Before the
Federal Communications Commission
Washington, D.C. 20554

In the matter of	)	
	)	
Revitalization of the AM Radio Service	)	MB Docket No. 13-249

To: The Commission

REPLY COMMENTS BY BRIAN J. HENRY

I. Introduction

I would again like to thank The Commission for initiating this proceeding as it attempts to mitigate some of its concerns regarding the long-term viability of the AM broadcast band. Included is a Reply Comment for your consideration in addition to the Comments that I submitted previously in this proceeding.

II. Annual Equipment Performance Measurements

Several Commenters have proposed eliminating the annual Equipment Performance Measurements and require them only for equipment changes and prior to license renewal application.

I feel that the annual Equipment Performance Measurements serve a valuable purpose and that this proposal would only serve to defeat their intent.

This proposal makes the assumption that AM broadcast transmission equipment remains stable after installation and fails to take into account the dynamic nature of an AM broadcast transmission chain and the environment around it.

I like to think of the annual Equipment Performance Measurements as a sort of annual RF "smog check."

In the vast majority of AM broadcast transmission facilities, the transmission and monitoring equipment is in excess of ten years old. At one point or another, I have done the annual Equipment Performance Measurements for the nearly every AM broadcast station throughout much of the northern California coastal region to the Oregon border. To my knowledge, there hasn't been a new AM transmitter installed at an existing station over this vast land area in at least ten years.

Having made spectrum measurements of many AM radio stations over the years, I can attest to the fact that there have been changes in transmitters' RF output spectrum of both tube and solid-state design due to failures and outside influences that were first identified when the annual Equipment Performance Measurements were performed.

Here are some examples as to why I feel that the annual Equipment Performance Measurements continue to serve an important role:

In one California radio market where there are several AM radio stations operating within reasonably close proximity of each other, when a new station signed on the air, that years annual Equipment Performance Measurements uncovered several (2A-B) intermodulation products that exceeded the FCC's RF emission limit by 10 to 15 dB that did not come from the new operation, but from existing operations that were as far as 5.4 miles (8.7 km) distant from the new facility. These intermodulation products were not generated inside the new station's transmitter but were instead generated in the transmitters of the existing stations and would likely have gone unnoticed had the licensee of those stations not been required to check the transmitted RF output spectrum annually.

Ironically, the transmitters that are most susceptible to IM products are the newer broader bandwidth solid-state models that do not have the RF output matching networks that the tube models required.

Modern solid-state pulse width modulated transmitters use switching frequencies in the 60 to 75 kHz region. With the aging transmitter infrastructure, it is not uncommon to see spurious radiation in the region of the RF spectrum that is removed from the carrier frequency by 60 to 75 kHz that exceeds the FCC emission limit by 10 to 15 dB. I feel that this sort of failure would also go largely unnoticed without the annual Equipment Performance Measurements.

Recently, while making spectrum measurements of a 1 kW Harris SX-1 transmitter, I measured spurious radiation that was greater than –73 dBc at 8 kHz intervals out to 100 kHz from the transmitter carrier frequency that exceeded the Commission's RF emission limit. This was caused by a bad capacitor in the transmitter's 5-volt switching power supply.

As an additional suggestion, for stations that operate with directional antenna systems, The Commission might want to add an annual directional antenna performance verification requirement that documents that a given station's directional antenna system is operating within licensed parameters.

Modern AM broadcast transmitters do not often outright quit, but that doesn't mean that there aren't components that can fail that will compromise the transmitter's RF output spectrum. I feel that there is no substitute for making routine RF spectrum measurements of an AM broadcast transmission facility to identify these kinds of problems. These measurements represent a minimal annual expense and help to assure that AM broadcast stations are compliant with part 73.44 of The Commission's rules.

III. Limiting Negative Modulation to 96%.

Several Commenters have proposed limiting negative amplitude modulation to 96%. While this is a good idea in principle and practice, it will make setting the negative modulation level somewhat more difficult to assess with an oscilloscope and it will also result in a large number of AM modulation meters becoming needlessly less useful. Many recently manufactured AM modulation meters have a –100% peak flasher (not –96%), which should never illuminate. In 73.1570(b)(1), The Commission specifies, "In no case shall the amplitude modulation of the carrier wave exceed 100% on negative peaks of frequent reoccurrence." Since exceeding 100% negative peak modulation is impossible, I feel that The Commission could change this sentence to "In no case shall the amplitude modulation of the carrier wave exceed 99% on negative peaks at any time" to resolve the discrepancy. I would also like to suggest that 73.128 be changed as

necessary, too. I feel that this simple change will achieve the primary objective of the commenters, which is to prevent transmitter carrier cutoff without the unintended result of making nearly every AM modulation monitor ever manufactured obsolete.

