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

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the Commission's	)	IB Docket No. 07-101
Rules to Allocate Spectrum and Adopt Service Rules	)	
and Procedures to Govern the Use of Vehicle-Mounted	)	
Earth Stations in Certain Frequency Bands Allocated to	)	
the Fixed-Satellite Service	)	

REPORT AND ORDER

Adopted: July 30, 2009 **Released: July 31, 2009**

By the Commission:

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Paragraph No.

I. INTRODUCTION

1. In this Report and Order we adopt allocation, technical and licensing rules to permit the domestic, U.S. licensing of Vehicle-Mounted Earth Stations ("VMES") as a primary application of the Fixed Satellite Service ("FSS") in the relevant Ku-band frequencies.[1] In Part 25 of the Commission's rules, we define VMES as an earth station operating from a motorized vehicle that travels primarily on land, receives from and transmits to geo-stationary satellite orbit ("GSO") FSS space stations, and operates within the United States pursuant to the requirements set out in Part 25 of the rules.[2] We amend Part 25 of the rules and add a new section 25.226 setting forth technical and licensing rules for VMES as a mobile application of the Ku-band FSS. We also adopt two footnotes to the U.S. Table of Frequency Allocations ("U.S. Table") contained in Part 2 of the Commission's rules.

2. We conclude that these rule changes promote innovative and flexible use of satellite technology. The new rules provide new opportunities for a variety of uses, including U.S. military training needs on VMES technology. They increase the potential that broadband communications capabilities will be made available for various emergency preparedness and commercial purposes where high-bandwidth, advanced mobile communications capabilities are beneficial. At the same time, the technical rules ensure that VMES operations will avoid interfering with existing and future FSS operators and their customers. The rules promote coordination with space research service ("SRS") and radio astronomy service ("RAS") facilities, protecting these important national assets from harmful interference. The rules protect terrestrially-based Fixed Service ("FS") operators and their customers in the relevant extended Ku-band frequencies.

II. BACKGROUND

A. Procedural History

1. General Dynamics Petition

3. On May 24, 2006, General Dynamics SATCOM Technologies, Inc. (together with its parent General Dynamics Corporation, "General Dynamics") filed a petition for rulemaking ("Petition") asking the Commission to amend Parts 2 and 25 of the rules to allocate spectrum and adopt technical and licensing rules for VMES as an application of the Ku-band FSS.[3] Specifically, General Dynamics asked the Commission to: (1) allocate spectrum for use with VMES in the FSS in the conventional Ku-band

[1] For purposes of this Report and Order, the "relevant" Ku-band frequencies refer to the "conventional" Ku-band frequencies in the 11.7-12.2 GHz (downlink) and 14.0-14.5 GHz (uplink) bands and the "extended" Ku-band frequencies in the 10.95-11.2 GHz and 11.45-11.7 GHz (downlink) bands. Excluded are the so-called "extended" Ku-band frequencies at 10.7-10.95 GHz, 11.2-11.45 GHz, 12.75-13.25 GHz, and 13.75-14.0 GHz.

[2] *See* Appendix B to this Report and Order, section 25.201, Definitions.

[3] Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the Ku- and Extended Ku-Bands to the Vehicle Mounted Earth Station Satellite Service ("VMES") on a Shared Primary Basis and to Adopt Licensing and Service Rules for VMES Operations in the Ku- and Extended Ku-Bands, Petition for Rulemaking, RM-11336 (filed May 24, 2006).

uplink at 14.0-14.5 GHz and conventional Ku-band downlink at 11.7-12.2 GHz on a primary basis, and in the extended Ku-band downlink at 10.95-11.2 GHz and 11.45-11.7 GHz on a non-protected basis; and (2) adopt Ku-band VMES licensing and service rules modeled on the Commission's rules for Ku-band Earth Stations on Vessels ("ESVs").[4]

4. In its Petition, General Dynamics asserted that a VMES allocation and regularized service and licensing rules would facilitate the U.S. military's training needs with respect to advanced VMES technologies and increase the potential that advanced communications capabilities would be made available for various emergency preparedness and commercial purposes where high-bandwidth, mobile communications capabilities are beneficial.[5]

2. Public Notice and *NPRM*

5. On July 20, 2006, the Commission placed the Petition on public notice.[6] On May 15, 2007, in response to the Petition and to comments filed in response to the Petition, the Commission initiated a Notice of Proposed Rulemaking ("*NPRM*") in this proceeding, seeking comment on whether to license VMES as an application of the FSS in the Ku-band within the United States.[7]

6. Specifically, the Commission sought comment on the proposed adoption of a primary allocation for VMES applications in the conventional Ku-band frequencies, of secondary or unprotected status in the relevant extended Ku-band frequencies, and of technical and licensing rules for VMES, possibly modeled on the rules for Ku-band ESV.[8] The Commission sought comment on how to promote innovative and flexible use of satellite technology while ensuring interference avoidance and efficient use of the spectrum.

7. A primary goal of the *NPRM* was to develop a record on the capability of VMES terminals, or classes of VMES, to meet the interference avoidance requirements of the Ku-band FSS, such that any VMES rules for the Ku-band frequencies would protect existing and future FSS operators and their customers from harmful interference.[9] The *NPRM* also sought comment on how to promote spectrum sharing with certain secondary and permissive operations in these frequency bands (that is, Federal SRS and RAS stations).[10] Finally, the *NPRM* sought comment on technical and licensing rules for VMES earth stations operating with GSO FSS satellites in the Ku-band.[11]

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[4] Petition at 15.

