

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of
The Boeing Company
Application for Blanket Authority to Operate
Up to Eight Hundred Technically Identical
Transmit and Receive Mobile Earth Stations
Aboard Aircraft in the 14.0-14.5 GHz and
11.7-12.2 GHz Frequency Bands
File No. SES-LIC-20001204-02300
Call Sign: E000723

ORDER AND AUTHORIZATION

Adopted: December 21, 2001

Released: December 21, 2001

By the Chief, International Bureau, and the Acting Chief, Office of Engineering and Technology:

I. INTRODUCTION

1. By this Order, we grant The Boeing Company ("Boeing") authority to operate up to eight hundred technically identical transmit and receive mobile Earth stations aboard aircraft in the 14.0-14.5 GHz ("14 GHz") uplink band and the 11.7-12.2 GHz ("12 GHz") downlink band ("Ku-band"), subject to the conditions set forth below. In doing so, we waive Section 2.106 of our Rules, premised on Boeing providing this service without causing harmful interference to other allocated services in these frequency bands. This authorization will permit Boeing to expand its recently authorized one-way Ku-band aeronautical communication service by making available two-way broadband connectivity to passengers and crew aboard aircraft.

II. BACKGROUND

2. In April 2001, we authorized Boeing to operate up to eight hundred technically identical receive-only mobile Earth stations in the 12 GHz band aboard aircraft in the United States. Specifically, we authorized Boeing to operate these receive-only stations in the Aeronautical Mobile-Satellite Service

1 As used here, the term "Ku-band" refers to the Earth-to-space (uplink) frequencies at 14.0-14.5 GHz and the corresponding space-to-Earth (downlink) frequencies at 11.7-12.2 GHz.

2 See 47 C.F.R. § 2.106.

3 See The Boeing Company, Order and Authorization, 16 FCC Rcd 5864 (Int'l Bur./OET 2001) ("Boeing Receive-Only Order").

4 Id.

(“AMSS”) using leased transponder capacity on Loral Skynet’s Telstar 6 satellite at 93° W.L.⁵ The U.S. Table of Frequency Allocations does not include an allocation for AMSS in the 12 GHz band.⁶ Accordingly, we granted a waiver of Section 2.106 of the Commission’s rules to allow Boeing’s proposed “non-conforming” use of the 12 GHz band.⁷ As part of its receive-only authorization, Boeing is required to accept interference from all authorized users of the 12 GHz band and may not cause harmful interference into services authorized to use the band.⁸

3. In the instant application, Boeing requests authority to operate up to eight hundred technically identical transmit and receive mobile Earth stations to provide two-way AMSS communications aboard aircraft in the United States, using the 12 GHz band for space-to-Earth transmissions and the 14 GHz band for Earth-to-space transmissions.⁹ Boeing states it will provide its service using leased transponder capacity on the Telstar 6 satellite at 93° W.L.¹⁰ Boeing’s request involves only the forward and return links between the satellite and the mobile Earth stations aboard aircraft. Transmissions between the satellite and the ground would be carried out using one or more fixed Earth stations licensed separately by the Commission to operate in the Ku-band.¹¹

4. The U.S. Table of Frequency Allocations includes a primary allocation for the Fixed Satellite Service (“FSS”) in the 12 GHz (space-to-Earth) and 14 GHz (Earth-to-space) frequency bands.¹² The major use of the Ku-band FSS allocation is for very small aperture terminal (“VSAT”) operations. These operations are widely deployed across the United States. The U.S. Table also includes a primary allocation to the radionavigation service in the 14.0-14.2 GHz band,¹³ and provides for protection of radio astronomy operations in the 14.47-14.5 GHz band.¹⁴ In addition, the U.S. Table includes allocations to secondary services in both the 12 GHz and 14 GHz bands, including mobile (except aeronautical mobile), space research, government-only terrestrial fixed and mobile, and the Land Mobile-Satellite Service (“LMSS”). As discussed above, the U.S. Table does not include an allocation for AMSS downlinks in the 12 GHz band. Similarly, the U.S. Table does not include an allocation for AMSS uplinks in the 14 GHz band. Accordingly, a waiver of Section 2.106 of the Commission’s rules is necessary for Boeing’s proposed two-way service. In requesting a waiver, Boeing indicates that it will operate its proposed

⁵ *Id.* at 5868 ¶ 13. We also authorized Boeing to operate receive-only stations in the AMSS from SES Americom’s Americom 4 (AMC-4, then GE Americom’s GE-4) satellite at 101° W.L. *Id.* Boeing does not request access to AMC-4 in the instant application.

⁶ *See* 47 C.F.R. § 2.106.

⁷ *Boeing Receive-Only Order*, 16 FCC Rcd at 5866-68 ¶¶ 9, 14.

⁸ *Id.* at 5868 ¶ 13.

⁹ *See Application of The Boeing Company for Blanket Authority to Operate up to Eight Hundred Technically-Identical Transmit and Receive Mobile Earth Stations Aboard Aircraft in the 11.7-12.2 and 14.0-14.5 GHz Frequency Bands*, File No. SES-LIC-20001204-02300 (December 4, 2000, supplemented January 10, 2001) (“*Boeing Two-Way AMSS Application*”).

¹⁰ *Id.* at 8.