IV. Change Bandwidth Mask for AM signal transmission and Eliminate the NRSC AM Response Curve

Several Commenters have proposed eliminating the NRSC AM frequency response curve.

The FCC rules as currently revised *do not* mandate the use of NRSC-1-B AM pre-emphasis for monophonic operation. In fact, it is common for AM broadcasters to use pre-emphasis curves[1] other than those specified in the NRSC-1-B AM Pre-emphasis specification.[2]

The only place where use of the NRSC-1 AM pre-emphasis is mandated is for Stereophonic operation. 73.128(c)(1) of the FCC rules states, "Effective on December 20, 1994, *Stereophonic* transmissions shall conform to the requirements of ANSI/EIA-549-1988 NRSC-1 AM Pre-emphasis/De-emphasis and Broadcast Transmission Bandwidth Specifications (NRSC-1)."

It would be good to resolve this discrepancy.

The NRSC-1-B modified 75 uS pre-emphasis standard[3] was developed in the late 1980s as a compromise to provide a modest amount of high frequency boost to flatten the response of narrow bandwidth receivers and to provide receiver manufacturers with a frequency response standard that would facilitate the introduction of wider bandwidth receivers using a complementary de-emphasis curve.

In his Comment in this proceeding, Burt I. Weiner states, "Many of today's broadcast engineers do not recall the time when AM radio sounded very good and was virtually noise free."

I had often wondered about this. So, as this AM revitalization proceeding was getting underway, I starting making some spectrum measurements and did some listening tests using restored AM broadcast transmission equipment from the late 1960s and early 1970s to try to get a better understanding of what had happened.

Interestingly, what I learned is that when a properly tuned AM transmitter[4] from that era is proceeded by an audio compressor/limiter[5] of the same vintage fed by low distortion, wide bandwidth, symmetrical audio[6] it meets the current FCC emission requirements with frequency

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[1] *See* Figure 5. Various pre-emphasis curves used by AM broadcasters

[2] *See* Orban Optimod-AM 9300 Digital Audio Processor Operating Manual, section 2-22, 6. (B), which states, "In Region-2 countries, we recommend configuring the 9300 for 9.5 kHz NRSC low pass filtering and the 18 dB/octave HF equalizer active." Section 3-21 and 3-22 detail this further.
http://www.orban.com/products/manuals/9300_1.0.5_Operating_Manual_rev_02.pdf

[3] *See* http://www.nrscstandards.org/SG/NRSC-1-B.pdf

[4] I used a restored 1975 Collins 820D-2 1 kW AM broadcast transmitter operating at 0.25 kW that met or exceeded all of the manufacture's original specifications while operating into a 50 ohm dummy load.

[5] I used several different "audio processors" that included a CBS Laboratories 444 Audimax+400 Volumax, 4440A Audimax+4300 Volumax, and a Dorrough Electronics 310 Discriminate Audio Processor that were adjusted as specified by the manufacturer and met or exceeded original specifications. All were operated without any sort of high frequency boost. I obtained essentially the same result with all of them.

[6] I used various musical recordings direct from compact disc as the source material to feed the "audio processors."

response out to 20 kHz without any additional low pass filtering.[7] The current FCC emission rules as specified in 73.44 are not limiting the transmitted bandwidth to 10 kHz.[8] It is worth noting that when a properly functioning AM broadcast transmitter is driven with high fidelity program material with flat audio frequency response using symmetrical modulation, its RF output spectrum is very clean and thus verifies the efficacy of audio proof of performance measurements. In my experience, if the input audio spectrum is clean, the output RF spectrum will also be clean and it will sound decent on virtually any AM receiver that demodulates that audio whether it be wide or narrow band.