[5] Petition at ii, 13.

[6] Public Notice, Report No. 2780, Consumer & Governmental Affairs Bureau, Reference Information Center, Petition for Rulemakings Filed, RM No. 11336 (July 20, 2006). Commenters filing in response to the Petition included: Association of Public Television Stations and Public Broadcasting Service ("APTS/PBS"); AvL Technologies Incorporated; General Dynamics; Maritime Telecommunications Network, Inc. ("MTN"); Qualcomm Incorporated ("Qualcomm"); Satellite Industry Association ("SIA"); SES Americom, Inc. and Americom Government Services ("Americom"); and ViaSat, Inc. ("ViaSat").

[7] *Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum and Adopt Service Rules and Procedures to Govern the Use of Vehicle-Mounted Earth Stations in Certain Frequency Bands Allocated to the Fixed-Satellite Service*, IB Docket No. 07-101, Notice of Proposed Rulemaking, FCC 07-86, 22 FCC Rcd 9649 (2007).

[8] *NPRM*, 22 FCC Rcd at 9652, ¶ 6, 9668, ¶¶ 39-40. *See also* 47 C.F.R. §25.222 (Ku-band ESV rules).

[9] *NPRM*, 22 FCC Rcd at 9651, ¶ 3, 9652, ¶ 7.

[10] *NPRM*, 22 FCC Rcd at 9651, ¶ 3.

[11] *NPRM*, 22 FCC Rcd at 9651, ¶ 3, 9652, ¶ 6.

3. Land Mobile Earth Stations

8. Currently, mobile earth stations, with the exception of ESV terminals, are not treated as an application of the FSS with primary status in the conventional Ku-bands.[12] Licensees operating mobile earth terminals ("METs") mounted on vehicles and used while in motion within the United States currently operate in the land mobile-satellite service ("LMSS") on a secondary and non-protected basis.[13] Primary status for VMES as an application of the FSS in the conventional Ku-bands within the United States means that VMES licensees can expect the same level of interference protection from adjacent satellite system operations as other primary FSS operators receive and, for coordination purposes, have the same status as other primary FSS systems.[14] There also are no specific service rules for LMSS in the Ku-band. VMES service rules will provide certainty as to the technical and licensing requirements for VMES systems.

B. VMES

9. A VMES system employs earth stations operating from motorized vehicles that travel primarily on land, receive from and transmit to GSO FSS space stations, and operate within the United States pursuant to the requirements set out in Part 25 of the Commission's rules. General Dynamics and the FSS industry propose to use VMES technology in conjunction with other FSS applications to provide high-bandwidth, mobile broadband communications capabilities for uses such as U.S. military training, emergency preparedness, and commercial purposes.

C. Two-Degree Spacing

10. Generally, U.S.-licensed GSO FSS satellites are spaced approximately two degrees apart along the geostationary orbit.[15] Spacing satellites this closely has required the adoption of stringent limits on the power-density emitted from an earth station antenna towards satellites other than the target satellite. FSS systems operate on a primary basis in the conventional Ku-band.[16] The Commission's regulatory framework for the conventional Ku-band establishes technical rules to govern earth stations communicating with Ku-band satellites to ensure that the earth stations' operations do not cause

[12] Traditionally, Ku-band mobile earth stations have been treated as a component of the mobile-satellite service ("MSS"). The 14.0-14.5 GHz band is allocated for MSS uplinks on a secondary basis for non-Federal use. There is no U.S. Table allocation for MSS in the 11.7-12.2 GHz downlink band. 47 C.F.R. § 2.106. MSS applicants seeking to use the 11.7-12.2 GHz band downlink must seek and receive a waiver of the U.S. Table allocation.

[13] *See, e.g.*, *Raysat Antenna Systems, LLC, Application for Authority to Operate 400 Land Mobile-Satellite Service ("LMSS") Earth Stations in the 14.0-14.5 GHz and 11.7-12.2 GHz Frequency Bands*, Order and Authorization, DA 08-401, 23 FCC Rcd 1985 (Int'l Bur. & OET 2008) ("*Raysat LMSS Order*") (authorizing Raysat to operate METs mounted on vehicles in conventional Ku-bands and communicating with FSS space stations in GSO orbit), *petition for reconsideration or clarification pending* (2009). The LMSS is a component of the MSS. Thus, U.S. Ku-band LMSS licensees operate on a secondary basis in the uplink frequencies and receive no U.S. Table protection in the downlink frequencies. *See* 47 C.F.R. § 2.106.

[14] Co-primary systems generally are obligated to coordinate with each other on a first-come, first-served basis, whereas a system operating under a secondary allocation must not give interference to, and must accept interference from, systems operating with primary status. *See* 47 C.F.R. § 2.105(c).

[15] *See generally Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations*, CC Docket No. 81-704, Report and Order, FCC 83-184, 54 Rad. Reg. 2d (P&F) 577 (1983) ("*Two-Degree Spacing Order*") (adopting 2º orbital spacing policy to maximize the number of in-orbit satellites operating in the Ku- and C-bands); *on reconsideration*, 99 F.C.C. 2d 737 (1985).