¹¹ In that regard, we note that nothing in this *Order* in any way addresses the characteristics of transmissions from the fixed Earth stations that will be used to uplink signals to Telstar 6. It is incumbent on Boeing and/or the licensee of those stations to ensure that the operations of those stations are properly authorized.

¹² *See* 47 C.F.R. § 2.106.

¹³ *Id.*

¹⁴ *Id.* Footnote US203 prohibits harmful interference to radio astronomy observations in the 14.47-14.5 GHz band.

service without causing harmful interference to authorized users of the Ku-band and will accept interference from authorized users.¹⁵

5. Boeing indicates in its application that it will protect geostationary satellite orbit (“GSO”) FSS satellite networks in the 14 GHz band from harmful interference from AMSS transmissions by controlling the aggregate equivalent isotropically radiated power (“e.i.r.p.”) spectral density along the GSO arc to the level required for routinely processed VSAT applications pursuant to Sections 25.134 and 25.209 of the Commission’s rules.¹⁶ Boeing further indicates that it will protect GSO FSS satellite networks operating in the 12 GHz band by using space-to-Earth e.i.r.p. spectral density levels that are equal to, or less than, those previously coordinated for the Telstar 6 satellite with adjacent satellite operators.¹⁷ Boeing also states that the cumulative interference from its AMSS service should not cause harmful interference into non-geostationary satellite orbit (“NGSO”) FSS networks.¹⁸

6. Boeing indicates in its application that it will protect radio astronomy (at 14.47-14.5 GHz) and space research systems (at 14.0-14.05 GHz) from harmful interference from its airborne terminals by means of hardware implementation, frequency avoidance, and control of network operations.¹⁹ The National Science Foundation (“NSF”) and Boeing have entered into a Technical Operational Coordination Agreement intended to facilitate Boeing’s proposed operations in the 14.0-14.5 GHz band without causing interference to radio astronomy stations.²⁰ The National Aeronautics and Space Administration (“NASA”) has sent a letter to Boeing providing guidance indicating the protection levels necessary to protect the NASA Tracking and Data Relay Satellite System (“TDRSS”) operations.²¹ Boeing also indicates that, before initiating operations, it will coordinate its non-conforming use of the spectrum with

¹⁵ See, e.g., Letter from David A. Nall and Philip L. Malet, Co-Counsel to The Boeing Company, to Donald Abelson, Chief, International Bureau, FCC, File No. SES-LIC-20001204-02300, at 3 (April 27, 2001) (“Boeing April 27 Letter”).

¹⁶ See *Boeing Two-Way AMSS Application*, Technical Supplement at 34. Section 25.134 of the Commission’s rules includes thresholds, based on the power radiated from transmitters, for routine processing of VSAT networks operating in the Ku-band. 47 C.F.R. § 25.134. Section 25.209 discusses FSS earth station antenna performance standards. 47 C.F.R. § 25.209.

¹⁷ See *Boeing Two-Way AMSS Application* at 17 n.36 & Technical Supplement at 26. Boeing requests a waiver of 47 C.F.R. § 25.134, as its proposed downlink equivalent isotropically radiated power (“e.i.r.p.”) density levels exceed those specified in Section 25.134 for routine VSAT licensing. Boeing’s proposed downlink e.i.r.p. density levels are consistent with those authorized for the Telstar 6 satellite that are required to be coordinated with adjacent satellite operators. See *AT&T Corp.*, Memorandum Opinion and Order, 11 FCC Rcd 15038 (Int’l Bur. 1996). For the reasons set forth in the *Boeing Receive-Only Order*, 16 FCC Rcd at 5867 ¶ 10, no waiver of 47 C.F.R. § 25.134 is necessary.

¹⁸ Specifically, Boeing states that the cumulative interference from its AMSS service would be “well below” the noise floor of NGSO FSS receivers. Boeing April 27 Letter at 2 (quoting *Working Document Towards CPM Text for WRC-2003 Agenda Item 1.11: Assessment of the Sharing Potential of AMSS Systems With NGSO FSS Systems in the Frequency Band 14-14.5 GHz*, United States of America, Document 4A/140-E, at 5-7 (April 11, 2001)). For the AMSS system studied in the referenced paper, “cumulative interference” is measured as 16 aircraft transmitting simultaneously at 64 kbps, or 1 aircraft transmitting at 1 Mbps. For the NGSO FSS systems studied in the referenced paper, the peak, short term interference-to-noise ratios ranged from approximately –10 dB to –30 dB.

¹⁹ See *Boeing Two-Way AMSS Application*, Technical Supplement at 38-39.

²⁰ 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, Version 3.1 (December 13, 2001).

²¹ See Letter from Robert E. Spearing, Deputy Associate Administrator for Space Communications, Office of Space Flight, NASA, to Craig Holman, Regulatory Counsel, The Boeing Company (December 18, 2001).

