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Federal Communications Commission

445 12th Street SW

Washington, DC 20554

In the Matter of	)	
	)	
Revitalization of the AM Radio Service	)	MB Docket: 13-249
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ATTN: Office of the Secretary

¶1 The noise issue on the MW(AM) band, including SW bands which are in the 3mHz to 30mHz, range, is one of the the biggest destructive force that if not addressed has the potential of making these bands completely unusable. The biggest sign that shows that this is happening is the number of requests for the use of FM translators by AM stations and the request for the opening up of analog TV channels of 5 & 6 for current AM stations to migrate to. While opening up channels 5 & 6 is not a bad idea in itself it should not be a solution to avoid the noise issue. The MW band is being abandoned because of lack of interference control. The noise problem should have never become this bad that would behoove broadcasters to request such migrations.

¶2 Whether the interference is man-made (QRM) or static (QRN) noise has always been a problem on the MW/SW bands regardless of the transmission type. While atmospheric noise is out of our control the man-made portion is not and this interference must be dealt with properly for these bands to remain viable. As technology has progressed and the regulations that have protected the MW/SW bands in the past from interference have not kept pace with newer technology and devices. This includes but is not limited to digital TV, computer devices, cell phones, digital music players, some LED traffic lights, DSL lines, broadband over power lines (BPL), Smart Meters, and etc. As more and more of these devices become part of our daily lives the current shielding regulations for them has not always been adequate in protecting the spectrum below 30mHz. Regardless of what kind of modulation used AM, FM, PM, or digital, noise has the potential to affect all of these.

¶3 While the current digital solution for the MW band may have cure for noise it is not without its issues in itself and has the potential to increase interference levels to the point that even it becomes its own worst enemy especially at night. It is my concern that adopting a fully digital solution at this time or if ever for the MW band for both the broadcasters and listeners is not a prudent decision. There are several issues with the MW band and there are very few if any significant benefits for going digital that would greatly out weigh the detractors for either broadcasters or listeners. Digital transmissions are not completely immune to interference either and while they may provide interference free recovery during good signal conditions they can cut out completely when the interference level exceeds the recovery level and will require several seconds for the receiver to re-buffer the signal. If operating in hybrid mode where a receiver can switch to an analog portion of the signal these several seconds of silence can be filled in with the analog signal, i.e. if the analog portion has not suffered an equal level of degradation that the human ear cannot copy. If the signal is un-intelligible to the human ear under some severe interference conditions this time is usually much shorter than the recovery time for the digital receiver to re-buffer the signal. To reduce the impact of the interfering signal during analog reception on the listener a noise blanker can be used to reduce or eliminate the interference intensity when the signal is completely un-intelligible for those short bursts of noise. This is a better solution for the listener as overall signal intelligibility is much better than several seconds of complete silence if a full digital signal is being transmitted.

¶4 While the bit rate available for a full digital signal on a per station basis may provide one channel with the equivalent sound quality of an analog AM 10kHz audio signal during good signal conditions with few if any recognizable digital compression artifacts this is hardly a reason to upgrade to a digital transmission system. The only thing that a full digital signal can offer vs. analog is virtually an unlimited number of very low fidelity channels confined within a finite and narrow bandwidth with a very high compression/artifact rate. Under a full digital scheme the potential for this abuse is great e.g. the current digital subscription radio services in the U.S. and other countries and internet radio have many news/sports/talk channels of low fidelity with a high level of compression artifacts. It has been a goal of both AM and FM to add multiple digital channels to increase variety in order to compete with internet and subscription radio. But isn't this just becoming like these other services which have become such a commodity these days? The variety that terrestrial radio needs is the uniqueness of interactive local programming with good audience participation. A pull, not a push format.

¶5 While these digital compression artifacts can be considered similar to low levels of background interference of a received analog signal most listeners find this less objectionable than the digital counterpart. Compression artifacts can produce listener fatigue much quicker at lower levels than the traditional incoherent background noise of a received analog signal. With a highly compressed digital signal these artifacts are always present regardless of the level of interference whereas with an analog signal apparent crystal clear reception is possible during periods of little to no interference.