Unfiltered audio results in quite a bit more energy occupying the second adjacent channel than is typically measured when the use of a NRSC-2-B[9] 10 kHz low pass filter is employed. Knowing this, I decided to do some listening tests to explore the effect of steep low pass filtering on the transmitted audio. To do this, I used an Orban Optimod 6200 Digital Audio Processor without pre-emphasis to modulate a Collins 820D-2 transmitter since the 6200 has an adjustable steep output low pass filter that ranges from 5 kHz to 20 kHz. I demodulated the transmitted audio with a calibrated TFT 753 FCC Type Approved AM modulation monitor which fed a Crown D-75 audio amplifier. After lengthy listening tests, I concluded that for audio bandwidths between 10 kHz and 20 kHz the loss of audio fidelity was not devastating. However, as the audio bandwidth was reduced below 10 kHz the degradation in audio fidelity became quite apparent and it became far less appealing to listen to the program material as the transmitted bandwidth closed in on 5 kHz. This led me to the conclusion that the protection afforded to the second adjacent channel by using the NRSC-2-B 10 kHz low pass filter is too great to ignore. And, although it can hide a multitude of sins,[10] I feel that the NRSC made a reasonable compromise by recommending its use at the audio input to an AM broadcast transmitter.[11] Taking things one step further by restricting transmitted audio bandwidth to 5 kHz would eliminate first adjacent channel interference, but it would also eliminate high fidelity analog service[12] which I am <u>not</u> in favor of. To me, steep low pass filtered 5 (or 6 kHz) bandwidth limited audio sounds lifeless and dull.

I am more conflicted by the use of transmitted audio pre-emphasis in the AM broadcast band as this puts additional energy into the first adjacent channel. The median audio bandwidth of a typical AM receiver is so poor that the NRSC-1-B modified 75 uS pre-emphasis only minimally improves its audio frequency response[13]. To flatten the frequency response of a median AM broadcast receiver requires approximately 40 dB of gain at 10 kHz (~18 dB/octave!) relative to 50 Hz. NRSC-1 pre-emphasis provides 10 dB of gain at 10 kHz (~ 6 dB/octave) relative to 50 Hz.

David L. Hershberger mentions in his Comment the use of a Pixel Technologies active broadband loop antenna (RF PRO-1B). It is a fabulous antenna for medium wave off air

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[7] Spectrum measurements were made with a Tektronix 2710 spectrum analyzer using 300 Hz resolution bandwidth at the transmitter's modulation monitor RF output sample.
[8] *See* Figures 1 and 3. Collins 820D-2 modulated by a Dorrough Electronics model 310 Discriminate Audio Processor using flat frequency response without 10 kHz low pass filtering.
[9] *See* http://www.nrscstandards.org/SG/NRSC-2-B.pdf
[10] Any audio distortion products that fall above 10 kHz are truncated by the 10 kHz low pass filter.
[11] *See* Figures 2 and 4. Harris Gates One modulated by an Orban 9200 Audio Processor using NRSC-1 pre-emphasis and NRSC-2 10 kHz low pass filter.
[12] *See* Opinion: Let's Keep AM Sounding Good. Radio World, January 19, 2005. http://www.rwonline.com/article/opinion-39let39s-keep-am-sounding-good39/16823
[13] *See* figure 6. Typical AM receiver frequency response flat, with 75 uS pre-emphasis and with 18 dB/octave pre-emphasis.

listening that I use as well. I have mine connected to a Carver TX-11b receiver that has flat audio frequency response from 50 Hz to nearly 15 kHz, a 10 kHz notch filter and switch selectable NRSC de-emphasis. The Carver TX-11b is one of the few receivers that conform to the AMAX (NRSC-3) receiver specification that is complementary to the NRSC-1-B pre-emphasis. What I have noticed when the de-emphasis circuit is activated is that the first adjacent channel "monkey chatter" isn't as objectionable and the 10 kHz first adjacent channel heterodyne is reduced compared to when it is not activated.

It is therefore my feeling that the case for using NRSC-1-B pre-emphasis/de-emphasis is that it is a recognized industry standard that has been codified previously[14] and has been in place for over two decades, it mildly improves a narrow bandwidth receiver's audio frequency response, it reduces the demodulated 10 kHz heterodyne on wide bandwidth receivers by 10 dB and it makes a slight improvement to the wide bandwidth listening experience.

An 18 dB/octave pre-emphasis curve, which was first proposed by Robert Orban and Greg Ogonowski in 1983,[15] more closely complements the frequency response of many narrow bandwidth receivers.[16] But, unless it is shelved off, its use can inflict considerable energy into the 0-5 kHz region of the first adjacent channel due to its large amount of high frequency boost.

