Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Service Rules and Procedures to Govern the Use	)	
of Aeronautical Mobile Satellite Service Earth	)	IB Docket No. 05-20
Stations in Frequency Bands Allocated to the	)	
Fixed Satellite Service	)	

COMMENTS OF THE BOEING COMPANY

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SUMMARY

The Boeing Company ("Boeing") fully supports the Commission's efforts to develop a comprehensive regulatory regime for Aeronautical Mobile-Satellite Service ("AMSS") earth stations in the Ku-band fixed satellite service ("FSS") frequencies. Adopting a revised AMSS regulatory regime is the first step in facilitating the expansion of innovative broadband services to the flying public while protecting other authorized users of the spectrum.

Boeing supports the Commission's proposals for AMSS licensing and service rules consistent with analogous precedent, current approaches to earth station regulation and international norms. In particular, Boeing supports:

- Affording secondary or primary protection for aircraft earth station ("AES") receive operations in the 11.7-12.2 GHz band, and granting access to "extended Ku-band" frequencies for AES receive operations both in the United States and abroad.

- Implementing a standard primary/secondary sharing environment in the 14.0-14.5 GHz band between co-frequency AMSS and FSS services, and requiring coordination with the Federal government to protect NASA Tracking and Data Relay Satellite System ("TDRSS") facilities and Radio Astronomy Service ("RAS") systems.

- Adopting an AMSS blanket licensing regime based on AES off-axis e.i.r.p. density limits to afford AMSS operators sufficient operational flexibility and fully protect co-frequency FSS operations, including (i) appropriately defining the angle at which the off-axis e.i.r.p. mask commences; (ii) adopting aggregate off-axis e.i.r.p. density limits that account for bandwidth-on-demand systems; (iii) granting ALSAT authority for operations at routine licensing levels; and (iv) permitting coordination of higher off-axis e.i.r.p. density levels to allow Ku-band AMSS systems to operate consistent with the coordinated parameters of their serving satellites.

- Adopting other provisions for AES operation and licensing, including requiring an AMSS system performance verification report prior to commencement of commercial operations to confirm that an AMSS system will operate in the manner authorized by the Commission.

However, Boeing questions certain elements of the Commission's proposals. In particular, Boeing believes that the Commission should not require that Ku-band AES operators maintain a network control and monitoring center ("NCMC") in the United States. Instead, a 24/7 point of contact located within the United States with the ability and authority to control AES transmissions should ensure Commission regulatory authority over licensed AES operations. In addition, the Commission should not seek to distinguish between U.S. and foreign AMSS systems, but instead should apply uniform requirements to all AES operators seeking to provide service in the United States and onboard U.S.-registered aircraft.

By adopting AMSS licensing and service rules consistent with these comments, the Commission will facilitate the further development and expansion of Ku-band AMSS services in the United States and around the world.

TABLE OF CONTENTS

Page

SUMMARY i

I. INTRODUCTION 1

II. DISCUSSION 5

A. AMSS Spectrum Allocations Issues 6

1. Downlink Band Issues 6

a. The Commission Should Afford Formal Regulatory Status to AMSS Receive Operations in the 11.7-12.2 GHz Band 6

b. The Commission Should Permit AMSS Operations in the 10.95-11.2 GHz, 11.45-11.7 and 12.2-12.75 GHz Bands 7

2. Uplink Band Issues 9

b. 14.47-14.5 GHz Band 12

c. Other Services in the AMSS Uplink Band 13

3. Proposed Footnotes to the U.S. Table of Frequency Allocations 14

B. AMSS Technical and Operational Issues 15

1. Essential Requirements Relating to the Protection of Adjacent Satellite Operators 15

a. Off-Axis E.I.R.P. Density Limits and Associated Conditions 15

b. Antenna Pointing Accuracy and Other Factors Affecting Off-Axis E.I.R.P. 26

2. Essential Requirements Related to the Protection of the Fixed Service 30

C. AES Licensing Considerations 31

D. Tracking AES Terminals 36

E. Regulation of AMSS Operations Based on Aircraft Country of Registry 38

1. U.S.-Registered Aircraft 39

2. Operation of AES on Foreign Registered Aircraft 40

III. CONCLUSION 43

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COMMENTS OF THE BOEING COMPANY

The Boeing Company ("Boeing") hereby submits its comments in response to the Notice of Proposed Rulemaking ("*NPRM*") in the above-captioned proceeding regarding the adoption of service rules and procedures governing the operation of Aeronautical Mobile-Satellite Service ("AMSS") earth stations in Ku-band Fixed-Satellite Service ("FSS") frequencies.[1] Boeing fully supports the Commission's efforts to develop a comprehensive regulatory regime for such systems, which will facilitate the expansion of innovative broadband aeronautical communications services to the flying public as well as protect other authorized users of the spectrum.

I. INTRODUCTION

Boeing is the leading proponent of advanced broadband satellite communications services for commercial, government and private aircraft customers through its Connexion by Boeing[SM] ("Connexion") service.[2] Boeing's Connexion service is available today on flights offered by

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[1] Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service, *Notice of Proposed Rulemaking*, 20 FCC Rcd 51 (2005) ("*NPRM*").

[2] *See* Radio Station Authorization, Call Sign E000723, File No. SES-MOD-20020308-00429; *see also The Boeing Company,* Order and Authorization, 16 FCC Rcd. 22645 (Int'l Bur./OET 2001) ("*Boeing Transmit-Receive Order*").

Lufthansa, SAS, Japan Airlines, ANA and Singapore Airlines, including routes to and from the United States. In addition, China Airlines, Korean Air, El Al, Asiana, Etihad and Austrian Airlines will begin offering Connexion service on their long-range aircraft in the near future. Boeing also provides Connexion service to certain U.S.-registered aircraft operating in the United States and abroad, as well as high-speed connectivity solutions for the business aviation and maritime markets.[3]

On July 21, 2003, shortly after the 2003 World Radiocommunication Conference ("WRC-03") added a worldwide secondary AMSS allocation in the 14.0-14.5 GHz band,[4] Boeing submitted a Petition for Rulemaking ("Petition") to the Commission seeking to include this AMSS allocation in the U.S. Table of Frequency Allocations and to adopt licensing and service rules for Ku-band AMSS operations.[5] In a separate proceeding implementing the results of WRC-03 and prior conferences, the Commission adopted a generic secondary Ku-band MSS

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[3] For its eXchange antenna, Boeing is authorized under an experimental license. *See* The Boeing Company, Experimental Radio Station Construction Permit and License, FCC File No. 0021-EX-ML-2005, Call Sign WC2XVE (granted April 7, 2005). Boeing has also applied for a permanent earth station authorization for its eXchange antenna. *See* The Boeing Company, FCC File No. SES-MFS-20050701-00853 (filed July 1, 2005). In addition, Boeing's service will soon be offering maritime services through earth stations on board vessels. *See* The Boeing Company, Experimental Special Temporary Authorization, FCC File No. 0703-EX-ST-2003, Call Sign WD2XFK (granted December 13, 2004). A separate experimental application remains pending before the Commission. *See* File No. 0194-EX-PL-2003, Call Sign WD2XFK (filed December 1, 2004). Additional information regarding the Connexion by Boeing[SM] service is available at http://www.connexionbyboeing.com.

[4] *See WRC-03 Final Acts* at 34-38 (adding a "Mobile-satellite (Earth-to-space)" allocation in the 14.0-14.5 GHz band in all three Regions, as well as footnote 5. 5.504A, which provides: "In the band 14-14.5 GHz, aircraft earth stations in the secondary aeronautical mobile-satellite service may also communicate with space stations in the fixed-satellite service…."), *see also* Radio Regulations, Vol.1 at 135-36 (2004 ed.).

[5] Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the 14-14.5 GHz Band to the Aeronautical Mobile-Satellite ("AMSS") and to Adopt Licensing and Service Rules for AMSS Operations in the Ku-Band, The Boeing Company, Petition for Rulemaking, filed July 21, 2003 ("Petition").

allocation domestically to permit AMSS operations in the 14.0-14.5 GHz band.[6] The *NPRM* raises certain allocation issues relating to this uplink allocation and AMSS downlink operations in the Ku-band, and addresses the need to adopt comprehensive AMSS service and licensing rules.

Two years prior to WRC-03, Boeing was granted authority to operate both receive-only and transmit-receive aircraft earth stations ("AESs") in Ku-band frequencies on a non-conforming use basis.[7] The Commission later authorized a number of changes to Boeing's transmit-receive license, including the addition of reflector antenna AESs in place of phased-array antenna AESs.[8] Under its license, Boeing was required to verify AMSS system performance prior to commencing full commercial operations, was not allowed to cause harmful interference to other authorized users of the spectrum, and was required to accept interference from such users.[9] Boeing's authorization was also limited to operations onboard aircraft located in U.S. airspace, including over U.S. territorial waters.[10] Currently pending before the Commission is an application by Boeing requesting authority for AESs to operate on U.S.-

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[6] *See* Amendment of Parts 2, 25, and 87 of the Commission's Rules to Implement Decisions from the World Radiocommunications Conferences Concerning Frequency Bands Between 28 MHz and 36 GHz and to Otherwise Update the Rules in this Frequency Range, ET Docket No. 02-305, *Report and Order*, 18 FCC Rcd 23426 (2003) ("*Above 28 MHz Order*").

[7] *See* The Boeing Company, *Order and Authorization*, 16 FCC Rcd. 5864 (Int'l Bur./OET 2001); *see also Boeing Transmit-Receive Order*.

[8] *See* Radio Station Authorization, Call Sign E000723, File No. SES-MOD-20030512-00639; Satellite Communications Services Information re: Actions Taken, *Public Notice*, Report No. SES-00561 (rel. Dec. 17, 2003).

[9] *See Boeing Transmit-Receive Order*, 16 FCC Rcd at 22653-54, ¶ 19.

[10] *Transmit -Receive Order* at ¶ 19.

registered aircraft located in international airspace (*i.e.*, over international waters) and in the airspace of foreign countries.[11]

Recently, ARINC, Inc. ("ARINC") was authorized to operate its SKYLink^{SM} AMSS system in the Ku-band.[12] The SKYLink^{SM} system was licensed to operate on a secondary basis in the 14.0-14.5 GHz band consistent with the existing U.S. Table of Frequency Allocations. The SKYLink^{SM} system, however, is subject to very different operational and performance verification conditions than those imposed on the Connexion system.[13] In light of some of these differences, Boeing filed a Petition for Partial Reconsideration of certain conditions contained in the SKYLink authorization.[14] Through this rulemaking proceeding, which seeks to develop service and licensing rules for all Ku-band AMSS systems, the Commission should be able to provide a greater degree of regulatory certainty and to promote competition by establishing uniform requirements for existing and future Ku-band AMSS providers.

Although authorizing Ku-band AMSS operations involves complex regulatory and technical issues, many of these issues have already been examined in prior AMSS licensing proceedings and by the International Telecommunication Union ("ITU") in developing international guidelines for AMSS systems.[15] Moreover, many of the same regulatory and

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[11] *See* The Boeing Company, Application to Modify Blanket AMSS Earth Station Authorization Call Sign E000723, File No. SES-MOD-20040301-00304 (filed March 1, 2004) ("Boeing International Waters Modification Application"). The Office of Engineering and Technology has granted Boeing an experimental license to test 10 AES terminals over international waters. *See* Call Sign WC2XVE, File No. 0002-EX-ML-2004 (Jan. 13, 2004).

