AM Broadcast Facilities

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Facilities Changes for AM Stations

- 1. Cost-effective changes in the AM transmission plant
- 2. What the “AM Revitalization” rulemaking may bring about
  (And if it’s already happened, what it does mean!)
- 3. What antenna characteristics are necessary for a Moment Method directional antenna proof, and when NOT to use a MoM proof even when it’s legally permissible

AM History in a Nutshell:

- The first broadcasting service
- Basic transmission facility technical standards well-developed by late 1930s
- Basic frequency allocation methods sorted out by the first North American Broadcast Agreement in 19xx
- Directional antennas developed in the 1930s
- Explosion of stations after WW II
- Decrease in value of stations after the market acceptance of FM

But Many AM Stations are Still Valuable!

- Some stations are valuable because:
  - They can serve specialized audiences – religious, “foreign” language
  - They have well defined small or medium markets with little other direct electronic media competition
  - Small market stations with fulltime operation can broadcast local sports
  - They have wide service areas and can profitably employ talk programming
  - They have good coverage of large markets and can profitably employ all-news or all-sports and sports talk programming

What's the Technical Basis for AM? How Does It Work?

- Daytime AM service is by "groundwave" – propagation of electric and magnetic fields along the boundary between the earth and the atmosphere
- Nighttime AM service – and significant interference effects – propagated by "reflection" of those fields by the ionosphere

How are Those “Electric and Magnetic” Fields Created?

- The justly famous physicist James Clerk Maxwell showed the math demonstrating that an electric current creates those fields, and that when an electrically conducting material is immersed in a field, a current will flow in it if the conductor or the field are in motion
- Another physicist, Henry Pocklington, developed the equations which could be used to describe antenna functions
- And an American engineer, Stuart Ballantine, showed that a vertical conductor – such as a tower – over ground was the most efficient and practical antenna for medium frequency broadcasting

Directional Antennas Allowed More AM Stations without Creation of (Much) More Interference

- The first one, in St. Petersburg/Clearwater, FL, was designed to eliminate interference to a Wisconsin station (WTMJ)
- After World War II ended, a great increase in the number of stations took place

Many Markets have Grown Far Larger than The Coverage Area of Some AM Stations in the Market

- American cities are generally not very densely populated – large in area
- Many cities have extensive suburbs
- Some cities have built-up “downtown” areas that make building penetration by AM signals difficult
- Noise levels from “electronic everything” have risen drastically, especially in the past 25 years or so

1. How to Make Cost Effective Changes to AM Station Facilities

- Increase power
- Reconfigure antenna system
- Move transmitter site
- Consolidate with other stations
- Reduce (or cease) operation to allow real estate sale or lease for other uses
- Reduce power cost by transmitter replacement and/or use of MDCL (Modulation Density Carrier Level control)

Are Any of These Changes Possible for Your Station?

Can you increase power?

- If you're not in a major market area where the band is congested, perhaps
- Because AM licenses are no longer in discrete steps (250 watts, 500 watts, 1 kW, etc) a careful allocation study may find that you can increase power by some amount – from 1 kW to perhaps 1.5 kW, or from 5 kW to 6.5 kW
- A determination of possible increased power can be made by an engineer experienced with the rules and with the allocation conditions
- The only limitation besides the prohibited overlap rules is the "roundoff rule" (§73.31) that prevents trivial increases, which don't make sense anyway
- The minimum really useful increase in power is probably about 1 dB – about 25% power increase

Can You Reconfigure the Antenna System?

- Many of the same considerations as a transmitter power increase
- Determine the allocation conditions
- If the antenna is non-directional, and if the tower needs replacement, perhaps a taller tower would be advantageous, and maybe even provide some space for wireless tenants
- If the antenna is directional, perhaps a change in the parameters would bring better coverage

Can You Change Transmitter Site?

- The present site may be just the place for a Walmart!
- A new site can be expensive to develop, but sometimes not
- The regulatory hoops are annoying, but if you're careful and deliberate their requirements can be met
  - Local land use rules
  - Section 106 Environmental rules
  - FAA airspace clearance
- Sometimes simplifying a station – selling the site, moving, downgrading to daytime only or even reducing power – makes economic sense

Can You Consolidate with Another Station?