The main benefit of transmitting with flat audio frequency response, which was the de facto standard until at least the mid-1960s, is that its use results in the least amount of interference to the first adjacent channel.[17] Using flat audio frequency response can also decrease the amount of high frequency energy that an AM broadcast antenna system has to pass and depending on how narrowband a particular antenna system is the result can also be fewer transmitted high frequency distortion products.

Whether it is flat transmitted audio frequency response, NRSC-1-B modified 75 uS pre-emphasis, or some manifestation of 18 dB/octave pre-emphasis, I feel that The Commission should codify an audio frequency response standard so there can be a complementary receive system. Otherwise, AM broadcasters will continue to adjust their transmitted frequency response as they see fit and receiver manufacturers will continue to design receivers to the lowest common denominator. I am not sure how you mandate the transmission of high quality low distortion audio, but in my mind that is the key to making an AM broadcast station sound good with the least amount of impact to adjacent channels. I would also suggest that just because some receivers are poorly built that alone should not be justification for narrowing the transmitted audio bandwidth more than it already is.

V. Revise the Ground Conductivity Map to Better Reflect Actual Conditions

When I constructed KLLK in Willits, California in the mid-1980s, I learned just how much R-3 could overstate ground conductivity. In much of northern California, R-3 predicts a ground conductivity of 4. When conducting the directional antenna proof of performance for KLLK, we

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[14] *See* FCC 73.44(e) and FCC 73.128(c)(1,2)

[15] *See* A recommended Preemphasis Characteristic and Deemphasis Characteristic for AM and AM Stereo Broadcast. Robert Orban and Greg Ogonowski. 1983. http://www.indexcom.com/pdf/A_Recommended_Preemphasis_and_Deemphasis%20_Characteristic_for_AM_Broadcast_%20.pdf

[16] *See* NRSC-R100: Consumer Testing of AM Broadcast Transmission Bandwidth and Audio Performance Measurements of Broadcast AM Receivers. http://www.nrscstandards.org/Reports/NRSC-R100.pdf

[17] *See* Figure 7.

found the conductivity to be as low as 0.5 along certain bearings. Revising the ground conductivity map to be more accurate could be a huge help to AM stations wanting to improve their facilities.

VI. How to Preserve Local Broadcasting

The Broadcast Maximization Committee and other Commenters have proposed allocating VHF TV channels 3 and 4 or 5 and 6 to AM broadcast licensees. In this regard and with every other point that he made, I found David L. Hershberger's Comment to be particularly intriguing. I feel that his ideas are worth further exploration! In addition to allocating some of the vacant VHF spectrum using digital modulation schemes, David threw out the idea of allocating some of the M/H packets on existing digital TV stations for use by AM broadcasters. If AM broadcasters can eventually transition to a VHF digital band along with the use of some M/H packets, then the current AM broadcast band could potentially be repurposed later to a small number of high power stations with wide area coverage that can provide needed service to small towns and rural areas. I applaud David's Comment as well as those of The Broadcast Maximization Committee as they give current AM broadcasters a hopeful path into the future on a multitude of levels!

VII. Non-Technical Issues

And finally, I would like to express my gratitude to all of the people who have shared their viewpoints in this proceeding as we all care about the future of AM broadcasting and benefit from a diverse discussion. One of my personal favorites was the Comment filed by Frederick R. Vobbe who was able to so eloquently articulate the impact that the Telecommunications Act of 1996 has had on all of us. I do not know how to put "the genie back into the bottle," but as Frederick suggests, The Commission might want to review its ownership rules to see if there is a way the public interest can be better served by fulfilling its long standing policy of promoting diversified media ownership more effectively.

