

ANALYSIS OF ET DOCKET NO. 186
UNLICENSED OPERATION IN THE TV BROADCAST BANDS
SECOND MEMORANDUM OPINION AND ORDER
RELEASED: SEPTEMBER 23, 2010

Introduction

The September 23, 2010 *Second Memorandum Opinion and Order* adopting rules for unlicensed transmitters in the TV Broadcast Bands, ET Docket No. 04-186, has been reviewed. The purpose of the review is to ascertain the level of protection provided to 700 MHz Band, frequency Block A licensees (“Block A”) operating in former TV Channel 52 spectrum (698-704 MHz). The purpose of this statement is to review the new rules in light of established industry protection standards to facilities authorized in the 698 to 704 MHz Lower A Block spectrum and to recommend simple changes to the new rules to provide protection to Block A licensees equivalent to the protection afforded occupants on TV channels 2-51.

Executive Summary

The FCC decision implements rules for operation of unlicensed transmitting devices in the television broadcast frequency bands (unlicensed TV bands devices, or “TVBDs”). The devices fall into two categories. First, TV band fixed local devices are authorized at a maximum EIRP of 4 watts with a maximum antenna height of 30 meters AGL and a HAAT of 106 meters. Second, TV Band personal/portable devices are limited to a maximum EIRP of 100 mW, with certain requirements for further reduction in power.

Section 15.709(c)(1) of the new rules sets out of channel emission requirements for TVBD operation. A TVBD operating on any TV channel, including CH 51, is required to meet this criterion: “In the television channels immediately adjacent to the channel in which a TVBD is operating, emissions from the TVBD shall be at least 72.8 dB below the highest average power in the TV channel in which the device is operating.”¹

¹ Note: Although the rules provide emission requirements they only pertain to adjacent channels exclusively in the range from Channels 2-51 and not CH 52, 698 to 704 MHz, Lower A Block spectrum.

Based on an EIRP of 4 watts (36 dBm) from a TVBD operating on CH 51, and a 72.8 dB attenuation in the adjacent CH 52 spectrum, the maximum radiated out of band emission is -36.8 dBm. Information provided to Cellular South from equipment manufacturer Alcatel-Lucent (“Alcatel”) indicates that the in-band interference level limit is -114.5 dBm. Based on standard free space loss calculations, the additional 77.7 dB of required attenuation needed to meet the Alcatel limit would occur if the TVBD and the 698 to 704 MHz Lower A Block spectrum LTE receiver are separated by a minimum of 0.1619 miles (855 feet).

For a 100 mW (20 dBm) portable device, the required attenuation is 61.7 dB, which requires a separation of 0.0257 miles (135 feet). For a 40 mW (16 dBm) portable device, the required attenuation is 61.7 dB which requires a separation of 0.0162 miles (85 feet).

Analysis of new rules - operation of unlicensed transmitters in the TV Broadcast Band

Review of the *Second Memorandum Opinion and Order* document revealed no mention of Block A or protection of 700 MHz band users. The only commenters who would presumably have an interest in protecting 700 MHz spectrum were APCO and the Land Mobile Communications Council. Both groups appear to have focused their comments on the PLMRS/CMRS, Offshore Radiotelephone Service and licensed authorized services operating on channels 14-20.

Page 3 of the Order – The FCC Modified the definition of the receive sites entitled to protection outside a television station’s service area to include all multi-channel video programming distributors as defined by the rules. There is no defined protection for 700 MHz band users operating from 698-704 MHz, Block A, however.

Paragraphs 69 & 77 set the maximum power level for fixed white space devices:

Fixed devices – The FCC declined to increase the 4 watt EIRP power limit for fixed devices and noted that the Commission also considered and rejected a higher power limit for fixed devices in the *Second Report and Order*. Although the Commission previously observed that there are advantages

to higher power levels for fixed devices, such as reduced infrastructure costs and increased service range, it did not adopt a higher power limit due to concerns of increased risk of interference in congested areas and a lack of experience with unlicensed wireless broadband operations in the TV bands. The Commission affirmed its previous decision on fixed device power levels stating: “we could revisit the issue of higher power levels for TV bands devices on a licensed or unlicensed basis at some point in the future as may be appropriate.”

