

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Unlicensed Operation in the TV Broadcast Bands)	ET Docket No. 04-186
)	
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band)	ET Docket No. 02-380
)	

**COMMENTS OF MSTV AND NAB
TO THE OET MEASUREMENT REPORT ON
DTV RECEIVER INTERFERENCE REJECTION CAPABILITIES**

April 30, 2007

SUMMARY

MSTV and NAB commend the Commission's Office of Engineering and Technology and its Laboratory Division for performing a thorough and comprehensive analysis of the interference rejection performance of eight late-model DTV receivers. The resulting FCC Report provides important data demonstrating many of the baseline protections necessary to protect consumers' access to digital programming and services just as they are poised to benefit from the multibillion dollar DTV investment of the broadcast and consumer electronics industries.

Most notably, the FCC Report confirms that in designing rules to govern any new devices introduced into the public's DTV spectrum, the Commission must account for:

- ***The presence of “weak” – and thus easily disrupted – DTV signals throughout the majority of a television station’s service area.*** With DTV receivers experiencing weak signal conditions in “fully 84 percent” of a station’s coverage area, it is essential that new devices operate solely *outside* the protected contour of co- and adjacent TV channels *and* at D/U ratios based upon such weak signal conditions. The widespread presence of weak signals also precludes reliance on so-called spectrum “sensing” technologies to prevent errant operation of a device on an occupied TV channel. A robust geolocation method is necessary to preserve DTV reception.
- ***Interference from multiple devices.*** The FCC Report correctly tests for the effects of multiple devices on consumers' ability to view DTV programming and services, as it is unrealistic to expect sets to receive undesired signals from just a single device. The Commission's rules must similarly assume interference from multiple devices.
- ***Wide variance of DTV interference rejection performance.*** As reflected in the results of the FCC Report, interference performance can vary substantially across DTV receivers as well as the type of interfering signal received. Such variance and the DTV “cliff effect” – in which a DTV receiver entirely loses picture and sound once its rejection threshold is crossed – preclude use of median performance among receivers in calculating appropriate protection ratios. The Commission's rules must therefore be based on protection to all measured DTV receivers and interference mechanisms.
- ***The Need to Prohibit Personal/Portable Devices from the DTV Spectrum.*** The findings of the FCC Report suggest that designing rules to protect the public's DTV service, and its massive investment in new sets, will be challenging at best. At a

minimum, the Commission should not authorize any personal/portable devices, which would be particularly harmful sources of interference.

In addition to the protections suggested by the FCC Report, the Commission's rules must also account for the effect of co-channel "splatter" interference from new devices. Such effects were expressly not within the scope of the FCC Report. Protections to prevent this type of interference include a reduction in the level of emissions allowed under Section 15.209 of the Commission's rules, as MSTV and NAB have previously documented in this proceeding, along with appropriate adjustments to the FCC Report's D/U ratio measurements.

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The Association for Maximum Service Television, Inc. (“MSTV”)¹ and the National Association of Broadcasters (“NAB”)² commend OET and its Laboratory Division for performing a thorough and comprehensive analysis of the interference rejection mechanisms affecting DTV receivers, and conducting extensive interference rejection tests on eight late-model receivers.³ The data in the resulting report on DTV Interference Rejection Thresholds (the “FCC Report”) substantiates MSTV and NAB’s previously filed interference concerns and analyses. The FCC Report does an excellent job of studying the impact of out-of-channel signals and interference from multiple signals and this data shows that TV band devices would cause

¹ MSTV is a non-profit trade association of local broadcast television stations committed to achieving and maintaining the highest technical quality for the local broadcast system.

² NAB is a nonprofit trade association that advocates on behalf of more than 8,300 free, local radio and television stations and also broadcast networks before Congress, the Federal Communications Commission and other federal agencies, and the Courts.