[12] *See* ARINC Incorporated, Order and Authorization, File Nos. SES-LIC-20030910-01261 and SES-AMD-20031223-01860, DA 05-1016 (rel. Apr. 6, 2005) ("*ARINC Order*").

[13] *Compare ARINC Order* at ¶58 and *Boeing Transmit-Receive Order* at ¶ 19.

[14] Petition for Partial Reconsideration of The Boeing Company, File Nos. SES-LIC-20030910-01261 and SES-AMD-20031223-01860 (filed May 6, 2005).

[15] ITU-R Recommendation M.1643 (Geneva 2003) sets forth technical and operational requirements for AESs operating in Ku-band AMSS networks. *See* Recommendation ITU-R M.1643 at Annex 1.

technical issues were recently addressed by the Commission in adopting a comprehensive regulatory regime for earth stations onboard vessels ("ESVs") operating in C-band and Ku-band frequencies.[16] Boeing believes that appropriate AMSS licensing and services rules also will be informed by recent initiatives to modify to the Commission's earth station licensing rules. Accordingly, Boeing proposes new AMSS rules to replace the proposed rules initially submitted with the Petition.[17]

II. DISCUSSION

Boeing strongly supports the Commission's efforts to develop a comprehensive, pro-competitive regulatory regime for Ku-band AMSS services. Uniform AMSS licensing and service rules that are consistent with Commission precedent and international norms will provide regulatory certainty and enhance competition in Ku-band AMSS services. With a few exceptions, Boeing believes that the approaches proposed in the *NPRM* are consistent with the Commission's goals of facilitating the deployment of AMSS networks and extending important new broadband services to U.S. consumers, while at the same time protecting the operations of incumbent users in the Ku-band.

In the *NPRM*, the Commission sought comment on a number of issues related to AMSS licensing and operation, including (i) spectrum allocation and co-frequency service protection issues; (ii) technical and operational requirements; (iii) AES licensing considerations; (iv)

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[16] Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz bands, IB Docket No. 02-10, *Report and Order*, 20 FCC Rcd 674 (2005) ("*ESV Report and Order* "). Boeing and others have filed petition for reconsideration and/or clarification of certain aspects of the Commission's *ESV Report and Order*. *See, e.g.,* Petition for Partial Clarification or Reconsideration of The Boeing Company (filed March 2, 2005).

[17] *See* Attachment A, hereto.

tracking and data retention requirements; and (v) AES regulation based on country of aircraft registry. Boeing addresses these issues below.

A. AMSS Spectrum Allocations Issues

Although the Commission previously modified the U.S. Table of Frequency Allocations to include a generic secondary allocation for MSS services in the 14.0-14.5 GHz uplink band (which includes AMSS),[18] the regulatory status of AMSS downlink operations was not addressed. In addition, the Commission has requested comment on requirements for AMSS systems to protect other co-frequency operations in Ku-band spectrum.

1. Downlink Band Issues

a. The Commission Should Afford Formal Regulatory Status to AMSS Receive Operations in the 11.7-12.2 GHz Band

In its Petition, Boeing suggested that the Commission need not amend the U.S. Table of Frequency Allocations to include AMSS downlink operations, and instead could continue to authorize such operations on an unprotected, non-conforming use basis.[19] The Commission, on the other hand, has sought comment on whether AESs receiving in the 11.7-12.2 GHz band should be afforded secondary status or, if they can maintain pointing accuracy toward geostationary satellite orbit ("GSO") FSS satellites, should be treated like other earth stations in the FSS (*i.e.,* as primary and therefore subject to the receive antenna protection levels set forth in Section 25.209(c)).[20] The Commission tentatively concluded that pairing the secondary AMSS uplink in the 14 GHz band with a secondary downlink in the 11/12 GHz band is preferable

[18] *See Above 28 MHz Order*; *see also* 47 C.F.R. 2.106 (2004).

[19] Petition at 11.

[20] *NPRM* at ¶ 15.

because it will help to standardize the application and acceptance process for these systems.[21] The Commission proposed a new footnote, however, which provides for primary protection for AMSS receive operations:

> **NGyyy** In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), aircraft earth stations in the aeronautical mobile-satellite service are an application of the Fixed-Satellite Service (FSS). The provisions of ITU Radio Regulations Nos. 5.29, 5.30 and 5.31 apply, except that reception from geostationary space stations in the fixed-satellite service in the 11.7-12.2 GHz shall be protected in the United States on a primary basis, provided that the aircraft earth stations operate under the same parameters as earth stations in the fixed-satellite service.[22]

Boeing believes that it is appropriate to afford Ku-band AMSS downlink operations superior protection than non-conforming uses of the spectrum. Boeing agrees with the Commission that such protection will help to standardize the application and acceptance process for these systems. At a minimum, Boeing supports the Commission's tentative conclusion that AMSS operations in the 11.7-12.2 GHz band should be afforded secondary status. Furthermore, since the same FSS satellite transponders used for Ku-band AMSS downlinks may also support primary ESV operations[23] or AMSS feeder link operations,[24] providing primary receive protection for AMSS receive operations in this band would also be appropriate.[25]

b. The Commission Should Permit AMSS Operations in the 10.95-11.2 GHz, 11.45-11.7 and 12.2-12.75 GHz Bands

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[21] *Id.* at ¶ 16.

[22] *Id.* at ¶ 31 (emphasis added).

[23] In fact, Boeing plans to offer Connexion AMSS and ESV services on the same transponders in certain areas.

[24] ARINC's SKYLink system is designed to use the same transponders for communications with AESs and for AMSS feeder links.

[25] As discussed herein, the Commission should afford similar regulatory status to AMSS receive operations in extended Ku-band frequencies vis-à-vis FSS services.

The Commission should permit AMSS operations in the so-called "extended Ku-band" (10.95-11.2 GHz and 11.45-11.7 GHz bands), as well as the 12.2 – 12.75 GHz band,[26] because global AMSS systems require access to all of these bands in order to provide seamless service around the world. In many countries, Ku-band FSS downlinks are allocated in spectrum other than the 11.7-12.2 GHz band. Because AMSS systems such as Connexion by Boeing[SM] operate in all regions of the world, their AESs must be designed to receive across the full range of spectrum used internationally for FSS Ku-band downlink operations in accordance with the ITU's regional allocations.[27] Thus, authorizing AMSS downlink operations throughout internationally allocated Ku-band FSS downlink spectrum provides AES operators serving U.S.-registered aircraft with the flexibility necessary to operate globally.

In addition, Boeing believes that AMSS downlink operations in the extended Ku-band should be permitted in the United States on an unprotected, non-harmful interference basis vis-à-vis the fixed service ("FS").[28] With this regulatory treatment, AMSS downlinks will have no adverse impact on FS operations, furthermore, access to this spectrum is important to provide incidental U.S. service for flights to and from the United States that may utilize extended Ku-band frequencies while the aircraft flies over international waters. Given the substantial benefits associated with use of the extended Ku-band, including the ability to provide seamless service on

[26] The band 12.2 – 12.5 GHz is allocated by the international Radio Regulations to the FSS in Region 3 and the band 12.5 – 12.75 GHz is allocated to the FSS in Regions 1 and 3.

[27] Thus, although Boeing normally limits downlink operations in the United States to the 11.7-12.2 GHz band, its AESs are designed to receive transmissions throughout the entire 10.7-12.75 GHz band to facilitate operations outside the United States.

[28] The Commission confirms in the *NPRM* that footnote NG104 would be inapplicable because AES receiver operating on an unprotected basis would not need any coordination with the FS. *See NPRM* at ¶ 18, n. 58.

flights to and from the United States, the Commission should permit the use of this spectrum by AES operators in the United States.

Importantly, however, AMSS downlink operations in the extended Ku-band should be granted the same regulatory status as FSS operations. In other words, the Commission should afford Ku-band AMSS receive operations in the extended Ku-band the same regulatory status afforded in the conventional Ku-band with respect to FSS operations. This will ensure that all authorized AMSS downlinks in the United States have the same protection vis-à-vis the FSS regardless of frequency band.

2. Uplink Band Issues

The U.S. Table of Frequency Allocations for the 14.0-14.5 GHz band includes a primary allocation for FSS uplink operations, including uplink transmissions from Ku-band ESV terminals, as well as a secondary allocation for AMSS uplink operations.[29] With regard to these services, the Commission proposed to apply standard primary/secondary sharing requirements.[30]

There is no doubt that Ku-band AMSS systems can share with other services in the 14.0-14.5 GHz band without causing harmful interference. The Conference Preparatory Meeting ("CPM") Report to the WRC-03 concluded that, based on the results of extensive studies conducted within the ITU-R, "it has been demonstrated that it is feasible for appropriately designed AMSS networks to be operated on a secondary basis in the band 14-14.5 GHz without causing harmful interference to primary services in the band" and "[a]dditional studies have shown the feasibility of AMSS sharing with services employing secondary allocations in the

[29] 47 C.F.R. 2.106 (2004).

[30] *NPRM* at ¶ 20.

band."[31] Moreover, the Connexion system has been operating for a number of years in the 14.0-14.5 GHz band on a non-harmful interference basis without any reported instance of interference to other services. Thus a standard primary/secondary sharing environment can plainly be implemented.

With respect to other co-frequency services, Boeing proposes that AMSS licensees should not be permitted to conduct transmit operations in the 14.0-14.5 GHz band that may affect Federal Government systems until successfully completing coordination through the National Telecommunications and Information Administration ("NTIA") Frequency Assignment Committee of the Interdepartment Radio Advisory Committee ("IRAC"). Although Boeing suggested that such coordination should be a condition of licensing that must be satisfied prior to commencing commercial operations,[32] the Commission proposes to make it a "prerequisite to licensing."[33] As discussed below, Boeing recognizes the need to protect these important government systems and therefore believes that coordination as a prerequisite to licensing will not unduly burden Ku-band AMSS providers.

a. 14.0-14.2 GHz Band

Existing Federal Government services in the 14.0-14.2 GHz band include Space Research Services ("SRS") for the Tracking and Data Relay Satellite System ("TDRSS"). In light of the vulnerability of existing TDRSS stations resulting from their low interference rejection characteristics, the Commission proposes to require that all AMSS operations throughout the 14.0-14.5 GHz band be coordinated through NTIA/IRAC to resolve any potential interference

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[31] *See* WRC-03 Document No. 3, CPM Report to 2003 World Radiocommunication Conference at 2.4.2.

[32] Petition at 19.

[33] *NPRM* at ¶¶ 23 and 28.

concerns.[34] Boeing agrees that current TDRSS operations in the 14.0-14.2 GHz band should be protected from harmful interference, and does not object to requiring Ku-band AMSS systems to coordinate operations throughout the 14.0 – 14.5 GHz band due to TDRSS system characteristics.

With respect to future TDRSS sites, the Commission envisions a supplemental coordination process by which NTIA would notify the International Bureau at least six months prior to the operational status of any new site. The Bureau would then issue a public notice requiring all Ku-band AMSS operators to complete coordination of their operations in the 14.0-14.5 GHz band through the FCC with the NTIA for the new site prior to its planned operational date. During the coordination period, should any party believe that an acceptable coordination agreement cannot be reached, the FCC and NTIA would jointly resolve the matter.[35]

Boeing believes that coordination of future TDRSS operations can be achieved, although such coordination will constrain Ku-band AMSS systems. This is particularly true for the future TDRSS earth station facility to be located in the Mid-Atlantic region because of its proximity to East coast flight routes. Therefore, it is particularly important that this facility be designed to minimize the coordination impact on AES operations (*e.g.*, use of advanced interference rejection filtering).[36] Because a newly constructed TDRSS earth station facility should be able to operate within generally accepted earth station performance standards, including rejection of out-of-band emissions, there is no basis for requiring coordination across the entire 14.0-14.5 GHz band. Thus, Boeing urges the Commission to limit the coordination obligation on AMSS operators for future TDRSS stations to the 14.0-14.2 GHz band only. This limitation will avoid the potential

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[34] *Id.* at ¶ 23.