[16] *See* 47 C.F.R. § 2.106, Table of Frequency Allocations.

unacceptable interference to adjacent satellite systems also operating on a primary basis.[17] The Commission "routinely" licenses Ku-band FSS earth stations that meet the technical requirements of the two-degree orbital spacing environment set forth in Part 25 of the Commission's rules.[18]

11. Until 2005, the Ku-band FSS had involved, for the most part, radiocommunication service between earth stations at specified fixed points communicating with space stations of the FSS.[19] In 2005, the Commission released the *ESV Report and Order*, which amended Parts 2 and 25 of the rules to include ESVs – earth stations operating on vessels in communication with FSS space stations – as a primary application of the FSS with mobile capabilities.[20] At the time, the Commission observed that authorizing ESVs presented the technical challenge of adopting rules to protect other FSS satellites from the mobile unit's potentially harmful interference.[21] In incorporating the ESV mobile environment into the FSS, the Commission advanced the concept of two-degree spacing by adopting off-axis equivalent isotropic radiated power-density ("E.I.R.P.-density") and other technical rules for ESV earth station transmitters.[22] The effect of these rules was to design an ESV regulatory environment whereby ESVs that exhibit radio frequency characteristics similar to those of other Ku-band FSS earth stations – such as very small aperture antennas ("VSATs") – are eligible for licensing as a primary application of the FSS.[23]

12. Authorizing Ku-band VMES, like Ku-band ESV, as a mobile application of the FSS presents a similar technical challenge of adopting rules that protect other FSS satellites from the mobile unit's potentially harmful interference. In the *NPRM*, the Commission sought to develop a record on the capability of VMES terminals, or classes of VMES, to meet the two-degree interference avoidance requirements of the Ku-band FSS, such that any VMES rules for the Ku-band frequencies – like the ESV

[17] *See generally* 47 C.F.R. Part 25, Satellite Communications.

[18] *See, e.g.*, 47 C.F.R. § 25.134(g) (VSAT applications for service in 12/14 GHz band that meet certain requirements will be routinely processed). Routine applications are those that meet the technical requirements of Part 25 of the rules and thus can be licensed without a case-by-case technical review to verify that the earth station will not cause unacceptable interference into other satellite systems. *See, e.g., 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, Fifth Report and Order, FCC 05-63, 20 FCC Rcd 5666, 5674, ¶ 17 n. 30 (2005) ("*Fifth Report and Order*"). *See also* 47 C.F.R. § 25.201, Definitions.

[19] *See, e.g.*, 47 C.F.R. § 2.1, Terms and Definitions, § 25.201, Definitions.

[20] *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, FCC 04-286, 20 FCC Rcd 674 (2005) ("*ESV Report and Order*").

[21] *ESV Report and Order*, 20 FCC Rcd at 681, ¶ 12. Previous to 2005, the Commission had authorized ESVs to operate in the Ku-band frequencies pursuant to special temporary authority ("STA"). *See id*. at 677-78, ¶¶ 5-6. Thus, the Commission had the experience of the STA operations to assist in informing its decisions on adopting allocation status and technical rules for ESV earth stations.

[22] Off-axis E.I.R.P.-density is a measure of the power-density emitted in directions other than the target satellite.

[23] The ESV rules combine the antenna gain and power-density requirements applicable to more traditional FSS earth stations to develop an off-axis E.I.R.P.-density envelope. Through this combination, the Commission designed the ESV rules to allow ESV operators the flexibility of using an antenna that might not meet the 2° spacing antenna gain pattern specified for routine earth station applications. The ESV rules permit such antennas as long as the licensee reduces the power-density into the antenna to the point that the off-axis E.I.R.P.-density limits – based on the Ku-band FSS 2° orbital spacing antenna gain and power-density requirements – still will be met. *ESV Report and Order*, 20 FCC Rcd at 682, ¶ 14.

rules for Ku-band frequencies – would protect existing and future FSS operators and their customers from harmful interference.[24]

D. Related Proceedings

13. The Commission noted in the *NPRM* the existence of four related proceedings and sought comment on how these proceedings might be relevant to rules for VMES.[25] In one of these, the *Eighth Report and Order*, adopted since release of the *NPRM*, the Commission streamlined the non-routine earth station processing rules to enable more applications to receive routine processing.[26] In the *ESV Order on Reconsideration*, we modify technical and licensing rules for ESVs.[27] Today's Report and Order reflects changes adopted in these two proceedings to Part 25 of the rules, as discussed below. Two additional proceedings remain pending and do not affect the VMES rules we adopt today.[28]

E. Commenters

14. Fifteen parties commented on the *NPRM*. Commenters include nine Commission licensees, manufacturers, systems engineers, and service providers, four trade and other associations, and two users – a non-profit organization and an RAS facility – of Ku-band capacity.[29]

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[24] *NPRM*, 22 FCC Rcd at 9651, ¶ 3, 9652, ¶ 7.

[25] *NPRM*, 22 FCC Rcd at 9655, ¶ 13.

[26] *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, FCC 08-246, 23 FCC Rcd 15099 (2008) ("*Eighth Report and Order*").

[27] *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, Order on Reconsideration, FCC 09-63, (rel. July 31, 2009) ("*ESV Order on Reconsideration*"). In the *ESV Order on Reconsideration*, we also reorder the provisions of 47 C.F.R. § 25.222. *ESV Order on Reconsideration*, Appendix B.

