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Federal Communication Commission
Bureau / Office

April 12, 2006

BY HAND DELIVERY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, N.W.
Washington, D.C. 20554

Attn: Scott Kotler, International Bureau
Trang Nguyen, International Bureau

Re: ViaSat, Inc. Supplemental Filing; Call Sign E050318;
File Nos. SES-LIC-20051028-01494; SES-AMD-20060314-00440

Dear Ms. Dortch:

ViaSat, Inc. hereby submits the enclosed coordination agreement with National Science Foundation to supplement the above-referenced pending application.

If you have any questions regarding this submission, please contact the undersigned at (202) 637-1056.

Respectfully submitted,

Elizabeth R. Park

Enclosure

DC\859456.1

DIVISION OF ASTRONOMICAL SCIENCES
NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230 USA

FAX Cover Sheet
Telefax Number: (703) 292-9034

Date: **April 12, 2006**
Number of pages (including cover sheet): 15

To: **Elizabeth Park, 202-637-2201**

From: **Dr. Tomas Gergely, NSF**
Phone: **703-292-4896**
FAX: **703-292-9034**
E-mail: **tgergely@nsf.gov**

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A Coordination Agreement Between the National Science Foundation (hereinafter "NSF") and ViaSat, Inc. (hereinafter "ViaSat") for Operation of the ViaSat Arclight AMSS and Radio Astronomy Sites Jointly Sharing the 14.0 – 14.5 GHz-Band

ViaSat seeks to license and operate aeronautical mobile-satellite stations (AMSS) over the Continental United States (CONUS) on a secondary basis in the 14.0 to 14.5 GHz FSS band. The AMSS terminals are part of the Arclight® satellite communications system aboard general aviation and commercial aircraft using transponders in the Geostationary Satellite Orbit (GSO) arc. This Coordination Agreement has been prepared in compliance with the rules of the Federal Communications Commission (FCC) and the recommendations of the International Telecommunication Union (ITU) in effect following the World Radiocommunication Conference WRC-03.

1. Overview

1.1 The 14.0 – 14.5 GHz-band has been allocated to mobile-satellite service, now including aeronautical mobile-satellite service, on a secondary basis, provided that airborne earth stations (AES) include specific protection to the radio astronomy service within the 14.47 – 14.50 GHz-band

1.2 The 14.47 – 14.50 GHz-band is allocated to radio astronomy service on a secondary basis.

1.3 ViaSat filed an application for license authorization with the FCC on October 28, 2005, File Number SES-LIC-20051028-01492, to operate up to 1000 technically identical AES units in the 11.7 – 12.2 and 14.0 – 14.5 GHz-bands.

1.4 These AESs receive from, and transmit to, the same transponder under control of a Ground Earth Station (GES) and Network Operations Center (NOC). They, and the terrestrial network to which they are connected, comprise the ViaSat Arclight system.

1.5 This Coordination Agreement has been prepared to ensure that operation of the Arclight AESs conform to the requirements of the FCC and the recommendations of the ITU for radioastronomy protection.

1.6 ViaSat has the authority to negotiate and sign this Coordination Agreement for the Arclight system and the Electromagnetic Spectrum Unit of the NSF has the authority to negotiate and sign this agreement for the Radio Astronomy sites listed in Section 2.1.

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2. National Science Foundation Radio Astronomy Observatories

2.1 Site Table

Following is a list of NSF supported Radio Astronomy sites within the United States and its territories which may make observations in the 14.47 – 14.50 GHz-band. Two different levels of protection are provided for these sites during periods when they are performing observations, as detailed in Section 3.

Observatory	Latitude (D,M,S)	Longitude (D,M,S)
National Radio Astronomy Observatory (NRAO) sites:		
Green Bank, WV (National Radio Quiet Zone)	38 25 59	79 50 24
Socorro, NM	34 04 43	107 37 04
National Astronomy and Ionosphere Center (NAIC) site:		
Arecibo, PR (tentative addition to site list)	18 20 46	66 45 11
Very Long Base Array sites, CONUS:		
Kitt Peak, AZ	31 57 22	111 36 42
Owens Valley, CA	37 13 54	118 16 34
N. Liberty, IA	41 46 17	91 34 26
Hancock, NH	42 56 01	71 59 12
Los Alamos, NM	35 46 30	106 14 42
Pie Town, NM	34 18 04	108 07 07
Ft. Davis, TX	30 38 06	103 56 39
Brewster, WA	48 07 53	119 40 55
Very Long Base Array sites, off shore		
Mauna Kea, HI	19 48 16	155 27 29
St. Croix, VI	17 45 31	64 35 03

2.2 Additional Radio Astronomy Sites

Additional Radio Astronomy sites may be added to the list in 2.1 above. NSF shall give ViaSat at least two months notice of additional sites which may be using the 14.47 – 14.50 GHz-band for observations or of changes in status to the existing sites.