Federal Government users of the band through the auspices of the National Telecommunications and Information Administration (“NTIA”) and the Interdepartment Radio Advisory Committee (“IRAC”).²²

7. As noted above, Section 2.106 of the Commission’s rules includes a primary allocation to the radionavigation service in the 14.0-14.2 GHz band. We are unaware of any Government use of the band for radionavigation services in International Telecommunication Union (“ITU”) Region 2,²³ and there is no non-Government use of the band for radionavigation services. Boeing notes that Section 80.375(d)(2)(vi) of the Commission’s rules indicates that “the 14.0-14.05 GHz band will be authorized only for test purposes and maritime radionavigation on a secondary basis to the fixed-satellite service.”²⁴ Boeing states that, because its operations in the 14.0-14.05 GHz band will need to avoid harmful interference to space research systems, any Section 80.375(d)(2)(vi) services that do exist similarly would be protected by means of hardware implementation, frequency avoidance, and control of network operations.²⁵

8. Some operations in the 14 GHz band have been authorized in the United States on a secondary basis for LMSS and on a non-conforming basis for the Maritime Mobile-Satellite Service (“MMSS”); some operations in the 12 GHz band have been authorized in the United States on a non-conforming basis for LMSS and MMSS.²⁶ Because these LMSS and MMSS operations use GSO FSS satellite transponders, and Boeing indicates that it will protect GSO FSS satellite networks in these bands,²⁷ Boeing states that it likewise will protect these secondary and non-conforming operations from harmful interference.²⁸ Finally, the Local Television Transmission Service (“LTTS”) is authorized to use the 14.2-14.4 GHz band pursuant to a secondary allocation to Mobile Services. Boeing indicates in its application that it examined the Commission’s licensing database and found 20 LTTS licensees for this band, and in all cases, the licenses also included authorization to operate in other bands pursuant to Section 101.803 of the Commission’s rules.²⁹ Boeing states that it attempted to contact the licensees, but most were no longer in business, and those that were still operating indicated that they did not utilize the 14 GHz band.³⁰

9. Boeing’s application was placed on public notice on February 21, 2001.³¹ PanAmSat Corporation (“PanAmSat”) filed comments and Lockheed Martin Corporation (“LMC”) filed a petition to

²² See *Boeing Two-Way AMSS Application*, Technical Supplement at 39.

²³ The International Telecommunication Union (“ITU”) Radio Regulations divide the world into three Regions. Generally, Region 1 includes Africa, Europe, Northern and Western portions of Asia; Region 2 includes the Americas and Greenland; and Region 3 includes Southern portions of Asia, Australia and the South Pacific. See ITU Radio Regulations Article S5, Section I.

²⁴ 47 C.F.R. § 80.375(d)(2)(vi).

²⁵ See *Boeing Two-Way AMSS Application*, Technical Supplement at 39-40.

²⁶ See *Qualcomm, Inc.*, Memorandum Opinion, Order and Authorization, 4 FCC Rcd 1543 (1989) (*Qualcomm OmniTRACS License*) (authorizing LMSS on a secondary basis in the 14 GHz band and on a non-conforming basis in the 12 GHz band); *Mobile Satellite-Based Communications Services by Crescomm Transmission Services, Inc. and Qualcomm Incorporated*, Order, 11 FCC Rcd 10944 (Int’l Bur./OET 1996) (*Crescomm/Qualcomm Order*) (authorizing non-conforming MMSS operations in the 14 GHz and 12 GHz bands).

²⁷ See paragraph 5, *supra*.

²⁸ *Boeing Two-Way AMSS Application*, Technical Supplement at 40.

²⁹ *Id.* at 39. See 47 C.F.R. § 101.803.

³⁰ *Boeing Two-Way AMSS Application*, Technical Supplement at 39.

³¹ Public Notice, Report No. SES-00263, at 1 (rel. February 21, 2001).

defer the processing of Boeing's application.³² PanAmSat asserts that Boeing must ensure that the aggregate interference from its airborne terminals do not cause harmful interference into primary GSO FSS operations.³³ LMC questions Boeing's ability to accomplish uplink interference control, and also expresses concern regarding aggregate interference from multiple emissions.³⁴ In addition, LMC urges the Commission to defer processing Boeing's application until it can conduct a "comprehensive rulemaking" on permitting AMSS and possibly other new services in the Ku-band.³⁵ Finally, LMC argues that Boeing did not sufficiently justify its request for waivers of the Commission's rules.³⁶

10. Boeing indicates that it has worked with PanAmSat and LMC, in part through the ITU process, to address potential interference concerns of FSS systems.³⁷ While prosecuting the instant application at the Commission, Boeing also presented technical analyses to various ITU Radiocommunication Sector ("ITU-R") Working Groups in support of activities related to 2003 World Radiocommunication Conference ("WRC-03") Agenda item 1.11, which proposes a world-wide secondary allocation for AMSS in the 14.0-14.5 GHz band. Following the close of the public comment period for Boeing's application, Boeing submitted for the record two United States contributions to the WRC-03 preparatory process, which include descriptions of Boeing's proposed AMSS network and explain a "technical methodology that allows it to share spectrum" with GSO and NGSO FSS networks on a secondary basis.³⁸ Boeing later submitted a document that was adopted by ITU-R Working Party 4A ("WP 4A")³⁹ for inclusion in the WP 4A Chairman's Report, which reflects the group's conclusion that AMSS systems operating on a secondary basis can share with GSO and NGSO FSS networks in the 14 GHz band, and as a result, the band "can be used by the AMSS on a secondary basis."⁴⁰ LMC and Intelsat Global Services Corporation ("Intelsat") also filed letters with the Commission regarding the

³² *Comments of PanAmSat Corporation*, File No. SES-LIC-20001204-02300 (March 23, 2001) ("PanAmSat Comments"); *Petition to Defer Processing of Lockheed Martin Corporation*, File No. SES-LIC-20001204-02300 (March 23, 2001) ("LMC Petition"). Boeing filed a response. *Response of The Boeing Company*, File No. SES-LIC-20001204-02300 (April 5, 2001). Both PanAmSat and LMC filed reply comments *Reply Comments of PanAmSat Corporation*, File No. SES-LIC-20001204-02300 (April 17, 2001); *Reply of Lockheed Martin Corporation*, File No. SES-LIC-20001204-02300 (April 17, 2001).