³ Specifically, MSTV and NAB applaud the Division for conducting out-of-channel interference tests using four different desired signal levels (-28 dBm -53 dBm, -68 dBm and $D_{\text{Min}} +3$ dB), and including both single-channel interferers and paired interferers at various channel combinations in this measurement program. See *Office of Engineering and Technology Report: Interference Rejection Thresholds of Consumer Digital Television Receivers Available in 2005 and 2006*, OET Report, FCC/OET 07-TR-1003 (March 30, 2007) (“FCC Report”).

significant interference. Moreover, as described in Section II, the Commission must also take account of the full potential of interference from the combination of co-channel “splatter” and out-of-channel emissions by TV band devices, which the FCC Report by its own terms does not fully address.

As discussed below, the FCC Report confirms that the Commission must adopt rules that protect the viewing public by accounting for (1) the presence of “weak” (and thus easily disrupted) DTV signals throughout the majority of a television station’s service area, (2) the likely presence of multiple interfering signals from TV band devices, and (3) a high degree of variability in interference performance among consumers’ television sets. Together, these findings also demonstrate that any operation of so-called “personal/portable” devices in the broadcast spectrum will significantly diminish consumers’ access to digital television (“DTV”) programming and services just as they are poised to benefit from the multibillion dollar DTV investment of the broadcast and consumer electronics industries.

I. THE FCC REPORT CONFIRMS PROTECTIONS THAT ARE NECESSARY TO PROTECT THE PUBLIC’S DTV SERVICE.

A. Most Receivers in a Station’s Service Area Receive Relatively Weak Television Signals.

The FCC Report correctly recognizes that “DTV receivers are at their most vulnerable [to interference] when operating at low desired signal levels” and that “fully 84 percent of the coverage area of a broadcast station” may experience such signal levels.⁴ Thus, the Commission’s rules cannot merely protect the relatively small number of receivers operating under “best case” signal scenarios, but also the majority of receivers that will receive weak but otherwise viewable DTV signals.

⁴ *Id.* at xi (emphasis added).

Specifically, the FCC Report finds:

[T]he -68 dBm signal level designated by the ATSC as “weak” is 16 dB above the -84 dBm minimum signal level at which a typical DTV receiver can operate; that minimum signal level of -84 dBm is also the signal level assumed by OET-69 (FCC’s document for predicting coverage of a TV station) to be available to a DTV receiver at the edge of coverage of a TV broadcast station ... Fully 84 percent of the coverage area of a broadcast station may experience desired signal levels weaker than -68 dBm, assuming that the same type of antenna system is used at all locations in the viewing area. *This suggests a need to test at lower signal levels.*⁵

The FCC Report also helpfully explains the difficulty in predicting when and where weak signals will occur within a station’s service area in light of significant variation in DTV signal levels based upon a number of factors.⁶ For example, it notes that “the signal level at the TV’s RF input can easily vary over a 26-dB range simply by changing from an indoor antenna to an outdoor, mast-mounted antenna” and that this “span can be even wider (30-dB or more) if a mast-mounted preamp is used to minimize the effect of download attenuation.”⁷

The policy implications of this finding are described more fully in comments and reply comments submitted in this proceeding by MSTV and NAB. Most notably, the widespread presence of weak signals in a station’s service area requires that:

- *All TV band devices must operate outside the protected contour of both co- and adjacent TV channels.* Otherwise, a strong signal from a TV band device will

⁵ *Id.* at 5-3 (emphasis added).

⁶ Weak signal levels can also occur, for example, when a receiver is behind an obstruction such as a building or a hill.

⁷ See FCC Report at 5-3, 2-6 (“Knowledge of the receive antenna system and deployment (*e.g.*, indoor versus outdoor) used by a given TV receiver is not generally available to an outside entity, whether that entity is a smart-radio device transmitting in locally unused TV spectrum or an analyst assessing potential for interference between two DTV broadcast stations ... [A] given receiver could be operating with a 1-dB signal margin (at $D = D_{MIN} + 1$ dB, or about -83 dBm) or at the ATSC ‘moderate’ signal level ($D = -53$ dBm), based only on changes in the antenna system.”)

overwhelm reception of a weak but otherwise viewable DTV signal within the contour.