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3. Operational Coordination Agreement

NSF and VIASAT agree to the following:

3.1 The purpose of this Coordination Agreement is to provide protection to the Radio Astronomy sites listed in the site Table of 2.1 during periods of observations in the 14.47 – 14.50 GHz-band to the following aggregate power flux density (pfd) levels within that band:

a. -221 dBW/m²/Hz, for the Green Bank, Socorro and Arecibo sites
b. -189 dBW/m²/Hz, for the VLBA sites

3.2 This Coordination Agreement should be reviewed periodically by all signatories to the agreement beginning within a year following commencement of service by ViaSat under an operational license from the FCC. The purpose of the review is to assess the effectiveness of this agreement as well as to update this, or successor operational agreements, as applicable.

3.3 Each party shall inform the other party in a timely manner of changes in the points of contact as defined in Section 5.

ViaSat agrees to:

3.4 Cease transmissions from AESs in the 14.47 – 14.50 GHz-band, within line-of-sight of Radio Astronomy sites listed in the site Table of 2.1, during periods of notified radio astronomy observations.

3.5 Control the AES transmitters so that the pfd levels in the 14.47 – 14.50 GHz-band, produced by individual AES, measured at the radio astronomy sites during periods of notified observation, do not exceed the following levels:

$pfd\ (dBW/m^2/MHz) = -182 + 0.5 * \theta \quad \text{for } \theta \leq 10°$
$pfd\ (dBW/m^2/MHz) = -177 \quad \text{for } 10° < \theta \leq 90°$
where θ is the angle of arrival at the receiving site

This will be accomplished by operating on transponders that are sufficiently removed from the RA frequencies and by reducing or ceasing AES transmissions in the vicinity of Radio Astronomy sites during periods of notified radio astronomy observations.

3.6 Respond expeditiously to an NSF request for protection in accordance with Sections 3.4 and 3.5 of any site listed in site Table 2.1, for observations of special transient celestial objects (comets, supernovae and other celestial objects of heretofore unknown type) that are not anticipated by the observation schedule in Section 3.7, and that may need to be accommodated on shorter notice. Requests for such observations are not expected to exceed 40 hours per calendar year.

NSF agrees to:

3.7 Maintain an observation schedule in the 14.47 – 14.50 GHz-band for the sites listed in the site Table 2.1 and provide this schedule via both e-mail and fax to the designated points of contact listed in Section 5.2 below at least 7 days prior to the scheduled observations.

3.8 Provide through NAIC and NRAO full access to ViaSat representatives to data relating to interference in the 14.47 – 14.50 GHz-band that may be collected during observations that fall within the scope of this Coordination Agreement.

4. Assignment and Termination

4.1 This Coordination Agreement shall be binding upon the parties hereto and their respective successors and assigns.

4.2 This Coordination Agreement may be terminated by either party upon 6 months of written notice.

5. Points of Contact

5.1 Points of contact concerning this Coordination Agreement:

Contact: Dr. Tomas E. Gergely
Title: Electromagnetic Spectrum Manager
Organization: National Science Foundation
Address: 4201 Wilson Boulevard, Room 1030
Arlington VA 22230 USA
Telephone: (703) 292-4896
Facsimile: (703) 292-9034
e-mail: tgergely@nsf.gov

Name: Keven Lippert
Title: Associate General Counsel
Organization: ViaSat, Inc.
Address: 6155 El Camino Real
Carlsbad, CA 92009-1699
Telephone: (760) 476-2214
Facsimile: (760) 929-3926
e-mail: keven.lippert@viasat.com

5.2 Points of contact for Radio Astronomy observation schedules:

Contact: Dr. Harvey Liszt
Title: Director, Spectrum Management
Organization: NRAO
Address: 520 Edgemont Rd.
Charlottesville, Va. 22903
Telephone: (434) 296-0344
Facsimile: (434) 296-0278
e-mail: hliszt@nrao.edu

Name: Daryl T. Hunter, P.E.
Title: Sr. Systems Engineer
Organization: ViaSat, Inc.
Address: 6155 El Camino Real
Carlsbad, CA 92009
Telephone: (760) 476-2583
Facsimile: (760) 929-3941
e-mail: daryl.hunter@viasat.com

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6. Signatures

This Coordination Agreement is being made in good faith by both parties and is effective on the date on which the later party signs it. It may be executed in one or more counterparts, each of which will be deemed an original, and all of which together will constitute one and the same instrument.

For the National Science Foundation:

By: *[signature]*

Name: Dr. Tomas Gergely
Title: Electromagnetic Spectrum Manager

Date: 4/03/06

For ViaSat, Inc.