Portable devices – The FCC retained the current 100 mW maximum transmitter power limit for Mode I and Mode II personal/portable devices and declined to establish a new class of higher power vehicle mounted portable devices. As the Commission noted in the *Second Report and Order*, personal/portable devices generally pose a greater risk of harmful interference to authorized operations than fixed devices because these devices will change locations, making identification of both unused TV frequencies and the devices themselves, if interference occurs, more complex and difficult. The Commission also noted the significant distances at which interference could occur from a personal/portable device operating at greater than 100 mW would make it very difficult to identify a device that is the source of interference. The FCC therefore declined to increase the power limit for personal/portable devices at this time and affirmed the limitation on transmit power of personal/portable devices operating on channels adjacent to the protected service contours of television stations to 40 mW.

Paragraph 66 sets AGL and HAAT limits for fixed device transmitting antennas:

In considering a limit for antenna HAAT, the Commission saw a need to balance the concerns for long range propagation from high points against the typical variability of ground height that occurs in areas where there are significant local high points – “we do not want to preclude fixed devices from a large number of sites in areas where there are rolling hills or a large number of relatively high points that do not generally provide open, line-of-sight paths for propagation over long distances. We find that limiting the fixed device antenna HAAT to 106 meters (350 feet), as calculated by the TV bands database, provides an appropriate balance of these concerns. We will therefore restrict fixed TV bands devices from operating at locations where the HAAT of the ground is greater than 76 meters;

this will allow use of an antenna at a height of up to 30 meters above ground level to provide an antenna HAAT of 106 meters. Accordingly, we are specifying that a fixed TV bands device antenna may not be located at a site where the ground HAAT is greater than 75 meters (246 feet). The ground HAAT is to be calculated by the TV bands database using computational software employing the methodology in Section 73.684(d) of the rules to ensure that fixed devices comply with this requirement.”

Paragraph 87 - the FCC set adjacent channel emission limits which are reasonably stringent:

“We are modifying the rule for adjacent channel emissions to require that emissions be measured relative to the total in-band power in a 6 megahertz bandwidth, rather than in a 100 kHz bandwidth. This change will address the concerns raised by petitioners that the measured in-band power in a narrow bandwidth will vary depending upon the bandwidth of the transmitted signal. We will continue to require that the adjacent channel emissions be measured with a 100 kHz bandwidth because a wider bandwidth would not be able to resolve emissions located just outside the channel of operation without being affected by the in-band power. The use of a 6 megahertz bandwidth for measuring the in-band power means that a higher reading will be obtained as compared to using a 100 kHz bandwidth, because the wider bandwidth will capture all the energy in a channel rather than only a portion of that energy. The 55 dB attenuation that the Commission adopted for adjacent channel emissions was based on the assumption that identical bandwidths would be used to measure both in-band and adjacent channel power, so we agree with IEEE that the currently required 55 dB attenuation should be increased to reflect the increased in-band measuring bandwidth while providing the same level of adjacent channel protection. As noted above, we will assume the maximum transmit bandwidth used to be the full 6 MHz channel. We will therefore base the increase in adjacent channel attenuation on a bandwidth ratio of 6.0 megahertz/100 kHz or 17.8 dB. Thus, we are revising the required adjacent channel attenuation to be 72.85 dB.”

698 to 704 MHz Lower A Block protection criteria

The data and analysis within this document concerning protection to Lower A Block receivers is obtained from an Alcatel-Lucent Proprietary document titled “Interference from DTV Ch 51 Station to Lower A Block LTE BS: Antenna isolation Calculation Based on Criterion 1” and the FCC Rules regarding Digital Television out of band emissions” as found in Appendix A, attached. This document pertains equally to TVBD devices operating on CH 51. Channel 51 is the six megahertz band from 692 to 698 MHz. The Lower A Block is the 6 MHz band from 698 to 704 MHz. The LTE (Long Term Evolution) equipment analyzed within this document will operate in the five MHz channel from 699 to 704 MHz. This leaves a 1 MHz “guard band” between DTV transmissions and the LTE lower Block A base station receive equipment.