Respectfully Submitted,

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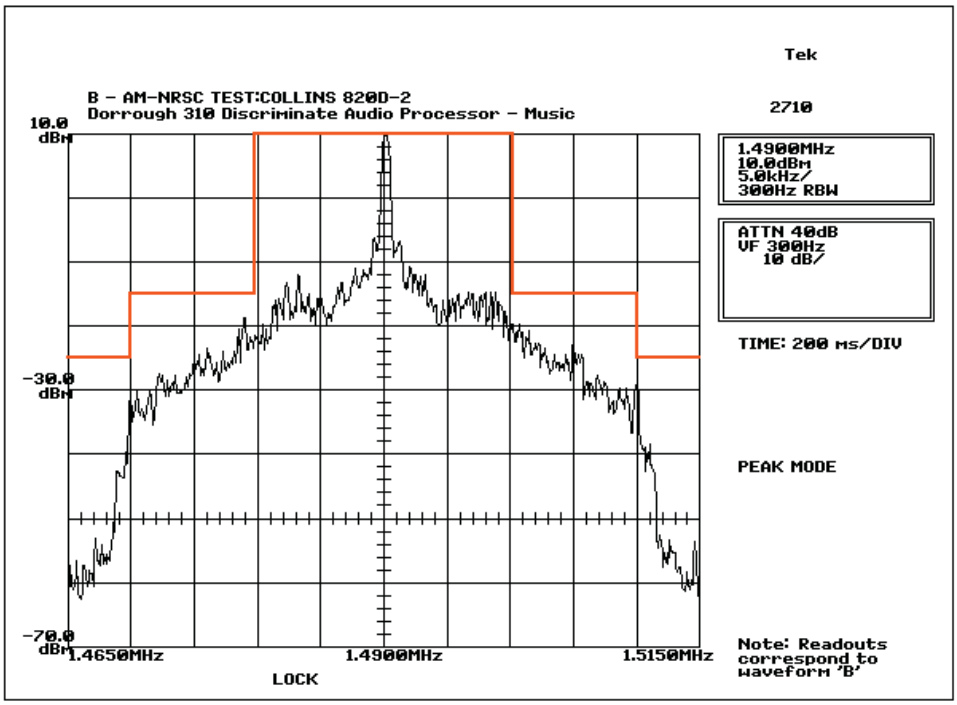

Figure 1 - Collins 820D-2 Modulated by a Dorrough Electronics model 310 Discriminate Audio Processor using flat frequency response without 10 kHz low pass filtering (5 kHz/division)

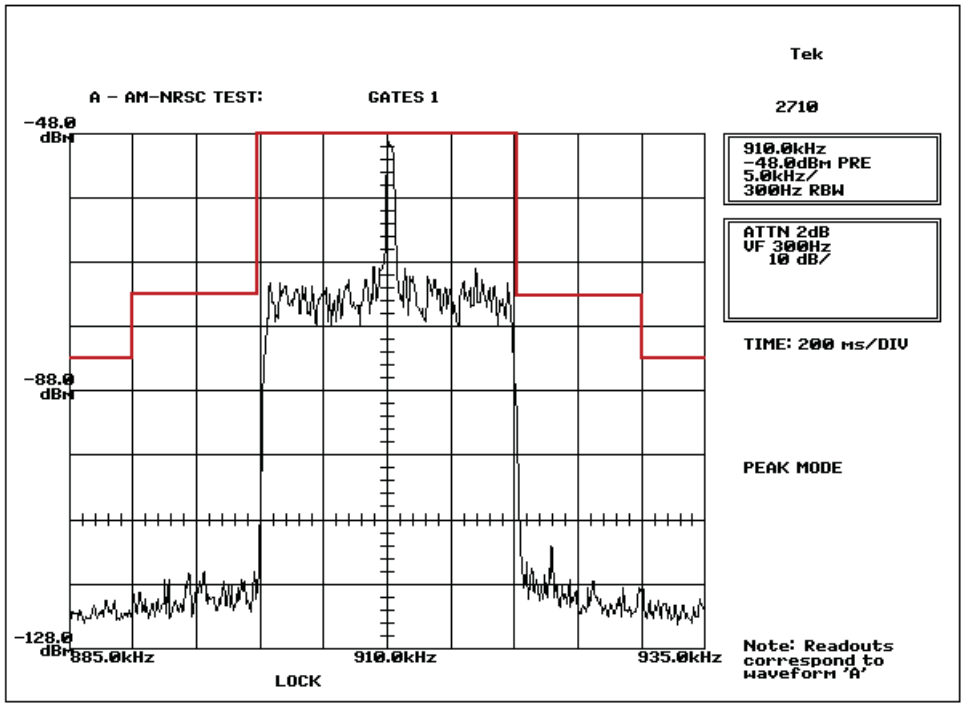

Figure 2 – Harris Gates One modulated by an Orban model 9200 AM Audio Processor using NRSC-1 modified 75 uS pre-emphasis and NRSC –2 10 kHz low pass filter (5 kHz/division)