By: *[signature]*

Name: Keven Lippert
Title: Associate General Counsel

Date: 2/17/06

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Attachment A

The ViaSat, Inc. AMSS Plan To Protect Radio Astronomy

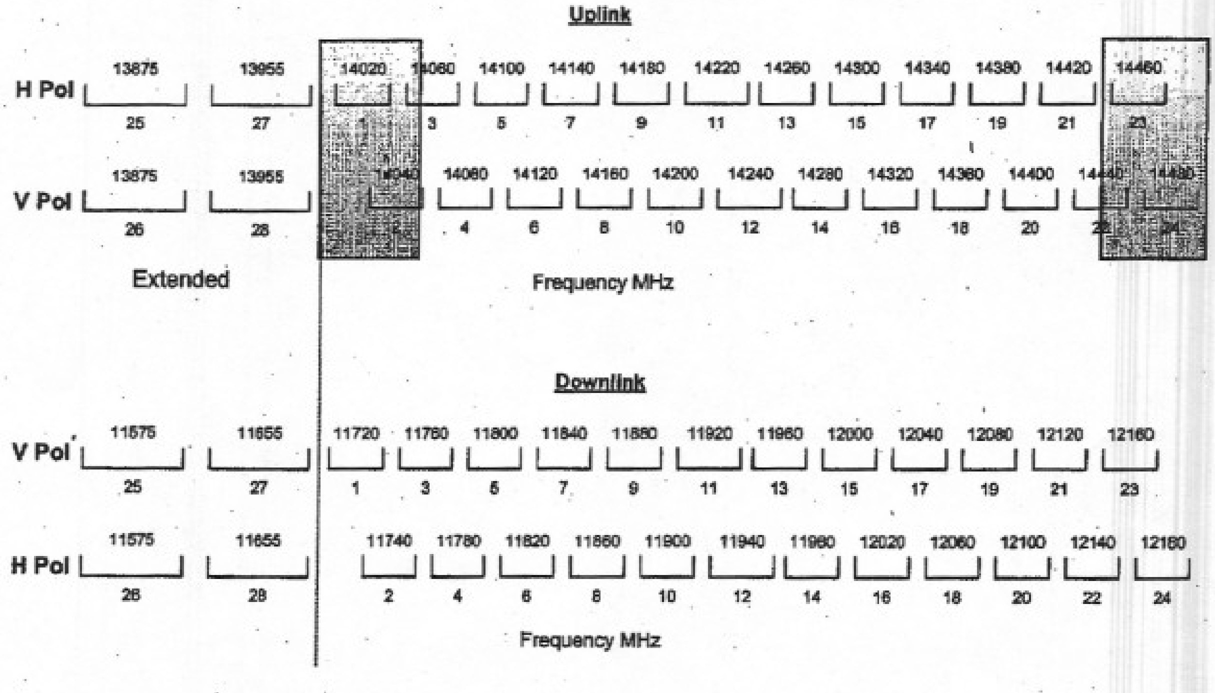
Overview

There are three methods that will be employed to provide protection to the NSF sites from interference by AES terminals. These methods are: frequency selection; AES transmission power control; and geographical avoidance of the coordinated sites.

There are two different protection criteria identified by the NSF. Interference thresholds for the Arecibo, PR, Green Bank, WV, and the Socorro, NM sites are -221 dB(W/(m^2 · Hz)), and the Very Long Baseline Array (VLBA) sites are -189 dB(W/(m^2 · Hz)) – aggregate power flux density.

Method One – Frequency Selection

Figure 1 depicts the transponder frequency arrangement for SES Americom's AMC-6, a typical Ku-band Fixed Satellite Service (FSS) satellite operating in a geostationary orbit providing service to the continental United States (CONUS).