[28] *See Service Rules and Procedures to Govern the Use of Aeronautical Mobile-Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Notice of Proposed Rulemaking, FCC 05-14, 20 FCC Rcd 2906 (2005) ("*AMSS NPRM*") (proposing service rules and procedures for aeronautical mobile satellite service ("AMSS") systems communicating with FSS networks in the Ku-band). *See also* Amendment to the National Table of Frequency Allocations to Provide Allocation Status for Federal Earth Stations Communicating with Non-Federal Satellites, Petition for Rulemaking of the National Telecommunications and Information Administration, RM-11341 (filed Aug. 4, 2006) ("NTIA Petition") (seeking primary status protection for some Federal government earth stations communicating with non-Federal satellites in several frequency bands, including the FSS Ku-bands); Public Notice, Consumer & Governmental Affairs Bureau, Reference Information Center, Petition for Rulemakings Filed, Report No. 2789 (Aug. 17, 2006) (placing NTIA Petition on public notice).

[29] Appendix A lists the filed comments. The commenters are: Americom, a space station licensee and potential VMES applicant, Americom Comments at 2; APTS/PBS, a non-profit organization that uses the Ku-band to receive and distribute non-commercial educational programming, APTS/PBS Comments at 1-2 & 1 nn.1-2; ARINC Incorporated ("ARINC"), which provides communications services among U.S. and foreign aircraft and AMSS to business jets using Ku-band FSS satellites, ARINC Comments at 2; Boeing Company ("Boeing"), a satellite manufacturer and service provider, Boeing Comments at 1-3; Fixed Wireless Communications Coalition ("FWCC"), a coalition of companies, associations, and individuals interested in the FS, FWCC Comments at 1 n.1; General Dynamics, a provider of mobile satellite communications products and services, General Dynamics Comments at 1; Green Bank Facility of the National Radio Astronomy Observatory ("Green Bank"), Green Bank Comments at 1; Hughes Network Systems, LLC ("Hughes"), a VSAT network operator and Ku-band satellite capacity user, Hughes Reply at 5; Intellicom Technologies, Inc. ("Intellicom"), providing systems engineering and other services, *see* www.intellicomaz.com/CONTACT_US.htm; MTN, which provides maritime communications, including ESV, *see* MTN Comments at 2; National Academy of Sciences' Committee on Radio Frequencies ("CORF"), representing the

(continued....)

III. DISCUSSION

15. As described more fully below, we find that the regulatory regime the Commission has adopted for Ku-band ESV, with certain modifications, is a good model for Ku-band VMES. That is, with respect to Part 2, ESV is an application of the FSS with FSS primary status in the conventional Ku-bands, and, with respect to Part 25, incorporates technical and licensing rules that protect other Ku-band users from harmful interference. We conclude that VMES – like Ku-band ESV, employing networks of terrestrial mobile terminals that communicate with Ku-band FSS space stations – is sufficiently similar in radio frequency characteristics to more traditional networks of FSS earth stations to operate compatibly within the two-degree Ku-band FSS satellite spacing environment. We amend Part 25 of our rules to add a new section 25.226 with technical and licensing rules for VMES, similar to the service rules the Commission has adopted for Ku-band ESVs.

16. We conclude that, in the conventional Ku-band, we should treat VMES as a mobile application of the FSS, with primary status like ESV. We address specific allocation issues: (1) revising the U.S. Table through the addition of two footnotes; (2) in the 14.0-14.2 GHz and 14.47-14.5 GHz bands, respectively, requiring VMES licensees to coordinate their proposed operations with Federal SRS and RAS stations; (3) declining to adopt commenter proposals to allocate the Ku-band downlinks based on antenna size, treat VMES as MSS instead of FSS, and address the status of "Aircraft-Mounted Earth Stations" within this proceeding; and (4) discussing the pending NTIA Petition in RM-11341 as it might affect this proceeding. We discuss the relevant VMES technical and licensing issues: (1) modeling Part 25 rules for VMES on the rules for Ku-band ESV, including off-axis E.I.R.P.-density masks, antenna pointing, and other technical and licensing rules; (2) treating potential radio frequency radiation hazards and equipment certification; and (3) considering other potential requirements.

A. VMES Allocation in the Conventional and Extended Ku-bands

17. *Background*. In the *NPRM*, the Commission sought comment on the feasibility of defining VMES as an application of the FSS in the conventional Ku-band, with primary status. The Commission asked whether VMES is sufficiently similar to ESV and other Ku-band FSS services – including VSAT networks that traditionally have operated in the Ku-band FSS – to ensure that VMES will not cause interference to existing and future FSS operations beyond that expected from existing FSS applications. In particular, the Commission sought comment on whether VMES can operate within the Commission's two-degree satellite spacing environment applicable to the Ku-band FSS.[30]

18. That is, the Commission asked whether VMES terminals – earth station antennas mounted on vehicles that will move and have ubiquitous access on-road and off-road throughout the

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interests of the passive scientific users of the radio spectrum, including users of the RAS bands, CORF Comments at 1; National Spectrum Managers Association ("NSMA"), a voluntary association of individuals involved in the spectrum management profession, NSMA Comments at 1 n.1; Raysat Antenna Systems, LLC ("Raysat"), a manufacturer of Ku-band antennas, LMSS licensee, and holder of experimental authorization, Raysat Comments at 1-2; SIA, a U.S.-based trade association representing satellite operators, service providers, manufacturers, launch service providers, remote sensing operators, and ground equipment suppliers, SIA Comments at ii, 2; and ViaSat, a digital communications company specializing in satellite and other wireless networking technologies, such as satellite networks, terminals, data encryption devices, among others, ViaSat Comments at 2. Americom and Intellicom filed their comments after the comment deadline, accompanied by motions to accept late-filed comments. Americom, Motion to Accept Late-Filed Comments, IB Docket No. 07-101 (filed Aug. 20, 2007); Intellicom, Motion to Accept Comments, IB Docket No. 07-101 (filed Aug. 29, 2007). We accept and consider Americom's and Intellicom's comments.