[35] *Id.* at ¶ 24. The Commission further indicated that it may be required to invoke Section 316 of the Communications Act to modify an authorization in order to protect TDRSS stations. *See id.* (citing 47 U.S.C. § 316).

[36] *Id.*

for unnecessary disruption of AMSS services while ensuring that new TDRSS operations are fully protected.

b. 14.47-14.5 GHz Band

The Commission also proposes to require that, as a prerequisite to licensing, AMSS operations throughout the 14.0-14.5 GHz band be coordinated with the NTIA to resolve any potential interference concerns with the Radio Astronomy Service ("RAS").[37] The Commission expressed concern that the sensitivity of U.S. RAS sites, combined with the limited signal attenuation of signals from AMSS stations (as compared to non-aeronautical platforms), warrants coordination of AMSS operations throughout the entire 14.0-14.5 GHz band.[38] However, RAS operations are already afforded adequate protection through Recommendation ITU-R M.1643, which provides conservative criteria for AMSS transmissions throughout the 14.0.-14.5 GHz band.[39] Additionally, based on Boeing's experience, coordination is needed only in the 14.47-14.5 GHz band.

Indeed, the comments already submitted by the National Radio Astronomy Observatory ("NRAO") in this proceeding confirm that imposing coordination requirements below 14.47 GHz is unnecessary.[40] NRAO suggests, and Boeing agrees, that sharing requirements in the 14.47-14.5 GHz portion of the band are best defined in a further rulemaking proceeding and based on the existing memoranda of understanding between the National Science Foundation

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[37] *Id.* at ¶ 28. This proposal would require coordination for AES transmissions outside the 14.47-14.5 GHz band in which radio astronomers conduct observations.

[38] *Id*.

[39] *See* Recommendation ITU-R M.1643 at Part C ("Essential requirements related to sharing with the RAS").

[40] Comments of National Radio Astronomy Observatory, IB Docket 05-20 (filed Apr. 4, 2005).

("NSF") and AMSS operators.[41] Boeing also agrees with the NRAO that the Commission should remove references to footnote US203 from the AMSS footnotes proposed in the *NPRM*.[42]

The Commission also seeks comment on whether it should modify the status of the RAS in the U.S. Table of Frequency Allocations to co-secondary relative to AMSS.[43] Boeing does not object to elevating the regulatory status of RAS vis-à-vis AMSS only. Boeing will continue to adequately protect RAS sites pursuant to its coordination agreement with the NSF regardless of the regulatory status afforded to RAS in this band.[44]

c. Other Services in the AMSS Uplink Band

The Commission proposes to make AMSS co-secondary with grandfathered Local Television Transmission Service ("LTTS") in the 14.2-14.4 GHz band.[45] Usage of the band by LTTS is very low, no new LTTS applications are being accepted, and existing LTTS licenses will not be renewed when their terms expire. In addition, there have been no reports of interference into LTTS receivers during the time that AESs have been operating in the United States. Accordingly, Boeing believes that AMSS uplink operations will not affect grandfathered LTTS operations in the 14.2-14.4 GHz band, and that the limited duration of existing non-renewable licenses confirms that no special requirements are necessary.

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[41] *See* NRAO Comments at p. 3. Such a rulemaking could address issues such as notification of RAS observations, the differences in protection requirements between standard RAS stations and VLBA stations (as provided by the ITU-R in Recommendation ITU-R RA.769), and other matters.

[42] *NRAO* Comments at 4. The NRAO notes that numerous inaccuracies exist in footnote US203 and other footnotes in the U.S. Table of Frequency Allocations. *Id.*

[43] *See NPRM* at ¶ 28 The U.S. Table of Frequency Allocations does not provide an allocation for radio astronomy in the 14.47-14.5 GHz band, but the International Table of Frequency Allocations does provide a secondary allocation for RAS in this band. *See* 47 C.F.R. § 2.106.

[44] *See* Technical Operational Coordination Agreement for the Joint Usage of the Band 14.0-14.5 GHz Between the National Science Foundation and Aircraft Earth Stations Operating in the Boeing Connexion Aeronautical Mobile Network, dated Dec. 13, 2001 ("NSF Agreement").

[45] LTTS has a secondary mobile allocation in the 14.2-14.4 GHz band for television pickup and television non-broadcast pickup stations.

The Commission also seeks comment on whether it is necessary to adopt any interference protection or coordination requirements to protect other users in the 14.4-14.5 GHz band. This portion of the band is allocated for primary FSS, secondary MSS, secondary FS and secondary mobile services for the Federal Government. The band is also allocated for use by the Federal Government for aeronautical mobile stations, land-based aeronautical mobile stations and land mobile stations.[46] Boeing cannot comment on how extensively the band may be used, but notes that the operations identified in the *NPRM* have posed no issues for Boeing's AMSS operations to date. Thus, it is not clear that Commission action is needed with respect to such services.

3. Proposed Footnotes to the U.S. Table of Frequency Allocations

The Commission proposes to add two non-Federal government footnotes to the U.S. Table of Frequency Allocations.[47] First, footnote NGyyy establishes the regulatory status of AMSS operations in the United States. As discussed above, Boeing believes that affording primary protection to AMSS receive operations would serve the public interest and therefore supports adoption of footnote NGyyy as drafted.[48]

Second, the Commission proposes to add footnote USxxx to the U.S. Table of Frequency Allocations for the 14.0-14.5 GHz band, which provides that AMSS operations in this band are subject to coordination with NTIA to minimize interference to TDRSS earth stations and RAS sites listed in US203.[49] As indicated above, Boeing believes that the spectrum bands subject to coordination should be different for TDRSS and RAS operations, that the spectrum subject to coordination should be narrowly tailored for future TDRSS facilities, and that the reference to

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[46] *NPRM* at ¶ 27.

[47] *Id.* at ¶¶ 31-32.

[48] *See supra* at Section II.A.1.a.

[49] *NPRM* at ¶ 32.

footnote US 203 should be eliminated. As a result, Boeing suggests splitting USxxx into two separate footnotes – one addressing TDRSS coordination and one addressing RAS coordination:

> **USxxx** In the band 14.0-14.5 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to NASA's Tracking and Data Relay Satellite System (TDRSS) earth stations in operation before [effective date of rule]. For other TDRSS earth stations, the operations of Aeronautical Mobile-Satellite Service earth stations in the 14.0-14.2 GHz are subject to such coordination.
>
> **USxxy** In the band 14.47-14.5 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to the radio astronomy sites that observe in the 14.47-14.5 GHz band.[50]

B. AMSS Technical and Operational Issues

1. Essential Requirements Relating to the Protection of Adjacent Satellite Operators

a. Off-Axis E.I.R.P. Density Limits and Associated Conditions

The Commission seeks comment on the several proposals regarding off-axis e.i.r.p. density limits and associated conditions to ensure that AMSS operations in the 14.0-14.5 GHz band adequately protect neighboring Ku-band FSS satellites. Boeing supports the adoption of an AMSS regulatory regime based on AES off-axis e.i.r.p. density limits because it affords AMSS operators significant operational flexibility, while at the same time fully protecting co-frequency FSS operations. As discussed below, however, certain elements of the Commission's proposed approach do not appear to be consistent with those objectives or with recent Commission actions adopting analogous ESV rules and addressing other earth station licensing reforms.

i. AMSS off-axis e.i.r.p. density mask

Boeing urges the Commission to adopt an off-axis e.i.r.p. density mask for Ku-band AESs that differs somewhat from the one included in its Petition and set forth in the *NPRM*.

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[50] *See* Attachment A, hereto.

Specifically, Boeing proposes that the *aggregate* off-axis e.i.r.p. density from AES transmissions should not exceed:[51]

Angle off-axis	Maximum e.i.r.p. density in any 4 kHz band
1. 5°** $\leq \theta \leq$ 7.0°	15 – 25log(θ) dBW/4kHz
7.0° < θ ≤ 9.2°	-6 dBW/4kHz
9.2° < θ ≤ 48°	18 – 25log(θ) dBW/4kHz
48° < θ ≤ 85°	-24 dBW/4kHz
85° < θ ≤ 180°	-14 dBW/4kHz

* Where θ is the angle in degrees from the axis of the main lobe.
* * The above pattern should begin at 2.0° instead of 1.5° where AES antenna pointing errors are taken into account by the system operator in controlling the off-axis e.i.r.p. density.

The following changes have been made to the mask previously proposed by Boeing: (i) the angle at which the mask commences has been increased from 1.0° to 1.5° or 2.0°, depending on how the AMSS operator takes into account AES antenna pointing errors; and (ii) the prior θ > 48° entry has been split into two entries.[52] These changes will result in an AES off-axis e.i.r.p. density mask that is more closely aligned with the proposed VSAT mask, and will allow for greater flexibility in antenna design without increasing the potential for harmful interference into adjacent FSS satellites.[53]

Boeing suggests starting the off-axis e.i.r.p. density mask at 1.5° (or in certain instances 2°) rather than 1.0° for several reasons. First, continuous monitoring and accurate control of overall AES antenna pointing (on the order of tenths of a degree for short periods of time, as

[51] See Attachment A (new Section 25.223(a)(1)).

[52] *See* Petition at 15; *see also NPRM* at ¶ 35.

[53] *See* 2000 Biennial Regulatory Review -- Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations, *Sixth Report and Order and Third Further Notice of Proposed Rulemaking*, IB Docket No. 00-248, FCC 05-62 (rel. Mar. 15, 2005) ("*Third Further NPRM*").

compared to ongoing and uncorrected mis-pointing up to 0.5° for VSAT terminals for indefinite periods) ensure that the proposed mask will be met and neighboring FSS satellites will not experience harmful interference. Commencing the off-axis e.i.r.p. density mask at an angle smaller than 1.5° will provide no benefit to adjacent satellite operators, but may unnecessarily constrain AES antenna design and operational flexibility.

Further, a strong case can be made for starting the mask at 2° rather than 1.5° for those AMSS systems that take into account AES antenna mis-pointing error in calculating aggregate off-axis e.i.r.p. density levels. These AMSS systems, such as Boeing's Connexion system, calculate the aggregate off-axis envelope taking into account the AES mis-pointing error, and then compare this envelope to the VSAT off-axis e.i.r.p. mask criteria, which also takes into account earth station mis-pointing.[54] This approach essentially accounts for the AES antenna mis-pointing twice because it includes the mis-pointing in both the calculation of the off-axis e.i.r.p. envelope and in the mask to which it is compared. Accordingly, AMSS systems that take into account AES antenna pointing error in the calculation of the aggregate AES off-axis e.i.r.p. envelope should be allowed to use an off-axis e.i.r.p. density mask that starts at an offset angle of 2° rather than 1.5° or 1.0°. In doing so, AES mis-pointing would be taken into account only once, resulting in a more accurate mask.