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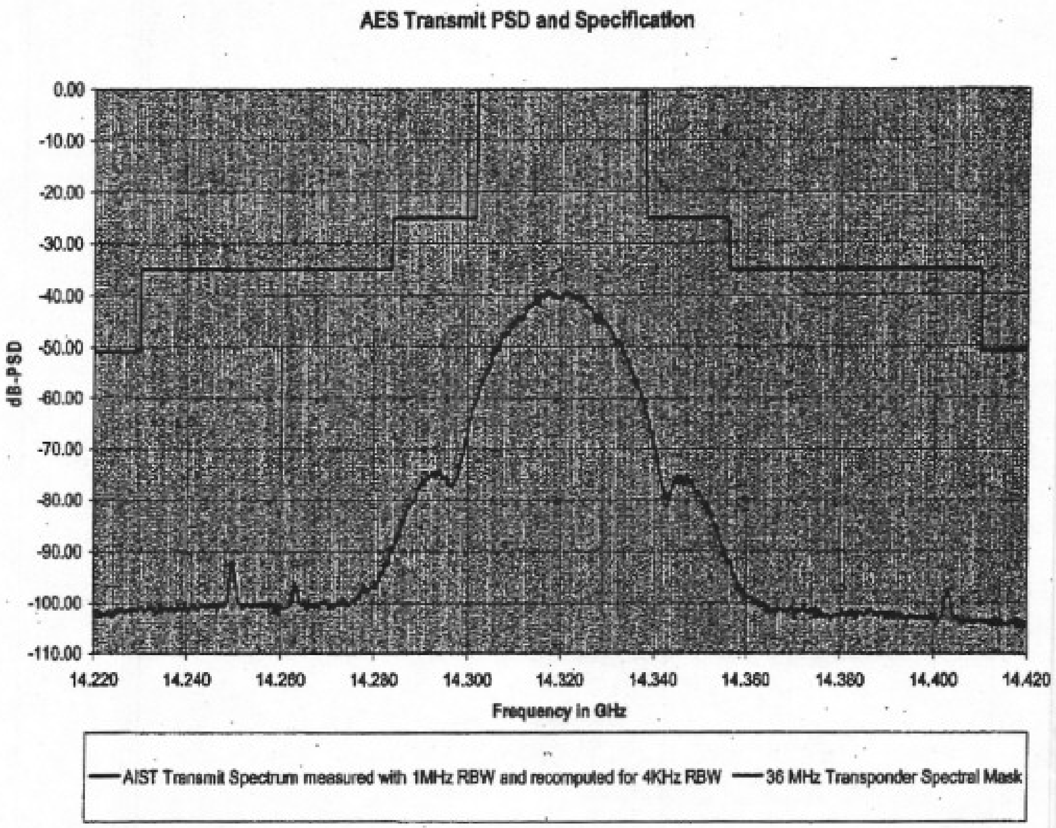

Figure 3 AES GMSK Spectral Output Plot

Method Two – AES Transmission Power Control

The ViaSat AMSS system has been designed to be compliant with ITU-R Recommendation M.1643, Annex 1, Part C, which has been accepted and implemented by the Federal Communications Commission subsequent to the World Radiocommunication Conference WRC-03. Figure 4 shows the limitations imposed on a single AES by that Recommendation for radio astronomy and by the coordination agreement for the National Radio Astronomy Observatory (NRAO) (includes the National Radio Quiet Zone (NRQZ) site at Green Bank, WV), and National Astronomy and Ionosphere Center (NAIC) sites.

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There are two frequency ranges that require protection, 14.0 – 14.05 GHz (NASA) and 14.47 – 14.5 GHz (NSF). By inspection of Figure 1 it is clear that frequencies supported by transponders 1, 2, 23, 24 fall within the protected ranges. The next step is to determine how much attenuation can be achieved by frequency separation. Figure 2 shows the spectral mask imposed by Section 25.202(f) of the FCC rules.

The actual performance of the ViaSat AES is considerably better than this mask. Figure 3 shows a measured spectrum plot of the ViaSat AMSS terminal's GMSK modulation measured at the output of the power amplifier and the Section 25.202(f) spectral mask. Inspection of the spectrum in figure 3 shows that 36 MHz away from the center frequency, the power spectral density is down 55 dB and beyond 40 MHz is generally 65 dB below the specified PSD.

By inspection of the transponder plot in Figure 1 and the spectral output of the modem in Figure 3, we can determine to what degree frequencies in addition to the above need to be considered in the protection strategy. In addition to transponders 1, 2, 23, and 24, transponder 22 is precluded from use during periods of radio astronomy observations and transponder 3, portions of which fall within the 14.0-14.05 GHz band used by NASA at the other end of the spectrum, must be avoided as well.

The key finding is that only transponders 21 and those at lower frequencies are practical for AMSS service with some additional attenuation necessary during periods of radio astronomy observations.

