Before the
Federal Communications Commission
Washington, D.C.

In the matter of:

	)	
Revitalization of the AM Radio Service	)	**MB Docket No. 13-249**
	)	**FCC 15-142**
	)	

REPLY COMMENTS OF KINTRONIC LABORATORIES, INC.

The domestic and international broadcast radio engineering, design, and manufacturing firm of Kintronic Laboratories, Inc. ("KTL") hereby submits these Reply Comments in response to the Commission's recent action on AM Revitalization, First Report and Order, Notice of Proposed Rulemaking (FNPRM), and Notice of Inquiry, dated October 23, 2015, in the above-captioned proceeding. In that Notice, the Commission solicited comments on its various further specific proposals to revitalize AM radio and also invited submission of further proposals. Based on experience from the 65-year history of our firm and its founder, Louis A. King, MSEE, PE, providing engineering consulting and product services to the licensees of U.S. AM radio stations as well as many international broadcasters, we intend with these comments to provide focused analyses of the Commission's specific proposals related to AM transmission standards and also add to the discussion with further proposals we believe to be essential for AM revitalization. Our comments will focus on several over-arching needs for AM radio, plus specific rule changes that can be used by AM stations in general to improve their flexibility in developing technical facilities to improve their coverage in the existing AM band. We believe that the Commission's stated goal of truly revitalizing the AM broadcasting service can only be achieved by a concerted, multi-faceted approach to this complex technical, economic, and policy challenge. Ultimately, the American listening public will be the real beneficiary of these changes.

Overview. We have reviewed the Notice (and its parent 13-249 Notice of Proposed Rulemaking [NPRM] of October 31, 2013), and we wholeheartedly support the Commission's goal of revitalizing the AM radio service. AM radio constitutes the most bandwidth-efficient broadcast medium and provides an essential service to many Americans, particularly in rural and remote areas, and those traveling in the vast expanses of this nation. We strongly concur with the full Commission's efforts in this regard, especially Commissioner Pai's efforts to champion this thrust, and with Commissioner Clyburn's recognition that AM provides a unique venue to facilitate female and minority media management and ownership, as well as to provide vital programming diversity for the American public, particularly in niche markets and demographics. AM radio, due to its generally lower capital requirements, can also provide a realistic setting for family-based, community-focused station programming and ownership, especially in smaller localities. AM radio is truly a national resource, a source of unique voices, and one that we can ill afford to abandon, particularly in light of its unique propagation characteristics and tremendous reach, especially in times of local, regional, and even national emergencies***. Truly, this action has the rare potential of conserving a unique national resource.***

Since the original NPRM over two years ago, we have as yet seen no substantive response from the Commission on the two salient issues we (and certainly others) have identified as key to the survival and ultimate viability of the AM band — **(1)** the worsening electromagnetic environment; and **(2)** the concurrent failure of the consumer-products industry to provide the listening public with high-quality AM receiver systems (comparable to their FM counterparts), particularly in the areas of sensitivity, selectivity, noise rejection, and audio bandwidth. As we cited then, these two effects are in fact closely interrelated, since the steadily increasing noise floor in the AM band has materially contributed to the unfortunate trend to reduce AM receiver bandwidths even further than those typical in the 1960s and '70s. It has been all too easy for the receiver manufacturers to simply reduce overall receiver bandwidths down to even 2-3 kHz (sometimes worse than telephone grade!) to address the pervasive issues of electromagnetic interference (EMI) noise from power lines, LED- and fluorescent-lamp ballasts, personal computers, consumer devices, battery chargers, and the like, not to mention broadband static impulses from lightning and increased adjacent-channel and alternate-channel interference from more recently allocated AM stations. Added on top of all this is the progressive trend in the automobile industry to replace metal body parts with plastic (which worsens EMI shielding), adapt windshield-type antennas (which provide markedly poorer reception performance for both AM and even FM), and add a multitude of noise-generating microcomputers for engine control, antiskid braking systems, and the like. The net result for the public has been AM radios with very low audio and reception quality.

It is therefore imperative to the sustainability of AM radio that the Commission strongly encourage (or, via legislation, even mandate) significant improvement in consumer AM receiver systems. Without this, the American listening public will continue to regard AM as a noisy, low-fidelity medium and will consequently tune out. In this NPRM the Commission is, we believe, very wisely considering several major technical improvements to the AM stations' transmitting system and allocation requirements, ***but without advanced consumer-receiver features to address the severe noise, interference, and bandwidth challenges to good, clean AM-band reception, the appeal of AM to the public will inevitably be lost***.

In the time since the NPRM issuance, we have been informally apprised by staff that though the Commission would be willing to assist in certification of receivers for minimum performance standards, the agency could not consider mandating AM receiver performance without specific signed legislation passed through Congress. As a result, our company has engaged in two separate internal development projects to design advanced, high-performance DSP-based AM/FM receivers, one a professional instrument-grade unit, and the second (collaboratively with a partner firm) to produce a high-volume, low-cost software-based DSP high-performance consumer-type unit, initially in table-top format. The latter unit is due to be completed later this year. ***Both designs will offer AM receiver parity with the dominant FM band to enable the user to make listening choices on a much more level playing field***. The relevant technical receiver standards to achieve effective parity include: **(1)** low internal noise floor; **(2)** high overall RF sensitivity, selectivity, and dynamic range; **(3)** highly effective noise (EMI) rejection**; (4)** full 10-kHz audio bandwidth capability with low distortion; and **(5)** stereo capability [both AM and FM].

Since the NPRM, we have also demonstrated wideband stereo AM reception (using music) versus standard FM stereo at our NAB booth in both 2014 and 2015, at the Association of FCC Consulting Engineers (AFCCE) meeting in Washington in the fall of 2014, and two separate demonstrations (also in the fall of 2014) at the Commission facilities in Washington to Commissioners Pai and Clyburn and multiple staff members from the Commissioners' Offices, the Media Bureau, the FCC lab, and the Enforcement and International Bureaus. All who auditioned the demos agreed that wideband 10-kHz AM stereo was (surprisingly) ***very*** competitive in discernable sound quality with FM (some even preferred the AM!) and would serve to boost AM listening when made available to the general public. This need for wideband AM reception to better compete with FM underscores our strong belief ***that the pessimistic perspective held by the majority of the engineering community that wideband AM receivers will never again be deployed could well lead to egregious policy errors in formulating new AM protection standards***. For example, in addition to the very large changes proposed in the protected contours for Class A, B, C, and D stations, the usual response is to ignore or reduce the role of adjacent-channel contributions to the overall interference picture. Unfortunately, for even narrowband receivers, it is much more than just-audible 10-kHz carrier whistles; the full-bandwidth (10-kHz) nature of the overlapping, inverted-spectrum sideband interference from adjacent channel stations, virtually all of which are very heavily modulated, results in an annoying "buzzy", syllabic-rate high-frequency splatter that directly degrades the audio from the selected station. If there is significant signal from both adjacent channels (e.g., as frequently encountered at night), the splatter is doubled, with the two interfering inverted-spectrum audios superimposed. (Second-adjacent stations are much less problematic, as their sidebands are significantly attenuated by the I-F selectivity of most all current receivers). In our local area, there is a very long-standing 1-kW Class-C station on 1400 kHz, and two nearby (~31-40 miles) adjacent-channel stations, one with 2.5 kW on 1390, and another with 500 W on 1410. At the reference location, 22 miles out from the 1400 station, a strong, low-noise daytime signal is readily received from the main station, but significant annoying crosstalk from the two (lower- and upper-) adjacent-channel stations is constantly received on a narrowband but sensitive Toyota radio. Since these stations were allocated prior to the adjacent-channel Rules changes in 1991, their 0.5-mV/m contours are (supposedly) no more than 0 dB relative to those of the 1400 station, but the adjacent-channel interference (ACI) clearly degrades the 1400 signal more than does the average power-line noise. On a wideband AM tuner at the same location, the ACI renders the 1400 station almost unlistenable with a 10-kHz I-F bandwidth, and very marginally listenable with a 5-kHz bandwidth, both with substantial, constant modulation splatter. Even with advanced DSP techniques, this form of ACI is exceedingly difficult to filter out. Circumstances like this remind us that ACI, due to its sideband spectral overlap with the desired station, is a tremendous detriment to good-quality wideband or even medium-bandwidth (e.g., 5-kHz) reception; if we are to have any hope of decent AM audio quality, the ACI must still be controlled to the 1991 levels. With the proposed changes to the AM protection contours in the FNPRM action, and the anticipated mutual power increases, the ACI would typically increase by 6 dB (at the traditional 0.5-mV contour) and could be as high as 12 dB (1.0-mV expanded contour), or 18 dB (2.0-mV expanded contour). We hold that this is unacceptable for AM to ever be a quality reception medium. We do not disagree with the logic of our engineering colleagues in agreeing to higher levels of permissible ACI (assuming narrowband voice programming into narrowband receivers), but we still firmly believe that to succeed, a large proportion of AM stations must also be able to successfully broadcast reasonably wideband (6-10 kHz) music programming. We certainly accede that wideband AM radios (e.g., the AMAX units, which have been somewhat available in the past) are currently difficult to obtain, but we believe the new DSP-based consumer unit we are collaborating on will within a few short years change all this.