[30] *NPRM*, 22 FCC Rcd at 9657-59, ¶¶ 18-20, 9664-65, ¶ 30.

United States – merit primary status as an FSS application if they are designed to exhibit radio frequency characteristics similar to those of ESVs and other FSS earth stations so as to operate compatibly in the Ku-band FSS two-degree spacing environment.[31]

19. The Commission specifically sought comment and advice from the FSS industry on granting primary status to VMES. The Commission stated that if it granted VMES primary status, the FSS industry would have to accept any increased noise-power from VMES, as if VMES terminals were FSS earth stations, and would have to provide primary status protection to the VMES.[32] At the same time, the Commission noted that the FSS industry might benefit by supplying satellite capacity, services and equipment to VMES systems.[33] The Commission stated, therefore, that the FSS industry was in a good position to provide comment on the various tradeoffs resulting from a grant of primary status to VMES as an application of the FSS.[34]

20. Ten commenters address the similarities and differences between VMES and existing FSS applications and support granting primary status in the conventional Ku-bands within the United States to VMES systems that are capable of operating like VSAT and ESV terminals to protect adjacent FSS satellite systems from interference[35] SIA states that such VMES terminals, because they meet the two-degree spacing technical requirements, are "truly FSS-like in character and use" and "will not disturb the balance that has been reached between primary FSS and secondary MSS services."[36] General Dynamics also urges primary status to preserve and enhance compatibility among relevant Ku-band services. General Dynamics contends that VMES systems most often will employ larger hub terminals with primary status – such as those used for VSAT, ESV and other FSS Ku-band services – at one end of the VMES link.[37] Although stating that it does not object to the licensing of VMES in the Ku-band,

[31] *NPRM*, 22 FCC Rcd at 9657-58, ¶ 18.

[32] *NPRM*, 22 FCC Rcd at 9658, ¶ 18.

[33] *NPRM*, 22 FCC Rcd at 9658, ¶ 18.

[34] *NPRM*, 22 FCC Rcd at 9658, ¶ 18.

[35] *See, e.g.*, SIA Comments at 3, 5-6, 9 (stating that VMES terminals that can protect FSS and that require no greater protection than FSS should be primary); General Dynamics Comments at 7-17 (stating there are no inherent radio frequency differences between ESV and VMES terminals); Boeing Comments at 3-5 (stating that VMES is functionally identical to ESV); MTN Comments at 3 (stating that lack of co-primary shared services should permit primary status for VMES as FSS application); Americom Comments at 4, Reply at 4 (stating there is no basis to conclude VMES is incompatible with incumbent uses); ViaSat Comments at 4 (stating primary for VMES is consistent with growing trend toward mobile applications in FSS and will not increase potential harmful interference into traditional FSS); ARINC Comments at 3 (stating VMES systems should be primary only if they comply with technical requirements so as to cause no undue interference); NSMA Comments at 2 (stating principal considerations are controlling potential interference from VMES transmission to protect co-frequency operators and ensuring VMES receive operations do not adversely affect incumbent users); Hughes Reply at 1-2 (endorsing SIA Comments; stating that, properly conditioned and regulated, VMES has capability to operate compatibly with existing and evolving applications in FSS while protecting other uses in conventional uplink band); Raysat Comments at 3 (stating that experience confirms VMES can operate successfully in 2º spacing environment, and primary status should apply to VMES that complies with VMES rules and to non-conforming operations that demonstrate compatibility with 2º spacing requirements).

[36] SIA Comments at 8.

[37] General Dynamics Comments at 21-22.

ARINC asserts that the Commission must be mindful of existing licensees and users and should avoid adopting rules that would increase harmful interference to other licensees and users in the band.[38]

21. Two commenters raise concerns about primary allocation for VMES. APTS/PBS is concerned that small VMES antennas will not maintain pointing accuracy. In this regard, APTS/PBS states that, unlike sea and air vessels, land vehicles move quickly on rough terrain, take sharp turns, and hit terrain obstructions, and urges the Commission to allocate spectrum to VMES services in the Ka-band instead of the Ku-band.[39] CORF argues that the best way to protect RAS facilities from in-band interference from VMES would be to prohibit VMES transmissions in the 14.47-14.5 GHz sub-band used by the RAS.[40] Alternatively, CORF recommends certain technical measures or coordination with the RAS as a prerequisite to licensing.[41]

22. *Discussion*. A principal objective of the *NPRM* was to develop a record on the capability of VMES to operate in the conventional Ku-band in compliance within the interference avoidance requirements of the Ku-band FSS. The Ku-band FSS now includes one mobile earth station application – ESV – sufficiently similar in radio frequency characteristics to those of more traditional FSS earth stations to operate compatibly within the two-degree Ku-band satellite spacing environment. The record demonstrates that VMES terminals licensed in accordance with the revised Part 25 rules we adopt today likewise will be capable of operating within the Commission's two-degree spacing environment applicable to the Ku-band FSS.[42]

23. Based on the record before us, we conclude that VMES should be defined as an application of the FSS in the Ku-band. As discussed below, we adopt a new U.S. Table footnote to permit the licensing of VMES operations in the conventional Ku-band as an application of the FSS with primary status within the United States. We adopt, below, a second U.S. Table footnote to permit VMES operations in the relevant extended Ku-bands on a non-interference basis with respect to the FS. We respond to CORF's concerns about the 14.47-14.5 GHz sub-band. We discuss antenna pointing accuracy.