³³ See PanAmSat Comments at 1-3. PanAmSat is concerned that unanticipated failures or deviations in Boeing's network control protocol could result in harmful interference into adjacent FSS networks that may be extremely difficult to isolate and correct. *Id.* at 2-3.

³⁴ See LMC Petition at 3-4.

³⁵ *Id.* at 5.

³⁶ *Id.* at 5-6.

³⁷ See, e.g., Letter from David A. Nall and Philip L. Malet, Co-Counsel to The Boeing Company, to Donald Abelson, Chief, International Bureau, FCC, File No. SES-LIC-20001204-02300, at 3 (May 23, 2001) (Boeing May 23 Letter).

³⁸ Boeing April 27 Letter at 1 (attaching *Working Document Towards Draft CPM Text In Response To Resolution 216 (WRC-2000): System Characteristics and GSO FSS Sharing Study for a Proposed AMSS System in the 14.0-14.5 GHz Band*, United States of America, Document 4A/129-E, at 3 (April 11, 2001) and *Working Document Towards CPM Text for WRC-2003 Agenda Item 1.11: Assessment of the Sharing Potential of AMSS Systems With NGSO FSS Systems in the Frequency Band 14-14.5 GHz*, United States of America, Document 4A/140-E, at 7 (April 11, 2001)).

³⁹ ITU-R WP 4A studies and develops recommendations concerning efficient orbit and spectrum utilization with regard to FSS.

⁴⁰ Boeing May 23 Letter (attaching, *inter alia*, *Working Document Concerning Agenda Item 1.11 of WRC-03*, ITU-R Working Party 4A, Document 4A/TEMP/94-E).

ongoing progress of WP 4A in coming to a consensus on a draft ITU recommendations concerning prevention of harmful interference to the FSS from secondary AMSS station operations.⁴¹

11. On October 31, 2001, PanAmSat, LMC and Intelsat filed a joint letter reporting that, based on the United States contributions to the WRC-03 preparatory process that Boeing submitted to the record, WP 4A developed a draft new recommendation (“DNR”) at its October 2001 meeting in Geneva “that significantly progresses the work on ensuring AMSS networks operating via GSO FSS do not cause unacceptable interference to adjacent FSS networks.”⁴² Significantly, PanAmSat, LMC and Intelsat reported that:

Boeing, LMC, Intelsat, and PanAmSat[] were able to reach consensus on the recommendations in the U.S. contribution to the WP 4A meeting. This U.S. contribution provides the basis for addressing the outstanding technical and regulatory issues associated with the licensing, on a non-conforming use basis, of an AMSS system using GSO FSS satellites in the 14.0-14.5 GHz band.⁴³

In their joint letter, PanAmSat, LMC and Intelsat attached the U.S. contribution to the WP 4A meeting, requesting that the technical and regulatory measures contained in the *recommends* section of the DNR be conditions in any license granted for operation of AMSS networks in the 14.0-14.5 GHz band.⁴⁴

III. DISCUSSION

12. As we explained recently in the *Boeing Receive-Only Order*, Commission rules may be waived for good cause shown.⁴⁵ A waiver is appropriate only if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule.⁴⁶ Generally, the Commission may grant a waiver of its rules in a particular case only if the relief requested would not undermine the policy objective of the rule in question, and would otherwise serve the public interest.⁴⁷ In considering requests for non-conforming spectrum uses, the Commission has indicated that it would generally grant such waivers “when there is little potential for interference into

⁴¹ Letter from Gerald Musarra, Vice President, Trade and Regulatory Affairs, Lockheed Martin Corporation, to Donald Abelson, Chief, International Bureau, FCC, File No. SES-LIC-20001204-02300 (May 16, 2001); Letter from Tony A. Trujillo, Jr., Acting Vice President, Corporate Services, Intelsat Global Services Corporation, to Thomas Tycz, Chief, Chief, Satellite and Radiocommunication Division, International Bureau, FCC, File No. SES-LIC-20001204-02300 (August 15, 2001).

⁴² Letter from Gerald Musarra, Vice President, Trade and Regulatory Affairs, Lockheed Martin Corporation, Kalpak S. Gude, Vice President, Government and Regulatory Affairs & Associate General Counsel, PanAmSat Corporation, and David Meltzer, General Counsel and Sr. Vice President, Regulatory Affairs, Intelsat Global Services Corporation, to Thomas Tycz, Chief, Satellite and Radiocommunication Division, International Bureau, FCC, File No. SES-LIC-20001204-02300, at 1 (October 31, 2001) (“October 31 Joint Letter”).

⁴³ *Id.* at 2.

⁴⁴ *Id.* (attaching *Draft New Recommendation on Operation and Control of AMSS Networks in the 14.0-14.5 GHz Band Relative to FSS Networks*, United States of America, Delayed Contribution, Document 4A/278-E (September 26, 2001)). The *recommends* section includes specific recommended methods for avoiding interference.