There are two normal cases of interference in which a CH 51 DTV might interfere with reception of the handheld subscriber radio signals operating in lower Block A at the LTE base station:

- 1) The base station receiver might receive some of the main DTV signal causing desensitization of the LTE base station receiver; and:
- 2) The DTV out of band emissions (OOBE) may cause interference to base station reception.

Appendix A hereto clearly states that the primary interference mechanism to Lower 700 MHz wireless Block A license facilities is case 2 OOBE.

It may be seen from Appendix A hereto that emissions from a CH 51 full service DTV station in CH 52 are attenuated 57.3 dB below the CH 51 DTV average power level based on 73.622(h)(1). The standard set for TVBD operation, found in 15.709(c)(1) is 72.8 dB. Neither 57.3 dB for DTV facilities, nor 72.8 dB for TVBD facilities, are sufficient levels of attenuation to prevent OOBE caused interference to 700 MHz wireless lower Block A license facilities operating on TV CH 52 unless the CH 51 transmission facilities are located at a sufficient distance that any external received

signal (noise) will be received at the antenna input port with a level not to exceed -114.5 dbm. This level of interfering signal at 10 db below the thermal noise level of the receiver would add virtually no noise to the system. Therefore, it is necessary to determine the received level of the undesired CH 51 OOBE signal to determine whether interference to the Lower 700 MHz wireless Block A license facilities will exist. It is noted that that Lower 700 MHz wireless Block A license facilities handheld subscriber units transmit in the 698-704 MHz band and receive in the 728-734 MHz band. Thus, Lower 700 MHz wireless Block A license facilities base stations receive the handheld subscriber signal in the 698-704 MHz band and transmit to the subscriber receiver in the 728-734 MHz band.

Recommended rule changes required to protect Lower 700 MHz wireless Block A license facilities

As noted, the rules currently do not afford protection to Lower 700 MHz wireless Block A license facilities despite the fact that CH 52 (698-704 MHz) is now allocated for wireless use throughout the U.S.. In the absence of protection to these facilities, they will likely suffer interference from fixed and personal/portable TVBDs operating on television channel 51. Protection to these facilities can be incorporated into the rules adopted in ET Docket No. 04-186 simply and effectively by the following proposed modifications:

Section 15.703 is revised to read as follows:

(j) *Receive site*. The location where the signal of a full service television station is received for rebroadcast by a television translator or low power TV station, including a Class A TV station, or for distribution by a Multiple Video Program Distributor (MVPD) as defined in 47 U.S.C. 602(13) **or the location of a licensed wireless facility base station receiver registered in the TV Bands database.**

Section 15.709 is revised to read as follows:

(c) *Emission limits for TVBDs*.

(1) In the television channels, **and licensed wireless systems**, immediately adjacent to the channel in which a TVBD is operating, emissions from the TVBD shall be at least

72.8 dB below the highest average power in the TV channel in which the device is operating.

Section 15.711 is revised to read as follows:

Geo-location and database access. A TVBD shall rely on the geo-location and database access mechanism to identify available television channels consistent with *the interference protection* requirements of § 15.712. Such protection will be provided for the following authorized and unlicensed services: digital television stations, **licensed wireless systems**, digital and analog Class A, low power, translator and booster stations; translator receive operations; fixed broadcast auxiliary service links; private land mobile service/commercial radio service (PLMRS/CMRS) operations; offshore radiotelephone service; low power auxiliary services authorized pursuant to §§ 74.801-74.882 of this chapter, including wireless microphones and MVPD receive sites; and unlicensed wireless microphones used by venues of large events and productions/shows as provided under section 15.713(h)(8). In addition, protection shall be provided in border areas near Canada and Mexico in accordance with § 15.712(g).