- *So-called spectrum sensing mechanisms are inadequate to prevent a TV band device from transmitting on an occupied television channel.* For example, as documented by MSTV and NAB, the -116 dBm detection threshold discussed in the Commission's *Further NPRM* would allow a device to transmit within the contour of a co-channel television station in the many portions of the service area with weak signal conditions.⁸ A robust geolocation method must be implemented to provide adequate protection to the public's DTV service.
- *The Commission must base protection of DTV reception on D/U ratios that are calculated to protect viewers from interference when they receive a weak but acceptable DTV signal.* As discussed below, further evaluation is necessary to determine those ratios, but at a bare minimum they should be no less stringent than proposed in the Commission's initial (2004) *NPRM* in this proceeding.⁹

In light of these important policy implications, MSTV and NAB applaud the Commission for recognizing that without protection of "weak" signal reception, millions of viewers could lose access to DTV programming and services.

B. The Commission's Rules Must Account for Interference from Multiple Devices.

In testing for the effects of multiple devices on consumers' ability to view DTV programming and services, the FCC Report corrects a mistake committed by many of the most aggressive proponents of TV band devices in considering interference from a single device to a single receiver.¹⁰ As MSTV and NAB have previously explained, in the real world, "a number

⁸ See Joint Comments of MSTV and NAB, ET Docket No. 04-186 (filed Jan. 31, 2007) at 11-13 ("January 2007 MSTV/NAB Comments").

⁹ See Joint Reply Comments of MSTV and NAB, ET Docket No. 04-186 (filed March 2, 2007) at 9 ("March 2007 MSTV/NAB Reply Comments").

¹⁰ See Comments of Dell Inc., Google, Inc., The Hewlett-Packard Company, Intel Corp., Microsoft Corp., and Philips Electronics North America Corp., ET Docket No. 04-186 at 8-9 (filed Jan. 31, 2007) ("Device Coalition Comments").

of TV band devices will be operating on multiple channels in close proximity to a TV receiver” and thus D/U ratios must take into account multiple interfering signals.¹¹

Specifically, the FCC Report finds that certain “paired” (*i.e.*, *multiple*) signals from TV band devices will constitute a “dominant interference susceptibility” at both high and low signal levels.¹² These findings pointedly demonstrate the inadequacy of any rule proposal based solely on an assumption that receivers will be affected by a single interfering device.

The FCC Report’s finding as to interference from even a *single* device are also instructive. Just one device’s signal can cause even more harmful interference on second adjacent channels (N-2 and N+2, where “N” is the desired station’s signal) than on first adjacent channels (N-1 and N+1). These results are similar to those documented by the study of Communications Research Centre Canada (“CRC”) and the University of Kansas study submitted by the New Americas Foundation (“NAF”), which show risk of harmful interference from TV band devices operating on second and third adjacent channels.¹³ And both the FCC and CRC studies suggest that operation on certain other channels such as, N+7, N+14, and N+15, may be problematic. The bottom line is that the Commission’s rules for TV band devices must prohibit operation not only on co- and first adjacent channels, but should also consider ways to mitigate the interference effects of second adjacent and certain other taboo channels on DTV reception.

¹¹ January 2007 MSTV/NAB Comments at 21.

¹² See FCC Report at 15-4.

¹³ See March 2007 MSTV/NAB Reply Comments at 20-21 and Exhibit B, figure A.11.

C. The D/U Protection Ratios Adopted by the Commission Must Account for Variance among Different Receivers' Ability to Reject Interference and Should Not Be Based on Median Receiver Performance.