⁴⁵ *Boeing Receive-Only Order*, 16 FCC Rcd at 5866 ¶ 8 (citing 47 C.F.R. § 1.3; *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969) (“*WAIT Radio*”).

⁴⁶ *WAIT Radio*, 418 F.2d at 1157. See also *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990).

⁴⁷ *WAIT Radio*, 418 F.2d at 1157.

any service authorized under the Table of Frequency Allocations and when the non-conforming operator accepts any interference from authorized services.”⁴⁸

13. At its April 2001 meeting, ITU-R WP 4A analyzed the feasibility of AMSS operations in the 14.0-14.5 GHz band and the associated FSS protection requirements. WP 4A concluded that the 14.0-14.5 GHz frequency band can be used by the AMSS on a secondary basis relative to FSS, provided that in the case where AMSS is implemented within FSS assignments, the interference levels reaching GSO satellites must at all times be no more than the levels to which potentially affected satellite systems agree in coordination.⁴⁹ In arriving at its conclusion, WP 4A recognized that the interference levels to which potentially affected satellite systems agree are based on stable antenna platforms with well-defined antenna patterns and aggregate levels that are not to be exceeded. WP 4A identified five operational factors that the AMSS must consider in designing uplink power control systems to ensure that the interference levels from the AMSS transmissions do not exceed the levels to which potentially affected satellite systems agree in coordination of FSS networks. The five factors identified were:

- Aggregation of off-axis power from multiple aircraft;
- Antenna mis-pointing;
- Antenna gain pattern variation;
- Input power-to-the-antenna variation; and
- Antenna capture by adjacent satellites.⁵⁰

14. Each of these factors is mapped to a specific *recommends* clause in WP 4A’s DNR drafted for its October 2001 meeting in Geneva.⁵¹ *Recommends* 1 addresses aggregation. *Recommends* 2.1 addresses antenna mis-pointing. *Recommends* 2.2 addresses antenna gain pattern variation. *Recommends* 2.3 addresses e.i.r.p. variation.⁵² *Recommends* 3 addresses antenna capture by adjacent satellites. Finally, *recommends* 4 and 5 address control and monitoring of AMSS terminals. PanAmSat, LMC and Intelsat state that these *recommends* clauses, initiated by Boeing’s submissions to WP 4A, represent the U.S. consensus on the appropriate measures for AMSS systems to protect primary FSS operations.⁵³

15. Other ITU-R Working Parties are examining the studies of the feasibility of AMSS operation sharing with radionavigation, space research, radio astronomy, LMSS, and terrestrial fixed services that are currently operating in various segments of the 14.0-14.5 GHz band. The conclusions from these studies show that AMSS feasibly can share the 14.0-14.5 GHz band with these services with no significant potential of harmful interference, provided AMSS coordinates its operations in accordance

⁴⁸ *Fugro-Chance, Inc.*, Order and Authorization, 10 FCC Rcd 2860, 2860 ¶ 2 (Int’l Bur. 1995) (authorizing non-conforming MMSS in the C-band); see also *Motorola Satellite Communications, Inc.*, Order and Authorization, 11 FCC Rcd 13952, 13956 ¶ 11 (Int’l Bur. 1996) (authorizing service to fixed terminals in bands allocated to the mobile-satellite service).

⁴⁹ See *Chairman’s Report From The Meeting of Working Party 4A, Seattle, 23 April-2 May 2001*, Document 4A/217 (Rev.1)-E, at 344 (June 22, 2001).

⁵⁰ *Draft New Recommendation on Operation and Control of AMSS Networks in the 14.0-14.5 GHz Band Relative to FSS Networks*, United States of America, Delayed Contribution, Document 4A/278-E (September 26, 2001).

⁵¹ *Id.*, a copy of which is attached hereto as Appendix A.

⁵² Transmit e.i.r.p. variation has been substituted for input power variation because input power is not as meaningful for phased array systems that have electronic gain in the antenna. This substitution yields an equivalent set of parameters.

⁵³ October 31 Joint Letter at 2.

with the provisions of Article S9 of the ITU Radio Regulations.⁵⁴ Lastly, ITU-R preliminary studies between the terrestrial fixed services and the AMSS have shown that AMSS adequately can protect the terrestrial fixed services with power flux density limits below certain levels.⁵⁵

16. Based on the analyses of potential interference from AMSS operations, and on the fact that all of the parties to this proceeding reached consensus on the appropriate measures for AMSS systems to protect primary FSS operations, we find that Boeing's request for waiver of the Table of Frequency Allocations is justified and grant of Boeing's application is in the public interest.⁵⁶ This action will enable Boeing to expand its recently authorized one-way AMSS service in order to provide two-way broadband entertainment and data services to passengers and crew on commercial and private aircraft. Boeing will provide its AMSS service using a licensed GSO satellite operating within applicable coordination agreements with adjacent satellite operators. Boeing also acknowledges that it will provide its service on a non-harmful interference basis vis-à-vis all authorized users of these bands. Therefore, as a condition of its authorization, Boeing will be required to accept interference from all authorized users of the Ku-band and may not cause harmful interference to any services authorized to use the band. In addition, Boeing is prohibited from utilizing the system for air traffic control communications or other restricted aeronautical transmissions.⁵⁷