- Diplexed (and even tri- and quadri-plexed) operation was once unusual but is now much more common
- It requires availability of a suitable “host” – an antenna system whose towers – height, spacing, orientation – can be used for a reasonable pattern for a “tenant” station
- Low frequency stations usually can’t be accommodated on the antenna of a high frequency one – a ¼ wave tower at 1500 kHz is only 1/8 wave tall at 1000 kHz, and only about 1/10 wave tall at 550 kHz

More Diplexing Considerations

- Diplexing two stations closer than 50 kHz is impractical
- 80 kHz spacing is sometimes practical, but the filtering can be expensive and good bandwidth can be difficult to obtain
- Almost every AM station antenna is unique, and every diplexed or multiplexed AM antenna is even more so
- The cost of a complicated duplexing project may be comparable to building a new site from scratch – but the land cost and the land use permitting requirements for a new site may be insurmountable

Is the Site Really, Really Valuable (a New Walmart or Shopping Center)?

- Perhaps just selling the real estate and giving up the AM license is the best course of action
- Or, changing to a different site and much simpler antenna is reasonable
- If the station really doesn’t benefit from nighttime operation (no high school football?) taking down all but one tower and selling the surplus land may be the best solution

Is the Existing Coverage More Than the Actual Core Market for the Station's Programming?

- Reduce power – lower the electric bill
- Employ Modulation Determined Carrier Level ("MDCL") and reduce power costs

2. “AM Revitalization” - What Does It Mean?

- A kind of “grab-bag” of changes
  - The FM translator “land-rush” rules have already happened
  - Community coverage and antenna efficiency rules were modified
  - “Ratchet Rule” deleted and “MDCL” allowed
- The possible changes in basic allocation rules
  - Change night protection to class A stations
  - Change night interference calculation method
  - Change daytime protection to class B, C, and D stations
  - Require license surrender for dual expanded band/regular band stations
  - Eliminate main studio requirement

Possible Allocation Rule Changes

- Class “A” stations now protected to their 0.5 mV/m 50% SKYWAVE contour at night
- The FCC and most commenters would just protect the nighttime groundwave contour of class A stations

Nighttime Allocation Rule Changes

- Night protection now involves the Root Sum Square (“RSS”) calculation of interfering signals from both co- and adjacent channel stations
- The threshold or “cutoff” is that a new interferer can’t enter the 25% RSS calculation
- The proposed rule – supported by most engineers – would return to the previous definitions
- Only co-channel interferers would be calculated, and the cutoff would be the 50% RSS

Change the Protected Daytime Signal Level

- The present day protected signal level is 0.5 mV/m
- This value was set in the 1930s
- Many more sources of noise and interference since then
- FCC and proponents propose to change this to the 1 or even 2 mV/m

- This would allow improvement for existing stations
- It’s also proposed to return the adjacent channel calculation to 0 dB (1:1) rather than the recent changes to 6 dB (1:2)

Other Proposed Change

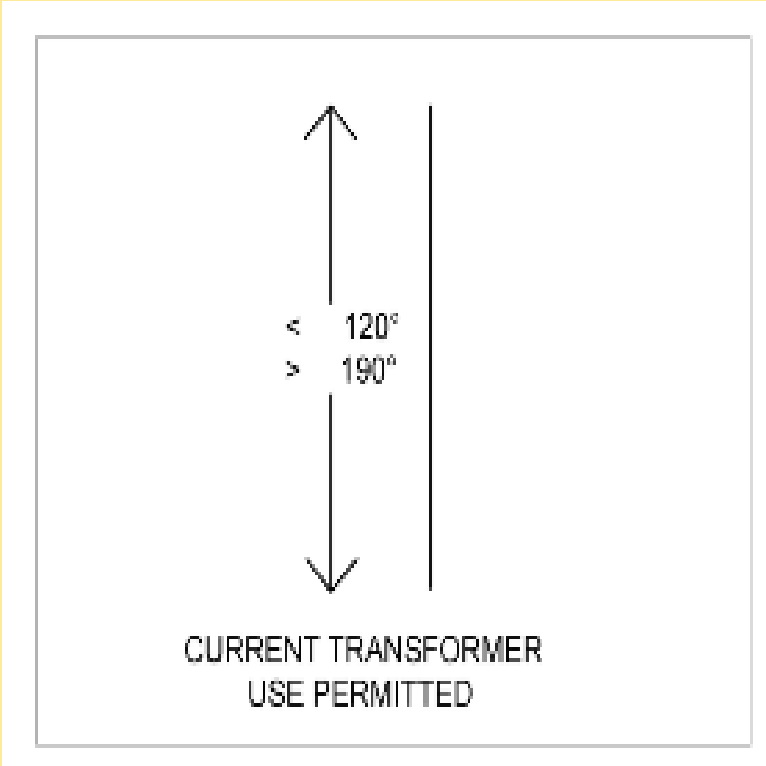
- Require license surrender for dual expanded band/regular band stations
- This was supposed to be a temporary situation, but there are quite a few of these, even though some licensees did turn in one of the authorizations