As we cited in Further Proposal 6 in our original NPRM Reply Comments of March 2014, numerous Commenters, especially those in the engineering community, have proposed several substantive changes to the Commission's Rules for co-channel protection of standard contours on virtually all classes of stations, based on the overriding assumptions that neither the levels of RFI nor average AM receiver performance will ever improve. Given these assumptions, the arguments presented are logical, but we fundamentally and emphatically disagree with that thesis. For the foreseeable future, we strongly encourage the Commission to defer any such irreversible allocation actions until all four of the initial measures we have proposed (q.v.) have truly had sufficient time to work. ***If these protection limits are reduced now, there will be no later chance of ever recouping the lost coverage areas — the zones previously denied by noise will simply now be squashed by added co-channel (and adjacent-channel) interference from other stations.***

NOISE — THE "ELEPHANT IN THE ROOM"

Historically, the foundation for the success of AM broadcasting has been due to the Commission's establishment of allocation standards that have supported a workable signal-to-noise+interference ratio ("SINR") in the vast majority of listening environments. In fact, the "noise" (random + impulse noise from lightning and static + broadband noise from man-made sources) and "interference" (from other radio stations) are all truly independent of each other and must be dealt with individually. In the past (perhaps 30-40 years ago), noise contributions from power lines and the like were generally quite modest, as Utilities were diligent to maintain their systems in very good working order; bad junctions and insulators were detected and repaired promptly. Even clear-channel signals, from many hundreds of miles distant, were readily receivable on both portable and home radios, both indoors and outside, without noticeable local utility interference; in fact, the biggest reception problem was usually skywave fading! Now, the noise situation is drastically worse, as we addressed earlier in this Proceeding. <u>Though certainly not reflective of the current Members of the Commission, the agency has for many decades been apparently distracted by a multitude of non-AM broadcast matters and has essentially completely ignored the growth of EMI/RFI issues</u>, which have most severely impacted the AM band, but have also caused significant harm to the amateur radio bands and have begun to impact both low-band VHF-TV and FM broadcasts (as per SBE and NPR sources). Establishment of the TAC committee is a good step forward, but a concerted move to solve the noise-pollution issue is nearly a generation overdue!

The noise term (N) in the SINR expression above, which used to be much less than the interference term (I), is now often dominant, especially in more dense urban environments. This shift has now led many broadcast engineers to think only in terms of SNR, essentially ignoring the interference term. Unfortunately, both terms are still valid and must be considered. Many decades ago, the Commission set up comprehensive, honest, yet conservative AM broadcast interference standards that have since been adopted worldwide. <u>Clearly, man-made noise was lower back then, but we believe that abandoning the time-tested allocation Rules (intended to minimize mutual interference and so preserve signal coverage) and trying to solve the SINR dilemma by arbitrarily raising transmitted power levels is fraught with severe implementation consequences, many of which are, of course, unintended</u>. These will be discussed further in the Reply Comments section of this document.

We now reiterate a portion of our Reply Comments in response to the original 13-249 NPRM:

<u>Further Proposal 1</u> – Immediately Enforce Part 15 Rules on Unintentional and Incidental Radiators for Electric Utilities, Telephone, and Cable Companies and for Consumer Devices that Degrade AM Radio Reception

Very obviously, the gradual growth of EMI from overhead electric power lines (at all voltage levels), telephone lines and cable TV lines, and a variety of consumer devices has been a tremendous detriment to AM broadcast reception, as we have cited in our Reply comments to the NPRM, as well as several others in this Proceeding. Part 15 of the Rules clearly sets reasonable limits for both Conducted and Radiated emissions, both within the AM band and elsewhere. Surprisingly, the Commission has never adopted parallel Rules for Incidental Radiators such as power lines; the obvious solution is to draft and enact new Part-15 regulations to put Incidental Radiators in the same category as other noise sources. Although AM-band emissions are especially problematic, wideband radiation from these sources can also affect AM receivers, amateur radio operations, and other communications users; such illegal emissions are rightfully deemed "harmful interference" and have been universally understood as such in the communications field. The proliferation in Utilities and general industry of bad high-voltage line insulators, transformer bushings, transient protectors, and line/ground connections, not to mention BPL transmissions, has led to broadly distributed degradations in AM radio reception, particularly since in most cases power lines follow roads. Although electric utilities are the most common offenders in this regard, telephone and cable TV firms also have caused problems, usually due to DSL and other forms of signal leakage. Most current AM radios are quite susceptible to the impulse-type noise so created; once this raucous "buzz" even temporarily overwhelms the radio, the listener is strongly prompted to switch to FM or another programming source.

A brief description of the nature and physical distribution of these "hot-spot" noise sources is provided below. The temporal nature of most power-line related noises, such as arcs, breakdown in insulators, and such are usually spikes or impulses which occur at rates equal to multiples of the basic AC power-line frequency, most often 120 Hz, since arcs generally occur each half-cycle of the line voltage. The comparative spectral plots in Appendix A show typical switching spectra for older magnetic systems such as fluorescent ballasts, switching at 60/120 Hz (in blue) versus the much higher rates of modern electronic switching power supplies (in red). Of course, the power-line noises much more closely resemble the magnetic devices. The noise spectra generally, but not always, fall with frequency as $1/f$. Nevertheless, both types of systems can significantly pollute AM radio signals, though the emissions from electronic switchers can easily reach even UHF frequencies, especially if the units have poor or no shielding and filtering. Sadly, these signals are not only radiated but often conducted along low-voltage power lines and later re-radiated, often typical in dwellings.

The sources of power-line and other Utility-based noise can generally be considered as relatively small, localized wideband noise generators. These can be modeled as approximately spherical in nature, so that their **E** (electric) fields fall off roughly with distance (r) as 1/r, unlike AM antennas, which are planar and have essentially a 1/r horizontal field reduction. The **B** (magnetic) field goes as $1/r^3$, so the source is effectively a noise "hot-spot" with very high local amplitude, but with generally short range, and is usually located well above street level (and that of typical vehicle antennas), so one doesn't stay under the spot very long at speed. Nonetheless, if one is stopped at a traffic light, it's a much different story! The main point here is that the amplitude of the "hot-spot" is so high that no sane amount of AM transmission power will quench the noise in the receiver, so all more power can accomplish is to reduce the apparent "size" of the spot source. Of course, each noise "hot-spot" can also couple to the adjacent power lines and so can radiate fairly efficiently along the wires, which all-too-often parallel the roadway. These power-line "hot-spots" are so large in number (yet usually small in total effective area, except when they are coupled into nearly lines) over the typical coverage area of a given station, we have used the term "noise archipelago" to represent the general physical distribution; in the notional drawing in Appendix B, these spots are distributed all around the coverage area, though obviously concentrated near the population center. As the transmitter power increases, the spot sizes decrease in size, but due to the high intensity of the local noise fields therein, the spots are rarely suppressed to effective inaudibility (i.e., ~ –26 dBc).

In terms of noise impacts on AM reception, it should be noted that modern receiver technology has already demonstrated some 20 years ago very effective suppression of many of these power-line related noise sources by the incorporation of advanced, highly effective RF noise limiting/audio blanking functions [long known to military and amateur radio operators] were initially developed by Motorola for the AM consumer radio market within later-model CQUAM stereo AMAX-compatible chipsets in 1996 (specifically the MC13027/MC13122 combo). In fact, this blanking was reported to be so effective that when a car radio was driven under an offending power-pole insulator, the noise was hardly noticeable until the blanking duty cycle became so large that the station audio began to drop out entirely! These chips were actually produced for the consumer market, but due to their cost and the decline in AM popularity in that era did not get major use. It should also be noted that the Motorola CQUAM chips supported adaptive-bandwidth 10-kHz notch filters to deal with ACI, driven from special analog on-chip detectors. Thus, these high-performance receiver features are hardly new, but in new receivers with low-cost modern chips and software-defined signal processing can be offered now with a far lower off-chip parts count and considerably less overall cost to the consumer.