17. In granting Boeing's application, we note the technical concerns that PanAmSat and LMC raised. Specifically, PanAmSat indicated that it is concerned about the adequacy of the system monitoring and interference isolation protocols that Boeing has incorporated into its network design.⁵⁸ Boeing states in its application that it will use a Network Operation Control center to restrict the number of airborne terminals operating concurrently and also to control their maximum data rates, power levels and other relevant factors. Utilizing these and other measures that Boeing has described in its submissions in this proceeding, Boeing should be able to prevent harmful interference to authorized users of the Ku-band. In any event, as a condition of this authorization, upon notification of interference by authorized primary or secondary users of the Ku-band, Boeing will be required to cease the offending operations. Additionally, we condition this authorization on Boeing's designing and operating its system in accordance with the design guidelines it submitted to WP 4A, as now delineated in the *recommends* clauses of the U.S. WP 4A DNR. Under these circumstances and with these conditions, one general purpose of the Table of Allocations – preventing harmful interference – would not be undermined.

⁵⁴ See *Working Document Towards CPM Text Regarding Sharing Between AMSS and Space Research Services in the 14-14.5 GHz Band*, United States of America, Delayed Contribution, Document 7E/46-E (October 8, 2001); *Working Document Towards CPM Text Regarding Sharing Between AMSS and the Radio Astronomy Service in the 14-14.5 GHz Band*, United States of America, Delayed Contribution, Document 7E/48-E (October 8, 2001); *Working Document Towards CPM Text Regarding Sharing of AMSS with LMSS and MMSS in the 14-14.5 GHz Band*, United States of America, Delayed Contribution, Document 8D/201-E (October 18, 2001). There are no records in ITU files indicating any use of the radionavigation allocation in the 14.0-14.3 GHz band by any administration. *Framework for Draft CPM Text for WRC-03 Agenda Item 1.11*, United States of America, Delayed Contribution, Document 8D/203-E, at 1.2.2 (October 18, 2001).

⁵⁵ See *Draft Elements of Chapter 2 of the Draft CPM Report In Reply to Resolution 216 (Rev. WRC-2000), Agenda Item 1.11 (WRC-03), Analysis of Interference from the AMSS into the FS in the Band 14-14.5 GHz*, ITU Working Party 9D, Document 9D/TEMP/75 (Rev.1), at 2 (October 9, 2001).

⁵⁶ See 47 C.F.R. § 2.102(a).

⁵⁷ See 47 C.F.R. §§ 87.173, 87.187(x) (these frequencies are not among those listed for air traffic control). See generally ICAO Handbook on Radio Frequency Requirements for Civil Aviation at 4-1 & 4-2 (Doc. 9718-AN/957, First Edition 1998).

⁵⁸ See PanAmSat Comments at 2-3.

18. Given our decision to grant PanAmSat, LMC and Intelsat's joint request to condition this license on Boeing compliance with the measures contained in the *recommends* section of the DNR, we have addressed all outstanding technical issues these parties raised in their pleadings and letters. We also decline LMC's request to initiate a rulemaking on secondary, non-conforming, and other possible new uses of the Ku-band in the context of this application. During the past twelve years we have authorized operators to provide secondary or non-conforming services in the Ku-band, including both transmit and receive operations.⁵⁹ We are not aware of any complaints of harmful interference resulting from the operations of these licensees, or other adverse effects on authorized operators utilizing the spectrum. Therefore, we believe that a rulemaking proceeding is unnecessary at this time.⁶⁰

IV. ORDERING CLAUSES

19. Accordingly, IT IS ORDERED that Application File No. SES-LIC-20001204-02300 is GRANTED and The Boeing Company IS AUTHORIZED to operate up to eight hundred technically identical transmit and receive mobile earth stations aboard aircraft operating with the Telstar 6 satellite in the 14.0-14.5 GHz and 11.7-12.2 GHz bands in the United States,⁶¹ including the airspace above the territorial waters,⁶² subject to the following conditions:

- a) Boeing shall not cause harmful interference to any authorized station operating in compliance with the Table of Allocations, either domestically (non-Government and Government stations) or internationally, in the 11.7-12.2 GHz and 14.0-14.5 GHz bands (*see* 47 C.F.R. § 2.106), and Boeing shall immediately cease mobile satellite operations upon notification of such harmful interference resulting from its operations;
- b) Boeing, as a non-conforming user, must accept any interference from any station authorized to use the 11.7-12.2 GHz and 14.0-14.5 GHz bands;
- c) Boeing shall not utilize the system for air traffic control communications;
- d) Boeing must comply with any equivalent isotropically radiated power ("e.i.r.p.") spectral density, or other limits adopted by the International Telecommunication Union ("ITU") to protect other services allocated internationally;
- e) Boeing shall not begin its proposed operations in the 14.0-14.5 GHz band until coordination of Boeing's aircraft earth stations have been successfully completed through the National Telecommunications and Information Administration ("NTIA") Frequency Assignment Committee of the Interdepartment Radio Advisory Committee ("IRAC");

⁵⁹ *See, e.g., Boeing Receive-Only Order*, 16 FCC Rcd 5864 (described *supra*, paragraph 2); *Qualcomm OmniTRACS License*, 4 FCC Rcd 1543 (described *supra*, footnote 26); *Crescomm/Qualcomm Order*, 11 FCC Rcd 10944 (described *supra*, footnote 26); *USA TODAY Sky Radio*, Order and Authorization, 7 FCC Rcd 7943 (Dom. Fac. Div., Com. Car. Bur. 1992) (authorizing non-conforming AMSS operations in the 12 GHz band).