Like the CRC Study, the FCC Report finds that interference performance can vary substantially across DTV receivers and across the type of interfering signal (*e.g.*, co-channel, adjacent channel, out-of-band) received. For example, the D/U values for second adjacent channel (N-2) interference performance of the eight receivers tested by the FCC varied by more than 25 dB between the best receiver and the worst receiver and performance on N-6 varied by over 40 dB.¹⁴ As MSTV and NAB have elsewhere explained, such a variance precludes the Commission from simply basing D/U protection on the median performance of all receivers.¹⁵

Due to the “cliff effect”, a DTV receiver that is one or two dB below the median performance ceases to display any picture or sound – making use of median performance standards inappropriate. As the FCC Report explains, “once an undesired signal reaches a level at which picture impairments become visible on a DTV receiver, the picture degrades extremely rapidly with further increases in undesired signal level.”¹⁶ In contrast, in the analog context, reception suffers degradation more gradually, allowing receivers below the median value to nevertheless display an acceptable (if imperfect) picture and service.

Thus, while median performance may have been acceptable for protection of analog TV reception, its use in the DTV context will leave far too many viewers in the dark. The

¹⁴ See FCC Report at A-3.

¹⁵ See January 2007 MSTV/NAB Comments at 18-19.

¹⁶ See FCC Report at 15-2 and 15-3. The study notes that for DTV “increasing interference level about 1 dB” causes “complete loss of picture” but that for analog TV interference effects occur much more gradually. For example, an 8 dB increase in interference may only cause interference to grow to the “slightly-annoying” level and “a total increase of 20 to 30 dB may be required to make the analog picture unusable.” *Id.*

variance among DTV receiver performance described in the FCC Report requires the Commission to select a value that is met by all measured TV receivers and therefore protects all TV viewers regardless of which DTV set (or digital-to-analog converter box) they have purchased.

In addition, the wide variance of interference performance among the small sample of receivers tested suggests that the Commission should test a greater number of receivers and range of conditions before determining appropriate protection ratios.¹⁷ As the FCC Report explains, the rejection performance measurements in the report were performed on “only a small sample of consumer DTV receivers” and do not provide a “robust statistical basis for identifying the overall range” of performance of DTV receivers.¹⁸ Further, DTV receiver designs are still not mature.¹⁹ It is not clear, for example, whether new smaller screen size DTV receivers will have comparable performance to the eight “best” and relatively expensive, large screen DTV receivers used in this study.²⁰ MSTV and NAB accordingly urge caution in drawing final conclusions from the relatively small sample of DTV receivers tested to date.

On a related point, the FCC Report confirms that in determining appropriate D/U protection ratios, the Commission cannot assume that DTV receivers will fully meet the

¹⁷ While the FCC testing was extensive, the test sample of DTV receivers was limited and only a few OFDM tests were performed. More rigorous OFDM tests should also be conducted since OFDM may represent the major modulation scheme used by TV band devices. OFDM will not exhibit identical interference characteristics into DTV. For example, the OFDM peak-to-average ratios differ depending on the number of carriers and the underlying carrier modulation (64-QAM, 16-QAM, or QPSK) on those carriers. Additional tests, specifically with this signal characteristic in mind, should be designed and conducted. In addition, the CRC Report also tested at a strong undesired level of -15 dBm.

¹⁸ *Id.* at 15-1.

¹⁹ The Commission only recently required that all television receivers have DTV reception capability.

²⁰ All of the tested DTV receivers had screen sizes of 26 inches and larger.

voluntary ATSC A/74 Recommended Practice guidelines for interference performance.²¹ Even the best performing of the eight receivers appears to have failed the guidelines at one channel offset. The Commission must accordingly rely on actual performance results and not those suggested in the A/74 guidelines.

In addition to the necessity of testing a greater number of receivers, the Commission must also test other varieties of receivers, including mobile and handheld devices, which were not within the scope of the FCC Report. Tuners for mobile/handheld devices will likely have different component, cost, and power tradeoffs from television set tuners, and will differ substantially in their ability to deal with interfering signals. Therefore, testing should account for specific mobile/handheld characteristics.