Suggested Actions to Combat Noise Emission. The Commission must protect the public interest, along with the licensed broadcasters, by aggressively enforcing its own Regulations. Our view is that a timely Notice of Violation letter to most Utility General Managers and the like should bring a quick response; hefty fines for repeat offenders would assure more than token efforts to resolve these emission issues (more on this later). The specific recommended Rules changes to accomplish this initially are as follows:

- Power distribution lines and associated equipment, traffic-control signals, switching-type power supplies, controllers, and amplifiers should be added to the list of Incidental Radiators [§15.3(n)] and additional engineering guidance for the design of Incidental Radiators added [§15.13].
- Conducted and Radiated emissions limits for Incidental Radiators should be the same as for Unintentional Radiators [§15.107(a)] and for Intentional Radiators [§15.209(a)] from 9 kHz to above 2 GHz. (Overall, a noise source is a noise source!)
- An official, user-friendly FCC website should be set up to facilitate reporting of specific interference incidents, for stations, engineers, and even members of the general public. These reports should be screened by OET and relayed to stations or Utilities as appropriate.

Closer to home, many existing radios and consumer devices (e.g., CD players), not to mention computers, MP3 players, and such, emit very high levels of local RFI (produced by clock circuits, RF synthesizers, microprocessors, and poor unit design) and thus impair or even preclude proximal AM radio reception. Common problems with Commission (FCC Laboratory) Type-Accepted, Verified, or Certified devices for consumers should be resolved, with some extra effort, through existing channels. Numerous internationally marketed products (from radios to fluorescent ballasts and LED drivers) with RF power-line filters for EU countries, when sold in the U.S. have filter components missing, in clear violation of Part-15 Rules. Given a few years, this major problem should eventually be soluble through concerted Commission action, particularly on resellers of these devices. It should be noted that the vast majority of these low-cost, low-quality devices will either fail or be obsoleted within 2-5 years and will thus fall out of use. Noisy industrial-grade products improperly sold to consumers, as cited by SBE, are also a growing problem, and must be addressed by the Commission now..

As this noise-reduction effort most directly benefits AM broadcasters, it is incumbent on them to help the Commission enforce the Part 15 regulations. We heartily agree with the Comments of Kevin C. Kidd, Mark D. Humphrey, and others concerning EMI/RFI sources, and we enthusiastically support Mr. Humphrey's proposal that the Commission establish a web-based clearinghouse for Part 15-related (and also Part 73) interference complaints. We further suggest that such complaints would be open to stations and concerned individuals, who would be required to submit a detailed "e-report" of the suspected offenses. Such reports could be automatically forwarded to the Enforcement Branch and to relevant Utilities in the area (or offending stations). Appropriate website design should assure that reports are submitted by technically competent persons; in contrast, members of the general, non-technical public would be directed to complain to the local station suffering the interference for problem resolution.

We commend SBE for their recent Comments in this Proceeding, which provide a clear, thorough, and accurate assessment of the many aspects of the current noise issues for the AM band. We heartily agree with all their conclusions, and deem this document as a must-read for all truly interested in the revitalization of AM radio. Their conclusion is simply that the Commission must immediately roll up its sleeves, take up the gauntlet, perform its legally-ordained regulation and enforcement duties, and not just address, but ***solve*** the AM noise issue via enforcement of its own Rules. The broadcasters who pay licensing fees and the listening public await! Though the task to control AM-band (and other) noise at first glance seems nearly insurmountable, we believe that a prioritized approach, coupled with dedicated, consistent, and persistent Commission action, ***led from the top***, will prevail. To achieve this, we suggest the following steps, in sequence:

- **(1)** Rewrite and adopt new Part-15 Incidental Radiator definitions and emission standards, paralleling those existing for Intentional and Unintentional Radiators, and shifting primary legal responsibility for non-complying Part-15/18 devices to the final seller rather than the end-user;

- **(2)** Through OET and the FCC Lab, establish approved RFI/EMI measurement techniques and procedures to assist Utilities (power, phone, cable, etc.), consultants, and broadcasters in establishing compliance and interference troubleshooting. Also certify multiple private RF compliance labs to handle most of the routine testing load;
- **(3)** Provide a web-based clearinghouse to document complaints and resolution actions;
- **(4)** Issue a friendly enforcement reminder letter concerning the revised Part-15 Regulations to all affected Utilities, phone, and data carriers, based on State Public Service Commission and similar databases;
- **(5)** After about 90 days, start the process of formally identifying problem areas, beginning with the most egregious cases, as reported by AM broadcasters, the consulting-engineering community, SBE members, amateur operators, and other technical personnel;
- **(6)** Begin issuance of Letters of Enforcement to offending Utilities and other entities;
- **(7)** Simultaneously, issue a friendly enforcement reminder letter to all electronics wholesalers and retailers who handle consumer and industrial Part-15 and Part-18 devices (e.g., Walmart, Best Buy, Home Depot, Lowe's, Target, Sears, Amazon, Newark, Digi-Key, Allied);
- **(8)** After about 90 days, request Part-15/Part-18 Compliance Letters and proof thereof via certified lab measurements;
- **(9)** As follow-up, have OET and FCC Lab personnel conduct spot tests to sample Part-15 and Part-18 devices sold in stores or on the web;
- **(10)** Set up a steep monetary fine structure to help finance Commission enforcement costs; eventually, enforcement could be nearly fiscally self-sustaining.

We opine that with vigorous action, including Part-15/18 enforcement actions and fines, by the Commission, the vast bulk of the Utility-related noise issues on the AM band could be resolved within about 2 years, though there will always be ongoing incidents until the Utilities are sufficiently "trained" to become more-or-less self-policing, with help from the AM broadcasters to resolve local noise problems as quickly as possible. The mess with Part-15 and Part-18 devices will take a bit longer to resolve, as these devices fail and/or cycle into newer devices (which should by then be fully compliant). We predict that these inexpensive, low-quality consumer devices are unlikely to survive more than 3-5 years at most; the industrial-grade units (e.g., LED traffic signals) may be required to have forced EMI/RFI filtering upgrades, which should not be more than 10% of the unit's cost, as a warranty repair.

REPLY COMMENTS. In the following Reply Comments on the Further Notice of Proposed Rule Making, we emphasize our general agreement with the broadcast engineering community, and in particular, the earlier cogent Comments and Reply Comments in the Proceeding from du Treil, Lundin & Rackley, Inc. ("dLR"), Sellmeyer Engineering ("Sellmeyer"), Hatfield & Dawson ("H&D"), Carl T. Jones Corporation ("CTJC"), the Society of Broadcast Engineers ("SBE"), the National Association of Broadcasters ("NAB"), and others on the five specific Proposals offered by the Commission in the FNPRM, as well as the two Proposals within the included Notice of Inquiry. We also offer several specific comments which differ somewhat from those earlier perspectives but which we believe provide significant additional considerations for implementing the necessary actions by the Commission to truly achieve a comprehensive revitalization of the AM broadcast band, to the great benefit of the broadcast industry and the general public.