Section 15.712 is revised to read as follows:

(c) Lower 700 MHz wireless Block A licensees operating on TV Channel 52 (698-704 MHz). Lower 700 MHz wireless Block A licensees operating base station receivers on former TV Channel 52 (698-704 MHz) will be protected when registered in the TV bands database. TVBD will be prohibited from operating within the following radius of a registered 700 MHz Band, frequency Block A, base station receiver operating on a first adjacent channel:

Fixed TVBD – none in the U.S.

Personal/Portable Device operating at 100 mW – none in the U.S.

Personal/Portable Device operating at 40 mW - 0.1 kilometer

Section 15.713 is revised to read as follows:

(9) Licensed wireless system receive sites. Registration for receive sites is limited to channels that are received over-the-air and are used as part of a licensed wireless network.

(i) Name and address of wireless company.

(ii) Location of the wireless receive site (latitude and longitude in NAD 83, accurate to +/- 50 m).

(iii) TV Channel number of each wireless channel received.

(iv) Call sign of the wireless system whose base station is eligible for registration.

The foregoing was prepared on behalf of **Cellular South, Inc.** by Clarence M. Beverage of *Communications Technologies, Inc.*, Marlton, New Jersey, whose qualifications are a matter of record with the Federal Communications Commission. The undersigned certifies, under penalty of perjury, that the statements herein are true and correct of his own knowledge, except such statements made on information and belief, and as to these statements he believes them to be true and correct.

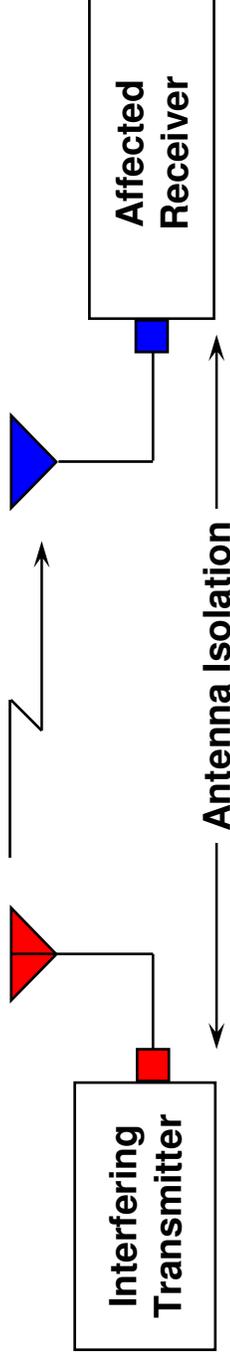
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December 31, 2010

Appendix A

Criteria for Determining BS to BS Antenna Isolation



- Antenna isolation is defined as the path loss (including both antenna gains, cable losses and propagation loss through the air) from an interfering transmitter Equipment Antenna Connector (EAC) to an affected receiver EAC
- Antenna isolation requirements are derived based on the following criteria:
 - *Criterion 1:* The interfering BS transmitter out-of-band emissions received by the affected BS is 10 dB below the affected receiver noise floor
 - *Criterion 2:* The total interfering BS carrier power attenuated by the affected BS RF receive filter is 10 dB below the affected receiver 1 dB compression point
 - *Criterion 3:* The affected BS receiver 3rd order IMP caused by interfering BS carriers (attenuated by the affected BS RF receive filter) is 10 dB below the affected receiver noise floor
 - *Criterion 4:* The total interfering BS carrier power attenuated by affected BS receiver RF, IF and baseband filters is 10 dB below the affected receiver noise floor
- The external interference threshold (10 dB below the affected Rx noise floor) will cause a 0.4 dB Rx desensitization
- If the cell layout is designed to the maximum cell range supported by the uplink budget and the propagation loss slope is 35 dB/decade, the 0.4 dB Rx desensitization could reduce the uplink cell coverage by 5%

Interference from DTV CH 51 Station to Lower A Block LTE BS: Antenna Isolation Calculation Based on Criterion 1