Indeed, the ATSC recently commenced work on a standard for delivering content to mobile/handheld devices using a DTV broadcast signal (ATSC-M/H).²² Two proposed mobile DTV reception systems were demonstrated at the NAB show in April 2007: one by Harris and LG, and the other by Samsung and Rohde & Schwarz. Also, a consortium of broadcasters has been formed to support the development of DTV delivery to mobile/handheld receivers using in-band DTV broadcast spectrum.²³ So long as not precluded by interference from TV band devices, local stations will be able to provide a variety of content and services directly to handheld receivers, notebook computers, and vehicles within their existing DTV channel assignment. The Commission should accordingly undertake further testing to ensure

²¹ Moreover, given the Commission finding that paired interferers effects are sufficiently higher than the signal interferer effect, the use of A/74 would be unsuitable.

²² See Press Release: ATSC to Develop Standard for Mobile and Handheld Services, April 9, 2007, available at http://www.atsc.org/news_information/press/2007/Mobile_07.html.

²³ See Press Release: Open Mobile Video Coalition to Promote Mobile Digital Broadcast TV in U.S., April 13, 2007, available at <http://www.ionmedia.tv/press/press.cfm?id=35>.

that TV band devices do not prevent consumers from enjoying the rich and diverse services made possible by these and other advances in digital television technology.

D. Personal/Portable Devices Will Prevent Consumers from Receiving DTV Programming and Services.

All of the findings described above suggest that designing rules that will protect the public's DTV service from harmful interference by TV band devices will be challenging, to say the least. There can be no doubt that authorization of *any* new TV band devices will degrade reception of DTV programming and services to some extent – the question is by how much. The Commission should therefore endeavor to prevent the most pernicious interference-producing devices from operating in the DTV spectrum. Simply put, the Commission should not allow the introduction of any non-fixed (*i.e.*, personal/portable) device.²⁴

For example, the above-described problem of multiple interfering signals will be far more prevalent if personal/portable devices are allowed in the public's DTV spectrum, because there is likely to be more than one personal/portable device within close proximity to a DTV set or digital-to-analog converter box. In contrast, multiple *fixed* devices in a consumer's home will be less common.

Also, unlike fixed devices, personal/portable devices can be operated anywhere, including indoors and often in close proximity to televisions. As such, there is no method of preventing personal/portable devices from operating in close proximity of a television set. And

²⁴ One of the main goals of this proceeding has been to provide new broadband services, especially to rural and underserved areas of the United States. MSTV and NAB fully support this goal, but it is the introduction of *fixed* devices, rather than personal/portable TV band devices, that furthers this goal. In fact, the interference caused by uncontrolled personal/portable devices may inhibit the deployment of fixed broadband operations. By authorizing only fixed TV band devices to operate, accompanied by proper protections, the commission can promote a broadband plan without endangering television reception.

there can be no reliable means of knowing where a personal/portable device ends up once it is sold to a consumer. This will make both identification and elimination of interference extremely difficult, if not impossible.

While any authorization of personal/portable devices would do great harm to the public's ability to receive DTV programming and services, it bears mention that they would be particularly harmful if allowed to operate on adjacent channels within a station's service area, as originally proposed in this proceeding's *NPRM*.²⁵ Specifically, the FCC Report finds that *median* D/U ratios for a desired signal level of -68 dBm were -39.3 and -39.7 dB for N-1 and N+1, respectively.²⁶ (The D/U ratios for the "best" DTV receiver tested was only 2.4 and 0.8 dB better than the median on the first adjacent channels). NAF has calculated that a 100 mW TV band device at a distance of 10 meters will present an undesired signal level of -28 dBm to a DTV receiver.²⁷ Using this NAF level of -28 dBm and the FCC Report's optimistic D/U ratios shows that a 100 mW device would cause interference to DTV receivers that receive a signal level only slightly below the -68 dBm level. Allowing interference to all television signals

²⁵ See *Unlicensed Operation in the TV Broadcast Bands*, Notice of Proposed Rulemaking, 19 FCC Rcd. 10018 ¶¶30-31 (2004) ("Initial White Spaces NPRM") ("With regard to personal/portable operations, we believe at this time that the potential for harmful interference to adjacent channel television operations is sufficiently low that we do not need to impose adjacent channel restrictions on these devices. We note that even in the 'worst case' situation at the edge of a television station's service area, *i.e.*, where the TV station's signal is the lowest, the interference potential from an adjacent channel personal/portable device would be minimal and, in practice, would be mitigated by the effects of ambient noise, shielding from buildings, walls, ground clutter, etc").