The major technical issue in the FNPRM is, in reality, dealing with the high levels of noise in the AM band. The current premise is that the only way to effectively address the deteriorating signal-to-noise+interference (SINR) levels for most AM listeners (at least in more urban/suburban areas) is to boost licensed radiated power levels, at the admitted cost of substantially more station-to-station interference, both co-channel and adjacent-channel. This, as is widely acknowledged, is the result of steadily increasing EMI/RFI from unlicensed and non-compliant devices, along with the effects of non-regulation of power-line and related noises from Utilities and wireline carriers. As we stated earlier, such noise has gone from essentially a background level to a foreground phenomenon over the last 30-40 years, and is currently accelerating in both level and geometric distribution. Clearly, man-made noise was lower back then, but we strongly believe that abandoning the time-tested allocation Rules (intended to minimize mutual interference and so preserve signal coverage) and trying to solve the SINR dilemma by arbitrarily raising transmitted power levels is fraught with severe implementation consequences, many of which are, of course, unintended. The two principal rationales behind these proposed "solutions" offered by the Commission and many in the industry, though logical in an engineering sense, are based on two incorrect premises: **(1)** that better, more wideband AM receivers will never be available to the public, and thus AM is limited to voice-grade programming only; and **(2)** there will never be any real forthcoming regulatory relief for all this noise, so the only way to counter the noise pollution is to raise transmit power levels. ***We understand this pessimism, but we firmly believe the Commission and the industry can and must do better for AM to survive and prosper. Fundamentally, reducing noise via better regulation and enforcement is still the real (and only) solution, not power increases for the minority of stations who can afford them.***

The implementation consequences of the "power approach", as we just stated, of which many are unintended, will now be discussed further. As we see it, among these drawbacks are:

- Increased co-channel and adjacent-channel interference in ***all*** cases, with often-significant reductions in station interference-free coverage areas;
- Inability, either through power and/or allocation limitations, to maximize facilities to meet proposed new contour protection levels (i.e., 50-kW ceilings);
- Unfair or uneven opportunities to upgrade along with neighboring co-channel stations;
- Inability for many stations to upgrade due to financial difficulties, including capital costs of new transmitter, matching, and antenna systems and increased operating power costs, with little resulting ROI;
- Land restrictions which preclude directional arrays to support higher powers;
- The Commission's need to make mutual upgrades "fair and balanced", to avoid increasing the gaps between "have" and "have-not" stations;
- Issues with Class-C stations, who cannot upgrade power due to existing overlapped allocations but who will suffer significantly worse adjacent-channel interference (ACI), both day and night. Again, we remind the Commission that this ACI, due to the total modulation-spectrum overlap with the desired station's sidebands, is ***very detrimental*** to the station's coverage, as the typical listener's reaction to this type of interference is a quick tune-out.

As a result, the benefits accrued by some stations able to upgrade their powers must be carefully balanced against the degradations in coverage suffered by those who cannot upgrade.

With these perspectives, we now provide our views of the specifics of the tentative FNPRM technical Rules changes for contour protection of Class A, B, and D stations. We fully agree with NAB and others that the Commission must move very carefully and deliberately, thoroughly understanding all pertinent Commenters' and stakeholders' viewpoints before adopting such profound changes. If indeed the Commission proceeds with these game-changing modifications to their traditional AM protection Rules, the process must be very carefully managed to assure fairness and order to all stations and avoid the unintended consequences we listed above.

<u>Commission Proposal A</u> – Modify AM Protection Standards

<u>1. Change Nighttime and Critical Hours Protection to Class A AM Stations</u>

We agree that the 73 large, longstanding Class A stations are worthy of preserving and protecting due to their wide coverage and key roles in major emergencies as disseminators of vital information to the public, especially in scenarios involving widespread electric power failures; in such events, a portable battery-powered radio or vehicle radio may be the only source of news and status information for the affected population. We agree with other Commenters that in special emergency situations, the Commission must fully define an operating protocol to preserve wide-scale broadcasting by the dominant station(s) in these emergencies, coordinated with FEMA and the 77 stations currently designated as Primary Entry Point (PEP) facilities.

Meanwhile, the need for more local AM facilities using the clear channels and those adjacent to clear channels, particularly for new nighttime service to local communities, cannot be ignored. The Commission, in the FNPRM, has tentatively proposed: "**(1)** all Class A stations should be protected, both day and night, to their 0.1 mV/m groundwave contour, from co-channel stations; **(2)** all Class A stations should continue to be protected to the 0.5 mV/m groundwave contour, both day and night, from first adjacent channel stations; and **(3)** the critical hours protection of Class A stations should be eliminated completely".

Our response to these three proposals are as follows: **(1)** the Commission's proposed Rule to protect the 0.1-mV groundwave contour for co-channel interference (CCI) and to the 0.5-mV contour for adjacent-channel interference (ACI) should probably be retained. It is still possible on the Interstate highways, usually well away from power lines (except in highly urbanized areas) to receive reasonably clean groundwave signals from Class A stations over 150 miles distant; in our area on I-75 and I-40 we can receive very listenable daytime signals from WSM

(Nashville, 650 kHz); WLW (Cincinnati, 700 kHz); WSB (Atlanta, 750 kHz); and WHAS (Louisville, 840 kHz); in some cases, nearby adjacent-channel daytimers limit the reception more than the background noise. Assuming that the traditional co-channel D/U ratio of 26 dB is maintained, we believe that to avoid materially degrading the daytime coverage of Class A stations, which have traditionally maintained large total audiences over wide areas, but to also permit more local service, the protected daytime contour should be continued at 0.1 mV/m. The Commission's traditional 0.5-mV/m protection on daytime Class A from adjacent channels (0 dB) is not ideal but nevertheless still adequate. The Commission must weigh the impacts of changing this limit. We do note that dLR has offered a protection contour of 0.5 mV/m, which would have some advantages in permitting more local stations to raise powers.

In the area of nighttime signals, we assert that the Commission's proposed Rule of protecting the 0.1 mV/m groundwave contour from co-channel signals (presumedly groundwaves) ***as stated*** does not provide adequate skywave protection criteria and will markedly harm the Class A stations' coverage at night. As a result, we agree with dLR, CTJC, and several others to use the compromise formula suggested by dLR , which provides protection to the Class A station's 0.5-mV/m groundwave contour from co-channel signals above the 0.5-mV 50% skywave signal interference-free level. Another good alternative was offered by CTJC. Either would assure reasonable protection for the Class A stations while also providing increased opportunities for nighttime service on many daytime-only stations in smaller communities. We also would agree that Alaskan Class A stations should use the same criteria as the CONUS stations; this should not cause problems since the background noise levels are typically lower in that state.

For critical hours, we vigorously oppose the proposed elimination of all such protection for Class A stations. This is simply illogical, as it ignores the physics of the ionosphere at AM frequencies within ± 2 hours of local sunset. This protection should absolutely continue as currently, though as a compromise, to the 0.2-mV/m contour of the Class A co-channel station. This protection is especially important in periods of reduced solar activity, which permit much more skywave during early and late daytime hours (witness any Class C channel at those times!) We understand the high cost of directional arrays for smaller stations, but reducing power at a given time (as currently done) is not a significant problem. Moving the protection contour on the

Class A station will afford more power in critical hours to the smaller stations and is a useful operational compromise.

2. Change Nighttime RSS Calculation Methodology

We generally concur with dLR, H&D, CTJC, and many others in the engineering community that the nighttime RSS calculations need to be simplified by returning to the traditional 50% exclusion method of RSS calculations of interfering signal strengths, and deleting the 25% exclusions entirely. The calculations should be made on a site-to-site basis, which is much simpler and provides similar overall results to the traditional contour studies. However, due to the importance of minimizing the disturbing effects of spectral overlap by adjacent-channel signals, we believe that it would be counterproductive to quality reception to ignore the adjacent-channel contributions entirely as many have suggested (from the perspective that AM will never be other than voice-grade). We therefore suggest as a compromise that adjacent-channel signal contributions be included into the RSS calculations, with a 50% weighting for each adjacent signal prior to the RSS computations using the 50% exclusion adjustments. This obviously favors the co-channel signals but permits some accounting for stronger adjacent-channel signals in the mix that could materially degrade the desired signal.

3. Change Daytime Protection to Class B, C, and D Stations

This part is undoubtedly the most controversial of the proposed protection Rules changes. Although there is considerable pressure to downgrade the basic longstanding protection limits on Class B, C, and D, we note that, as we have stated earlier in the section on AM noise, the simple boosting of transmit powers, though helping the close-in signal-to-noise ratios, only does so at the expense of materially and permanently degrading fringe-area reception by replacing random and occasional impulse noise with full-time, wide-area, and pervasive co-channel and adjacent-channel interference. Actually, the correct, quickest, and most economic fix is for the Commission to strengthen and rigorously enforce its own noise Rules, including Parts 15 and 18.

Meanwhile, many Commenters seek a change to 2.0 mV as the protection contour, with a standard 26-dB D/U for CCI and a 0-dB D/U for ACI. The additional interference areas (correctly defined as zones where overlap causes D/U signal-strength ratios of less than 26 dB [i.e., a factor of 20], as dLR and others have explained, do in fact occur at the outer boundaries of the protected contour; these areas typically encompass only roughly $^1/_3$ of the total contour-overlap area. At any rate, the interference zone also extends over the full sector (based on a single interferer) outside the protection contour, thus producing excessive (i.e., > 26 dB D/U) in those outer areas previously still inside the traditional 0.5 mV/m contour. The net result is that we have traded better SINR inside the 2.0-mV/m area for more CCI outside. An entirely analogous argument holds for the case of upper and lower ACI signals.