B. Allocation Issues

1. U.S. Table of Frequency Allocations

24. In the *NPRM*, the Commission proposed to adopt two non-Federal footnotes to the U.S. Table set out in Part 2 of the Commission's rules.[43]

a. Conventional Ku-bands

25. *Background.* In the conventional Ku-bands, the Commission proposed the following footnote:

[38] ARINC Comments at 1. ARINC contends that training use of VMES should occur on a secondary allocation basis because it states that training exercises have a greater potential for causing interference when personnel set up and manipulate new communications systems. ARINC Reply at 2 n.4.

[39] APTS/PBS at 2-3. In the event that the Commission decides to allocate spectrum in the Ku-band for VMES use, APTS/PBS suggests a number of technical measures to minimize interference with incumbent Ku-band users. *Id.* at 3.

[40] CORF Comments at 6.

[41] CORF Comments at 6-8.

[42] *See, e.g., supra*, Section III.A.2.

[43] *NPRM*, 22 FCC Rcd at 9668, ¶¶ 39-40. *See also* 47 C.F.R. § 2.106 (U.S. Table).

> **NGyyy** In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 are an application of the fixed-satellite service and may be authorized to communicate with space stations of the fixed-satellite service on a primary basis.[44]

The FSS community agrees that VMES, like ESV, can be implemented in a fashion that impacts existing and future FSS use no more or less than other FSS systems, and that primary status for VMES will be beneficial in enhancing compatibility among Ku-band FSS services.[45]

26. *Discussion*. The U.S. Table allocates the 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) bands for FSS operations on a primary basis.[46] In the *ESV Report and Order*, the Commission added a footnote to the U.S. Table stating that ESVs are an application of the FSS in these two bands.[47] The *NPRM* proposed a similar footnote for VMES.[48]

27. We find a primary allocation for VMES to be in the public interest. We conclude that VMES as regulated under a revised Part 25 of our rules can operate compatibly within the two-degree Ku-band satellite spacing environment without causing harm to other FSS operations in the United States.[49] We adopt the *NPRM* proposal for a new non-Federal footnote to the U.S. Table, as follows:

> **NG187** In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 are an application of the fixed-satellite service and may be authorized to communicate with space stations of the fixed-satellite service on a primary basis.

b. Extended Ku-bands

28. *Background.* The Commission proposed in the *NPRM* to adopt a second footnote to the U.S. Table for VMES operations in the relevant extended Ku-bands:

> **NGxxx** In the bands 10.95-11.2 GHz and 11.45-11.7 GHz (space-to-Earth), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 may be authorized to communicate with space stations of the fixed-satellite service but must accept

[44] *NPRM*, 22 FCC Rcd at 9693, Appendix B.

[45] *See, e.g.*, *supra*, Section III.A.2 (commenters state that compatible VMES systems protecting adjacent FSS satellite systems from interference should be primary); SIA Comments at 9 (stating VMES will be "functional equivalent" of conventional FSS VSAT uplink, and thus existing FSS operations will be protected from harmful interference while not having any greater obligations to conforming VMES than to ESVs and non-moving, conforming, VSAT terminals); General Dynamics Comments at 21-22 (stating primary allocation for VMES in FSS would preserve and enhance compatibility among Ku-band services).

[46] 47 C.F.R. § 2.106. There are no primary FS allocations in any portion of the 14.0-14.5 GHz band.

[47] *ESV Report and Order*, 20 FCC Rcd at 706, ¶ 79. *See* 47 C.F.R. § 2.106 Footnote NG183.

[48] *NPRM*, 22 FCC Rcd at 9668, ¶ 40.

[49] We note that ARINC comments that the Commission must be mindful to avoid adopting rules that would increase harmful interference to other licensees and users, and suggests secondary status for domestic training exercises using VMES as a way to address its concern about harmful interference caused by training with new equipment. *See supra*, ¶ 20 note 38. We find that the technical rules we adopt in this proceeding, including antenna pointing requirements, will address this concern. We conclude that primary status is appropriate for domestic training exercises, as it is for other uses.

> interference from stations of the fixed service operating in accordance with the Commission's Rules.[50]

FWCC, a coalition of companies, associations, and individuals interested in the terrestrially-based FS, has no objection to the Commission's authorizing VMES downlinks at 10.95-11.2 GHz and 11.45-11.7 GHz so long as VMES cannot claim protection from FS operations.[51] Eight other commenters also support VMES operations in these bands on a non-protected basis with respect to the FS.[52]

29. *Discussion*. The International Table of Frequency Allocations allocates the frequency band 10.7-11.7 GHz internationally to FSS on a primary basis.[53] Within the United States, we refer to this band as the extended Ku-band downlink band, and footnote NG104 to the U.S. Table reserves FSS use of this band for international systems.[54]

30. In the United States, the FS also uses this band. Our regulatory treatment of ESVs in the 10.95-11.2 GHz and 11.45-11.7 GHz bands requires ESV operators to accept interference from all current and future FS operations in these bands. VMES, like ESV, would use these bands for reception only. Within the United States, we do not anticipate that unprotected receive-only operations in the extended Ku-band would interfere with or restrict other authorized operations in the band.

31. Because Ku-band VMES downlink operations will not interfere with current or future FS operations and because VMES will not receive protection from the FS in these bands, we find, as the Commission did for ESV, that the intent of NG104 will not be undermined by allowing VMES to operate domestically in these bands. Thus, we adopt the *NPRM* proposal for the following non-Federal footnote for VMES operations in the extended Ku-bands:

> **NG186** In the bands 10.95-11.2 GHz and 11.45-11.7 GHz (space-to-Earth), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 may be authorized to communicate with space stations of the fixed-satellite service but must accept interference from stations of the fixed service operating in accordance with the Commission's Rules.