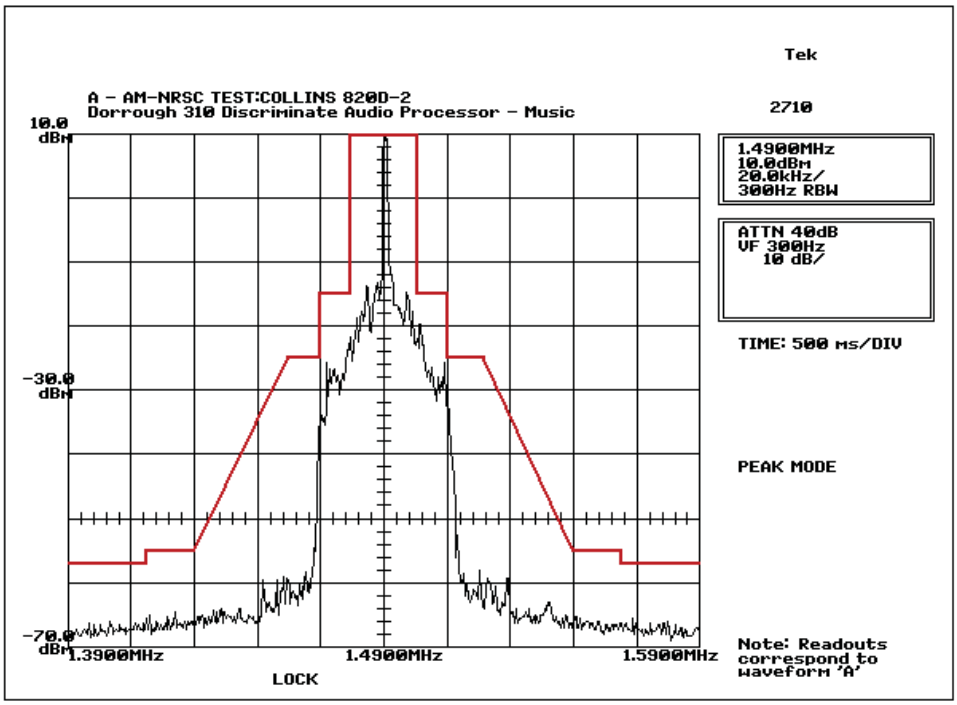

Figure 3 –Collins 820D-2 modulated by a Dorrough Electronics model 310 Discriminate Audio Processor using flat frequency response without 10 kHz low pass filtering (20 kHz/division)