¶6 This begs the question if using digital at all on the MW band has any real weighted benefit to the broadcasters and listeners. The only real benefit at this time is revenue for design royalties and manufactures at the expense of the broadcasters and listeners. Even for receiver manufactures the margins are slim and offers little encouragement for them to provide customers with reasonably priced digital units. For the consumers under a full digital transmission system this means tossing all analog AM radios in the trash and replacing them with their digital counterparts. For small handheld units this is not much of an issue but there has yet to be a portable digital AM receiver made that offers the convenience factor that a portable analog AM radio does. As for the larger units in cars and home receivers these units are more expensive and difficult to replace and it is questionable whether an owner of these units would replace a home receiver that already suits his needs for most other purposes or a car owner would replace the current radio if possible or even buy a new car to receive an AM all digital signal. A move to an all digital signal at this time would only hasten the death of AM radio as listeners would have little choice but to abandon the band if an easy and economical migration is not available.

¶7 Other digital systems proposed for the MW and SW bands, specifically Digital Radio Mondial (DRM) of Europe, was designed as an overlay onto the existing analog system that would co-exist with analog broadcasting, occupied the existing analog transmission mask, and was defined as an open royalty free system to encourage broadcasters and manufactures to migrate to. Even with the absence of all the restrictions that exist on the system proposed in the U.S. DRM has had limited uptake and it doesn't look like that it is a system that the listeners are adopting with excitement.

¶8 Any migration to an all digital system if at all has to be a process that allows the cream of ideas to rise to the top where all the best ideas produce a system that both the broadcasters and listeners can live with, is very economical and royalty free to implement. Many AM stations are barely making a profit and for them to spend money they don't have on expensive digital systems that may not improve their bottom line that has very little chance of succeeding, a system that is expensive up front for profits that at best may not even materialize many years later. Any digital system that wants to be adopted has to remove as many barriers as possible and offer a quick return on investment.

¶9 For now from a technical perspective AM needs to capitalize on its uniqueness that an analog signal can offer that a digital signal can't or isn't at an economical advantage to do so. Listeners are also drawn to live, creative and spontaneous local programming vs. the many cookie cutter formats that exist today. It is often said "It's the Programming, …... !" as the bigger issue in AM station survival but sadly this is not limited to just the AM band but can be a problem on FM also. As of now the FM band still enjoys reasonable profits but if FM is not careful this story playing out on the AM band may eventually be the harbinger of things to come for FM to. The AM and FM bands are not the only players on the block any more as they have to share market with a growing and diversified list of providers which includes portable music players, internet radio, and the current digital subscription radio service offered here in the U.S. As result the AM band no longer has the captive audience it once had in its eariler days. It was first taken away by FM and now the current competition is taking it away from both AM and FM as many listeners are flocking to these other services because they offer many, many more channels with greater creativity, spontaneity and a wide variety of programming that is not heard on terrestrial broadcasting today. What AM can offer now that these other national digital services can't is a high quality analog signal especially for strong local stations that is free from any digital compression artifacts and a program that is locally produced where the local audience has a large participation in. These are two cards in the hand of AM radio that existing digital doesn't have or can't or won't cater to. What is needed on the receiver end is higher fidelity analog radios that will provide an FM like quality signal instead of the muffled sound of telephone quality audio.

¶10 Other things that are within the jurisdiction of the FCC are station ownership rules that would encourage ownership diversification as compared to this station ownership consolidation that has occurred over the last several decades. This ownership consolidation has created a blandness in station programming and many stations have been put on remote control removing the spontaneity that once existed with local programming. This station consolidation may have generated profits in the beginning for the owners when this other competition didn't exist but today the market is different and this highly automated system that these large broadcasters use and their large corporate structure inhibits them from being flexible enough to adapt to a quickly to a changing market. These broadcasters just may become the modern radio dinosaurs stuck in the LaBrea tar pits. The only saving feature for AM as of now is mostly sports and politics programming and there is hardly any variety here compared to the golden age of radio.

¶11 Here is some history on radio and AM stereo that in many was still has ideas to offer for improving AM radio. While this may be a bit long there are still some good ideas that are well proven that can be adapted to todays needs for AM radio.

¶12 The birth of AM radio occurred in the early part of the last century and along with it the envelope detector became synonymous with its reception. It has proven itself as the workhorse of AM reception with its simplicity and flexibility but is not without its shortcomings. An envelope detector will only produce completely distortion free reception during a no interference condition but this is not the normal condition for most AM reception. An envelope detector requires that all information be contained in the in-phase channel and none in the quadrature channel. This requires that the information in the upper and lower sidebands maintain their proper phase and amplitude characteristics in relation to the carrier. During skywave, selective fading, and multi-path conditions these relationships can become distorted and the coherent information that once was only contained in the in-phase channel can now be found in the quadrature channel. Interfering signals from other stations and natural sources are incoherent in relation to the desired carrier and produce information in both the in-phase and quadrature channels of the desired signal and will produce the same kind of distortion known as "quadrature distortion."