Notwithstanding, if the Commission chooses to enact new, lesser protection standards for Class B, C, and D stations, we would prefer the choice offered by CTJC and others for a 1.0-mV/m standard, which still permits a more modest 6-dB increase in signal strengths and potential 4× power increases. The alternative 2.0-mV/m yields a 12-dB increase, requiring power boosts up to 16×, which are, with Rules limitations, more difficult to implement. The suggestion by dLR to alter the D/U ratio for the 2.0-mV/m contour to 32 dB is intriguing but we have not yet analyzed the effects of that recommendation. The proposed 6-dB increase advocated by CTJC also fits well with the potential effective 6-to-10 dB apparent improvement in CCI offered by wide-area carrier-synchronization techniques, as we have explained in detail in our Reply Comments response to the original NPRM, in several of the References, and summarized later in this document.

As an illustration of the effects of these proposed contour changes, Appendices C, D, and E contain notional plots of the scenarios involving a simple pair of stations, where station A on the left stays at its initial power, while station B upgrades to 4× its original level, with 1.0 mV/m contour protection, and then to 16× with a 2.0-mV/m contour. Note the significant CCI signal encroachment on the station A coverage area (the red crescent-shaped areas. Of course, real situations will involve more stations, usually in different orientations, and will result in more extensive overlap and CCI at multiple headings.

<u>Commission Proposal B</u> – Revise Rule On Siting Of FM Cross-Service Fill-In Translators

We recognized, along the lines of earlier NPRM Comments from dLR, Sellmeyer, and H&D, that FM translators should afford short-term economic assistance to existing AM stations that are able to use them to provide service to the public, and we support the Commission's facilitation of that with the proposed AM filing window, but we likewise do not see FM translators as more than a stop-gap solution to revitalization of the AM radio service. The acute lack of FM frequency availability will appreciably limit the extent to which AM stations are able to utilize FM translators, particularly in and near larger radio markets. Unfortunately, the widespread use of FM translators will in the short run only serve to speed the exodus by AM listeners to the superior FM band and thus will ultimately work against both AM broadcasters and the overall public interest. Nevertheless, the current noise issues in the band, as well as the generally depressed business for AM broadcasters, justifies the ready availability of FM cross-service fill-in translators to AM broadcasters, especially in medium to small markets. These factors lead us to agree with the Commission's current proposal to modify Section 74.1201(g) of the Rules to provide that the 1 mV/m coverage contour of an FM translator station rebroad-casting an AM radio station as its primary station must be contained within the **greater** of either the 2 mV/m daytime contour of the AM station or a 25-mile (40-km) radius centered at the AM transmitter site, but that in no event may the translator's 1 mV/m coverage contour extend beyond a 40-mile (64-km) radius centered at the AM transmitter site. Perhaps, as in studio siting requirements (addressed later in this document), certain relaxations of these rules, or case-by-case exceptions, could be granted to stations operating at a fiscal loss, since effectively these are also currently non-profit operations.

Commission Proposal C – Modify Partial Proof of Performance Rules

We, along with CTJC, dLR, and others, fully support the Commission's proposal to modify Section 74.154(a) of the Rules to require that partial proof-of-performance measurements be made only on radials which contain a monitor point. In most cases, radials containing a monitor point correspond to the directions of the pattern minima, and the field strengths along these radials are the most sensitive to parameter or other changes in the array that may affect the directional pattern. These therefore virtually always represent the best indication of the condition of the directional pattern, and are sufficient to verify pattern compliance (at least minima) when performing a partial proof-of-performance measurement. For those patterns with large major lobes, an additional measurement of these major-lobe signal strengths at several points along the associated radial should also be included to assure compliance with the pattern maximum(s).

Commission Proposal D – Modify Rules for Method of Moments Proofs

We believe (along the lines expressed by dLR, CTJC, H&D, and many others in the engineering community) that the requirement for AM directional antenna recertification measurements should be completely eliminated. These are generally not very useful and result in the unnecessary disassembly and reassembly of critical sampling-system components that would best be left alone, except in the rare cases of suspected lightning damage. The very thorough set of internal system measurements initially required to implement a proper Method of Moments (MoM) proof can be used, in the event of any significant shift of observed parameters, to quickly and accurately troubleshoot and restore the antenna system to its initial condition.

We further believe, in concert with many other Commenters, that the requirement for reference field-strength measurements should be eliminated both for MoM proofs and recertifications, as they are usually just redundant, especially since MoM proofs have successfully demonstrated in the field the ability to maintain AM directional antenna systems using internal system measurements in a manner far superior to the more traditional methods based on field strength measurements. We further agree with the engineering community that the requirement for surveying existing directional antenna arrays should be dropped from the Rules as long as: (a) tower array geometry is not being altered and (b) no new towers are being added to the array.

We also concur that Commission Rule 73.151(c)(1)(viii) should only apply when the total capacitance used to model base region effects exceeds 250 pF and should only apply when base current sampling is used, since at that level stray capacitances will not result in significant errors.

We believe that it is too early to make any final Rules determination on MoM proofs on arrays having skirt-fed towers; perhaps if the skirt has a sufficient number of wires, spaced far enough from the tower structure, to provide a sufficient level of shielding of the tower, it should be possible to accurately model such antennas in an MoM scenario, but this has not yet been fully substantiated. We agree with dLR that such measurement issues with skirt-fed towers and other MoM-specific techniques should be considered in a further AM proceeding, once adequate study and field experience has been accumulated to support the adoption of definitive standards. We further support dLR's view that the Rules should be amended to not require re-proofing for stations licensed with MoM proofs if re-measurement of the base impedance of a modified tower is within the required tolerance of the proof-modeled value, nor should current-distribution measurements be required for antennas when modern MoM analysis techniques have been used to determine their electrical and radiation characteristics.

<u>Commission Proposal E</u> – Require Surrender of Licenses by Dual Expanded Band / Standard Band Licensees

It is our position that holders of dual expanded-band and standard-band licenses should be permitted to retain both only if they are programming both essentially separately, or are licensed to separate communities and are providing distinctly local programming on both. If the stations are simulcasting and serve the same immediate geographic area, the owner should be allowed to sell one of the stations in a short time frame or else surrender one of the licenses, preferably in the Expanded Band, to facilitate better future Commission development of the newer band.

NOTICE OF INQUIRY

A. UTILIZATION OF AM EXPANDED BAND

We agree with dLR, H&D, and others that the establishment of standardized allocation rules for use in the AM Expanded Band – the channel frequencies from 1610 through 1700 kHz – are timely. As we stated in our Reply Comments in the original 13-249 action, the existing rigid, inefficient allocation guidelines clearly stifle the opportunity for standard-band AM stations to voluntarily migrate to these frequencies and also restricts the flexibility of stations already there to make facility changes. As is, the Expanded Band is comparatively under-developed and should be seamlessly integrated with the rest of the AM service, including the adoption by the Commission of a set of allocation rules fully consistent with those in the standard band. The more efficient use of these frequencies would definitely aid in reducing the congestion in the standard band; in addition, the addition of at least one or even two Class-C channels in the band would be a boon for small communities without an existing local AM outlet. It would also seem logical for the Commission to reclaim the 1610-kHz frequency from NTIA, move all the TIS highway-information stations to 530 kHz (with a concurrent RF power increase for them to overcome the higher levels of noise, both atmospheric and man-made, at that lower frequency). This would better serve the public by making TIS more consistent throughout the U.S. Also, TIS could be further utilized in local or wide-area emergency scenarios to alert and inform mobile listeners. A TIS alerting-tone system could then be added at low cost to provide timely traffic information and other forms of emergency communications.

Another future possibility would be to introduce potential all-digital operational experiments into the Expanded Band (either DTS and/or DRM), owing to the much-reduced level of impulse noise at those frequencies and the comparative lack of skywave interference versus the standard band. However, we do not believe that these digital operations should in any way impede the growth of analog AM operations, and all future digital AM-band transmissions must be required to properly integrate with existing analog AM signals, without causing additional interference issues.