Similarly, Boeing proposes to include two off-axis e.i.r.p. density entries ($48° < \theta \leq 85°$ and $85° < \theta \leq 180°$), rather than a single $\theta > 48°$ entry in accordance with the Commission's proposed VSAT mask in the *Third Further NPRM*.[55] The Commission has proposed a more permissive off-axis e.i.r.p. density level for angles of $85° < \theta \leq 180°$ because of the reduced

[54] That is, in order to protect a satellite at 2 degrees, the proposed VSAT mask starts at 1.5° so as to account for possible VSAT antenna mis-pointing.

[55] Petition at 15; *see also NPRM* at ¶ 35.

impact of off-axis e.i.r.p. density to satellites located at these large angular separations. AESs should obtain the same operational flexibility associated with the less restrictive off-axis e.i.r.p. density requirements afforded to Ku-band VSAT terminals.

ii. Exceedance of AES off-axis e.i.r.p. density levels

In its Petition, Boeing proposed that the Commission permit minor variances in the off-axis e.i.r.p density values to account for variations in antenna performance where such variances would not adversely affect adjacent satellite operators.[56] The Commission agreed and proposed that for angles greater than 7.0°, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope by more than 3 dB.[57] Boeing supports this proposal and has included such a provision in the draft AMSS rules attached hereto.[58]

In addition to potential exceedance caused by minor antenna variations, in the *Third Further NPRM* the Commission proposed a new contention protocol rule that would permit additional exceedances of extremely short duration for varying percentages of time based on the extent of the exceedance.[59] Specifically, the Commission proposed off-axis e.i.r.p. density exceedances from Ku-band earth station transmissions of between 2 and 16 dB, with the permissible amount of time for such exceedances reduced by an order of magnitude for each 2 dB increase in exceedance.[60] The Commission reasoned that such an approach

> . . . seems to strike a reasonable balance between protecting adjacent satellites from harmful interference and allowing VSAT network operators to make

[56] Petition at 16.

[57] *NPRM* at ¶ 38.

[58] *See* Attachment A (new Section 25.223(a)(1)).

[59] *Third Further NPRM* at ¶ 120.

[60] *Id.* at ¶ 119.

> efficient use of their facilities. Specifically, by requiring VSAT operators to meet an off-axis EIRP envelope in the aggregate, we should not allow any increase in the potential for harmful interference to adjacent satellites. On the other hand, VSAT network operators are given substantial flexibility as a result requiring operators to meet the envelope in the aggregate rather than on an individual earth station basis, and by allowing the operators to exceed the off-axis EIRP envelope by increasing amounts, provided that the amount of time that the envelope is exceeded is sufficiently low.[61]

Boeing believes that this approach should be extended to Ku-band AESs employing multiple access techniques for the same reasons the Commission proposes adopting it for VSATs. Allowing exceedances of extremely short duration (less than 100 ms each) for variable periods of time based on the extent of the exceedance adequately balances the need to protect adjacent satellite operators with the need for efficient operation of Ku-band AMSS systems.

The mobile nature of AMSS systems leads to statistical variations in the off-axis e.i.r.p. density emitted by the AES due to various pointing factors and/or the stochastic performance of contention protocols. AMSS systems are designed to take these statistical variations into account, but currently there is a lack of guidance in the Commission's rules on the manner in which these variations are to be addressed. The two currently authorized U.S. AMSS systems control AES off-axis e.i.r.p. using different statistical probabilities and different approaches to their probability calculations. The table of exceedances proposed here would clarify this issue.

This approach should be extended to all types of multiple access schemes and not just contention protocols. The effect of the variations on adjacent FSS satellites, as limited in accordance with the following table, is independent of the reason for the variation (e.g., contention protocol transmission collision versus potential exceedance under positive control). Accordingly, Boeing proposes that the AES off-axis e.i.r.p. density envelope not exceed the

[61] *Id*. at ¶ 120.

specified mask by more than the percentage of time set forth below, with the maximum duration of any single exceedances being less than 100 milliseconds.[62]

Percentage of Time	Increase in Aggregate E.I.R.P. Allowed
10% (10^{-1})	0 dB
1% (10^{-2})	2 dB
0.1% (10^{-3})	4 dB
0.01% (10^{-4})	6 dB
0.001% (10^{-5})	8 dB
0.0001% (10-^{6})	10 dB
0.00001% (10-^{7})	12 dB
0.000001% (10-^{8})	14 dB
0.0000001% (10-^{9})	16 dB

An important parameter in applying these values is the time period over which the percentage of time is evaluated. Consistent with similar time periods given in Recommendation ITU-R S.614-4, Boeing believes that the period over which the percentage of time is averaged should be one month.

iii. Adoption of individual versus aggregate AES off-axis e.i.r.p. density levels

In the *NPRM*, the Commission seeks comment on whether to adopt individual AES off-axis e.i.r.p. density limits or whether such limits can be applied to the aggregate off-axis e.i.r.p. density of all simultaneously transmitting AESs.[63] The Commission expressed concern that AES terminals are rapidly moving and an AMSS network's topology is continuously changing, and that it may be simpler for AMSS network control facilities to control individual AES terminal

[62] *See* Attachment A (new Section 25.223(a)(3)). The values in this table are under active consideration in the Part 25 VSAT proceeding, and may be modified by the Commission in the context of adopting final rules.

[63] *NPRM* at ¶ 36.

transmissions.[64] The Commission further proposed that if an AMSS operator chooses to implement a modulation technique that permits multiple co-frequency AES transmissions terminals being simultaneously received at the same satellite, it would impose equal off-axis e.i.r.p. density limits on each individual AES by dividing the applicable limit by the number of simultaneously transmitting AESs.[65] The Commission's proposals, if implemented, would seriously undermine the existing operations and future development of AMSS systems in the United States.

The Commission's concerns with respect to the ability of AMSS systems to control dynamically AES transmissions to meet aggregate off-axis e.i.r.p. limits are entirely unfounded. As the Commission is well aware, the Connexion system employs positive control to vary the transmit power levels of individual AESs based on their capacity needs and to ensure that the aggregate off-axis e.i.r.p. density of all simultaneously transmitting AESs remain within prescribed limits. This technique, under which the Connexion system has been operating for some time without complaints of interference, allows Boeing to provide true bandwidth-on-demand[66] to its AMSS customers while fully protecting co-frequency FSS operations. Adopting static, individual AES off-axis e.i.r.p. density limits would foreclose advanced AMSS network management techniques such as those employed by the Connexion system and adversely affect Boeing's ability to service its many AMSS customers, including the U.S. Government. Given

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[64] *Id.*

[65] That is, if "N" AES transmitters were implemented, each operating on the same channel, transmitting to the same satellite, at the same time, the EIRP density limit on each individual transmitter would be reduced by a factor of 10*log(N), in dB. For example, if five AES terminals were equipped with CDMA AMSS transmitters all operating to the same satellite, in the same uplink bandwidth, the e.i.r.p. density of the individual transmitters would be reduced by a factor of 10*log(5) = 7.0 dB. *See id.*

[66] In this context, the term bandwidth-on-demand is used to describe a system in which the data rate can be varied based on user requirements. In actuality, the frequency bandwidth of a CDMA system remains constant while the data rate changes.

the interference-free operation of the Connexion system and the significant adverse impact of adopting individual AES limits, the public interest requires that the Commission allow the off-axis e.i.r.p. levels for Ku-band AES transmissions to be applied as an aggregate limit for multiple AESs.

Similarly, the Commission's proposal to divide available off-axis e.i.r.p. density equally among individual AESs in AMSS systems which use modulation techniques that permit multiple co-frequency transmissions from different AES terminals is misguided. Adoption of the Commission's proposal would seriously handicap a bandwidth-on-demand system such as the Connexion system because it does not account for the varying capacity needs of individual AESs. Equal AES off-axis e.i.r.p. density limits would unnecessarily reduce the efficiency of such systems.[67] Boeing has successfully operated the Connexion system using dynamic power control to assign available off-axis e.i.r.p. density among multiple AESs, and adopting a rule that prohibits this well-proven approach would be a major setback for properly designed Ku-band AMSS systems.

iv. Coordination of higher AES off-axis e.i.r.p. values

In its Petition, Boeing suggested that, like VSAT operators, Ku-band AMSS systems should have the flexibility to coordinate AES transmissions in excess of the off-axis e.i.r.p. values set forth in the Commission's rules, subject to an additional technical showing and the

[67] The data rate of bandwidth-on-demand systems is directly related to their power levels. Thus, a rule that imposes equal off-axis e.i.r.p. limits on AESs also imposes an equal data rate limit on the AESs. For instance, if an aggregate e.i.r.p. density limit would permit an aggregate data rate of 3 Mbps, and there are 3 AESs in the system, the maximum data rate for an individual AES would be 1 Mbps. However, one AES may have higher data rate requirements than the others, so it may be desirable to allocate a 2 Mbps data rate for one AES and only 0.5 Mbps for the other two AESs because their capacity requirements are smaller. If the off-axis e.i.r.p., and therefore the data rate, is allocated equally, the AES with the higher data requirement would be limited artificially to 1 Mbps, for a total system throughput of 2 Mbps, instead of the system capacity of 3 Mbps. In this case, one third of the system's capacity would be wasted.

rights of future Ku-band licensees to require compliant operations in certain circumstances.[68] Boeing further proposed that AMSS systems should have the flexibility to operate at power levels in excess of the U.S. values for operations with satellites in regions where two-degree satellite spacing is not the norm and operator-to-operator coordination is relied on to establish adjacent satellite interference limits.[69] Evidence of coordination of higher off-axis e.i.r.p. density levels would be demonstrated "by obtaining a certification from their satellite providers that the aggregate off-axis e.i.r.p. density levels produced by all co-frequency AES terminals communicating with the relevant satellite will be no greater than the interference levels that have been accepted by adjacent satellite systems through the operator-to-operator coordination process."[70] The Commission sought comment on these proposals.

In certain circumstances, it may be necessary or appropriate for AMSS licensees to communicate at higher powers than the routine licensing levels with individual U.S. or foreign-licensed satellites operating in a two-degree orbital spacing environment.[71] The Commission's analogous VSAT rules allow for the possibility of such higher-power operations. The Commission similarly should permit higher-power Ku-band AMSS operations, subject to requirements that protect the interests of potentially affected satellite operators.[72] This approach

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[68] Petition at 15.

[69] *Id*. at 16.

[70] *Id*.

[71] For example, a satellite may already have coordinated higher transmit power levels for its associated earth stations, and AMSS operations at those higher levels may have no adverse impact on neighboring satellites while substantially enhancing service to AMSS customers.

[72] *See* Attachment A (new Section 25.223(a)(5)). Like VSAT networks authorized to operate at higher power, Ku-band AMSS systems authorized to operate at off-axis e.i.r.p. levels in excess of the routine licensing values should bear the burden of coordinating with any future applicants or licensees that propose compliant Ku-band operations that may be adversely affected by such higher-power operations. If no good faith coordination agreement can be reached, the higher-power AMSS licensee would be

ensures that Ku-band AMSS licensees can utilize the spectrum consistent with the Commission's routine licensing rules.

Likewise, in Europe and Asia, where larger orbital spacing is the norm, the routine power levels for Ku-band AMSS systems and VSATs are higher than the levels proposed by the Commission. In such circumstances, Ku-band AMSS operators should be allowed to operate at the higher power levels that have been accepted by adjacent satellite systems through the normal coordination process. It is critical for U.S. AMSS licensees to be able to operate with satellites in other regions of the world at power levels consistent with the coordinated parameters of their serving satellite. Unnecessarily restricting the transmit power levels of Ku-band AESs operating with satellites in other regions would handicap U.S.-licensed AMSS operations by reducing spectrum efficiency and network capacity, and place them at a competitive disadvantage vis-à-vis foreign operators. This plainly would be contrary to the public interest.