¶13 The amount of distortion produced depends on the level in the quadrature channel in relation to the in-phase channel. A ±10° phase modulation of the carrier produced by quadrature information will produce a 1.02% change in the envelope detection level for an un modulated carrier, or 2% peak distortion. If an unmodulated carrier equaled 1 then the information in the quadrature channel would be 0.176 . During +125% modulation (2.25 instantaneous carrier level) a .176 value in quadrature level would produce a ±4.5° phase deviation and a 0.007 change from 2.25 or 0.32% peak distortion, which would be hardly noticeable. At -90% modulation that same vector would produce a ±29.6° phase deviation, a 15% change in level or 0.115, or 5.65% peak distortion. For a signal that has +125% and -90% modulation with .176 in the quadrature channel this distortion will be somewhat noticeable especially if the interference is incoherent to the desired programming.

¶14 An modulated co-channel signal that is at +125% modulation and its carrier level is at -20dB in signal level (10:1 in volts) in relation to the desired signal interfering with the desired signal at -90%

modulation will produce 11.3% peak distortion.

¶15 This envelope detector deficiency is what makes AM sound so poor producing a scratchy sound under less that optimal reception conditions. This occurs mostly at night for both local and skywave reception. As a side note digital radio is not immune to this interference either and an all digital system would make skywave issue so much worse with its constant level always on characteristics across its full channel mask.

¶16 A solution to this distortion issue with envelope detection is "Synchronous Detection." For many decades synchronous detection has been employed for the detection of a SSB signal mainly used on the SW bands. For an AM signal the detected audio from an envelope or synchronous detector is exactly the same when no interference or amplitude/phase errors between the sidebands from transmission path irregularities are present. During interference or transmission path irregularities a synchronous detector is completely immune to these effects producing no distortion at all but will detect the desired and undesired signal as a simple addition and not produce any interrelated distortion components. FM uses a form of synchronous detection and the synchronously detected AM signal has that similar polished sound instead of that scratchy envelope sound. The other benefit to synchronous detection is that the carrier at the current level needed for envelope detection is unnecessary and wasteful. Only enough carrier is needed for the PLL to lock onto. A greatly reduced carrier level could be up to ⅛ the power for synchronous detection. This also greatly reduces the need for 10kHz notch filters to eliminate the carrier whistle of the 1st adjacent signal thus simplifying receiver design.

¶17 The older NTSC television system used envelope detection for the black & white portion of the signal but in the latter years before the switch to HDTV many of the higher end sets used synchronous detection instead for its superior reception capabilities.

¶18 During the analog AM Stereo marketplace decision there was one proposed system that used synchronous detection and that was the Harris system. It was a Quadrature AM system that transmitted L+R in the "I" or in-phase channel and L-R in the "Q" quadrature channel. Quadrature AM produces distortion with an envelope detector but the Harris system used a variable quadrature angle that limited the phase deviation to no more than ±15° that kept the distortion down to acceptable human levels. For human listening most of the harmonics produced under envelope detection of a quadrature signal were the 2nd, 4th, 6th, even order harmonics and to the listener this would usually appear as a treble boost.

Under many conditions the Harris system produced less distortion overall on many envelope detectors than some of the competing envelope based systems because those systems produced pre-distorted sidebands when a phase modulated carrier was forced to carry a different envelope than what was natural to it. These non-linear systems which included all the others Belar, Kahn, Magnavox, and Motorola, all produced several higher order harmonics higher than the highest modulated frequency. Not only does this pose issues for conventional envelope based mono receivers but this also produces harmonics outside the required emission mask that broadcasters are required to comply with and have the potential to interfere with 1st adjacent channels. Unless the mono envelope receiver had an amplitude/phase linear reception in the passband the envelope would not be faithfully reproduced at the envelope detector producing distortion which is exacerbated by these non-linear pre-distorted signals. On the other hand the Harris system emission mask is the same as a mono AM transmission and has less potential to cause issues with envelope detectors with its narrow angle of modulation.

¶19 In the 1980's if the Harris system was chosen over the other one now currently in use and most mono radios made after the adoption were required to have synchronous detectors instead of envelope detectors, today the Harris system could operate in a full ±45° mode with full compatibility with the vast majority radios that would have saturated the market by now with synchronous detectors.

