Interference Analysis of BRS/EBS Rules Applied to AWS-3

This report provides a technical analysis of the mobile-to-mobile interference issues associated with the application of FCC's BRS/EBS band rules to the AWS-3 band,[1,2] and provides an assessment of the impact to adjacent AWS-1 band devices.[3] The interference analysis & assessments are based upon test results performed with actual CMRS devices, and analysis of the mobile limits in the BRS/EBS rules applied to the AWS-3 band.

BRS/EBS Band Rules

The FCC BRS/EBS band rules for mobile devices are as follows:

> *Power Limits* – The power limit for mobile devices operating in the BRS/EBS band is defined in Part 27.50(h)(2) of the Commission's rules. The mobile power limit is equal to +33 dBm EIRP, which is equal to 2 Watts EIRP (effective radiated isotropic power).
>
> *Emission Limits* – The out-of-band (OOBE) emission limit for mobile devices operating in the BRS/EBS band is defined in Part 27.53(l)(4) of the Commission's rules. The emission limit is equal to 43 + 10*Log Pw at the licensed channel edge, and 55 + 10*Log Pw at 5.5 MHz away. This is equal to an OOBE limit of -13 dBm/MHz at band edge, and -25 dBm/MHz at 5.5 MHz away.[4]

If applied to the AWS-3 band, these BRS/EBS mobile limits will cause significant harmful interference to the lower adjacent AWS-1 band,[5] as outlined below. For this case, the mobile-to-mobile interference mechanism is in one-direction, i.e. from AWS-3 device to AWS-1 device, and does not occur in the opposite direction. Therefore, mobile power and OOBE limits are needed for AWS-3 devices to protect AWS-1 devices from harmful interference.

---

[1] BRS/EBS represents "Broadband Radio Service" and "Educational Broadband Service" in the 2496-2690 MHz spectrum band.
[2] The AWS-3 band is designated as the 2155-2175 MHz frequency band.
[3] The AWS-1 band is designated as the 2110-2155 MHz frequency band for base station transmissions, and 1710-1755 MHz for mobile station transmissions.
[4] For the BRS/EBS band, the emissions are referenced to a 1 MHz resolution bandwidth measurement.
[5] In addition, it has the potential to cause harmful interference to the upper adjacent AWS-2 band (or J Block), which is a planned future band assigned as 2175-2180 MHz for base station transmissions, and 2020-2025 MHz for mobile station transmissions.

Impact to AWS-1 with BRS/EBS Power Limits Applied to AWS-3

The impact to AWS-1 band is provided below, for the case with BRS/EBS power limits applied to AWS-3 band devices.

As demonstrated in Motorola's AWS tests,[6] an AWS-3 interference level received at -34 dBm causes AWS-1 band devices to Dropped Calls.[7] Motorola's use of a "dropped call" as the interference reference point for its AWS test is representative of an extreme measure of interference. Previous H-Block testing used degradation in call quality, as measured by an increase in Frame Error Rates, as the appropriate reference point.[8] Based on analysis of lab test data, impairments to call quality occur about 8 dB (typical value) before a call drops, indicating an occurrence of harmful interference at lower levels (i.e., -42 dBm). In summary, the adjacent channel interference due to receiver overload causes harmful interference at -42 dBm, and is severe enough to drop calls at -34 dBm.

Consistent with the analysis provided in the V-COMM H-Block Report,[9] for the mobile antenna gain,[10] path losses and typical minimum separation distances between CMRS device users, V-COMM uses similar values to assess the impact to AWS-1 band devices from AWS-3 band interference. In the H-Block report, V-COMM studied a variety of typical minimum separation distances between handsets used in close proximity, in addition to referencing wireless standards for minimum device separation distances, and determined that 1 meter is the appropriate standard. In addition to the path loss for a 1 meter separation distance, V-COMM provided an explanation for using 3 dB of additional losses associated with both devices, to account for body loss and/or other miscellaneous losses.[11] Therefore, the total path losses between AWS band devices

---

[6] Motorola's AWS test results were submitted in the AWS-3 band Comment proceeding, and included receiver overload tests with Motorola's AWS-1 device from interfering signals in the AWS-3 band. These tests utilized similar test methods and procedures as developed and submitted by the CTIA in the H-Block proceeding. The CTIA test plans included a variety of tests developed study the mobile-to-mobile interference impact to CMRS devices operating in the PCS bands, which was separated from the H-Block by 10 MHz of spectrum.

[7] These test results utilize a victim CDMA device operating in the AWS-1 band, with a CDMA signal source as the interferer, for the Case 2 tests simulating a faded signal condition.

[8] As demonstrated in H-Block tests with CMRS devices, increasing the interference above the threshold results in FER levels that increase quickly (as the call quality deteriorates further) until the call is dropped. For examples, see the CTIA test results that utilized PCTEST and WINLAB test laboratories, which was submitted as attachments to the CTIA H-Block Comments (WT Docket No. 04-356) on Dec. 8, 2004.