- FCC has proposed to eliminate the main studio rules, and there appears to be considerable support for this

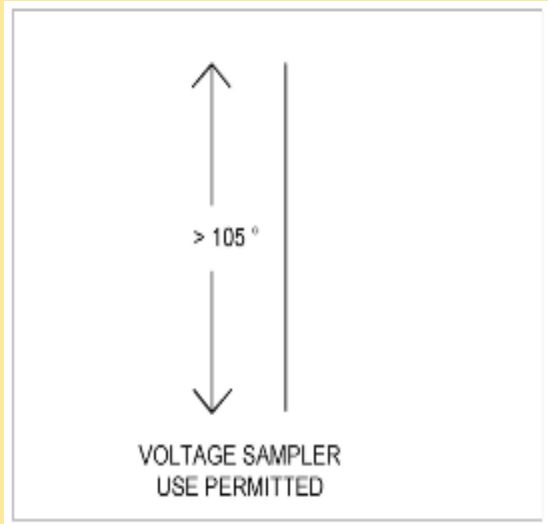
3. When a Moment Method Proof is a BAD Idea

A FEW MOMENT METHOD PROOF BASICS

TOWERS 120° OR SHORTER OR 190° AND TALLER CAN BE BASE MONITORED FOR MOMENT METHOD PROOFS



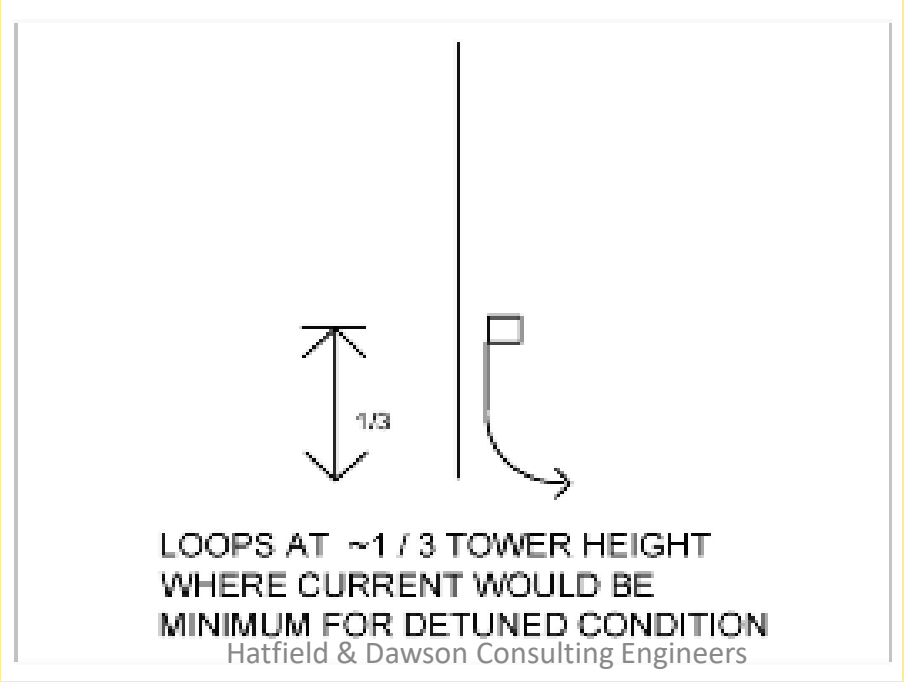
TOWERS 105° AND TALLER CAN USE BASE VOLTAGE SAMPLES



SYSTEMS WITH TOWERS OF ANY HEIGHT CAN BE SAMPLED WITH LOOPS AT ~1/3 TOWER HEIGHT

IF

THEY HAVE IDENTICAL CROSS SECTION, INCLUDING ALL CROSS MEMBER DETAIL



This slide shows picture of the KFNQ 1090 array towers as examples of not *quite* identical towers

Leg and Cross Member Sizes Identical

But Cross Member Geometry Different!

There are many systems which meet these criteria.

A moment method proof might be a good idea – or it might not!

TWO SITUATIONS AND A THIRD CONSIDERATION:

- PATTERNS WITH SIGNIFICANT AUGMENTATIONS
- PATTERNS WHICH HAVE OPERATING PARAMETERS SIGNIFICANTLY OFFSET FROM THEORETICAL
- A MOMENT METHOD PROOF MAY BE A POOR ECONOMIC CHOICE

Situation One:

ARRAYS WITH SIGNIFICANT AUGMENTATIONS SHOULD ALWAYS BE CAREFULLY EVALUATED BEFORE A MOMENT METHOD PROOF IS PERFORMED

THERE ARE SEVERAL POSSIBLE REASONS WHY A PATTERN MAY HAVE AUGMENTATIONS