¶20 Of the other unique features of one of the proposed systems, Kahn, used an independent sideband transmission system where the left and right channels were placed on the lower and upper sidebands respectively. Although this system used envelope detection for L+R and is the main detractor of this system the two channels were separated by frequency and not phase during transmission and in many ways preformed better than all the other systems during skywave for channel separation and for co-channel interference which could produce platform motion on the other competing systems but this was rarely an issue with the Kahn system.

¶21 In leu of this “let the marketplace decide” approach a hybrid of the Harris and Kahn systems using synchronous detection and independent sideband (ISB) would have been much better than any of the systems proposed. Synchronous detection would offer distortion free detection along with some noise reduction especially of the impulse type. The ISB feature would eliminate the issue of channel separation that the Harris QuAM as well as the Motorola C-QUAM systems has during asymmetrical sideband reception or PLL phase mis-tracking. For an ISB signal asymmetrical sideband reception only results in equalization differences between the channels but full channel separation is still maintained.

During a PLL mis-tracking of an ISB signal the L and R channels would become differentially phase shifted upon detection would produce results acoustically in the listening environment similar to a phasor effect for a guitar but this effect is more tolerable than platform motion from non ISB signals. During extreme conditions when the phase mis-tracking would approach 90° the L+R in the L & R channels would become inverted and the information in the L+R channel would become L-R and would null out in the listening environment. If reception conditions are this bad to produce this amount of PLL mis-tracking other signal quality issues are a play that would also greatly detract from listenability. PLL mis-tracking of this extreme level is of no consequence if only one of the sidebands is desired as in SSB.

¶22 Using an ISB system offers a broadcaster two fully independent channels that have no chance of mixing with each other during transmission and detection. Two separate programs can be transmitted doubling the channels available that would occupy the same bandwidth of a mono AM transmission. Two fully independent channels can potentially mean double the revenue over a single channel. If the broadcaster only had one channel to broadcast spectrum efficiency would be doubled and effective signal to noise would increase along with helping to reduce the band overcrowding issue that exists today. These two channels would have the same or higher quality distortion free reception as a mono AM signal synchronously detected. If a synchronous ISB system was adopted instead of the current AM Stereo system most all radios by now would be Synchronous ISB/SSB capable and the broadcasters would already be benefiting from revenue from the broadcast of two independent programs instead of one.

¶23 SSB receivers using synchronous detection already exist on the SW bands and an ISB/SSB transmission scheme fits in perfectly with SW as well as the MW bands. A single detection system from 530kHz to 30mHz that could be employed into a single receiver. A system that has been in use for over 60 years in both the commercial SW bands and Ham radio.

¶24 Think of an ISB/SSB system as a transmission container with four different modes, double sideband mono (DSB), stereo (ISB), an and two separate channels containing two completely different programs as lower sideband (LSB) and upper sideband (USB). A broadcaster could use only one channel LSB or USB for a single program or both LSB & USB for a primary and secondary program transmission scheme. While using both LSB and USB for two separate programs this would not have any compatibility with todays radios, which would detect both programs at once, and deployment for this mode would have to wait before enough radios could be made available to consumers. The other modes, which one is already in use as DSB (regular mono), and ISB stereo if modulation levels in the "Q" "L-R" channel was reduced to a level that would minimize distortion to acceptable levels, could be implemented today along with either LSB or USB mode in a vestigial modulation scheme that would provide spectrum efficiency, like what was in use with NTSC television for envelope compatibility. All new radios that would immediately decode ISB stereo would also be capable of decoding LSB & USB when transmitted together. When enough of these radios have made it in the hands of the consumers then the simultaneous LSB & USB individual transmission scheme could be employed. These transmission containers are not just limited to analog signals but could be used for data and digital audio in the future when such a service would prove viable.

¶25 While the noise issue regarding digital electronic devices is one of the components plaguing AM reception band overcrowding is the other issue. Opening up the expanded band from 1.62mHz to 1.7mHz added 9 more stations and this was a minor improvement but more station slots are needed to help reduce overcrowding. The 120 meter band (2.3-2.495mHz), being below 3mHz is a part of the MW band and for the most part is not being used commercially in the U.S., and is internationally defined for commercial broadcasting. Adding this band would add 19 more stations spaced 10kHz apart a, 16% increase in channel space. Moving into the SW space there are more commercial spaces to add more stations. Using the 90 meter band (3.2-3.4mHz) would add 11 more stations, a 9.3% increase. These bands are close enough to the existing AM band to have similar propagation characteristics to the upper part of the existing AM band that reception would not be much different. Depending on international agreements regarding the use of these bands for these purposes is another issue but for the most part there are large areas in the SW bands that go completely unused for the most part and could potentially play a role in the overcrowding issue.

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