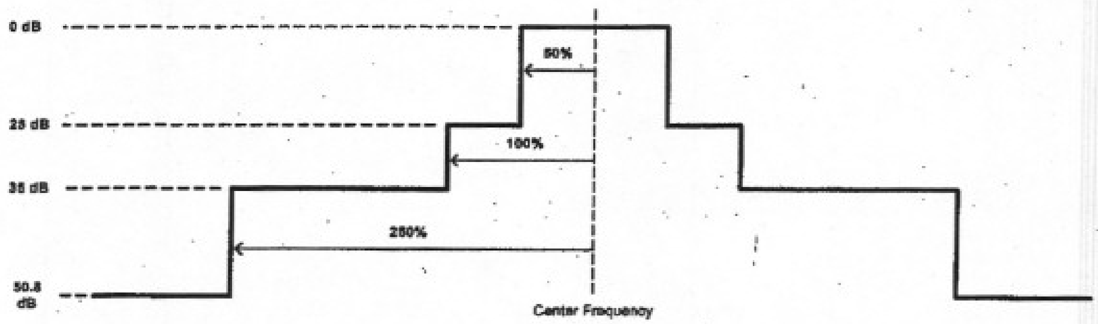

Figure 2 FCC 25.202(f) Transponder Spectral Mask

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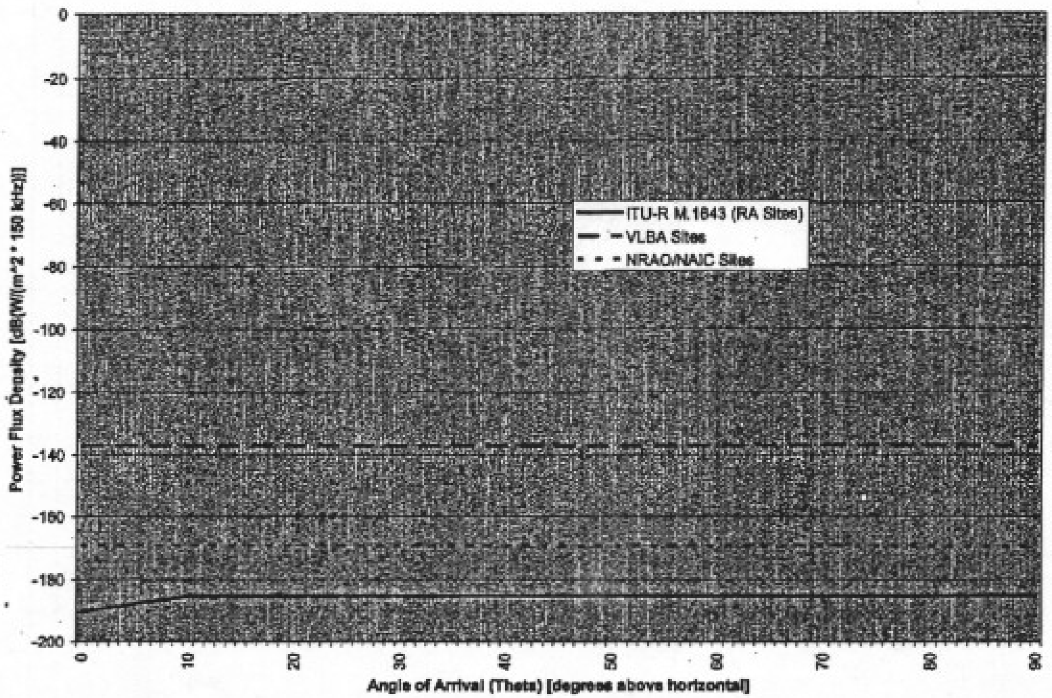

Figure 4 Maximum Permitted PFD from a Single AES Terminal

Annex 2 to ITU-R M.1643 provides a method for defining a lower hemisphere EIRP mask from a power flux density (pfd) mask. Given the altitude of the aircraft and the angle below the horizontal of the radio signal departing from the AES, the angle of arrival of the radio signal at the Earth is determined along with the spreading loss from the AES to the considered point on the Earth's surface.

The resultant mask gives the maximum allowed EIRP density for the specified pfd mask. Figure 5 shows the resultant radio astronomy masks for several AES altitudes and the NRQZ and VLBA masks for 5,000 ft.

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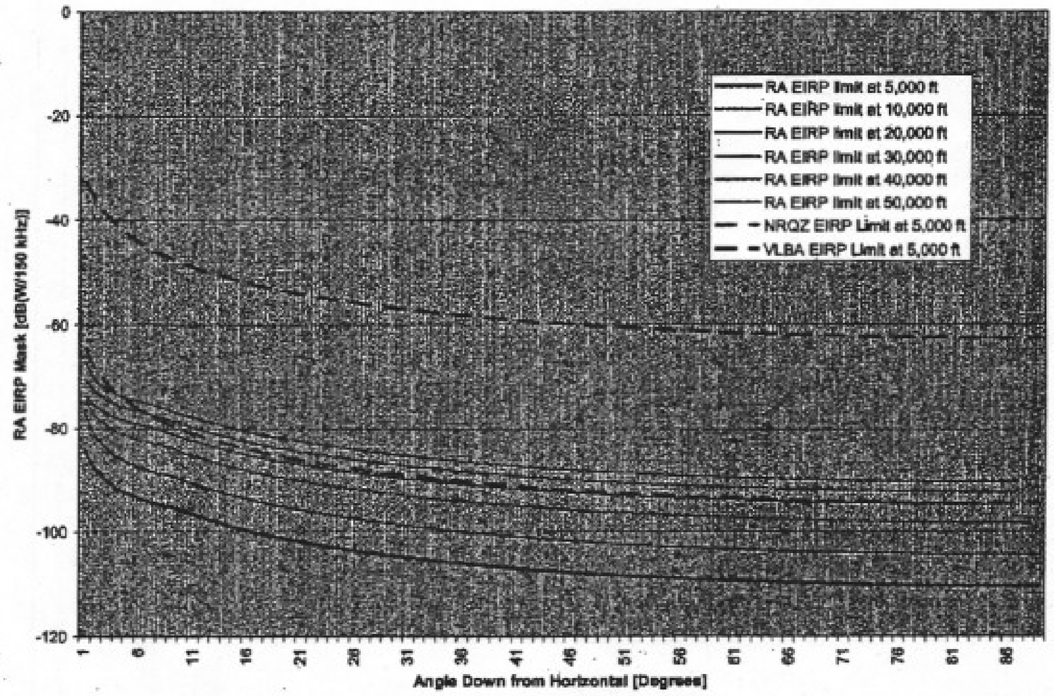