B. RELAXED MAIN STUDIO REQUIREMENTS

We agree with dLR and several other Commenters that there should be no physical location restrictions with regard to an AM station's main studios, as long as basic requirements are met with regard to the public having ready, convenient access to the people responsible for the station's management, programming, and engineering. This would pertain to matters including Public File inquiries, public service features, programming, sales, and engineering issues including interference reporting. Such public access should be available during normal business hours and include (toll-free) telephone, e-mail, website, and, of course, normal mail. Each station, including those in groups, should have a dedicated, easily identifiable website (i.e., using station call letters) and include all pertinent station contact information. To assure prompt and appropriate interface to the public, response times should be maintained typically within one business day or less, excepting weekends and holidays.

ADDITIONAL PROPOSALS FOR AM REVTALIZATION

KTL believes that the following significant steps can also be undertaken now to encourage revitalization of the AM radio service, and we strongly encourage the Commission to take them quickly. We reiterate our agreement in principle with most of the Further Comments and Reply Comments already offered by dLR, Sellmeyer, H&D, and others in the consulting engineering community, though with some alternative suggestions. These are not at all due to any fundamental technical disagreements, but are driven by our overriding view that ***the Commission must move forcefully to enforce Part 15 Unintentional Radiator rules on Utilities and others, and further mandate major improvements in AM receiver performance, especially to achieve near-parity with FM.*** Without these key high-level actions, many of the other suggestions for improving AM service will likely become moot unless the listening public is incentivized to return to the band, via the rapid establishment of noticeably better audio and reception conditions. These Further Proposals (presented also in the original NPRM) are generally ordered in terms of overall importance to the sustainability of AM radio, with the first (concerning noise enforcement, presented earlier in this document) being considered by far the most critical. All of these concepts have been presented to the Commission and at NAB Conferences, as well as AFCCE and other groups. We believe these proposals are very significant to revitalizing AM radio, but have yet not received any official response from the Commission; it is our hope that these will be considered by the Commissioners and staff in the very near future.

<u>Further Proposal 2</u> – Establish Minimum AM Receiver Performance Levels to Provide Parity with FM-Band Counterparts

As previously covered in the Overview section of this document and in a recent paper [8], for the long-term health of the AM radio medium, it is absolutely essential that very close to full parity be established for new AM radio receivers versus their FM radio counterparts. This includes, as was cited earlier, all key AM receiver performance attributes, including: **(1)** low internal noise floor, well below the average AM-band atmospheric noise level; **(2)** high overall RF sensitivity, selectivity, and dynamic range, to provide adequate amplification of weak signals, even in the presence of significant adjacent- and/or alternate-channel signals, especially in strong-signal environments; **(3)** highly effective noise (EMI) rejection, including staged RF and IF noise blanking, accompanied by appropriate audio blanking/expansion when required**; (4)** full 10-kHz audio bandwidth capability with low detector distortion, plus dynamic bandwidth control (including adaptive 10-kHz notch filtering) as dictated by noise and adjacent-channel interference; and **(5)** stereo capability (if the receiver has FM stereo capability, it must have CQUAM decoding for AM). Without the first three requirements (this also includes the associated AM antennas), basic AM reception will suffer greatly compared with FM; without the last two, the output sound quality cannot be closely competitive with FM (10 kHz full bandwidth on AM versus 15 kHz maximum for FM).

Several commenters have suggested a 6-kHz bandwidth for AM, largely to minimize potential ACI to next-channel stations, based on earlier data obtained during NRSC tests on typical AM receivers. Although this might be adequate for all-speech programming, for many small- and medium-market stations, who program music for significant parts of their broadcast days, the full 10 kHz is definitely needed. The line of reasoning used by the NSRC to back a 6-kHz bandwidth was largely circular in nature; the use of wider bandwidths (again, we believe 10 kHz is truly needed for music) was not preferred on average by the test listeners simply due to the high ambient channel noise levels. Actually, if the noise for these tests were processed out correctly via proper dynamic filters and blanking circuits, a greater bandwidth would have certainly been favored, since it is well known that people in general prefer wider audio bandwidths, ***but only if*** they are essentially noise-free. To eliminate all audio content above 6 kHz using the current sorry state of AM receivers as justification is to ignore the fundamental need of AM to achieve a close parity with FM sound quality to remain sustainable in the future.

As mentioned previously, older receivers are so bad that such ACI concerns are probably moot, and the new, high-performance units can gracefully narrow detection bandwidth as needed in fringe-reception or high-noise scenarios. On top of all this, so poor is the AM sound of many current radios that to compensate for the overwhelming lack of treble (with a typical 2.5-kHz bandwidth), the bass is likewise reduced via low-cut filters to "balance" the sound, rendering the AM audio truly anemic (muffled *and* tinny) compared with FM (rich and full, and in stereo to boot). ***This stunning disparity cannot continue if AM is to endure***.

<u>Further Proposal 3</u> – Immediately Open Local Synchronous Booster Stations to Permanent Licenses

We emphatically support the Comments of Eng. Wifredo G. Blanco-Pi on the beneficial use of synchronous transmission by AM stations to provide coverage of isolated areas of significant population, as he cited from his experience with multiple installations on the island of Puerto Rico. The requirement to continually re-authorize synchronous boosters is an unnecessary administrative burden for both the licensees and the Commission staff. The technology of local and wide-area synchronization of dispersed transmitters via GPS and similar means has been well-proven in numerous communications venues, including television, cell-phone base stations, and even in HD radio systems; thus, the technology is well-established and there is no need to continue its "experimental" designation. We fully agree with the Reply Comments on the subject in the 13-249 NPRM from dLR, and further strongly endorse the new Rules they have suggested for synchronous boosters. We cite these items below, with a few modifications based on our own studies:

(1) A synchronous AM system should be defined as a master, licensed standalone station with one or more synchronized, co-frequency, lower-power booster transmitters carrying identical modulation formats and time-synchronized audio signals. All boosters shall be sited within the 2 mV/m daytime contour, or 40 miles of the master transmitter's location, whichever is greater.

(2) Synchronous operation shall require absolutely synchronized carrier frequencies (also see Further Proposal 4 below). If precision offset operation is desired to minimize standing-wave fading zone effects between transmitters, this shall be accomplished via cyclic or randomized phase-shift means in the carrier reference of the booster unit(s).

(3) Synchronous systems shall consist of multiple authorized transmitters with normally protected daytime signal-level contours that overlap or are contiguous with nighttime operation, even if higher nighttime interference levels might result in disjoint interference-free contours.
(4) Nighttime-only synchronous transmitters at locations meeting the daytime criteria shall be authorized, if desired, so long as they comply with normal channel allocation Rules.
(5) Each transmitter in a synchronous system should be studied for allocations with each such transmitter considered individually.
(6) A system of synchronous transmitters, each of which meets all applicable allocations criteria with regard to protecting other stations (except each other) from interference when considered alone, shall be licensed without regard to extension of the coverage area of the primary station. If overall coverage is expanded without interference being produced to any other station, that is explicitly permitted.
(7) As synchronous boosters may have intentionally limited power and coverage areas, no minimum antenna efficiency, height or ground system requirements shall apply to them.
(8) A synchronous system of transmitters (i.e., a master station and its set of boosters) shall count as one station for the purposes of ownership rules, license renewal, and transfers.

The aforementioned synchronous-booster system could be of significant benefit to Class-C and -D stations with limited nighttime coverage, as well as other stations (mostly Class-B) with deep nighttime directional-antenna nulls. All these stations could greatly benefit from the improved population coverage at night and during critical hours, particularly where urban/suburban sprawl has expanded beyond the stations' existing strong-signal zones. Unlike FM translators, such on-channel boosters would serve to increase the AM stations' audiences while concurrently maintaining the future viability of the band. The use of synchronous boosters could clearly provide new, productive nighttime AM signals into each community from the local area, at very low cost to the stations involved and with significant public benefit. Further, these and other such synchronous boosters could well prove to be an economic boon to many struggling AM operations by permitting tailored coverage areas to match listening locales.