The pattern may have had its proof of performance performed before the FCC adopted the Standard Pattern rule

The pattern may have had augmentations added because the measured radiation exceeded the Standard Pattern values at some azimuths

The augmentations may have been added to allow null fill or other intentional adjustment to obtain better coverage

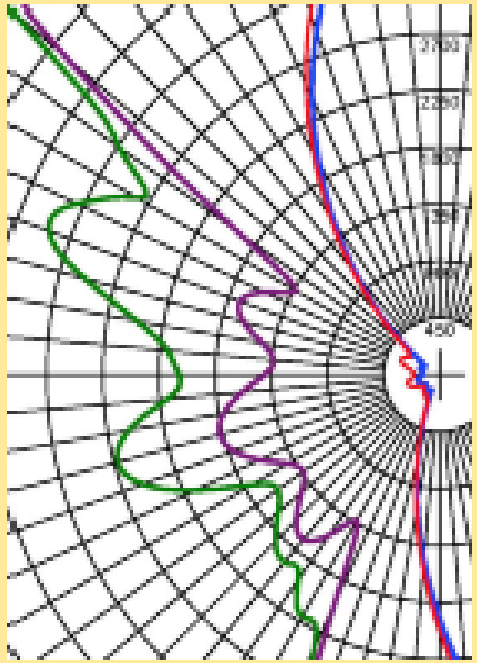
SOME DIRECTIONAL ANTENNAS MAY HAVE ACCEPTABLE OPERATING PARAMETERS THAT ARE SIGNIFICANTLY DIFFERENT THAN THE THEORETICAL PARAMETERS WHICH ARE THE BASIS OF THE STATION LICENSE

- This is not unusual for antenna systems tuned up before modern analytical tools were commonly used
- And some arrays have been intentionally adjusted to “offset” parameters to overcome local reradiation sources

EXAMPLE 1

This station was licensed in the 1940s but increased radiation in some directions much more recently by partial proofs and augmentations – by adjusting the parameters to values offset from the original settings

- Augmentations exceed theoretical pattern by more than 2:1 at some azimuths



Use of a Moment Method Proof would result in radiation in the minor lobes and minima to the theoretical values – even lower than the standard pattern allowable values!