By permitting higher-power Ku-band AMSS operations in the manner proposed by Boeing, the Commission can preserve operational flexibility for AMSS licensees while fully protecting the interests of potentially affected parties. In addition, such an approach would ensure more consistent regulatory treatment for Ku-band VSAT and AMSS operations – services that have similar capabilities and characteristics, and share a common interest in appropriately managing the Ku-band interference environment because they use the same FSS satellites to provide service.

Finally, Boeing agrees that U.S. AMSS applicants should be able to establish consistency with applicable coordination agreements by filing a certification from the serving satellite

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required to reduce its power density levels to the routine licensing levels. *See* 47 C.F.R. § 25.134(c); *see also* 47 C.F.R. § 25.138(c).

operator.[73] As noted in the *NPRM*, this approach is consistent with the requirement adopted by the Commission in the *Part 25 Earth Station NPRM*.[74] Certification would provide confirmation that the proposed power levels have been coordinated, and ensure that the AMSS licensee and its satellite operator can be held accountable for their representations in the licensing proceeding.[75] This approach is also necessary given the realities of operating with foreign satellites in accordance with parameters established in operator-to-operator coordination agreements.[76] Given that AMSS licensing proceedings are subject to notice and public comment, and thus can be challenged by interested parties, a certification from the serving satellite operator should be more than sufficient to establish that the proposed AMSS operations are consistent with the satellite's coordinated parameters.

v. Contention protocols

The ARINC AMSS application proceeding raised significant questions regarding whether contention protocols are consistent with the network control requirements in Recommendation

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[73] *NPRM* at ¶ 40.

[74] *Id*., citing 2000 Biennial Regulatory Review Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations, IB Docket No. 00-248, *Notice of Proposed Rulemaking*, 15 FCC RCd 25128 (2000) ("*Part 25 Earth Station NPRM*").

[75] Because AMSS applications will be placed on public notice for comment and any interested party, there is a process for full substantive review of an AMSS system's operational parameters and claims of consistency with a serving satellite's coordination agreements.

[76] Alternatives such as obtaining an affidavit from adjacent satellites operators are not workable. Boeing itself has experienced such difficulties in the context of Commission licensing of its Connexion AMSS operations. For example, Boeing spent many months negotiating with U.S. satellite operators to obtain an agreement to support licensing of its AMSS antennas. In addition, Boeing has experienced outright refusals on the part of foreign space segment providers to re-coordinate AMSS operations with adjacent operators on the grounds that such an approach is inconsistent with the international coordination process. *See*, *e.g.*, Letter from Philip L. Malet, Counsel for the Boeing Company, to Marlene H. Dortch, FCC, re The Boeing Company Application to Modify Blanket AMSS Earth Station Authorization Call Sign E000723, File No. SES-MOD-20040301-00304 (filed Sep. 1, 2003).

ITU-R M.1643.[77] In that proceeding, the Commission concluded that contention protocol access is consistent with the provisions of Recommendation ITU-R M.1643.[78]

If properly designed, an earth stations using contention protocol access can protect adjacent FSS satellites from harmful interference. The Commission recognized this in the Part 25 streamlining proceeding, proposing permissible off-axis e.i.r.p. exceedances for such systems consistent with protection of co-frequency FSS operations.[79] The AMSS off-axis e.i.r.p. density restrictions discussed above in Section II.B.1.a.iii , which are based on the values identified by the Commission, should similarly ensure compatibility with Ku-band FSS networks.

Furthermore, a contention protocol access system may provide significant operational efficiencies for Ku-band AMSS systems. There is little doubt that the positive control approach employed by the Connexion system is bandwidth intensive and requires significant processing power for accurate network management. Contention protocol access reduces the bandwidth and processing "overhead" associated with AMSS network control, and thus has the potential to enhance system capacity and spectrum efficiency. Express clarification that U.S. AMSS systems may employ contention protocol systems consistent with the requirements of Recommendation ITU-R M.1643, as well as adoption of explicit rules governing contention protocol access systems, would provide greater flexibility in the design and operation of AMSS systems.

b. Antenna Pointing Accuracy and Other Factors Affecting Off-Axis E.I.R.P.

The Commission proposes to require an AMSS applicant to provide information demonstrating that it has accounted for factors in the design, coordination and operation of an

[77] *ARINC Order* at ¶ 15.

[78] *Id.* at ¶16.

[79] *Third Further NPRM* at ¶¶ 113-19.

AES, including mis-pointing of AES antennas, variation in the antenna pattern of an AES and variations in the transmit e.i.r.p. density for the AES.[80] Boeing supports the Commission's proposal to require Ku-band AMSS applicants to fully account for these factors.

Boeing disagrees, however, with the Commission's proposal that AMSS operators should maintain a pointing accuracy of 0.2º for all AESs within its licensed network. Although the Commission suggests that such a requirement is consistent with the results reached at WRC-03, no such pointing accuracy requirement was adopted for Ku-band AMSS systems.[81] Rather, AMSS providers must account for AES pointing error (whatever it may be) in the context of controlling off-axis e.i.r.p. density levels. Imposing a uniform AMSS pointing accuracy requirement may unnecessarily constrain AMSS system development and deployment, particularly since the off-axis e.i.r.p. density limits already take pointing error into account.

c. Additional Requirements

i. Recommendation ITU-R M.1643

The Commission sought comment on several proposals consistent with ITU Recommendation ITU-R M.1643. First, the Commission proposed that AES terminals that use closed loop tracking of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals. AES terminals would have to immediately inhibit transmission when they detect that unintended satellite tracking has happened or is about to happen. In addition, AES terminals must be self-monitoring and if an individual AES detects a fault which can cause harmful interference to FSS networks, the AES must automatically mute its

[80] *NPRM* at ¶ 41.

[81] *See* Recommendation ITU-R M.1643. ITU-R Resolution 902 (Geneva, 2003) imposed a 0.2º pointing accuracy requirement on ESVs but no parallel requirement was adopted for Ku-band AESs.

transmissions until the cause of harmful interference has been remedied. Boeing supports these requirements.

The Commission also proposed that U.S.-licensed AES terminals should be subject to the monitoring and control of a Network Control and Monitoring Center ("NCMC") or equivalent facility located within the United States.[82] Under this proposal, AES terminals must be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC. AES terminals would have to automatically cease transmissions immediately upon receiving any "parameter change" command, which may cause harmful interference during the change, until the AES receives an "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning. Consistent with Recommendation ITU-R M.1643, Boeing supports applying these proposals to Ku-band AES operations in the United States.

ii. AES Minimum Elevation Angle

Although not addressed in Boeing's Petition or the *NPRM*, it is appropriate to adopt a requirement regarding minimum elevation angles for Ku-band AESs. Boeing proposes that the Commission adopt a five-degree minimum for AESs operating on the ground, but that no minimum elevation angle is necessary for AESs operating in flight. The intent of the five-degree minimum angle of elevation for earth stations on the ground is to protect terrestrial services and to limit the protection required by the earth station. Imposing a five-degree minimum elevation angle for AESs on the ground, the same minimum elevation angle generally

[82] As discussed in Section II. C, *infra*, Boeing does not believe the Commission should require an NCMC to be located within the United States.

applicable to FSS earth stations, is a reasonable limitation to address interference concerns.[83] For AESs onboard aircraft in flight, however, such concerns are not implicated because any potential interference victims are well below the horizontal plane of the aircraft.[84] Because other mechanisms to protect terrestrial services in the 14.0-14.5 GHz band,[85] and Ku-band AES receivers operate on an unprotected basis with respect to terrestrial services, there is no need to establish a minimum elevation angle for AESs in flight.

iii. Performance Verification Testing

Finally, Boeing believes that new AMSS licensees authorized by the Commission to provide service within the United States or on a U.S.-registered aircraft should be required to submit an AMSS system performance verification report prior to commencement of commercial operations to ensure that the licensee adequately accounts for all factors affecting AES off-axis e.i.r.p density, including antenna pointing control, variations in the antenna patterns and transmit power variations. Given the complexity of this issues and the possibility of network control modifications during system implementation, it is important to confirm that an AMSS system fully accounts for these factors and operates its system in the manner authorized by the Commission prior to initially commencing commercial operations.

Boeing does not believe such a testing requirement would be overly burdensome in the context of initial AMSS system implementation, particularly given the significant resources required for system development and deployment, and the potential risk of harmful interference to primary FSS systems and other spectrum users. Furthermore, Boeing proposes such a

[83] The Commission's rules permit significantly lower elevation angles where these concerns do not arise (e.g. when an earth station on the coast is pointing toward open water). 47 C.F.R. 25.205 (2004).

[84] Indeed, even the horizon as seen from an aircraft has a negative elevation angle.

[85] *See* Recommendation ITU-R M.1643 (Geneva 2003).

requirement before initial commercial operations only. The performance verification requirement would not apply to subsequent system modifications because the AMSS operator would have already verified its system performance characteristics.

2. Essential Requirements Related to the Protection of the Fixed Service

In the *NPRM*, the Commission proposes that when Ku-band AMSS providers operate in the international airspace within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in the 14.0-14.5 GHz frequency band, the maximum power flux density ("pfd") produced at the surface of the Earth by emissions from a single AES of an AMSS network should not exceed the following values unless the foreign administration has imposed other conditions for protecting its FS stations:

$$-132 + 0.5 \cdot \theta \text{ dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad \theta \leq 40^\circ$$
$$-112 \text{ dB(W/(m}^2 \cdot \text{MHz))} \quad \text{for} \quad 40^\circ < \theta \leq 90^\circ$$

Where: θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal) and the aforementioned limits relate to the pfd and angles of arrival would be obtained under free-space propagation conditions.

Boeing supports the Commission's proposal to require AMSS providers operating within line-of-sight of administrations with co-frequency FS operations to protect such operations from harmful interference.[86/] As stated in its Petition, and noted by the FCC, AMSS providers will be operating on a secondary basis as compared to the primary FS operations outside the United States and will have to protect such operations from harmful interference.[87]

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[86] *NPRM* at ¶ 45. Boeing generally agrees with this requirement, although it would note that Ku-band AESs need not be in "international airspace" to be within line-of-sight of the territory of a foreign administration and the pfd values above should apply anywhere within line-of-sight of a relevant administration.

[87] Although such a requirement is inherent in the secondary status of the AMSS allocation, it is underscored by new country footnotes Nos. 5.504C, 5.508A and 5.509A, in the International Table of Frequency Allocations.

The Commission sought comment on an alternative proposal that these pfd limits apply only in the absence of an explicit adoption of different conditions by a foreign administration.[88] The pfd limits should apply within line-of-sight of administrations with primary fixed service stations operating co-frequency unless a different requirement is adopted by that country. It is not necessary to restrict the pfd levels to the Recommendation ITU-R M.1643 levels if the country has adopted or otherwise agreed to higher pfd levels.

The Commission also invited comment on Boeing's proposal that in cases where AMSS operations may affect FS operations in more than one country simultaneously, the protection requirement to be applied "should be the most stringent requirement needed to protect a FS station within the jurisdiction of a potentially affected administration."[89] When two or more countries requiring protection are within line-of-sight of an AES, each of the countries must be protected pursuant to its own requirements. It is not necessary to identify precisely which requirement is most stringent, so long as the protection requirements of each country are met.

