SBE/DoD MEMORANDUM OF UNDERSTANDING

ON 2025-2110 MHz SPECTRUM SHARING

A. This Memorandum of Understanding (MOU) describes the radio frequency sharing arrangement of the spectral band, 2025-2110 MHz, between the Department of Defense (DoD) Space Operation Service, and the Federal Communications Commission (FCC)-licensed Television Broadcast Auxiliary Service (2GHz BAS) and related services as described below pursuant to the FCC Seventh Report and Order (7th R&O), FCC 04-246, dated 14 October 2004 (ET Docket No. 00-258).

B. The parties to this MOU are the DoD Assistant Secretary of Defense/Networks and Information Integration (OASD/NII) Spectrum, representing the interests of the DoD, and the Society of Broadcast Engineers (SBE), acting as an advocate for the interests of the 2GHz BAS licensees, and as the sponsor of the private sector frequency coordination program for this band as documented in the attached Addendums appropriate to the local site coordination. As used herein, the term "2GHz BAS" includes the Television Broadcast Auxiliary Service (BAS), the Cable Television Relay Service (CARS), and the Local Television Transmission Service (LTTS); all three services are included in the arrangements documented in this MOU.

C. The sharing of this band is indicated at Paragraph 28 of the 7th R&O, which revised footnote US346 in the Table of Allocations (47 C.F.R. 2.106) as follows:

> *US346 Except as provided for below and by footnote US222, Federal use of the band 2025-2110 MHz by the space operation service (Earth-to-space), Earth exploration-satellite service (Earth-to-space), and space research service (Earth-to-space) shall not constrain the deployment of the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service. To facilitate compatible operations between non-Federal terrestrial receiving stations at fixed sites and Federal earth station transmitters, coordination is required. To facilitate compatible operations between non-Federal terrestrial transmitting stations and Federal spacecraft receivers, the terrestrial transmitters in the band 2025-2110 MHz shall not be high-density systems (see Recommendations ITU-R SA. 1154 and ITU-R F. 1247). Military satellite control stations at the following sites shall operate on a co-equal, primary basis with non-Federal operations.*

[Continued on next page]

Facility	Coordinates (NAD83)	
Naval Satellite Control Network, Prospect Harbor, ME	44°24'16"N	068°00'46"W
New Hampshire Tracking Station, New Boston AFS, NH	42°56'52"N	071°37'36"W
Eastern Vehicle Check-out Facility & GPS Ground Antenna & Monitoring Station, Cape Canaveral, FL	28°29'09"N	080°34'33"W
Buckley AFB, CO	39°42'55"N	104°46'36"W
Colorado Tracking Station, Schriever AFB, CO	38°48'21"N	104°31'43"W
Kirtland AFB, NM	34°59'46"N	106°30'28"W
Camp Parks Communications Annex, Pleasanton, CA	37°43'51"N	121°52'50"W
Naval Satellite Control Network, Laguna Park, CA	34°06'31"N	119°03'53"W
Vandenberg Tracking Station, Vandenberg AFB, CA	34°49'21"N	120°30'07"W
Hawaii Tracking Station, Kaena Pt, Oahu, HI	21°33'44"N	158°14'31"W
Guam Tracking Stations, Anderson AFB and Naval CTS, Guam	13°36'54"N	144°51'18"E

D. The footnote in paragraph C above indicates the need for coordination. Details contained within the 7th R&O indicate that this coordination must take place at the local level in the area surrounding the 11 military uplink sites. The 7th R&O also gives guidance as to approaches and possible mitigations that would facilitate compatible sharing of the band. The following three-level process describes the over-arching principles with respect to the coordination of the band.

1. The DoD will be able to operate at any time within the set of parameters as agreed to and documented in the particular Addenda associated with the specific 11 military satellite control station sites. The details of this parameter set will be determined by analysis, simulations, and tests that will ensure that DoD space operation service transmissions do not preclude or significantly degrade the actual performance of 2GHz BAS (as defined above) radio links operating between identified fixed and mobile, or mobile-only 2GHz BAS transmitters and documented fixed 2GHz BAS-Receive Only (RO) terminals. It is anticipated that only 2GHz BAS-RO terminals located within line of sight of the particular military uplink transmitting station will be protected per this MOU. It is agreed that the non-fixed or itinerant 2GHz BAS terminals that are not normally used in the region around the particular military site of interest will not be protected from DoD uplink operations and are not covered by this agreement. Itinerant 2GHz BAS terminal operation could be addressed on a case-by-case basis using "real-time" or "near real-time" operational coordination discussed in Item D.2 below.