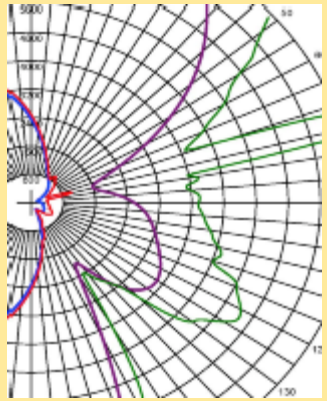
AZIMUTH	THEORETICAL FIELD	STANDARD/AUGMENTED FIELD
215°	92 mV/m	140 mV/m
245°	6 mV/m	258 mV/m
290°	30 mV/m	129 mV/m

Some representative radials in the pattern minima area

EXAMPLE 2

This class A station filed an application for a pattern change, but because of a spurious “window” application on an adjacent channel in the direction of its major lobe, ran afoul of the infamous “ratchet” rule, which the Commission refused to waive.

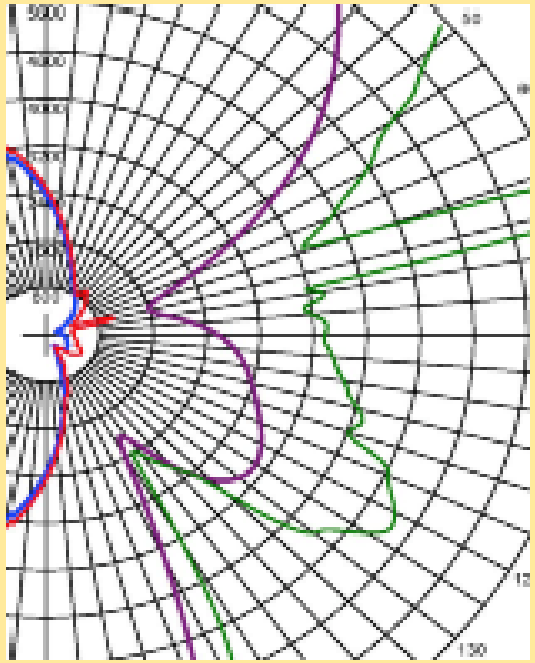
- Pattern with significant augmentations



EXAMPLE 2

- Pattern with significant augmentations

So the application was withdrawn, and new adjustments to the pattern made, and augmentations requested in the 302 license application, which was promptly granted.



A moment method proof was considered, but the idea was quickly abandoned after a study showed the large area and population that would lose nighttime service.

(Even though the MM proof would have been paid for by a state government agency which needed the station's cooperation for a highway project!)

Situation 2

Patterns not adjusted to theoretical parameters

Intentionally “Misadjusted” Patterns

- Historically, some patterns were adjusted to operating values that don’t “fit” the theoretical pattern parameters
- Before the Standard Pattern rule, Maximum Expected Operating Values (“MEOVs”) could sometimes be arbitrary enough that intentional misadjustment could provide desired coverage
- Those MEOVs were converted to augmented standard patterns

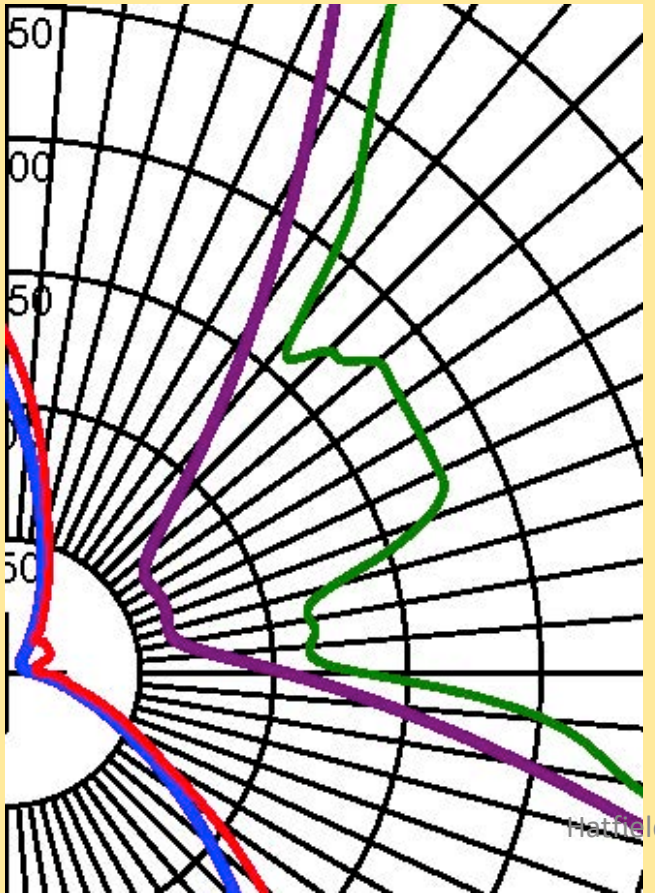
Some Patterns can be Created with More Than One Set of Parameters