As noted below, VMES applicants proposing to use the extended Ku-band frequencies must identify each space station they propose to use.[55]

2. International Allocation Status

32. *Background*. In the *NPRM*, the Commission observed that there currently is no international recognition in the 14.0-14.5 GHz band for VMES as an FSS application.[56] The Commission

[50] *NPRM*, 22 FCC Rcd at 9693, Appendix B.

[51] FWCC Comments at 2.

[52] *See, e.g.*, MTN Comments at 3, Reply at 2 (supports secondary); SIA Comments at 12 (supports proposed U.S. Table footnote NGxxx); Boeing Comments at ii, 17-18 (supports operations on non-protected basis); Raysat Comments at 4 (supports adoption of proposed footnote NGxxx); NSMA Comments at 3 (supports adoption of proposed footnote NGxxx); ViaSat Comments at 4 (supports secondary, non-interference operations with respect to FS); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 7 (supports receive-only VMES on non-protected basis with respect to FS).

[53] *See* 47 C.F.R. §§ 2.104, 2.106.

[54] 47 C.F.R. § 2.106 Footnote NG104.

[55] *See infra* Section III.C.6.c.

[56] *NPRM*, 22 FCC Rcd at 9659-60, ¶ 21.

stated that international recognition may be less relevant for VMES operating solely within the United States than for ESV and AMSS systems, which, once licensed by the Commission, operate both domestically and internationally.[57] The Commission noted that, even in the absence of International Telecommunication Union ("ITU") agreement on a VMES allocation, it would design any proposed VMES rules to ensure that other countries' communications systems would not receive interference from VMES terminals operating within the United States.[58] The Commission sought comment on the relevance, if any, of the current international recognition of other services involving mobile terminals – LMSS, ESV, and AMSS – to consideration of a domestic allocation status for VMES.[59]

33. Raysat and SIA state that VMES inherently is domestic, unlike ESV or AMSS, and thus international requirements do not apply.[60] SIA asserts that primary status should be accorded to VMES terminals that cause no more interference to, and demand no greater protection from, non-U.S.-licensed satellite networks than other types of FSS earth stations.[61] SIA urges the Commission to proceed with domestic VMES without delay, and asserts that the international status of VMES is not relevant given our commitment to design VMES rules to prevent interference to other countries' communications systems.[62]

34. *Discussion*. In today's Report and Order, we adopt new domestic U.S. allocations and technical and licensing rules that will permit the licensing and operation of VMES systems within the United States. The new Part 2 allocation status and Part 25 technical and licensing rules for VMES do not authorize operations outside of the United States. We find that the rules we adopt today will ensure that VMES systems licensed by the Commission and operating under these rules within the United States will cause no more interference than other types of FSS earth stations. Based on our review of the record, we conclude that the lack of international recognition for VMES as an FSS application is not a critical factor in allocating VMES as an FSS application solely within the United States.[63]

3. Coordination with SRS Stations in 14.0-14.2 GHz Band

35. As discussed below, we require VMES licensees proposing to operate in the 14.0-14.2 GHz band within 125 kilometers of space research tracking and data relay satellite system ("TDRSS") facilities to coordinate through the National Telecommunications and Information Administration ("NTIA") before beginning operations.

[57] *NPRM*, 22 FCC Rcd at 9660, ¶ 21.

[58] *NPRM*, 22 FCC Rcd at 9660, ¶ 21.

[59] *NPRM*, 22 FCC Rcd at 9660, ¶ 21.

[60] Raysat Comments at 13; SIA Comments at 7. *See also* Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[61] SIA Comments at 7.

[62] SIA Comments at 7-8, *citing to NPRM*, 22 FCC Rcd at 9660, ¶ 21.

[63] Further, we observe that ITU Radio Regulation 4.4 ("ITU RR 4.4") permits licensing of services that otherwise do not conform to the Radio Regulations so long as the services do not cause interference to, or claim protection from, other services licensed in compliance with the Radio Regulations. It is possible that an administration neighboring the United States might authorize Ku-band FSS VMES-like operations based solely on ITU RR 4.4. We would expect that any such VMES-like terminal operating pursuant to ITU RR 4.4 will not cause interference to the operations of any U.S. licensee in the Ku-band FSS frequencies.

36. *Background.* The U.S. Table allocates the 14.0-14.2 GHz portion of the Ku-band on a primary basis to FSS for non-Federal operations.[64] Additionally, the U.S. Table allocates this sub-band on a secondary basis to the SRS for both Federal and non-Federal use.[65]

37. Two National Aeronautics and Space Administration ("NASA") space research TDRSS receive facilities, located in Guam and White Sands, New Mexico, operate with frequency assignments in the 14.0-14.05 GHz band. The TDRSS wideband requirements and associated filtering in this portion of the band leave these two TDRSS receive facilities vulnerable to interference to varying degrees. In addition to the two existing facilities, NASA plans to establish another TDRSS receive facility at Blossom Point on the Eastern Shore of Maryland.