   The set of Operating Parameters defining DoD operations are:

   a) Uplink (Earth-to-space) power levels and transmission characteristics used by the DoD in spacecraft command and control signals

   b) Location of the DoD transmitting stations

c) Carrier frequency and spectral bandwidth of both the 2GHz BAS and DoD signals

d) Pointing of the DoD uplink antenna when transmitting relative to the identified 2GHz BAS-RO terminals

e) Times of DoD uplink transmission

f) Nominal times of relevant 2GHz BAS link usage

g) Locations and technical characteristics of the 2GHz BAS-RO terminals

The set of these Operating Parameters for each local site will be documented and agreed to as of the signature date of the Addendums applicable to the 11 military uplink sites (template at Exhibit A of this MOU). The protection goal of 2GHz BAS-RO terminals is no more than a 0.5 dB degradation of the receiver/noise threshold as noted in Footnote 63 of the 7th R&O (attached at Exhibit B of this MOU).

2. If contingencies arise that require DoD or the 2GHz BAS operators to operate outside the parameter set appropriate to each site's specific Addendum, DoD and 2GHz BAS representatives will need to coordinate on a "real time" (minutes/hours) or "near-real time" (days) basis. DoD and 2GHz BAS representatives will each provide a 24/7 real time communication interface for use as needed by both parties. Desired methods of communicating with the relevant 2GHz BAS entities shall be identified through interchange at the local level for each of the 11 military site regions. The nature of this coordination in the region of any given military site should be agreed in advance by discussions at the local level. This also would be the mechanism whereby 2GHz BAS itinerant users would coordinate with DoD for possible 2025-2110 MHz usage.

3. DoD vehicle emergencies (VE) associated with critical spacecraft problems (anomalies) or events occur historically about 1 percent of the time for spacecraft control. It is understood that the 2GHz BAS will accommodate DoD needs in these rare but critical VE situations even if they occur during normal 2GHz BAS operational times.

E. Upon execution of this MOU and the site-specific Addenda, all items documented will be considered baselines for the purpose of the coordination process. This includes all the Operating Parameters of the identified DoD and 2GHz BAS terminals and the parameters of the DoD operations associated with the identified 11 military sites. Any changes or additions to these items will be the subject of a future coordination wherein both parties would be "co-equal primary" per FCC direction and per the terms of the applicable footnote (US346) to the Table of Allocations. Both parties agree to notify the other of all needed changes to the set of Operating Parameters technical characteristics (discussed in Section D. 1 above) at least 90 days in advance of any planned operational changes. If the proposed changes would affect only a subset of the 11 military sites,

then only the appropriate Addenda will need to be changed and signed by the responsible parties.

F. This MOU shall be valid after the date of signing by both parties and can only be modified by mutual consent of both parties. It is binding on the parties and their successors and assigns according to its terms. Each party agrees to bear its own costs associated with the implementation and performance of the obligations set forth in this MOU.

G. This MOU is subject to the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook), and the applicable FCC rules in Title 47 of the Code of Federal Regulations. It is anticipated that this MOU will be reviewed by its signatories or their representatives every five years.

H. Subject to unilateral change by either party as to its designated recipients notice shall be provided within 30 days of any change to the following organizations and/or their duly appointed representatives:

1. OASD/NII (Spectrum)
2. SBE Executive Director

In Witness Whereof, the parties hereto have signed this Memorandum of Understanding this

30th day of April, 2009.

Department of Defense
Assistant Secretary of Defense/
Networks and Information Integration
(OASD/NII) Spectrum

By: John B. Grimes

Society of Broadcast Engineers, Incorporated

By: Barry Thomas, President

Exhibit **A**

ADDENDUM (This is the outline for the site-specific Addenda)

A. This Addendum to the SBE/DoD MOU on 2025-2110 MHz Spectrum Sharing specifically addresses the following military site facility: TBS

B. The list of the 2GHz BAS terminals protected by this MOU is: TBS

C. The locations of the DoD military site terminals are: TBS

D. The set of Operating Parameters defining DoD operations are:

1. Uplink (Earth-to-space) power levels and transmission characteristics used by the DoD in spacecraft command and control signals

2. Location of the DoD transmitting stations

3. Frequency and spectral bandwidth of both the 2GHz BAS and DoD signals

4. Pointing of the DoD uplink antenna when transmitting relative to the identified 2GHz BAS-RO terminals

5. Times of DoD uplink transmission

6. Nominal times of relevant 2GHz BAS link usage and

7. Locations and technical characteristics of the 2GHz BAS-RO terminals.

E. Notice shall be provided regarding any change of these parameters within 30 days to the following:

1. Local DoD site frequency manager.

2. Local 2GHz BAS frequency coordinator

F. Appropriate signature information to be inserted, as required.

Exhibit B

Footnote 63 of the 7th R&O, ET Docket 00-258, FCC 04-246, released October 21, 2004:

For example, we note that a DOD TT&C uplink earth station using the maximum transmitter power of 40 dBW, bandwidth of 4 MHz, and a 46 foot antenna as described in the *DOD IMT-2000 Assessment* at ¶ B.4.2.1.2, with its main beam elevated 3 degrees above the horizon plane, would produce an effective isotropic radiated power ("EIRP") as high as 58 dBW in the horizon plane. Under unobstructed line of sight (LOS) conditions, an EIRP produces an isotropic receive power, RXI (in dBW), at a point located a distance D from the transmitter, given by RXI = EIRP - (92.4 + 20log10(F) + 20log10(D)), where F is the frequency (in GHz) and D is the distance (in km) (The expression within the parentheses is usually referred to as the Free Space Loss ("FSL")). For EIRP = 58 dBW in the horizon plane and F = 2.07 GHz (*i.e.*, a frequency in the center of the 2 GHz band), at distances D of 20, 50, 100, and 200 km, the above expression yields RXI's of -66.7, -74.7, -80.7, and -86.7 dBW, respectively.

The maximum permissible isotropic receive power of interference present at a receive antenna, MAXRXI, to avert degrading the receiver noise threshold, is given by MAXRXI = 10log10(kTB) + NF + (I/N) + LR - GR, where k is Boltzman's constant (1.38x10E-23 joules/K, or 1.38E-17 W/(MHzK)), T is the receive antenna temperature (usually 290 K), B is the receiver bandwidth (in MHz), NF is the receiver noise figure (in dB), (I/N) is the maximum interference-to-noise ratio (in dB) required to avert degrading the receiver noise threshold, LR is the line loss (in dB) between the output of the receive antenna and the receiver, and GR is the isotropic gain (in dB) of the receive antenna (in dB). For a typical BAS ENG TV Pickup receiver, as described in the *DOD IMT-2000 Assessment* at ¶¶ B.7.2.2.1 and C.6.1.1.1, with a bandwidth of 17 MHz, a noise figure of 3 dB, an (I/N) of -9 dB (to avert a receiver noise threshold degradation exceeding 0.5 dB), a lineloss of 2 dB, and an isotropic antenna gain of 22 dB (main beam, no sidelobe suppression), the above expression yields a MAXRXI of -157.7 dBW. We adjust this figure downward 1.5 dB, to account for the 12 MHz receiver bandwidth consistent with the new BAS channel plan, to -159.2 dBW.

The above-calculated RXI's of the DOD TT&C uplink earth station horizon plane interfering signal, with an EIRP of 58 dBW, at distances D of 20, 50, 100, and 200 km, exceed MAXRXI for a BAS ENG TV Pickup receiver by 92.5, 86.5, 80.5, and 72.5 dB, respectively, representing significant worst case interference potentials. Analysis of the SBE data indicates such interference potentials, often in multiple directions, around several of the eleven TT&C sites, due to LOS or near LOS conditions owing to the height of ENG receive antennas with respect to their surroundings, whether on tall buildings or towers in urban areas or on mountain sites, in order to obtain maximum visibility from potential ENG transmit locations. Under this worst case analysis, the Buckley AFB site, in particular, exhibits numerous interference potentials, ranging from 71 to 95 dB, into ENG receive antennas located around downtown Denver, generally southwest, west, and northeast of Buckley, all at distances from 15 to 18 km. In addition, several interference potentials, ranging from 79 to 87 dB, occur at mountain sites located west and northwest of Buckley, at distances from 40 to 100 km. These sites could pose a challenge because their antennas may tend to point eastward and southeastward, toward Denver and its suburbs, and therefore toward Buckley AFB, located just east of Denver, during most of their use.

We emphasize, however, that these potentials are typically worst case, with the TT&C uplink at maximum power, which could be reduced by as much as 20 dB, and antenna pointing within 3 degrees of the horizon plane, where more restrictive, skyward pointing, such as to the GSO arc, could offer an improvement up to 40 dB, or more through antenna redesign to increase sidelobe suppression. TT&C site mitigation could also include construction of berms and other attenuating features, as well as taking advantage of existing manmade and terrain obstructions. Further, on-going case-by-case coordination with BAS ENG operations has the potential to take advantage of the fact that the TT&C antenna spends relatively little time pointing in a particular direction, much less at an elevation of 3 degrees; of a typical ENG receive antenna sidelobe suppression of 20 dB, where the antenna main beam pointing need not be toward the TT&C earth station; and/or operation on adjacent ENG channels, where they are available. Finally, we note that, during on-going coordination, receiver threshold degradation, on which this worst case was based, may be supplanted by less stringent criteria which fully

consider actual ENG power, modulation, performance, or other requirements, as were considered by Gannett, NAB, and SBE in their comments.