- It is suggested that acceptable in-band interference level at Alcatel-Lucent LTE RRH EAC be - 114.5 dBm/4.5 MHz (i.e., 10 dB below the noise floor of -104.5 dBm/4.5 MHz considering a 3 dB receiver noise figure)
- Assumption: DTV station ERP is 25 kW (i.e., 76 dBm EIRP)
 - Assuming a 11 dBi effective BS antenna gain (i.e., antenna gain minus cable loss), the DTV CH 51 station transmit power is 65 dBm referenced to the EAC
- Conservative assumption: According to FCC CFR Title 47 Part 73.622 (h)(1), DTV station out-of-block emissions measured in a 500 kHz band must be attenuated no less than - 11.5x(Δf in MHz + 3.6) dB at 0.5-6 MHz offsets from the block edge
 - When a 5-MHz LTE channel is at 699-704 MHz (uplink), TV station emission power falling into the effective LTE resource blocks (699.25-703.75 MHz) is 57.3 dB below the DTV carrier power
- **The required isolation from the DTV CH 51 station to LTE BS is 122 dB [= 65 - 57.3 dBm - (-114.5 dBm)] to meet Criterion #1**
- **If the DTV station ERP increases from 25 kW to 1000 kW (i.e., FCC power limit for DTV), the antenna isolation based on Criterion 1 will increase from 122 dB to 138 dB**

Interference from DTV CH 51 Station to Lower A Block LTE BS: Antenna Isolation Calculation Based on Criteria 2, 3 and 4

- Assumption for DTV station Tx power: 25 kW ERP → 65 dBm power at EAC
- **Criteria 2, 3 & 4:**
 - Alcatel-Lucent commercial Lower 700 MHz LTE RRH (equipped with 15.5 MHz Filter) shall maintain a 0.4 dB Rx desensitization in the presence of a -10 dBm DTV carrier power at EAC (i.e., a 6 dB Rx desensitization in the presence of +5 dBm DTV carrier power)
 - ALU RRH Rx blocking performance is 54 dB better than TS 36.104 Rx narrowband blocking standard (a blocking level of -49 dBm with a 6 dB Rx desensitization)
 - **The antenna isolation required is 75 dB [= 65 dBm - (-10 dBm)]**
- **If the DTV station ERP increases from 25 kW to 1000 kW, the antenna isolation based on Criteria 2, 3 & 4 will increase from 75 dB to 91 dB**

Summary

- The required antenna isolation from DTV CH 51 Station to Lower A Block LTE BS to meet all interference mitigation criteria is about 122 dB for 25 kW DTV ERP and 138 dB for 1000 kW DTV ERP (dictated by FCC out-of-band emissions for DTV CH 51 station)
 - Further improving LTE BS Rx filters does not improve antenna isolation requirement, unless DTV CH 51 station emission mask (with 1000 kW carrier ERP) is improved to be 47 dB below FCC emission limit
 - The 122 dB and 138 dB antenna isolation requirements could be difficult to meet by antenna engineering in the field alone
 - If the free space propagation with a slope of 20dB/35dB per decade can be applied between DTV station and Lower A Block BS, the antenna separation requirement for 1000 kW DTV ERP is about 6/3 times that for 25 kW DTV ERP
 - If the antenna isolation in the field meets the 122 dB requirement for 25 kW DTV ERP and the DTV station ERP increases from 25 kW to 1000 kW, then the LTE BS Rx desensitization increases from 0.4 dB to 7 dB (corresponding to a uplink cell coverage reduction of 60% for a 35 dB/decade propagation loss slope)
- The antenna isolation requirement are conservative due to consideration of FCC emission limit for DTV CH 51 station
 - The real isolation requirement could be less than the above requirement
 - It is suggested that DTV Channel 51 emission mask be obtained from DTV operators/vendors or measured in the field
 - If the actual DTV Channel 51 station carrier and out-of-band emission power are available, the antenna isolation requirement will be revised accordingly