- Semi-Cardioid patterns – null fill by field ratio or by phase adjustment
- Three Tower in-line patterns – different multiplication pairs

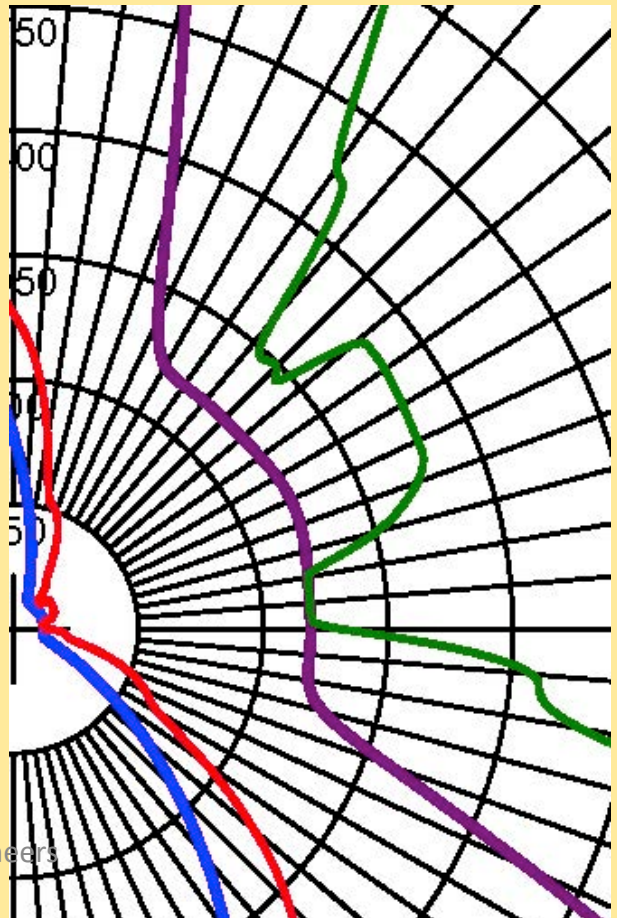
Setting them to the theoretical licensed pattern may require a complete rebuild of the total feed system

Example 3:

Licensed



Operating



But Using the Theoretical Parameters Would have Cost Thousands!

The power distribution, phase budget, and bandwidth situation would have required a complete rebuild of the feed system!

Solution: A conventional proof after needed system repair.

The Final Examples are the Simply Economic Ones:

- A well established, well maintained relatively simple array
- Long term operation shows no significant drift
- Monitor point values are stable

- Leave it alone! Biannual recertification costs – staff time or outside expert time – are modest but real.

Well constructed systems sometimes are capable of low cost operation for years

- Check the parameters regularly
- Check the monitor points every few months (when the weather changes, or when a day outdoors is a nice change from working on the sales department computer problems!)

One final economic example

- If an array has existing sample lines of an obsolete type, in good condition, but unequal length,
- Adding extra length to make them equal may be impossible.

- BECAUSE:

- New line sections of a “replacement” type won’t have the same attenuation even if they make the lines all equal length.
- So a moment method proof would require replacement of the entire sample line system

Moment Method Techniques are Invaluable:

- Virtually all sophisticated analysis of AM antenna systems is performed with Moment Method techniques
- They allow “full system” mathematical modeling of the performance of arrays for pattern and impedance bandwidth
- They allow careful evaluation of possible reradiation for conventional proofs
- They allow proofs based on modeling and sample system verification
- ***BUT:***
- Moment Method proofs aren’t appropriate for some very common situations even if they would otherwise be permitted by the rules!

Thanks!

- Any Questions?

- Look at our website: www.hatdaw.com

  for technical data sheets on a whole variety of AM subjects

  (and other subjects, too)