C. AES Licensing Considerations

The Commission invited comments to identify, either generally or in connection with specific proposals, licensing methods that may simplify and speed the Ku-band AMSS licensing process, while adequately addressing interference concerns.[90/] In this connection, Boeing acknowledges the full authority of the Commission to regulate all AES operations within U.S. airspace and on U.S.-registered aircraft wherever they may be located. However, as discussed below, Boeing urges the Commission to be cognizant of the potential impact of AES licensing requirements adopted in this proceeding on AMSS operations around the world.

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[88] *NPRM* at ¶ 46.

[89] *Petition* at 9.

[90] *NPRM* at ¶ 47.

1. Blanket Licensing of Ku-band AESs

The Commission seeks comment on whether Ku-band AES terminals should be permitted to operate under blanket licensing rules that are similar to those which VSATs and ESVs are subject.[91] The Commission proposes issuing an "AMSS system license" that would consist of a hub located within the United States and/or blanket AES license to applicants who demonstrate that "they are capable of controlling all aspects of the AMSS network."[92] Boeing agrees with the Commission's conclusion that blanket licensing is appropriate for AES terminals because the number and mobility of AES locations would make it impractical to license on a unit-by-unit basis.[93] As discussed in Boeing's Petition, a blanket licensing scheme is most appropriate in the context of Ku-band AMSS operations because individual licensing of each AES would substantially delay service, significantly increase the costs of deployment and unnecessarily waste Commission and commercial resources.[94]

2. U.S. NCMC and 24/7 Point of Contact Requirements

In the *NPRM*, the Commission proposes that Ku-band AMSS networks should operate under the direct control of a NCMC that would be located within the United States.[95] The

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[91] *Id.* at ¶ 48.

[92] *Id.* The Commission proposes that applicants would be required to file a narrative describing the overall system operation as well as specific information on the antennas, power density, and emission characteristics for each class of earth station compromising the network. *Id*. at ¶ 49. It also proposes requiring a point of contact to maintain information about the location of aircraft and frequencies that they use. *Id*.

[93] *Id.* at ¶ 49.

[94] Petition at 21. The Commission also sought comment on whether it should provide for the licensing of individual AESs using the same technical criteria that are applied to AESs in a blanket-licensed AMSS network. *NPRM* at ¶ 50. Boeing believes that there will be little or no demand for such uses and, in any event, that no separate rule provisions are required to address these cases.

[95] *Id.* at ¶¶ 43, 48.

Commission also proposes that U.S. licensees maintain in the United States a 24 hours a day, seven days a week point of contact in the United States whether or not the applicant requests authority to operate a U.S. hub.[96]

Boeing agrees that U.S. AMSS system operators should maintain a 24/7 point of contact to address any interference concerns and other issues that may arise given the scope of the geographic area to be covered and the unique spectrum sharing issues associated with service to the United States. However, requiring an NCMC to be located in the United States would be unduly burdensome and could have substantial adverse consequences for AMSS services around the world.

The Commission has not sought to impose a network control location requirement for similar services. For example, the Commission has permitted traditional MSS systems with control facilities located outside the United States to serve the U.S. market.[97] More recently, the Commission declined to impose a network control location requirement on ESV systems.[98] Thus, the Commission's proposal to require an NCMC located in the United States is inconsistent with prior precedent.

There is no practical reason to require an AES operator providing U.S. service to maintain an NCMC located within the United States, and it is neither technically nor

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[96] *Id* . at ¶ 48.

[97] *See e.g.* In the Matter of COMSAT Corporation d/b/a COMSAT Mobile Communications, Application for authority under Section 753(c) of the International Maritime Satellite Act and Section 214 of the Communications Act of 1934 as amended, to establish channels of communication between land earth stations at Brewster, Wa., Santa Paula, Ca., Southbury, Ct., and Clarksburg, Md., and Inmarsat Third generation satellites in the Atlantic Ocean Region-West and Pacific Ocean Region in support of Federal Aviation Administration's Wide Area Augmentation System, *Memorandum, Opinion and Order and Authorization*, 16 FCC Rcd 21661 (2001); *see also*, Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band, *Report and Order*, 15 FCC Rcd 16127, ¶¶ 86-87 (2000).

[98] *ESV Order* at ¶¶ 47-52.

economically feasible to have numerous NCMC facilities in multiple countries to control Ku-band AES operations. As is the case with ESVs and other MSS systems, effective regulatory oversight can be conducted by the Commission and responsive network control can be accomplished by a Ku-band AES licensee regardless of the physical location of the control facilities. This is particularly true if, as the Commission has proposed, AES operators must maintain a 24/7 point of contact within the United States that will have the capability and authority to cause each AES to cease transmitting.[99]

The Commission explains, however, that it "do[es] not wish to have U.S. sovereignty and regulatory control of U.S.-licensed AES terminals to be subject to the sovereignty and regulatory control of a foreign administration."[100] Although Boeing is sensitive to such concerns, the Commission can maintain regulatory authority over AMSS operations without requiring network control facilities to be located in the United States. The Commission's jurisdiction over an AMSS licensee operating in the United States, including the authority to impose sanctions, will ensure ongoing regulatory control over authorized operations. In addition, the requirement for a 24/7 point of contact with the capability to control AES transmissions in the United States will ensure that compliance with Commission instructions are not subject to control of a foreign nation. Imposing appropriate licensing conditions or concluding operating agreements to address individual AES operator circumstances also can satisfy Commission policy concerns without imposing a rule of general applicability that could have unintended adverse consequences.[101]

3. ALSAT Authority

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[99] *NPRM* at ¶ 57.

[100] *Id*.

[101] For example, a U.S. NCMC requirement would set a precedent that could have grave implications for the provision of AMSS services internationally if implemented by multiple administrations.

The Commission seeks comment on whether it should authorize Ku-band AESs compliant with the proposed off-axis e.i.r.p. density requirements to operate under "ALSAT" authority (*i.e.*, authority to communicate with any U.S.-licensed satellite and non-U.S. satellites on the Permitted Space Stations List).[102] Boeing urges the Commission to extend ALSAT authority to Ku-band AMSS licensees because it will afford AES operators significant operational flexibility and enhance competition. In addition, from the Commission's perspective, extending ALSAT authority would further the interests of administrative convenience and reduce unnecessary regulation of AMSS systems because the Commission would not be required to process an AES earth station modification application each and every time a Ku-band AMSS licensee sought to add an authorized satellite point of communication. It would also promote the efficient and flexible use of Ku-band spectrum, while in no way increasing the potential for harmful interference to other authorized users of the band.

Although AMSS currently falls outside of the services traditionally considered for ALSAT authority, the Commission should now extend such authority to Ku-band AESs operations because, from an interference perspective, they are regulated in essentially the same manner as routinely licensed VSATs. In an analogous context, the Commission granted ALSAT authority to ESVs even though they are not traditional FSS services.[103] Extending ALSAT authority to Ku-band AMSS systems would similarly serve the public interest.

The Commission also tentatively concluded that ALSAT authority would not be available to AMSS applicants whose operations must be coordinated with adjacent satellite operators (*i.e.*,

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[102] *Id.* at ¶ 51.

[103] *ESV Report and Order* at ¶ 105.

if the AES terminals exceed the proposed off-axis e.i.r.p. density requirements).[104/] Although Boeing agrees in principal that ALSAT authority should not extend to non-compliant AMSS operations, the Commission should clarify that AMSS applicants may obtain ALSAT authority for compliant AES operations even if they also propose certain higher power operations.[105]

4. License Term

The Commission tentatively concludes that a fifteen-year term is for AMSS system licenses is reasonable and requests comment on whether, in the context of Ku-band AMSS operations, there is any reason to diverge from this standard earth station license term.[106/] Boeing supports the Commission's proposal because there is no basis to adopt a different license period.

D. Tracking AES Terminals

The Commission requests comment on whether there is a need to track Ku-band AES operations.[107] Specifically, the Commission asks whether AMSS operators should maintain aircraft tracking data for a one-year period of time and provide the Commission, NTIA, or other interested parties (*e.g.*, frequency coordinators, or fixed-satellite system operators) with detailed information regarding the operating channels of its AES terminals on a particular air route within 24 hours upon request. The Commission notes that this information will not be made public, and would be used to resolve harmful interference and for enforcement purposes.[108]

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[104] *NPRM* at ¶ 51; *see also, Id*. at ¶ 40 (proposals for authorizing non-routine operations).

[105] For example, an AMSS application that includes a request to communicate with a single U.S.-licensed satellite should not preclude grant of ALSAT authority (even for compliant operations with that satellite). Similarly, a request to communicate with foreign-licensed satellites at higher coordinated power levels should not preclude ALSAT authority for communications with U.S.-licensed satellites and foreign-licensed satellites on the Permitted Space Station List.

[106] *Id.* at ¶ 52.

[107] *Id.* at ¶ 54.

[108] *Id.*

Boeing supports the general proposition that Ku-band AMSS operators should be able to provide identification and location information that will assist in resolving reports of interference and aid the Commission in enforcing its rules. Boeing also agrees that the provision of real-time location information presents security problems that must be addressed.[109] While real-time location information regarding a Ku-band AESs may be needed to resolve reports of harmful interference, the sensitivity of this information suggests making it available only in the context interference resolution. Accordingly, Boeing supports a requirement for AMSS licensees to maintain location information for Ku-band AESs operating within a network for a period of 90 days, but such information should only be used in resolving reports of harmful interference or provided to the Commission in response to Commission enforcement activities.[110]

In this connection, the Commission also suggests that it or some third party separately maintain a record of real-time AES tracking data to assist in interference resolution if it receives a complaint of harmful interference. In other words, in addition to providing information in response to specific requests, Ku-band AMSS operators would provide real-time tracking data on an ongoing basis to the Commission or a third party.[111] Boeing believes that such an approach is unnecessary and potentially raises security concerns. The Commission's 24/7 point of contact requirement, real-time AES tracking and data retention provisions will result in effective interference resolution and obviate the need for separate retention of real-time tracking data by

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[109] For example, many existing and future Ku-band AMSS customers will be government aircraft that may not want to have their exact positions known to others under any circumstances. In addition, private commercial customers could be sensitive to revealing such information both for competitive and security reasons.

[110] The Commission proposes a longer data retention period of one year. *NPRM* at ¶ 54. Given the requirement to retain real-time AES tracking data and the near-term response required for effective interference resolution, Boeing submits that a data retention period of longer than 90 days does not further the Commission's objectives.

[111] *NPRM* at ¶¶ 54-55.

the Commission or third-party clearing house. As a result, the administrative burdens and security risks associated with such an approach outweigh any potential benefit from this proposal. Furthermore, to the extent a Ku-band AMSS provider does not cooperate with the Commission or any interested party in resolving claims of harmful interference, the Commission has enforcement mechanisms -- including license revocation -- to address such situations.

E. Regulation of AMSS Operations Based on Aircraft Country of Registry

The Commission recognizes that AMSS services are international in scope and involve significant regulatory and legal issues. It identified three important regulatory factors related to the technical rules under which AES terminals must operate: (i) the aircraft's country of registry; (ii) the country in which the AMSS operator and its control systems are located; and (iii) the physical location of the aircraft if a claim of interference occurs.[112] At the outset, Boeing would note that the Commission's suggestion that it should regulate Ku-band AES operations based, in part, on the country in which the AMSS operator and its control systems are located, does not appear to have a basis in Commission precedent or ITU requirements. Boeing submits that adopting different requirements for U.S. and foreign AMSS systems (to the extent they can be distinguished in such a manner) would be contrary to the Commission's goals of facilitating the development of AMSS services and minimizing the regulatory burdens associated with the provision of such services to U.S. consumers.