[9] An overview of the H-Block tests and analysis of results were provided in a V-COMM report (refer to herein as "*V-COMM H-Block Report*") and was submitted in the WT Docket No. 04-356, on Dec. 8, 2004, as an attachment to the *Joint Comments of Sprint Corporation and Verizon Wireless*.

[10] V-COMM studied the device antenna gain values for 11 typical CMRS devices (from FCC type certification reports submitted by manufacturers), in addition to referencing wireless standards documents, and provided support for the mobile antenna gain of 0 dBi, as an appropriate and conservative value to use for mobile-to-mobile interference analyses.

[11] Using a total of 3 dB for additional losses is consistent with the mobile-to-mobile interference assessments submitted in the H-Block proceeding by many parties including V-COMM, Verizon Wireless, Sprint, T-Mobile, AT&T, CTIA, and other parties. In addition, it is consistent with industry standard values for body losses. As per 3GPP Standards (see Table 4.1 of TR 25.942), 1 dB body loss is specified for use with each mobile. Assuming 1 dB loss for each handset, and an additional 1 dB loss for miscellaneous losses, is equal to 3 dB of total losses for both devices.

operating at 2160 MHz is 39 dB for 1 meter distance, plus 3 dB of additional losses, which equals a total path loss of 42 dB.[12]

Therefore, to protect AWS-1 devices from receiver overload interference occurring at -42 dBm, an AWS-3 mobile power limit of 0 dBm EIRP is required.[13] At this limit, an AWS-3 device transmitting at 0 dBm EIRP causes harmful interference to AWS-1 devices, and at +8 dBm EIRP it causes dropped calls to AWS-1 devices.[14]

In contrast to these relatively low power levels of 0 dBm and +8 dBm EIRP, the BRS/EBS rules allow much higher power levels. BRS/EBS power limits permit devices to operate up to +33 dBm EIRP.[15] Therefore, an AWS-3 device operating at the BRS/EBS power limit of +33 dBm EIRP, would be operating at 33 dB above the point that causes harmful interference to AWS-1 devices, and 25 dB above the point that causes dropped calls to AWS-1 devices.

These are very strong interfering levels that have the ability to impact AWS-1 devices within a very large surrounding area. For example, assuming free-space path loss and 3 dB of additional losses, AWS-3 devices operating at the BRS/EBS power limit have the ability to cause harmful interference to AWS-1 devices within 44 meters (144 feet), and drop calls to AWS-1 devices within 17.5 meters (57 feet).[16]

Thus, the BRS/EBS power limits should not be applied to the AWS-3 band, due to the significant harmful interference it will cause to AWS-1 devices within very large surrounding areas. These are very large impact areas with harmful interference to CMRS users that can occur, for example, in large outdoor arenas (i.e. football/baseball stadiums) and large indoor areas (i.e. airport/train/bus terminals) with a single AWS-3 device having the potential to cause interference to many AWS-1 user devices. In addition, this has the potential to cause dropped calls to in-building AWS-1 devices in adjacent rooms, in addition to all the devices in the same room as the AWS-3 device.

---

[12] Using the free-space path loss formula for 1 meter separation with an isotropic antenna reference and frequency of 2160 MHz, the propagation loss (L) is equal to 39 dB, and computed as: L = -27.56 + 20*Log (Freq in MHz) + 20*Log (Distance in Meters) = 39.1 dB, which is also equal to L = 39.1 dB + 20*Log (Distance in Meters) for free-space path loss at 2160 MHz.

[13] Compute as: AWS-3 device 0 dBm EIRP – 42 dB total path losses = -42 dBm at victim receiver, which causes receiver overload interference to AWS-1 band devices.

[14] Compute as: AWS-3 device +8 dBm EIRP – 42 dB total path losses = -34 dBm at victim receiver, which causes dropped calls to AWS-1 band devices.

[15] It is noted that a *continuous* power level of 2 Watt EIRP can exceed the FCC's SAR limits for devices, however, TDD and other TDMA type signals utilizing less than half duty cycles would be able to operate up to 2 Watts (i.e. 30% duty cycle) and comply with FCC SAR limits. In this example, the TDD device would have an equivalent SAR value as a mobile device at the *continuous* power level of 600 mW EIRP.

[16] Computed using free-space path loss plus 3 dB additional loss: +33 dBm EIRP – 72 dB (path loss for 44 meters @ 2160 MHz) – 3 dB = -42 dBm, which is the received interference level that causes harmful interference; and +33 dBm EIRP – 64 dB (path loss for 17.5 meters @ 2160 MHz) – 3 dB = -34 dBm, which is the received interference level that causes dropped calls to AWS-1 devices.