It is useful to examine how the phases/delays of the audio and RF components of the AM radio signals can affect reception quality in the field, particularly in signal-overlap regions. For instance, the RF signal delay is very roughly 1 millisecond for 186 miles (corresponding to the speed of light in air). At a point equidistant from two omnidirectional, co-phased (synchronous) transmitters with equal power and propagating via groundwave mode over land paths of identical RF conductivity, the two RF signals will arrive with equal amplitudes and delays (phases). Now if we assume that the RF carriers and the sideband audio signals are precisely in phase (matched in time) as they leave the two antennas, at the exact midpoint between the two transmitters the RF signals and the detected audio will also be in phase; the signals can be added algebraically to calculate the resultant. Now for points *not* equidistant from the two transmitters, the RF signals will vectorially add; in general, there will be augmentations and cancellations of the two waves occurring at spatial intervals of one-half wavelength, essentially the same as is the case for standing waves on a mismatched transmission line. Modulation distortion will be minimal near the 0°-additive points and rise somewhat at quadrature-phase contours, and peak as the summed signal approaches null at the 180° points. Obviously, near the equal-signal points, the standing wave patterns will exhibit maximum variations; in fact, **§**73.182(t) of the Commission's Rules defines the region of "satisfactory service" for synchronous stations as areas where the ratio of field strengths is ≥ 6 dB (≥ 2:1). However, the Rules as quoted did not assume the accurate time-synchronization of both audio components; as cited by Blanco-Pi and dLR, the audio time-matching significantly mitigates the apparent distortion and reduces the area of discernible distortion. The interference patterning in the synchronous overlap zone can be further reduced by phase-dithering of the booster signal(s), either in a cyclic or random-phase fashion. Terrain variations, buildings, and other groundwave scatterers or diffractors (i.e., multipath sources) will also reduce the magnitude of these overlap-zone disturbances via the inherent dithering of carrier phase. In moving vehicles, the audible effects will be even less, especially on speech programming. It has been long known [4] that the distortion zones can be designed to fall over less-populated areas and major arteries; for instance, the overlap zones (near 1:1 signal ratios) would obviously be configured to fall in the more rural areas between cities. Further, U.S. Patent 7,881,416 describes the further reduction of these standing-wave patterns (and distortion) with the use of additional low-power localized boosters in or near the equal-signal zones. The net result of all this is that synchronized AM boosters are indeed ready for immediate wide-scale deployment.

<u>Further Proposal 4</u> – Mandate Regional/National Synchronization of All AM Stations

Three papers, published by the IEEE and NAB in the 2007-2010 time frame, [2], [3], [4], four U.S. Patents [5], and a paper at NAB 2015 [7], described a straightforward but highly accurate carrier-frequency synchronization scheme for actively, automatically locking multiple, remotely located AM broadcast transmitters to a common frequency/timing reference source such as GPS. The extremely tight frequency lock (to ~1 part in 10^9 or better) permits the effective elimination of audible and even sub-audible beats between the local (desired) station's carrier signal and the distant stations' carriers. Generally, an AM radio listener during the evening and nighttime hours, and to a lesser extent in the early morning, receives undesired skywave signals from several distant co-channel stations as well as the desired local (groundwave) signal. These carrier-beat components in the current (non-synchronized) scenario can cause annoying modulations of the desired station's audio at the receiver and concurrent distortion of the audio modulation from the distant station(s) and often cause listeners to "tune out" due to the poor reception quality. This is quite understandable since the average carrier power is on the order of 10 dB above that of the typical levels of the sideband modulation components, and the inter-carrier beats will dominate the receiver's AGC and thus modulate the audio level. Along with EMI, these beat-related effects are certainly ***a*** (if not ***the***) principal factor in the degradation of evening and nighttime AM fringe-area reception quality and the resulting loss of outlying listeners for virtually *all* AM stations. Perhaps the most deleterious aspect of these beats is the listener-annoyance factor, in that the high-level artifacts (volume modulation, cyclic distortion, and pronounced swishing sounds) often quickly induce listener tune-outs. This situation is not only progressively worse further into the fringe areas of the desired stations (usually in the outer suburbs of the city of license), but also occurs much closer in, in the deep nighttime nulls of directional stations. The current poor state of repair of many AM directional arrays, plus the low-power pre-sunrise/post-sunset (PSRA/PSSA) operations at many Class-D stations, only exacerbates these problems.

If, however, we employ carrier synchronization, all of these signals' frequencies can be held to within about 0.01-0.001 Hz of each other, and any resulting carrier beats will be of such long periods that the beats will be effectively suppressed by the action of the receiver's AGC circuitry and become completely unnoticeable to the listener. The significant reduction or elimination of the beats and related effects achievable via synchronization will greatly enlarge the effective *co-channel interference-limited* listening area of the desired station (from 4 to 10 times as indicated in our tests, dependent on program material) and simultaneously reduce the corresponding interference of the local transmitter to the distant stations as well. In addition, AM stereo (CQUAM) reception will be particularly improved by minimizing the phase shifts induced by co-channel interfering signals; HD signals will also benefit via reduction in beats from co-channel analog signals.

The automatic frequency-control hardware described in the references is inexpensive, requires no periodic recalibration, has essentially zero long-term drift, and could employ alternate wide-area frequency references of suitable accuracy, including broadcasts from WWVB, LORAN-C, and equivalent sources. The basic configuration of a commercially available GPS-disciplined oscillator which solves this problem is extremely simple and costs under $300 (including the GPS antenna). The main oscillator is a conventional high-stability ovenized quartz-crystal type. To counter long-term drifts, the oscillator is automatically adjusted to track a high-precision source of standard frequency obtained from a specialized GPS receiver (or other source), usually at 10.000 MHz. This very stable local reference frequency is then used as a clock for a standard digitally implemented frequency synthesizer, which is programmed to generate the specific (AM broadcast) transmitter carrier frequency desired. The stability of the disciplining source, typically ~ 1 part in 10^9 to 10^{11}, is thus transferred to the final AM transmitter carrier output frequency. Most modern, synthesizer-based transmitters can directly lock to the precision disciplined 10-MHz source, while older units usually require references at either 1×, 2×, or 4× the final frequency. In these latter cases, the existing transmitter crystal can usually be satisfactorily “pulled” via injection locking.

The effectiveness of the synchronization concept to reduce interference effects was demonstrated by ORNL researchers in a laboratory test setup, as described in the references above. Many hours of careful subjective listening were conducted, with the two interfering units both precisely on-frequency with the main unit (synchronous operation) and with the two interferers at various frequency offsets, from below 1 Hz to above 10 Hz. The most audibly annoying beats were generally judged to be below roughly 2 Hz, so several tests were conducted with offsets of 0.7 and 1.7 Hz, respectively, which tend to more closely emulate current AM channel beat characteristics. Subjective measurements to determine the familiar audible interference assessment criteria of “imperceptible”, “perceptible”, “annoying”, and “objectionable” were made and documented. Overall, the net effect to the listener of synchronizing the AM carriers and thereby eliminating the beats is on average about 6 dB minimum and can often be as great as 10 dB; this is of major importance in evening, nighttime, and pre-sunrise situations where the SIR due to incoming skywave signals can degrade to levels of 12 dB or worse. From the standard propagation data, at the nominal fringe signal level of 0.5 mV/m (for all Classes of stations except A, defined as 0.1 mV/m), the daytime, groundwave co-channel signals (re **§**73.182) must each be no more than $^{1}/_{20}$ the amplitude (−26 dB) at the stated field-strength contour [or 25μv/m, (5μv/m for A)]. The same corresponding nighttime values of acceptable co-channel interference levels (−26 dB) are specified for Class A, 0.5 mV/m (50% skywave) contours and the 2 mV/m contours for Class B (groundwave). Allowing for finite ground conductivities, it is evident that an improvement of 6 dB in effective co-channel levels will ***nearly double*** the interference-limited contours of the stations compared with the standard, non-synchronous case (*almost quadrupling the equivalent coverage area*). As will be described later, our simulations with real broadcast audio demonstrated that for some types of programming (i.e., with good masking properties) the effective improvement can even approach 10 dB, which could nearly triple the interference-limited coverage range! With the beats eliminated, the background audio from the co-channel stations will be clean; often, the so-called "cocktail party" effect will reduce the apparent level of those signals to the listener even further, especially in high-background ambients such as automobiles. The net result of these effects will be universally evident but particularly beneficial to nighttime operations at local Class-C and Class-D stations, whose coverage areas are already acutely curtailed by heavy co-channel skywave interference. For these latter classes, the near-quadrupling of equivalent coverage at night should be a major benefit, particularly to listeners in outlying suburban areas.