²⁶ The D/U ratios from the FCC Report are somewhat optimistic because they do not account for any co-channel "splatter" interference that can be a very significant factor for first adjacent channel operation. Nevertheless, the calculations using these overly optimistic D/U ratios still show significant interference concerns.

²⁷ See Comments of New America Foundation- University of Kansas Interference Study, ET Docket No. 04-186 (filed Jan. 31, 2007) at 2-3.

slightly below -68 dBm is extremely problematic given the above-described finding that 84% of a TV station's service area received a signal less than -68 dBm. In other words, the vast majority of a TV station's service area would not meet the D/U protections required and potentially could receive significant interference from personal/portable devices. The situation on second adjacent channels is similar.

Similarly, in addition to interference caused by a single TV band device, the FCC Report indicates that significant interference will occur on multiple taboo channels in situations involving paired signals unless such operation can be reliably prevented. Some of the results of the Commission's testing are contained in Figure 15-16 of the Report shown below. A solid blue line was added to the figure to show the -28 dBm undesired signal level from 100 mW unlicensed device at 10 meters. As can be seen below, consideration of multiple interferers means that a personal/portable TV band device must also avoid channels N-4, N-5, N-8, N-10, N+3, N+4, N+6, N+8 and N+16 in addition to the single channel interference situations to avoid causing interference to DTV viewers.²⁸

²⁸ These results also confirm that the Device Coalition's so-called interference avoidance algorithm is woefully inadequate to protect DTV service and its viewers. *See* Reply Comments of Dell Inc., Google, Inc., The Hewlett-Packard Company, Intel Corp., Microsoft Corp., and Philips Electronics North America Corp., ET Docket No. 04-186 (filed March 2, 2007) at 5-8 ("Device Coalition Reply Comments").