Impact to AWS-1 with BRS/EBS OOBE Limits Applied to AWS-3

The impact to AWS-1 band is provided below, for the case with BRS/EBS out-of-band emissions (OOBE) limits applied to AWS-3 band devices.

As demonstrated in CTIA's H-Block test results, and as analyzed in the *V-COMM H-Block Report*, co-channel interference levels received at -117 dBm/MHz can cause harmful interference to CMRS devices.[17] Therefore, to protect AWS-1 devices from OOBE interference at a separation distance of 1 meter, assuming 3 dB of additional losses, an AWS-3 device OOBE limit of -75 dBm/MHz RMS is required for emissions in the adjacent 2110-2155 MHz spectrum band.[18] At this limit, AWS-3 device OOBE at -75 dBm/MHz EIRP has the potential to cause harmful interference to adjacent band AWS-1 devices.

In contrast to the low out-of-band emission level of -75 dBm/ MHz, the BRS/EBS rules allow much higher emission levels into adjacent bands. As provided above, BRS/EBS emission limits permit devices to operate up to -13 dBm/MHz within 5.5 MHz of the band edge, and -25 dBm/MHz at 5.5 MHz from the band edge and beyond. Therefore, AWS-3 devices operating at BRS/EBS emission limits would be operating at 62 dB above the level that causes harmful interference to AWS-1 devices within 5.5 MHz of the band edge, and 50 dB above the level that causes harmful interference to AWS-1 devices at 5.5 MHz or more from the band edge.[19]

These are very strong interfering levels that have the ability to impact a substantial number of AWS-1 devices within an extremely large surrounding area. For example, assuming free-space path loss and 3 dB of additional losses, AWS-3 devices operating at the BRS/EBS emission limits have the ability to cause harmful interference to AWS-1 devices operating at a distance of 1.24 kilometer (approx. 4,000 ft, or 0.77 miles) within 5.5 MHz of the band edge, and within 312 meters (approx. 1,000 ft, or 0.2 miles) at 5.5 MHz or more from the band edge.[20]

---

[17] See results of CTIA's tests conducted by PCTEST and WINLAB test laboratories, which was submitted as attachments to the CTIA H-Block Comments (WT Docket No. 04-356) on Dec. 8, 2004. The CTIA's test results for its AWGN tests utilize on-channel interference sources to demonstrate interference thresholds to a variety of victim CMRS devices. In the H-Block proceeding, many parties that analyzed the test results, including Sprint, Verizon Wireless, V-COMM, CTIA and others, observed interference to CDMA devices at the interference level of -117 dBm/MHz (RMS) in tests using a faded signal condition.

[18] Compute using free-space path loss for 2160 MHz with 3 dB of additional losses: AWS-3 device OOBE -75 dBm/MHz EIRP – 39 dB (path loss for 1 meter) – 3 dB = -117 dBm/MHz RMS at the victim AWS-1 device, which causes OOBE interference to CMRS devices. The RMS notation represents a "root-mean-square" power measurement, which is a time-averaged measurement that permits higher power levels for TDD and TDMA type signals that transmit with less than 100% duty-cycles. For example, a 50% duty cycle transmitter would be able to transmit 3 dB higher than this limit.

[19] Compute as: -13 dBm/MHz – (-75 dBm/MHz) = 62 dB; and -25 dBm/MHz – (-75 dBm/MHz) = 50 dB.

[20] Computed using free-space path loss plus 3 dB additional loss: -13 dBm/MHz – 101 dB (path loss for 1.24 km @ 2160 MHz) – 3 dB = -117 dBm/MHz, which is the received OOBE interference level that causes harmful interference to CMRS devices; and -25 dBm/MHz – 89 dB (path loss for 312 meters @ 2160 MHz) – 3 dB = -117 dBm/MHz.

Thus, the BRS/EBS emission limits should not be applied to the AWS-3 band, due to the significant harmful interference it will cause to AWS-1 devices within extremely large surrounding areas. With application of the BRS/EBS OOBE limits, AWS-3 devices can be expected to cause significant harmful interference to adjacent band AWS-1 devices in extensive portions of their respective market areas. Even in cases with signal path obstructions between device users such as trees, buildings, and other structures (i.e. 12 dB of additional signal attenuation due to obstructions or building penetration losses), AWS-3 devices operating at BRS/EBS OOBE limits can still cause harmful interference to AWS-1 devices within 1,000 feet (for AWS-1 devices operating within 5.5 MHz of the band edge) and within 250 feet (for AWS-1 devices operating at 5.5 MHz from the band edge and beyond).[21]

[21] These distances are computed with a 12 dB reduction in signal levels from the above distances without obstructions, which is equivalent to one-fourth the unobstructed free-space path loss distance. Included in the path losses for both cases (obstructed and unobstructed cases above) is a total of 3 dB of additional losses to account for the user's body and other miscellaneous losses.