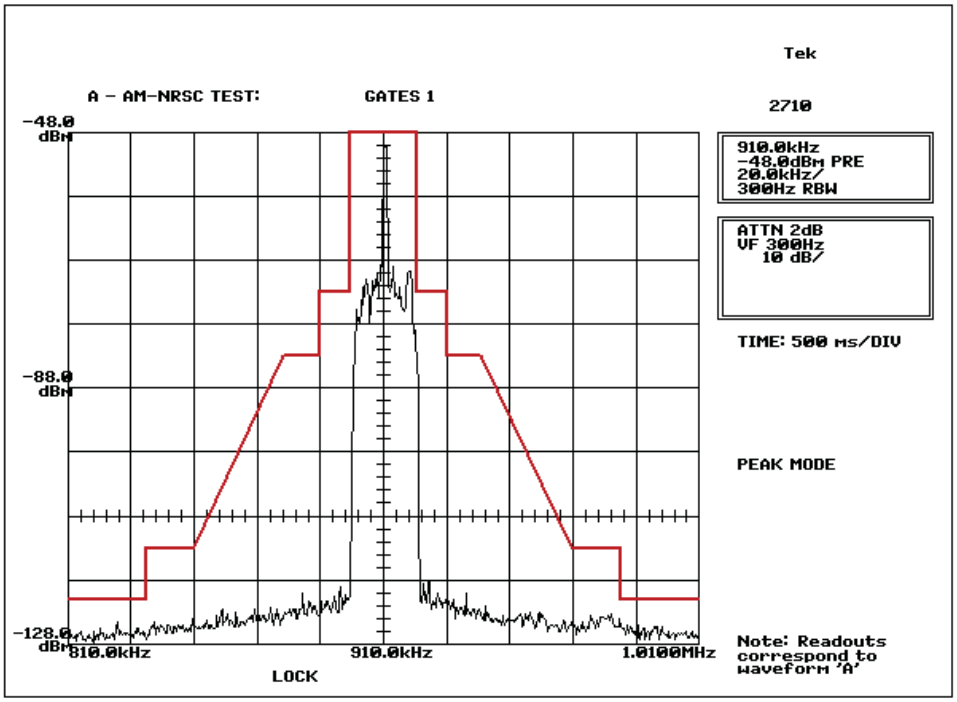

Figure 4 – Harris Gates One modulated by an Orban model 9200 AM Audio Processor using NRSC-1 modified 75 uS pre-emphasis and NRSC –2 10 kHz low pass filter (20 kHz/division)

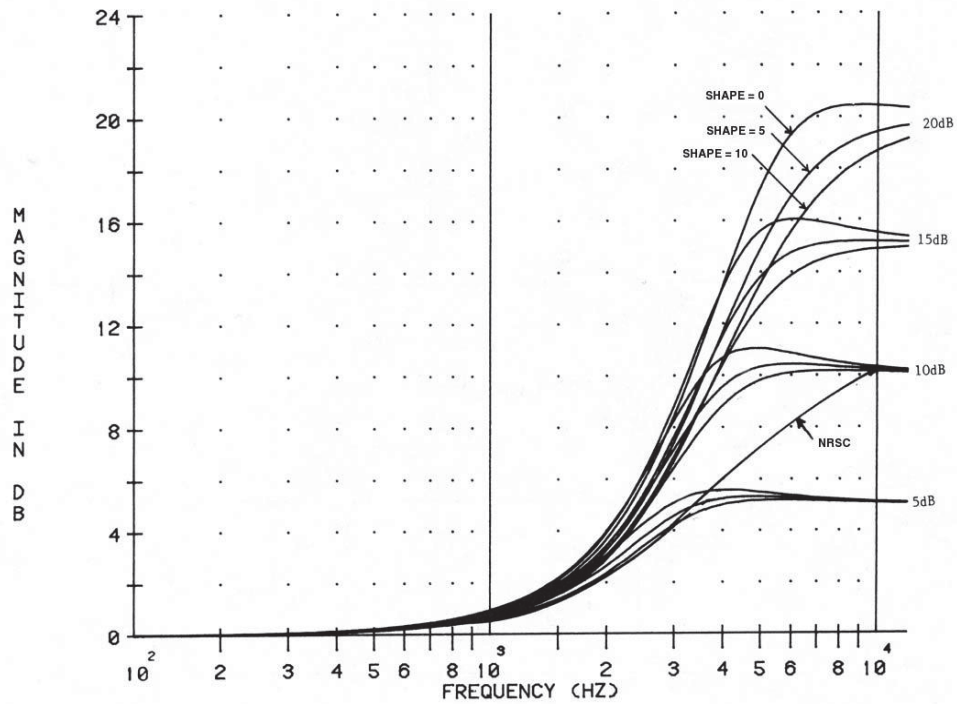

Figure 5 – Various pre-emphasis curves used by AM broadcasters[18]

