of each tower with all other towers shorted at their base. Iterative changes to the modeled towers were made until the resulting model-derived base impedance of each tower matched the measured base impedance for the case where all other towers were shorted at their base. The directional model was then re-run with the modified towers to establish the relative magnitude and phase of the base currents required to produce the directional pattern.

The charts above contains a comparison of the relative magnitude (ratio, normalized to tower 2 values, shown in upper chart) and phase (lower chart, also normalized to tower 2) of the radiated fields (FCC field parameters), the NEC derived feed line currents, and the corresponding TCT measured currents at the output of the antenna tuning unit (ATU) network. Comparison of the measured relative ATU output currents with the corresponding feed line currents demonstrates the impact of stray capacitance associated with diplexing filters used in this installation. Comparison of the NEC derived feed line parameters with the FCC field parameters indicates that the TCT-based sampling system provides a good approximation of the field parameters for the tower height of 73.4 degrees.



Next, field strength measurements were performed in accordance with FCC Rules. Non-directional and directional measurements were made along twelve radial bearings including the bearings of the six pattern minima. A helicopter outfitted with a specially mounted and calibrated receive antenna and GPS receiver was used for these measurements. The results are shown in the polar plot below, which compares the measured pattern with the FCC authorized "standard pattern" (an interesting historical paper on the standard pattern was referenced in the IEEE paper and is available on the Internet at www.dlr.com/pdfs/StandardPattern.pdf).

This plot shows that the measured pattern shape, even in the highly suppressed null directions of the pattern, is in excellent agreement with the authorized pattern shape. Further, the measured radiated fields are within the authorized maximum radiation values (standard pattern fields) for all radial bearings except for the pattern minimum at 224.5 degrees, where the measured radiation exceeds the standard pattern radiation by approximately 16%. Mr. Jones believes that even this small perturbation is the result of re-radiation from sources external to the antenna array rather than the result of an error in the set-up procedure or in the TCT-based current samples.

Mr. Jones believes this example case shows that TCT-based sampling systems can be used to set up and verify complicated directional antenna systems when moment method modeling techniques are used to establish accurate estimates of the required feed line currents. For additional information or for a copy of this paper, contact Mr. Jones by email at ctjones@ctjc.com or Stephen Lockwood by email at lockwood@hatdaw.com

Both of the topics discussed in this IEEE paper (antenna modeling and sampling systems) will be covered in detail at the upcoming NAB AM Antenna Computer Modeling Seminar, to be held on November 20-21, 2008 in Washington, D.C. (additional information below).

FCC Releases Public Notice on Proposed FM Digital Power Increase

The Federal Communications Commission is seeking public input on a proposal to allow FM in-band/on-channel (IBOC) digital radio broadcasters to increase the power of the digital portion of their signal by up to 10 dB.

As discussed in the Public Notice, in June 2008 a group consisting of 18 broadcasters and the 4 largest manufacturers of broadcast transmission equipment (identifying themselves as "Joint Parties") filed a request

asking the Commission to revise the current technical specifications for FM IBOC digital radio (available on the Internet at http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520027716). Specifically, the Joint Parties request that the Commission increase the maximum permissible digital operating power of FM stations from the current level of 1 percent of a station's authorized analog power (-20 dBc, referenced to the unmodulated analog FM carrier power) to a maximum of 10 percent of a station's authorized analog power (-10 dBc).

Additionally, technical reports have been filed by iBiquity Digital Corporation and NPR Labs on studies which relate to this matter. The FCC is seeking comment on the Joint Parties request, the iBiquity study, and the NPR study. A copy of the Public Notice is available from the FCC's Web site at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-08-2340A1.pdf. Comments are due on November 28, 2008 and replies are due on January 4, 2009. Comments and replies may be filed electronically by accessing the Electronic Comment Filing System (ECFS) at www.fcc.gov/cgb/ecfs/. Filers should follow the instructions provided on the Web site for submitting comments, and should include their full name, U.S. Postal service mailing address, and the applicable docket number: MM Docket No. 99-325. Parties may also submit an electronic comment by email—to get filing instructions, send an e-mail to ecfs@fcc.gov, and include the words "get form" in the body of the message. A sample form and instructions will be sent in response.

The FCC Adopted Computer Modeling for AM Antenna Proof of Performance on September 24, 2008

Attend NAB's AM Antenna Computer Modeling Seminar and Learn How It's Done

Computer modeling for AM Antenna proof of performance was adopted by the FCC on September 24. To learn the basics needed to utilize modeling software, such as MININEC and nodal analysis – used for designing performance-optimized AM directional antenna phasing and coupling systems and proving the performance of directional antenna patterns –- plan on attending NAB's AM Antenna Computer Modeling Seminar in Washington, D.C. November 20 and 21.

You will learn about:

- Moment Method Modeling Basics
- DA Proofing Using Moment Method Modeling
- Overcoming Limitations of Using Field Strength Measurements for DA Proofs
- State of the Art in Phasing System Design Nodal Analysis of AM DA Phasing and Coupling Systems
- Pattern Design Considerations for Optimum Performance

AM antenna experts Ron Rackley and Ben Dawson, along with antenna modeling software specialist Jerry Westberg, will lead the seminar demonstrating how moment method modeling makes analysis of actual tower current distributions possible and how a model can be used to proof an array provided the proper criteria are considered. All instructors are well known in the radio industry as experts in the field of directional antenna design and maintenance. Their decades of experience offer station engineers an opportunity to learn techniques, tips and tricks that can be immediately useful.

Seminar fee: $395.00 (NAB members) and $495.00 (non-members). For more information on the curriculum, how to register or housing go to AM DA Seminar on the NAB Web site or call Sharon Devine at (202)-429-5338. Register now for the NAB AM Antenna Computer Modeling Seminar!

Share Your Expertise with Your Fellow Engineers
Last Call for 63rd NAB Broadcast Engineering Conference Proposals

The NAB Show will host the 63rd NAB Broadcast Engineering Conference (BEC) on April 18 – 23 at the Las Vegas Convention Center in Las Vegas, Nev. This world-class conference addresses the most recent developments in broadcast technology and focuses on the opportunities and challenges that face broadcast engineering professionals around the world. The BEC is a highly technical conference where presenters

deliver technical papers ranging over a variety of topics relevant to the broadcast and allied industries. We invite you to submit a proposal to present a technical paper at our conference. The deadline for submitting your proposal is **October 27, 2008**.

To submit a technical paper proposal, click here and complete the electronic form. If you have questions regarding the NAB Broadcast Engineering Conference, please contact John Marino.

NAB EUROPEAN CONFERENCE 2008
The Changing Landscape of Audio and Video Broadcasting