Figure 5 EIRP Density Mask per 150 kHz for Various Altitudes

With the emission limits established, the next steps are to derive and plot the AES EIRP density as a function of angle below the horizontal and compare the results to the mask and to the NSF site protection requirements. The first step in that process is to compute the EIRP density in the main lobe of the AES at boresight. Using data from the link budget for a typical AES terminal operating at 128 kbit/s in CONUS, the EIRP is 31.3 dBW. The occupied bandwidth is 30.346 MHz, so the EIRP density is -43.52 dB(W/Hz), or 8.24 dB(W/150 kHz) – the reference bandwidth used in ITU-R M.1643 Annex 1 Part C.

Having determined that the boresight EIRP density for the AES terminal is 8.24 dB(W/150 kHz), the next step is to apply the antenna gain as a function of elevation angle relative to the main lobe to determine a lower hemisphere EIRP density.

When operating on the AMC-6 spacecraft, the lowest operating elevation angle for CONUS is 15.4°, when operating in the Seattle, WA area. The pointing angle with respect to the satellite remains constant, regardless of changes in aircraft attitude.

The mechanical lower limit for antenna pointing is 6 degrees and if, due to aircraft maneuvers, the antenna can not remain pointed at the satellite, the transmitter will be inhibited. The only effect of aircraft maneuvers therefore is to the change the effective masking of the signal by the airframe.

For the purposes of this plan, airframe masking is estimated to be 10 dB.

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Figure 6 depicts the relative E-Plane (elevation) off-axis gain of the ViaSat AMSS antenna compared to the boresight gain. Also shown in figure 6 is a relative antenna gain mask used for calculation purposes in this plan. It shows a -30 dB floor for relative gain for off-axis angles greater than 26.5°.

Next this relative antenna gain mask is combined with the 8.24 dB(W/150 kHz) AES EIRP density and the 65 dB of out of band attenuation and then overlaid on the Radio Astronomy mask in Figure 7. We see that with this antenna pattern the NRQZ and VLBA sites are protected for all angles of arrival as long as the AES is above 5,000 ft.