⁶⁰ A rulemaking proceeding to modify the U.S. Table of Frequency Allocations may be warranted in connection with any adoption of an international secondary allocation for AMSS in the 14 GHz band.

⁶¹ *See* 47 U.S.C. § 153(51) ("The term 'United States' means the several States and Territories, the District of Columbia, and the possessions of the United States, but does not include the Canal Zone.")

⁶² Consistent with Presidential proclamation and the United Nations Convention on the Law of the Sea, the territorial waters would extend 12 nautical miles from the baselines of the geographic areas described in 47 U.S.C. § 153(51). *See* Presidential Proclamation No. 5928, 54 Fed. Reg. 777 (1988). This approach is consistent with the international law principle that each nation has exclusive jurisdiction over the airspace above its land territory and territorial waters. *See* U.N. Convention on the Law of the Sea, 21 I.L.M. 1261, at Part II, Art. 2 (opened for signature 1982).

- f) In the 14.0-14.5 GHz band, in order to facilitate the protection of the National Science Foundation (“NSF”) radio astronomy operations, Boeing shall design and operate its system in accordance with Boeing’s Technical Operational Coordination Agreement with NSF, dated December 13, 2001;⁶³
- g) Boeing’s non-conforming use of the 14.0-14.5 GHz band shall not constrain future deployment of additional Federal Earth Stations in the space research service authorized pursuant to existing allocations;
- h) Boeing shall design and operate its system in accordance with the following design guidelines,⁶⁴ such that:
- 1) the aggregate off-axis e.i.r.p. levels produced by all co-frequency AMSS mobile terminals are no greater than the interference levels that have been accepted by other FSS satellite systems in coordination with Telstar 6 while operating at the 93° W.L. GSO satellite location;
 - 2) AMSS mobile terminals shall employ an algorithm that is resistant to capturing and tracking adjacent satellite signals, and each terminal shall be capable of inhibiting its own transmission in the event it detects unintended satellite tracking;
 - 3) AMSS mobile terminals are monitored and controlled by a ground-based Network Control and Monitoring Center (“NCMC”) or equivalent facility;
 - 4) each AMSS mobile terminal shall:
 - 4.1.) be able to receive at least “enable transmission” and “disable transmission” commands from the NCMC;
 - 4.2.) cease transmissions after receiving any “parameter change” command, which may cause harmful interference to other satellite systems during the change, until it receives an “enable transmission” command from its NCMC; and
 - 4.3.) be monitored by the NCMC to determine if its operation is malfunctioning; and
 - 4.4.) self-monitor, and shall automatically cease transmission in the event of an operation fault which can cause harmful interference to an adjacent FSS satellite;
 - 5) no later than 60 days prior to commencing 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 modifications⁶⁵ 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:
 - 5.1.) 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

⁶³ See Letter from William T. Hatch, Associate Administrator, Office of Spectrum Management, NTIA, to Donald Abelson, Chief, International Bureau, FCC (December 18, 2001), Attachment 1.

⁶⁴ These requirements are derived from the *recommends* clauses of the U.S. WP 4A DNR, attached as Appendix A.

⁶⁵ *But see* 47 C.F.R. §§ 25.117 (modification of station license), 25.118 (modification not requiring prior authorization).

and latency of their AMSS mobile terminal antenna pointing systems, tracking error of closed loop tracking systems, and misalignment between transmit and receive apertures;

- 5.2.) 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
 - 5.3.) 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;
- i) Boeing shall maintain a point of contact to address immediately any harmful interference events from other authorized users in the frequency bands, and shall arrange to terminate operations if necessary; Boeing shall submit a letter to be included in its license file with the name and telephone number of the contact within 30 days of the release of this *Order*.

20. IT IS FURTHER ORDERED that Boeing IS GRANTED a waiver of Section 2.106 of the Commission's rules for the purpose of operating transmit and receive AMSS stations in the 14.0-14.5 GHz and 11.7-12.2 GHz bands, consistent with the technical parameters specified in its application and supporting documents, and the conditions set forth in this *Order*.

21. IT IS FURTHER ORDERED that the Petition to Defer Processing filed March 23, 2001 by Lockheed Martin Corporation IS DENIED.

22. Boeing is afforded 30 days from the date of release of this *Order* to decline the authorization as conditioned. Failure to respond within that period will constitute formal acceptance of the authorization as conditioned.

23. This *Order and Authorization* is issued pursuant to Sections 0.241 and 0.261 of the Commission's rules on delegated authority, 47 C.F.R. §§ 0.241, 0.261, and is effective upon release.