The principal drawback to the approach is a practical implementation issue **–** ***all stations on the channel in question (at least those with signals above the noise floor at the receiver) must be closely frequency-locked to a common precise reference as just described, or the beats will not be eliminated. It is therefore incumbent on the Commission to mandate the wide-area synchronization requirement for all AM stations as soon as practicable.*** In our view, wide-area AM transmitter synchronization is (and at very low cost) the only technology that, when adopted, will immediately benefit *all* stations, *all* frequencies, and *all* receivers, both day *and* night

CONCLUSIONS

As we stated in response to the original 13-249 NPRM over two years ago, AM radio is a longstanding American institution, a source of unique voices, and one that we can ill afford to abandon, particularly in light of its unique groundwave and nighttime skywave propagation characteristics and tremendous reach, especially in times of local, regional, and even national emergencies***. During the recent national disasters, Hurricane Katrina and Hurricane Sandy, AM radio stations proved to be the news source that the public utilized more than any other when telecom and other services were unavailable. In addition the Primary Entry Point Network operated by the Department of Homeland Security and the Federal Emergency Management Agency to facilitate Presidential access to the US population in the event of a national emergency is primarily comprised of AM 50-kW clear channel stations Truly, this AM Revitalization action has the rare potential of conserving a unique national resource.***

We believe that AM radio stations can be relied upon to provide needed service well into the future, but the Commission must take several bold steps in the very near future to preserve AM radio for future generations of Americans. KTL believes that the suggested actions can be undertaken rapidly to encourage a general revitalization of the AM radio service, and we strongly encourage the Commission to take them now. We reiterate our agreement in principle with most of the Further Comments and Reply Comments already offered by others in the consulting engineering community, though with some alternative suggestions. <u>Our proposals are driven by our overriding view that to save and revitalize the AM band ***for broadcasters and the public***, the Commission must move rapidly and forcefully to enforce Part 15 and 18 Unintentional Radiator rules on Utilities and others, enforce Part 15 regulations on non-compliant imported electronics via actions against their domestic vendors and further mandate major improvements in AM receiver performance, especially to achieve near-parity with FM. Also included in our proposals to improve AM reception are the simplified adoption of synchronous booster stations to augment existing AM station coverage and the mandate of wide-area GPS-based synchronization to significantly reduce co-channel interference via the elimination of carrier beats</u>. Without these high-level actions, most of the other suggestions for improving AM service offered by our firm and other Commenters will likely become moot unless the listening public is incentivized to return to the band, via the rapid establishment of noticeably better audio and reception conditions throughout the U.S.

Respectfully Submitted, April 18, 2016

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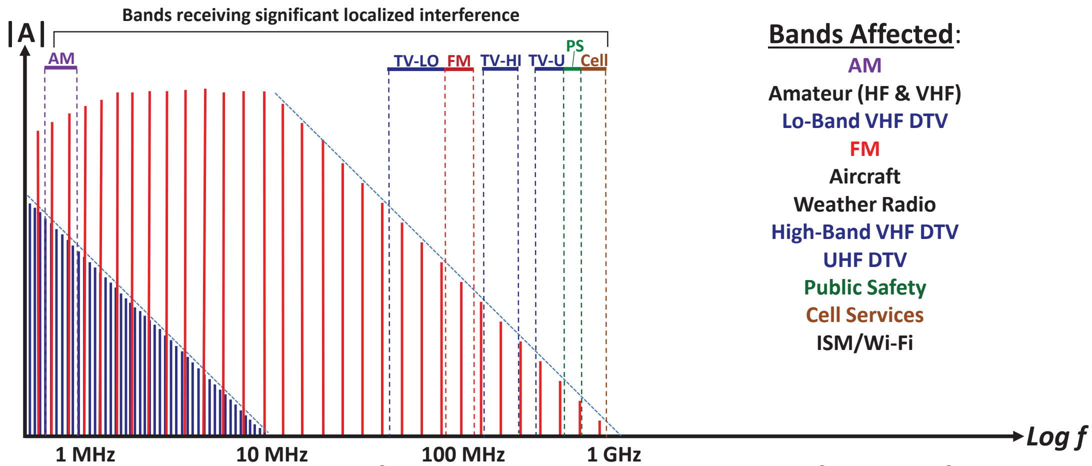
[6] U.S. Patents 7,881,416; 7,587,017; 7,218,696; and 6,563,893, to S. F. Smith and J. A. Moore.

[7] Stephen F. Smith and Thomas F. King, "***Smart AM Receivers for the 21st Century"***, Proceedings of the National Association of Broadcasters Engineering Conference, Las Vegas, NV, April 12, 2015.

[8] Thomas F. King, Stephen F. Smith, Wifredo G. Blanco-Pi and Jorge G. Blanco-Galdo, "***Field Trial Results of AM Transmitter Carrier Synchronization"***, Proceedings of the National Association of Broadcasters Engineering Conference, Las Vegas, NV, April 12, 2015.

APPENDIX A

Noise is also Progressively Encroaching on FM, DTV, and Other Services

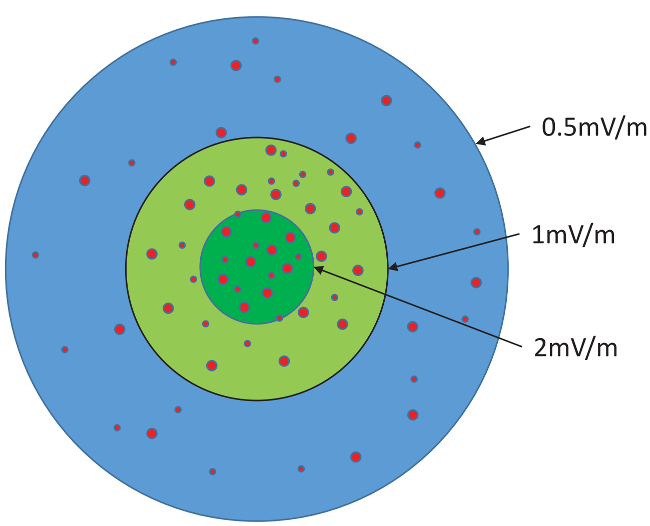


- **Older devices(magnetic/slower electronic): $f_s \cong$ 60/120 Hz/~ kHz**
- **Modern high-frequency switchers: $f_s \geq$ 1-2 MHz, increasing**
- **Newer devices typically have little or no filtering & shielding!**

APPENDIX B

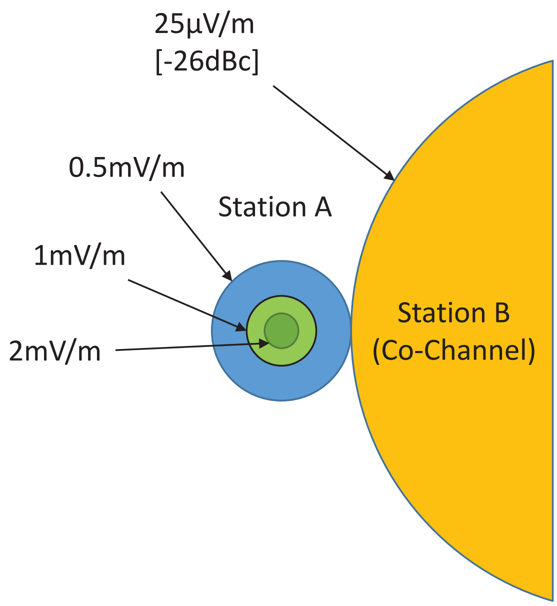
"Noise Archipelago"

(Distributed AM Noise Sources)



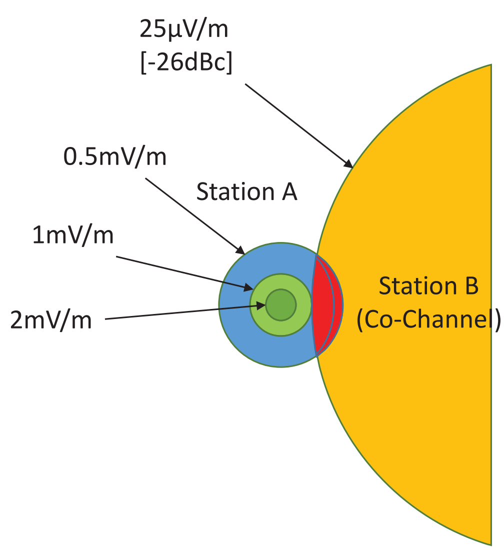
APPENDIX C

Current FCC Rules
(0.5-mV/m Protection Contours



APPENDIX D

1.0mV/m Protection Contour
Stations after 4:1 Power Increase on B



APPENDIX E

2.0mV/m Protection Contour
Stations after 16:1 Power Increase on B