The Commission did not distinguish between U.S.-licensed and foreign-licensed ESV systems[113] and should not do so here. Like ESV networks, Ku-band AESs are authorized by individual administrations to operate within their territory and on their registered aircraft

[112] *NPRM* at ¶ 57.

[113] *ESV Report and Order* at ¶¶ 114-28.

pursuant to national requirements that should be applied equally to domestic and foreign operators. Accordingly, while Boeing believes that AMSS regulation based on aircraft country of registry is appropriate, Boeing urges the Commission to adopt uniform licensing requirements applicable to all AES operators seeking to provide service in the United States.

1. U.S.-Registered Aircraft

As noted in the *NPRM*, the Commission is responsible for licensing AES operations on U.S.-registered aircraft.[114] U.S. AES licensees must have a 24/7 point of contact within the United States with the capability and authority to cause such AES terminals to cease transmitting, regardless of the location of the AMSS hub earth station and without concern for the location of the aircraft.[115] Boeing supports applying these proposals to all Ku-band AES operators that seek to provide service on board U.S. registered aircraft.

The Commission also sought comments on rules to prevent potential harmful interference from AMSS operations on U.S.-registered aircraft in foreign airspace and over international waters. With regard to AES operations in the airspace of foreign nations, the Commission proposes to require that prior to operations within the foreign nation's airspace, a U.S. AMSS licensee would have to determine whether the relevant administration has operations that could be affected by AES operations, and whether that administration has adopted requirements concerning AMSS operations. Once the aircraft enters foreign airspace, the AES would have to operate under U.S. technical rules, or those of the foreign administration, which ever are more

[114] *NPRM* at ¶ 57.

[115] The Commission would mandate that the point of contact have a direct connection to the hub's or NCMC's network functions controlling AES terminals on U.S. aircraft. *NPRM* at ¶ 57.

constraining.[116] This proposal appropriately recognizes that U.S.-licensed AESs are subject to the regulatory authority of other administrations when U.S.-registered aircraft are flying within the airspace of a foreign country. Boeing supports the Commission's suggested approach.

With respect to AMSS operations over international waters, the Commission inquires whether the only concern is protecting adjacent satellite operators and, if so, whether U.S. AMSS licensees seeking to operate over international waters should certify that the operators of all satellites to be accessed have confirmed that the proposed AMSS operations are within the coordinated parameters of the satellite.[117/] Boeing notes that certain systems (*e.g.*, RAS and SRS facilities) could be affected by AES operations near but outside foreign airspace, and that the provisions of Recommendation ITU-R M.1643 and any relevant coordination agreements will address such issues. Accordingly, the Commission's focus on adjacent satellite interference is appropriate. In this connection, Boeing believes that AES operators licensees seeking to operate over international waters (and in foreign airspace) should certify that their serving satellite operators have confirmed that the proposed AMSS operations are within the coordinated parameters of the satellite.

2. Operation of AES on Foreign Registered Aircraft

The Commission sought comment on whether it should develop rules to authorize AES communications of foreign-registered aircraft that are traveling through U.S. airspace and communicating with U.S.-licensed hub stations and/or are controlled by a U.S.-licensed AMSS

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[116] *Id.* at ¶ 58. The Commission also suggested that it would encourage bilateral arrangements between the United States and foreign administrations that would set forth specific technical rules that AMSS operations must comply with in foreign airspace. *Id.* at n 148.

[117] *Id.* at ¶ 59.

operator.[118] As advocated in its Petition, Boeing proposes that AESs on a foreign-licensed aircraft "be temporarily associated with and licensed to the U.S. AMSS licensee (or service vendor authorized by the operator) when the AES is operating within U.S. airspace. For this temporary period, the U.S.-licensed AMSS operator shall assume the same licensee responsibility for the AES as if the AES were regularly licensed to it."[119/] This is similar to the approach recently adopted by the Commission in the *ESV Order,*[120] and will ensure that U.S. AMSS licensees control foreign-licensed AESs and comply fully with the Commission's technical and operational rules while the AESs operate within U.S. airspace. This approach also furthers the interests of international comity in that it effectively recognizes the AES authorization issued by a foreign administration, while at the same time ensures full Commission regulatory authority over the actual operations of the AES through the U.S. AMSS licensee.

Boeing strongly believes, however, that any alternative that would restrict or prohibit the provision of AMSS service by a U.S. licensee using non-U.S. licensed AES terminals on aircraft of foreign registry in U.S. airspace would be contrary to the public interest.[121] Such alternatives would preclude current and planned AMSS operations to a number of foreign airlines flying to and from the United States, thereby depriving U.S. consumers of these advanced communications

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[118] *Id.* at ¶ 60. In the NPRM, the Commission used the term "U.S.-located" rather than U.S.-licensed, but the meaning of these terms appear to be equivalent. *Id.*

[119] Petition at 22.

[120] *ESV Order* at ¶¶ 122-126. Such an approach is similar to the Commission's treatment of MSS transceivers designed to operate with U.S.-licensed systems, and is appropriate in the context of transborder Ku-band AMSS operations given the global nature of the service. *See* 47 C.F.R. § 25.136(c); *see also Big LEO Report and Order*, 9 FCC Rcd. 5936, ¶ 208 (1995) ("[A] roaming user's transceiver operations would fall within the blanket license of the satellite operator or the service vendor."); *see also* 47 C.F.R. § 25.135(d).

[121] *Id.* at ¶ 63.

services.[122] Limiting the provision of AMSS services by U.S. licensees also would jeopardize U.S. leadership in advance broadband communications technologies and international satellite services. Accordingly, such an alternative must be rejected.

Finally, the Commission asks whether it should permit foreign AMSS operations in U.S. airspace on an unprotected, non-harmful interference basis under International Radio Regulation No. 4.4.[123] As discussed herein, Boeing believes that prior Commission review and authorization of foreign AMSS operations in the United States is essential to ensure that such operations are conducted in accordance with applicable AMSS rules and that other U.S. policy considerations are satisfied. Thus, the Commission should reject the option of permitting foreign AMSS operation in U.S. airspace under Radio Regulation No. 4.4.

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[122] For example, Boeing is currently providing Connexion AMSS service to Lufthansa flights traveling to and from the United States.

[123] *Id.* 66.

III. CONCLUSION

For the foregoing reasons, Boeing respectfully requests that the Commission adopt rules consistent with these comments.

Respectfully submitted,

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Dated: July 5, 2005

Attachment A

Draft Rules for the Aeronautical Mobile-Satellite Service

Attachment A

Draft Rules for the
Aeronautical Mobile-Satellite Service

§ 2.106 Table of Frequency Allocations.

Revise the table to include the following footnotes

* * * * *

FEDERAL GOVERNMENT (US) FOOTNOTES

* * * * *

USxxx In the band 14.0-14.5 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to NASA's Tracking and Data Relay Satellite System (TDRSS) earth stations in operation before [effective date of rule]. For other TDRSS earth stations, the operations of Aeronautical Mobile-Satellite Service earth stations in the 14.0-14.2 GHz are subject to such coordination.

USxxy In the band 14.0-14.47 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to the radio astronomy sites that observe in the 14.47-14.5 GHz band

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NON-FEDERAL GOVERNMENT (NG) FOOTNOTES

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NGyyy In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), aircraft earth stations in the aeronautical mobile-satellite service are an application of the Fixed-Satellite Service (FSS). The provisions of ITU Radio Regulations Nos. 5.29, 5.30 and 5.31[124] apply, except that reception from geostationary space stations in the fixed-satellite service in the 11.7-12.2 GHz shall be protected in the United States on a primary basis, provided that the aircraft earth stations operate under the same parameters as earth stations in the fixed-satellite service.

[124] ITU Radio Regulation Nos. 5.29. 5.30, 5.31 state that stations of a secondary service:

5.29 a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

5.30 b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;

5.31 c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

* * * * *

§ 25.115 Application for earth station authorizations.

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(a)(2)(iii) The earth station is not an ESV or an AES transmitting in the Ku-band.
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§ 25.130 Filing requirements for transmitting earth stations.

(a) Applications for a new or modified transmitting earth station facility shall be submitted on FCC Form 312, and associated Schedule B, accompanied by any required exhibits, except for those earth station applications filed on FCC Form 312EZ pursuant to § 25.115(a)…. All such earth station license applications must be filed electronically through the International Bureau Filing System (IBFS) in accordance with the applicable provisions of part 1, subpart Y of this chapter. Additional filing requirements for Earth Stations on Vessels are described in §§ 25.221 and 25.222 of this part. Additional filing requirements for AESs transmitting in the Ku-band are described in §§ 25.223 of this part. In addition, applicants not required to submit applications on Form 312EZ, other than ESV or AES applicants, must submit the following information to be used as an "informative" in the public notice issued under § 25.151 as an attachment to their application:

* * * * *

§ 25.220 Non-conforming transmit/receive earth station operations.

(a)(1) This section applies to earth station applications, other than ESV or AES applications, in which:

(i) The proposed antenna does not conform to the standards of §§25.209(a) and (b), and/or

(ii) The proposed power density levels are in excess of those specified in §25.134, §25.211, or §25.212, or those derived by the procedure set forth in paragraph (c)(1) of this section, whichever is applicable.

§ 25.202 Frequencies, frequency tolerance and emission limitations.

* * * * *

(a)(9) The following frequencies are available for use by Aircraft Earth stations:
10.95-11.2 GHz (space-to-Earth)
11.45-11.7 GHz (space-to-Earth)

11.7-12.2 GHz (space-to-Earth)
14.0-14.5 GHz (Earth-to-space)

AESs shall be authorized and coordinated as set forth in §§ 25.223 of this chapter.

§ 25.203 Choice of sites and frequencies.

(a) Sites and frequencies for earth stations, other than ESVs and AESs, operating in frequency bands shared with equal rights between terrestrial and space services, shall be selected, to the extent practicable, in areas where the surrounding terrain and existing frequency usage are such as to minimize the possibility of harmful interference between the sharing services.

(b) An applicant for an earth station authorization, other than an ESV and AESs, in a frequency band shared with equal rights with terrestrial microwave services shall compute the great circle coordination distance contour(s) for the proposed station in accordance with the procedures set forth in § 25.251.

* * * * *

(c) Prior to the filing of its application, an applicant for operation of an earth station, other than an ESV or AES, shall coordinate the proposed frequency usage with existing terrestrial users and with applicants for terrestrial station authorizations with previously filed applications in accordance with the following procedure:

* * * * *

(d) An applicant for operation of an earth station, other than an ESV or AES, shall also ascertain whether the great circle coordination distance contours and rain scatter coordination distance contours, computed for those values of parameters indicated in § 25.251 (Appendix 7 of the ITU RR) for international coordination, cross the boundaries of another Administration. In this case, the applicant shall furnish the Commission copies of these contours on maps drawn to appropriate scale for use by the Commission in effecting coordination of the proposed earth station with the Administration(s) affected.