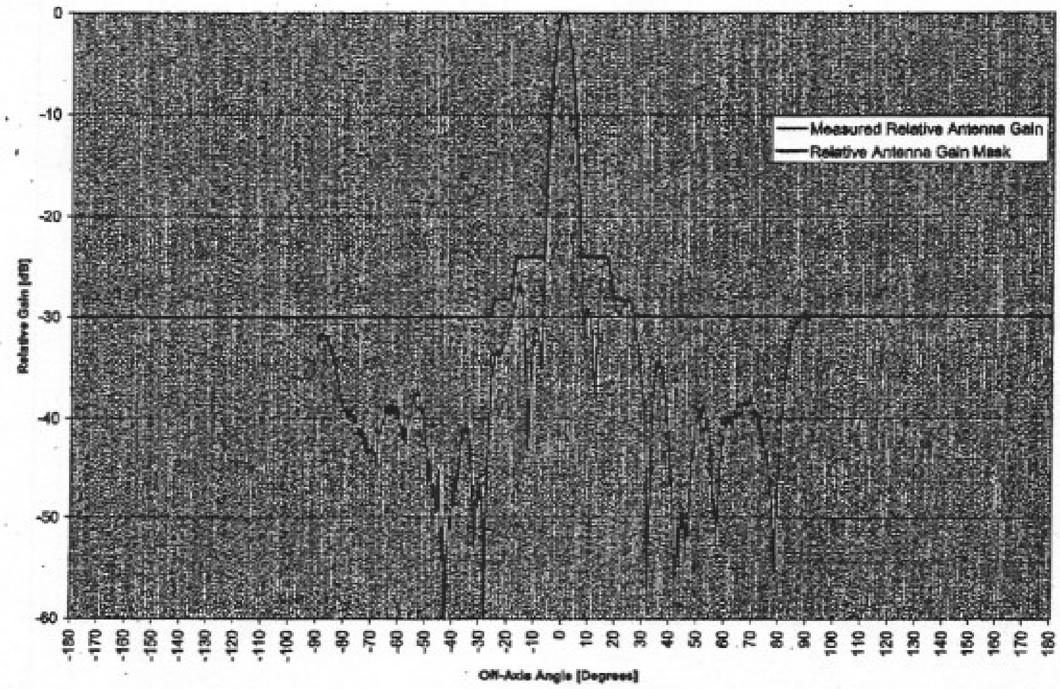

Figure 6 Relative Off-Axis Gain

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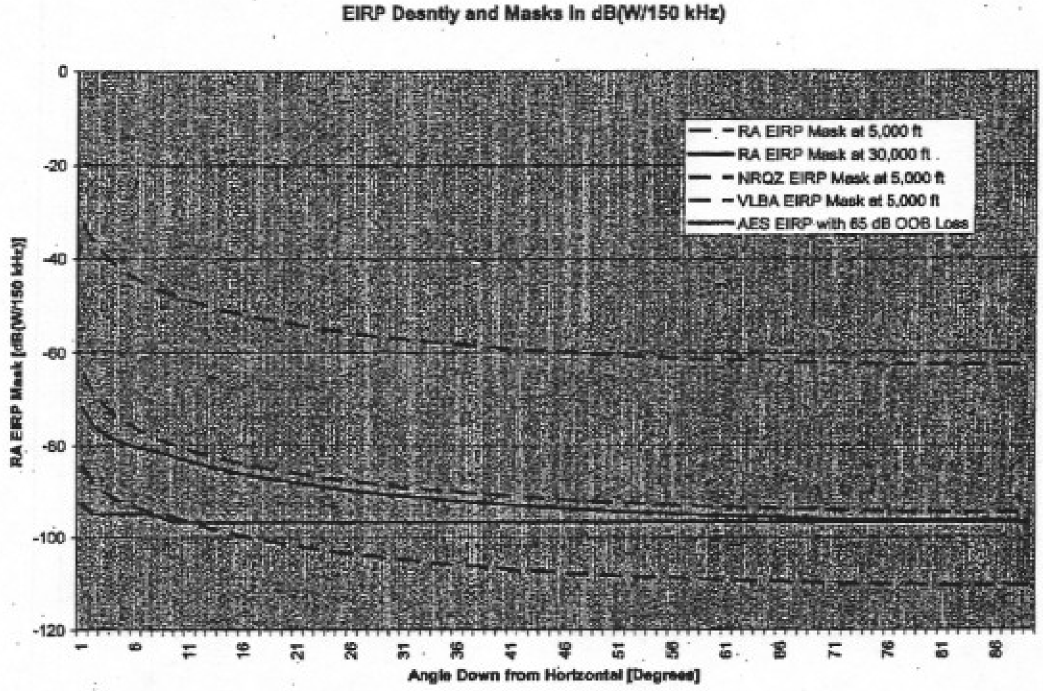

Figure 7 AES EIRP Density and RA Masks

Assuming a 65 dB out of band attenuation value, a lower hemisphere elevation antenna pattern mask as good as, or better than the one used in figure 6 would be required to support unrestricted operation on transponders 4 – 21 down to 30,000 feet at angles of arrival of 65° or higher.

This is consistent with ITU-R Recommendation M.1643, which states that AMSS earth stations should not transmit in the 14.47-14.5 GHz band within line-of-sight of radio astronomy stations operating within this band.

The data presented thus far has been limited to a single AES terminal operating at a nominal EIRP for a 128 kbit/s data transmission. The ViaSat AMSS network will be comprised of many aircraft each equipped with a technically identical ViaSat AMSS terminal. All AES terminals operate under control of the Network Management System (NMS) located at the Network Operations Center (NOC). The NMS software manages the multiple user aspects of the system.

Each AES terminal operates in a continuous receive, burst transmit mode. The terminal only transmits when the user has data to send, i.e., mouse clicks, URL address requests, emails, and so on. Additionally, the terminal will respond to periodic polls for status from the NMS. Network statistics indicate that the majority of the time the AES terminal is quiet and not transmitting.

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The link budget data shows that the number of simultaneous transmitters for this network is 34. The network itself is designed to accommodate a large number of logged in users, most of which are not transmitting at any given time. The NMS manages Network capacity by monitoring the number of simultaneous transmissions and applying "throttling" commands to the terminals in the network if the average number of simultaneous transmissions reaches a configured limit.

Given the spatial separation of the AES terminals in the network and the fact that the terminal does not transmit unless there is user data to send, the likelihood of a significant number of AES terminals transmitting at the same time while in the vicinity of a RA site is low.