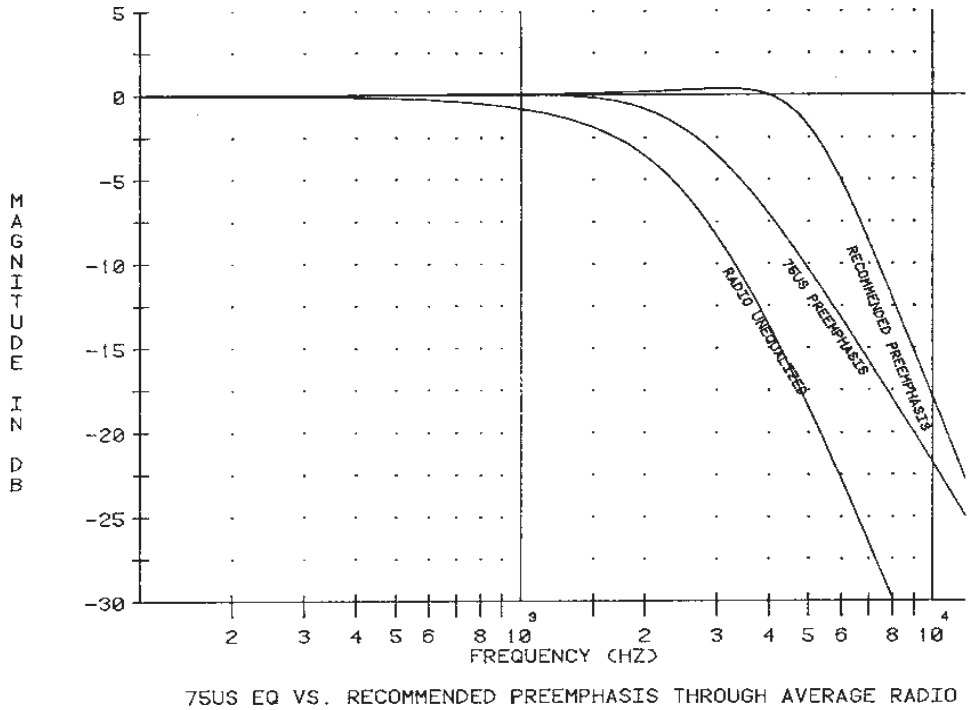

Figure 6 – Typical AM receiver frequency response flat, with 75 uS pre-emphasis and with 18 dB/octave pre-emphasis[19]

[18] Orban Optimod-AM 9300 Digital Audio Processor Operating Manual, Section 3-21. Figure 3-1.
[19] A recommended Preemphasis Characteristic and Deemphasis Characteristic for AM and AM Stereo Broadcast. Robert Orban and Greg Ogonowski. 1983. Figure 5.

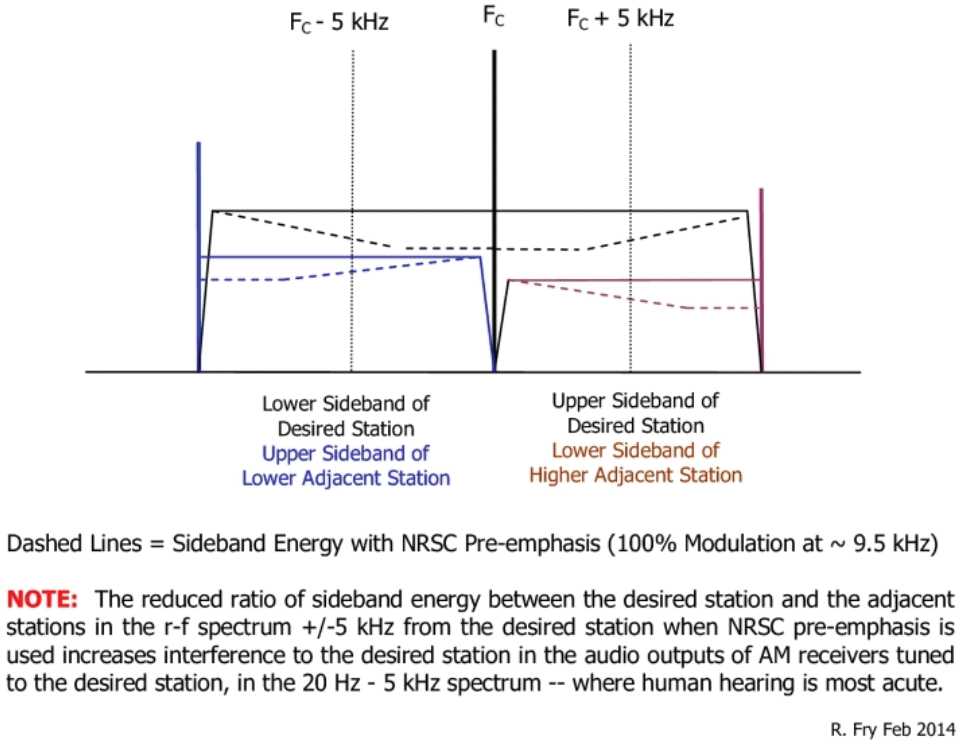

Figure 7- Effect of NRSC-1 modified 75 uS pre-emphasis on the first adjacent channel[20]

[20] By Richard Fry, CPBE. http://s20.postimg.org/t0xk02n71/NRSC_Adjacent_Channel_Effects.jpg