* * * * *

(k) An applicant for operation of an earth station, other than an ESV or AES, that will operate with a geostationary satellite or non-geostationary satellite in a shared frequency band in which the non-geostationary system is (or is proposed to be) licensed for feeder links, shall demonstrate in its applications that its proposed earth station will not cause unacceptable interference to any other satellite network that is authorized to operate in the same frequency band, or certify that the operations of its earth station shall conform to established coordination agreements between the operator(s) of the space station(s) with which the earth station is to communicate and the operator(s) of any other space station licensed to use the band.

§ 25.205 Minimum angle of antenna elevation.

c) For AESs in flight, there is no minimum angle of elevation. For AESs operating on the ground, the minimum angle of elevation shall be 5 degrees.

<u>§ 25.223 Blanket Licensing provisions for Aircraft Earth Stations (AESs) receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) frequency bands and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, operating with Geostationary Satellites in the Fixed-Satellite Service</u>.

(a) All applications for licenses for AESs receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) frequency bands, and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, to Geostationary Satellites in the fixed-satellite service shall provide sufficient data to demonstrate that the AES operations meet the following criteria, which are ongoing requirements that govern all AES licensees and operations in these bands:

(1) The off-axis EIRP spectral density for co-polarized signals, emitted from the AES in the plane of the geostationary satellite orbit as it appears at the particular earth station location (*i.e.*, the plane determined by the focal point of the antenna and the line tangent to the arc of the geostationary satellite orbit at the position of the target satellite), shall not exceed the following values:

$15 - 25\log(\theta)$ dBW/4kHz	for	$1.5°* \leq \theta \leq 7.0°$
-6 dBW/4kHz		for $7.0° < \theta \leq 9.2°$
$18 - 25\log(\theta)$ dBW/4kHz	for	$9.2° < \theta \leq 48°$
-24 dBW/4kHz	for	$48° < \theta \leq 85°$
-14 dBW/4kHz		for $85° < \theta \leq 180°$

where θ is the angle in degrees from the axis of the main lobe.
* If the AES antenna pointing error is taken into account by the Network Control Facility in controlling the off-axis EIRP density, the above pattern starts at 2° instead of 1.5°.

For the purposes of this section, the peak EIRP of an individual sidelobe may not exceed the envelope defined above for θ between 1.5° and 7.0°. For θ greater than 7.0°, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.

(2) For networks in which 2 or more Earth stations can transmit simultaneously on the same frequency, the envelopes in 1 above apply to the aggregate emissions of the Earth stations.

(3) The aggregate off-axis E.I.R.P. shall not exceed the envelope in (1) above by more than the amounts set forth in the following Table, with the maximum duration of any single exceedence being less than 100 milliseconds.

Percentage of Time	Increase in Aggregate EIRP Allowed *
10% (10^{-1})	0 dB
1% (10^{-2})	2 dB
0.1% (10^{-3})	4 dB
0.01% (10^{-4})	6 dB
0.001% (10^{-5})	8 dB
0.0001% (10^{-6})	10 dB
0.00001% (10^{-7})	12 dB
0.000001% (10^{-8})	14 dB
0.0000001% (10^{-9})	16 dB

The time interval over which the percentage of time is averaged shall be 1 month.

(4) For non-circular AES antennas, the alignment of the major axis of the antenna with respect to the tangent to the geostationary satellite orbital arc at the target satellite point will be taken into account in controlling the AES aggregate EIRP to meet the specified off-axis EIRP criteria.

(5) AES operations at levels higher than the limits given in 1above may be authorized if the AMSS applicant provides certification from the satellite operator that the levels are consistent with the satellite's coordination agreements. Such an authorization shall not prejudice coordinations with future FSS licensees.

(6) The AMSS applicant shall provide information demonstrating that it has accounted for the following factors in the design, coordination and operation of an AES

i. Mis-pointing of AES antennas.
ii. Variations in the antenna pattern of AES.
iii. Variations in the transmit e.i.r.p. density from AES.
iv. Contention access protocol.

(7) Other technical requirements

i. AES terminals that use closed loop tracking[125] of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals.
ii. AES terminals should be subject to the monitoring and control of a NCMC or equivalent facility, located within the United States.
iii. AES terminals need also to be self-monitoring and if an individual AES detects a fault which can cause harmful interference to FSS networks, the AES must

[125] Closed loop logic is deployed to overcome various faults that may cause unintended satellite tracking. In closed loop systems a feedback is used to see if the desired tracking has taken place by measuring the difference between the input and output signals and the corrective action takes place as the result of comparison.

automatically mute its transmissions until the cause of harmful interference has been remedied.

(8) There shall be a point of contact in the United States, with phone number and address included with the application, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the AESs.

(9) AESs that exceed the radiation guidelines of Section 1.1310 Radiofrequency radiation exposure limits must provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines.

(10) There shall be an exhibit included with the application describing the geographic area(s) in which the AESs will operate.

(b) Applications for AES operation in the 14.0-14.5 GHz (Earth-to-space) to geostationary satellites in the fixed-satellite service must include, in addition to the particulars of operation identified on Form 312 and associated Schedule B, the following data for each earth station antenna type:

(1) A series of EIRP density charts or tables, calculated for a production earth station antenna, based on measurements taken on a calibrated antenna range at 14.25 GHz, with the off-axis EIRP envelope set forth in paragraphs (a)(1) through (a)(4) of this Section superimposed, as follows:

(i) showing off-axis co-polarized EIRP spectral density in the azimuth plane, for off-axis angles from minus 10° to plus 10°and from minus 180° to plus 180°.
(ii) showing off-axis co-polarized EIRP spectral density in the elevation plane, at off-axis angles from 0° to plus 30°.
(iii) showing off-axis cross-polarized EIRP spectral density in the azimuth plane, at off-axis angles from minus 10° to plus 10°.
(iv) showing off-axis cross-polarized EIRP spectral density in the elevation plane, at off-axis angles from minus 10° to plus 10°.

Or

(2) A series of gain charts or tables, for a production earth station antenna, measured on a calibrated antenna range at 14.25 GHz, with the Earth station antenna gain envelope set forth in Section 25.209(a) and b superimposed, for the same planes and ranges enumerated in paragraphs (b)(1)(i) through (b)(1)(iv) of this Section, that, combined with input power density entered in schedule B, demonstrates that off-axis EIRP spectral density envelope set forth in paragraphs (a)(1) through (a)(4) of this Section will be met.

Or

(3) A certification that the ESV antenna conforms to the gain pattern criteria of 25.209(a) and (b), that, combined with input power density entered in schedule B, demonstrates that the off-

axis EIRP spectral density envelope set forth in paragraphs (a)(1) through (a)(4) of this Section will be met.

(c) AESs receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) frequency bands, and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band shall operate with the following provisions:

(1) For each AES transmitter a record of the aircraft location (*i.e.*, latitude/longitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than 90 days. Records will be recorded at time intervals no greater than every 5 minutes while the ESV is transmitting. The AES operator will use this data to analyze instances of reported interference and will make this data available upon request to a coordinator, NTIA, or the Commission within 24 hours of the request.

(2) AES operators communicating with aircraft of foreign registry must maintain detailed information on each aircraft's country of registry and a point of contact for the relevant administration responsible for licensing AESs.

(3) AES operators shall control all AESs by a hub earth station located in the United States, except that an AES on U.S.-registered aircraft may operate under control of a hub earth station location outside the United States provided the AES operator maintains a point of contact within the United States that will have the capability and authority to cause an AES on a U.S.-registered aircraft to cease transmitting if necessary.

(d) Operations of AESs in the 14.0-14.2 GHz (Earth-to-space) frequency band within line-of-sight of the NASA TDRSS facilities on Guam (located at latitude: 13° 36' 55" N, longitude 144° 51' 22" E) or White Sands, New Mexico (latitude: 32° 20' 59" N, longitude 106° 36' 31" W and latitude: 32° 32' 40" N, longitude 106° 36' 48"W) are subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). When NTIA seeks to provide similar protection to future TDRSS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission at least 6 months prior to initial operational status. Upon public notice from the Commission, all Ku-band AES operators must cease operations in the 14.0-14.2 GHz band within line-of-sight of the new TDRSS site until after NTIA/IRAC coordination for the new TDRSS facility is complete. ESV operations will then again be permitted to operate in the 14.0-14.2 GHz band within line-of-sight of the new TDRSS site, subject to any operational constraints developed in the coordination process.

(e) Operations of AESs are also subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC).

(f) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands AESs shall not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned, or may be assigned in the future.

(g) When an AES operates in the 14.0-14.5 GHz frequency band within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in this band, the maximum power flux density (pfd) produced shall be in accordance with the most recent version of Recommendation ITU-R M.1643 unless the AMSS operator has obtained an agreement with that administration to permit operations at higher pfd levels.

(h) Prior to operations within a foreign nation's airspace, the AMSS operator shall ascertain whether the relevant administration has operations that could be affected by AES terminals, and determine whether that administration has adopted specific requirements concerning AES operations. Once the aircraft enters foreign airspace, the AES would have to operate under the Commission's rules, or those of the foreign administration, which ever is more constraining.

(i) An AMSS operator seeking to operate over international waters to certify that the operator(s) of all satellites to be accessed over international waters have confirmed that the proposed AMSS operations would be within the coordinated parameters of the satellite.

(j) An AMSS operator using a U.S. hub to communicate with non-U.S. licensed AES terminals (or using a U.S.-located NCMC to control the AMSS network) on foreign-registered aircraft shall be responsible for ensuring that the operations of the AES terminals comply with all US rules.

(k) AES terminals which operate on aircraft registered with foreign administrations and operating through hubs located outside of the United States may operate in U.S. airspace in the vicinity of radio astronomy and TDRSS sites only after the technical parameters and operational procedures of these terminals and their associated hubs have been coordinated with the FCC/NTIA and been determined to satisfy Commission rules established for this service.

(l) No later than 60 days prior to commencing initial commercial operations, Boeing shall submit a report verifying its ability to comply with these conditions, and include test results and a description of any design modifications[126] or operational procedures necessary to ensure that these conditions are met; the report shall, *inter alia*, address the following factors regarding the aggregate off-axis e.i.r.p. levels generated by the AMSS mobile terminals:

(1) variations in aggregate off-axis e.i.r.p. caused by mis-pointing of AMSS mobile terminal antennas; this includes, at least, effects caused by bias and latency of their AMSS mobile terminal antenna pointing systems, tracking error of closed loop tracking systems, and misalignment between transmit and receive apertures;

(2) variations in aggregate off-axis e.i.r.p. caused by variations in the antenna pattern of AMSS mobile terminals; this includes, at least, effects caused by manufacturing tolerances, aging of the antenna, and environmental effects, variation in antenna pattern with scan angles (elevation and azimuth), element phase error, amplitude error, and failure rate; and

(3) variations in aggregate off-axis e.i.r.p. caused by variations in the transmit e.i.r.p. from AMSS mobile terminals; this includes, at least, effects caused by measurement error, control error, and latency for closed loop power control systems;

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[126] *But see* 47 C.F.R. §§ 25.117 (modification of station license), 25.118 (modification not requiring prior authorization).

§ 25.271 Control of transmitting stations.

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(b) The licensee of a transmitting earth station, other than an ESV or AES, licensed under this part shall ensure that a trained operator is present on the earth station site, or at a designated remote control point for the earth station, at all times that transmissions are being conducted. No operator's license is required for a person to operate or perform maintenance on facilities authorized under this part.

(c) Authority will be granted to operate a transmitting earth station, other than an ESV or AES, by remote control only on the conditions that:

* * * * *

(g) Rules for control of transmitting AESs are provided in § 25.223.