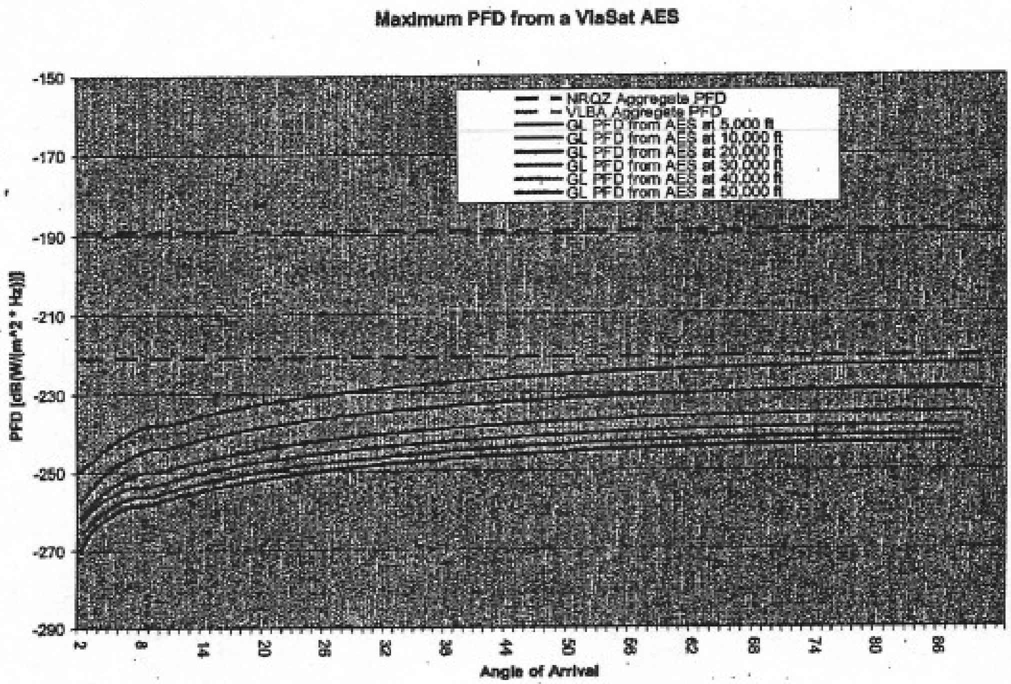

Figure 8 Maximum AES PFD ate Selected Altitudes vs. Angle of Arrival

Figure 8 shows the PFD from a single AES operating at various altitudes. This figure includes the 65 dB of out of band attenuation and 10 dB of airframe shielding. When operating at a flight level of 30,000 ft there is 17.7 dB of margin above the NRQZ aggregate PFD limit. Even if all 34 aircraft were above a NRQZ site and transmitted simultaneously (from above, 34 is the maximum number of aircraft in the network allowed to transmit simultaneously by the NMS) there would still be 17.7 – 10 * log(34) = 2.38 dB of margin in meeting the aggregate PFD limit.

This is a pathological case as Internet usage statistics suggest a ratio in the 30:1 range for a less than 1% chance that users would request data at the same time, i.e., out of 300 users, less than 10 would likely request data at the same time.

The ViaSat AMSS AES terminals are programmed with the locations of the protected sites and equipped with algorithms that determine when an AES must cease transmission while operating in the vicinity of a protected site. ViaSat will monitor network operations and update the AES operating parameters periodically as required to ensure that AES terminals inhibit their transmissions as required to adequately protect NSF sites during periods of scheduled observations.

Method Three – Geographical Avoidance

The final protection method is geographical avoidance. As previously noted, ITU-R M.1643 and subsequently the FCC, requires that the SFD masks for both types of radioastronomy sites are met. As determined above, the AES must inhibit transmission within line-of-site of any RA site during periods of radio astronomy observations. To ensure that this requirement is met the AMSS system operator must be notified of which sites will be active and at what times. The AMSS operator must then load this information into the Network Management System so that it can be broadcast to all active aircraft. The aircraft will then be required to inhibit transmissions by transponders 21-24 while within line of sight of the affected observatory .

ViaSat will make the locations and schedules of radio astronomy sites available to its customers so they may modify flight paths if they choose, to avoid the coordination zone and thereby avoid loss of Internet communications during the flight.

Finally, the location of each aircraft equipped with the AMSS system is logged throughout their flight. This data is maintained at ViaSat and can be used to help determine if an aircraft was near a site when interference by ViaSat was suspected. This data will be reviewed periodically to produce such statistics as the closest aircraft approach to a protected site, aircraft heading, minimum altitude over the site, and maximum number of aircraft simultaneously within the protection zone for the site.