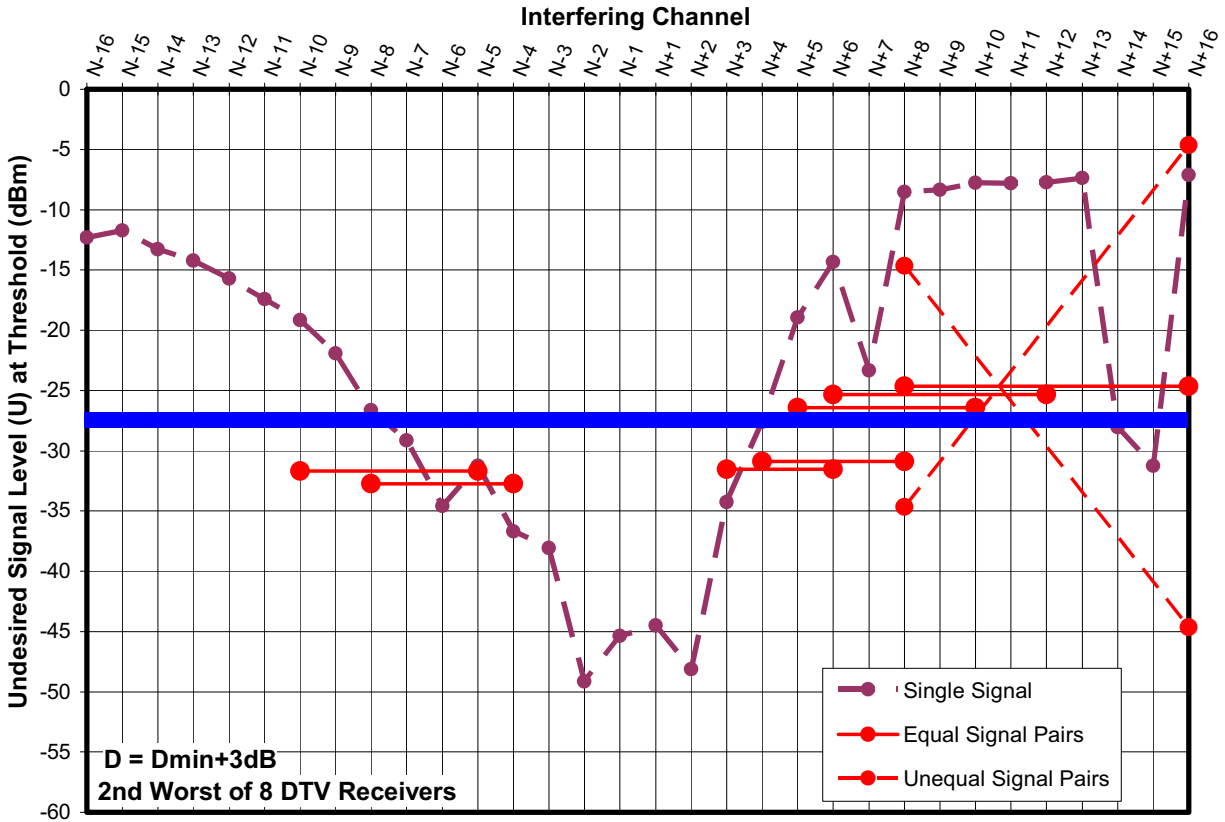


Figure 15-16. 2nd Worst Threshold U of 8 Receivers at $D = D_{MIN} + 3dB$ With IM3 Signal Pairs

II. CO-CHANNEL “SPLATTER” EFFECTS WILL CAUSE ADDITIONAL INTERFERENCE THAT WAS NOT STUDIED BY THE FCC REPORT.

While the results of the FCC Report suggest many of the protections necessary to protect DTV viewers, the FCC Report, by its own terms,²⁹ does not address all the sources of interference. Significantly, the FCC Report does not measure the effects of co-channel “splatter”

²⁹ See FCC Report at viii.

interference from TV band devices.³⁰ Protections to prevent this type of interference – such as reducing the level of emissions allowed under Section 15.209 – must also be adopted.

Specifically, the FCC tests were performed to measure the “out-of-channel” interference rejection capabilities of some of the newest generation DTV receivers,³¹ but the report specifically did not include or intend to include the effects of co-channel “splatter” interference.³² Rather, the out-of-channel tests were performed using a test setup that was intended to specifically suppress leakage of the undesired signal into the desired channel to a degree such that the spectral leakage effects were made negligible; this approach represents a scientific investigation of specific but isolated interference mechanisms. Thus, the FCC report, unlike the CRC studies and the University of Kansas study, did not measure the full interference potential of a “real-world” TV band device. For example, the first-adjacent channel tests do not include the effects of spectral splatter representative of a practical, real-world transmitter.³³

³⁰ *Id.* at 1-3. The device may unintentionally “splatter” enough energy into the channel to which the DTV receiver is tuned to interfere with TV operation. The resulting interference is a combination of this co-channel splatter effect and the out-of-channel mechanisms study in the report.

³¹ The term, “out-of-channel” interference, as used in this report, includes any interference occurring outside of the 6-MHz width of the TV channel to which the receiver is tuned. *See Id.* at 1-1.

³² *Id.* at 1-3 (“we applied filtering to the outputs of out-of-channel signal sources used in the tests in order to reduce their spectral splatter into the desired channel to negligible levels”).

³³ To illustrate the importance of this effect, note that it drives the first-adjacent channel protection ratios used for DTV channel allotments.

CONCLUSION

At stake in this proceeding is the public's ability to benefit from the multibillion dollar investment of the broadcast and consumer electronics industries in DTV technology and services. MSTV and NAB accordingly commend the Commission for testing and reporting on the interference rejection thresholds of eight DTV receivers, and urge the Commission to conduct further testing and adopt appropriate protections before authorizing any new devices to operate in the DTV spectrum.

Respectfully submitted,

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