FEDERAL COMMUNICATIONS COMMISSION

Donald Abelson
Chief, International Bureau

Bruce A. Franca
Acting Chief, Office of Engineering and Technology

Appendix A



INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION
STUDY GROUPSDelayed Contribution
Document 4A/278-E
26 September 2001
English only

Received: 24 September 2001

Subject: Res.216, Agenda item 1.11 - Doc. 4A/TEMP/94 (§ 4.11 of Doc. 4A/217)

United States of America

DRAFT NEW RECOMMENDATION ON OPERATION AND CONTROL
OF AMSS NETWORKS IN THE 14.0-14.5 GHz BAND
RELATIVE TO FSS NETWORKS

At its April 2001 meeting, Working Party 4A proposed that five operational factors form the basis of a Recommendation on the use of the 14.0–14.5 GHz band by AMSS (on a secondary basis) relative to FSS. The purpose of this paper is to reformat these factors into a draft new recommendation. It is appropriate to submit these factors in the form of a Draft New Recommendation because the material has already been reviewed and agreed to by WP 4A.

The five factors identified were:

- Aggregation of off-axis power from multiple aircraft
- Antenna mis-pointing
- Antenna gain pattern variation
- Input power to the antenna variation
- Antenna capture by adjacent satellites

Each of these factors is mapped to a specific *recommends* in the attached DNR. *Recommends* 1 covers aggregation. *Recommends* 2.1 covers antenna miss pointing, *recommends* 2.2 covers antenna gain pattern variation, and *recommends* 2.3 covers EIRP variation. Transmit EIRP variation has been substituted for input power variation because input power is not as meaningful for phased array systems which have electronic gain in the antenna. This substitution yields an equivalent set of parameters. *Recommends* 3 addresses antenna capture by adjacent satellites. Finally, *recommends* 4 and 5 address control and monitoring of AMSS terminals

DRAFT NEW RECOMMENDATION ITU-R S.AMSS
OPERATION AND CONTROL OF AMSS NETWORKS
IN THE 14.0-14.5 GHz BAND RELATIVE TO FSS NETWORKS
(Resolution 216 WRC-2000)

The ITU Radiocommunication Assembly,

considering

- a) that the 14.0–14.5 GHz frequency band is allocated to the FSS (Earth-to-space) on a primary basis;
- b) that Resolution 216 of WRC-2000 invites the ITU-R to study, inter alia, the feasibility of sharing that band between the FSS and the AMSS, with the latter service on a secondary basis;
- c) that a secondary allocation for AMSS in the 14.0–14.5 GHz frequency band will be considered at WRC-2003;
- d) that it is necessary to protect FSS networks in the 14.0–14.5 GHz frequency band from interference caused by other networks and services;
- e) that the Radio Regulations provide adequate means of protection of FSS networks from interference by other FSS networks;
- f) that utilization of suitable techniques to protect FSS space stations will enable AMSS networks to operate in the 14.0–14.5 GHz frequency band without causing unacceptable or harmful interference to FSS networks;
- g) that AMSS networks must take into account a variety of factors that can affect interference levels into FSS networks;
- h) that AMSS networks must have control and monitoring functions to limit interference to other users in the 14.0–14.5 GHz frequency band;
- i) that AMSS mobile terminals receive control information from their associated Network Control and Monitoring Center or an equivalent facility, in the frequency range 10.7 to 12.75 GHz;

recommends

- 1 that an AMSS network in the 14.0–14.5 GHz frequency band be designed and operated in such a manner that the aggregate off-axis e.i.r.p. levels produced by all co-frequency AMSS mobile terminals are no greater than the interference levels that have been accepted by other satellite systems;
2. that the design and operation of an AMSS network should, at least, account for the following factors which could vary the aggregate off-axis e.i.r.p. levels generated by the AMSS mobile terminals:
 - 2.1. that the design and operation of an AMSS network should account for variations in aggregate off-axis e.i.r.p. caused by miss-pointing of AMSS mobile terminal antennas. Where applicable, this includes, at least, effects caused by bias and latency of their pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures;
 - 2.2. that the design and operation of an AMSS network should account for variations in aggregate off-axis e.i.r.p. caused by variations in the antenna pattern of AMSS mobile terminals. Where applicable, this

includes, at least, effects caused by manufacturing tolerances, aging of the antenna, and environmental effects. AMSS systems using certain types of antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). Systems using phased arrays should also account for element phase error, amplitude error, and failure rate.

2.3. that the design and operation of an AMSS network should account for variations in aggregate off-axis e.i.r.p. caused by variations in the transmit e.i.r.p. from AMSS mobile terminals. Where applicable, this includes, at least, effects caused by measurement error, control error, and latency for closed loop power control systems. Systems that calculate the e.i.r.p. of AMSS mobile terminals based on the received signal should account for error sources and latency in this calculation. Systems that calculate the e.i.r.p. of AMSS mobile terminals based on input power should account for measurement error and reporting latency;

3. that AMSS mobile terminals that use closed loop tracking should employ an algorithm that is resistant to capturing and tracking adjacent satellite signals. The AMSS mobile terminals should also inhibit transmission if it detects unintended satellite tracking has happened or is about to happen;

4. that AMSS mobile terminals should be subject to the monitoring and control of a Network Control and Monitoring Center (NCMC) or equivalent facility. AMSS mobile terminals should be able to receive at least “enable transmission” and “disable transmission” commands from the NCMC. AMSS mobile terminals should cease transmissions after receiving any “parameter change” command, which may cause harmful interference during the change, until it receives an “enable transmission” command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AMSS mobile terminal to determine if it is malfunctioning;

5. that AMSS mobile terminals should also be self monitoring and should a fault which can cause harmful interference to an adjacent FSS satellites be detected, the AMSS mobile terminal should auto-disable itself;