38. The Commission proposed in the *NPRM*, as a condition of the VMES license, to require VMES licensees that intend to operate in the 14.0-14.2 GHz frequencies and plan to travel within 125 kilometers of the TDRSS sites at Guam or White Sands to coordinate their proposed operations prior to operating in this sub-band within 125 kilometers of the two sites.[66] This is the same approach the Commission took with respect to ESVs.[67] The Commission also proposed that, should NASA seek to provide similar protection to future TDRSS sites, NTIA should notify the Commission's International Bureau that the TDRSS site is nearing operational status. The International Bureau then would issue a notice requiring all Ku-band VMES operators to cease operations in the 14.0-14.2 GHz band within 125 kilometers of the new TDRSS site until they had coordinated with the new site. After coordination, VMES operators again would be permitted to operate within 125 kilometers of the new TDRSS site, subject to any operational constraints developed in the coordination process.[68]

39. Nine parties commenting on this issue support requiring coordination with the two existing TDRSS sites as a condition, not prerequisite, of VMES licensing.[69] Of these, General Dynamics, SIA, ViaSat, Boeing, Americom, and Hughes comment on and agree with the NPRM's proposal that coordination be conducted through NTIA and NASA as opposed to working through the Commission.[70]

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[64] 47 C.F.R. § 2.106.

[65] 47 C.F.R. § 2.106. The U.S. Table set out in 47 C.F.R. § 2.106 includes the Federal column for informational purposes only. 47 C.F.R. § 2.105(d)(3) and (e).

[66] *NPRM*, 22 FCC Rcd at 9665-66, ¶ 32, 9698, Appendix B, proposed section 25.xxx(a)(11).

[67] *ESV Report and Order*, 20 FCC Rcd at 712-13, ¶ 90.

[68] *NPRM*, 22 FCC Rcd at 9665, ¶ 32.

[69] *See, e.g.*, MTN Comments at 3 (recognizes need to protect TDRSS if VMES granted primary status); ViaSat Comments at 6 (urges same coordination procedures for VMES as for ESV); General Dynamics Comments at 45-47 (supports operation within 125 km of TDRSS sites only after successful coordination); Raysat Comments at 5 (supports coordination requirement as condition of licensing); SIA Comments at 10 (supports extension of section 25.222(d) coordination condition for ESV to VMES); Hughes Reply at 2 (finds coordination proposal in proposed section 25.xxx(a)(11) acceptable); NMSA Comments at 4 (supports coordination); Boeing Comments at ii, 18-19 (supports equal basis coordination as condition of license); Americom Comments at 1 (supports SIA Comments).

[70] *See, e.g.*, General Dynamics Comments at 46-47 (supports coordination via NASA, but sees notification of International Bureau and public notice as administratively burdensome); SIA Comments at 10 (supports extension of section 25.222(d) of the rules to VMES, and intends to explore with NASA and NTIA a general coordination scheme); ViaSat Comments at 6 (supports coordination with NASA), Reply at 21 (supports SIA's general coordination scheme); Boeing Comments at 18-19 (supported NTIA process in ESV proceeding and supports same approach for VMES); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

40. Commenters are less supportive of extending the 125 kilometer coordination requirement to the new TDRSS site. General Dynamics states that current FSS Ku-band VSAT network licenses do not include geographic restrictions to protect future NASA TDRSS earth stations or other potential users and that VMES transmissions technically identical to VSAT transmissions should not pose any greater interference threat.[71] ViaSat asserts that the proposed 125 kilometer coordination zone is large and would impose unnecessary burdens on VMES operations.[72] Hughes suggests that an area more remote than Blossom Point would be better suited for TDRSS, and proposes soliciting comments on an area and frequency range that would be subject to coordination.[73] SIA supports the extension but notes that receive radio frequency filtering at Blossom Point will be very important.[74] Boeing states that Blossom Point should be designed to operate with generally accepted earth station performance standards.[75]

41. *Discussion*. TDRSS is an important part of the space science work conducted by NASA and is essential to NASA mission requirements.[76] Accordingly, we find it in the public interest to protect TDRSS earth stations from potential interference from VMES operating as an application of the FSS. Therefore, we adopt the Commission's proposal to make SRS coordination a VMES licensing condition. We require VMES licensees proposing to operate in the 14.0-14.2 GHz sub-band within 125 kilometers of the Guam and White Sands, New Mexico TDRSS receive facilities to coordinate through NTIA before beginning operations.[77] VMES licensees shall notify the International Bureau once they have completed coordination. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the new coordination zone in 30 days if no party has opposed the operations.[78]

42. We observe that the International Bureau has notified ESV network operators in the 14.0-14.2 GHz band that they will be required to cease operations within 125 kilometers of the new Blossom Point facilities, when these facilities have become operational, unless and until the ESV operator has reached a coordination agreement with NASA that has been approved by both the Commission and

[71] General Dynamics Comments at 48. General Dynamics notes that it built and currently operates much of the TDRSS ground infrastructure. General Dynamics Comments at 48 n.45. General Dynamics states it is confident that current technology is sufficient to produce future TDRSS earth stations immune to potential VMES interference. General Dynamics Comments at 48.

[72] ViaSat Reply at 22.

[73] Hughes Reply at 2-3.

[74] SIA Comments at 10, Reply at 8. *See also* MTN Comments at 3 (recognizes need to protect Blossom Point site); Americom Comments at 1, 3, Reply at 1 (supports SIA Comments and Reply; recognizes need to protect); ViaSat Reply at 22 n. 62 (urges filtering).

[75] Boeing Comments at 19.

[76] NASA missions supported by TDRSS include the Hubble Space Telescope, the space shuttle, and the International Space Station, among others. *See, e.g*., http://msl.jpl.nasa.gov/Programs/tdrss.html.

[77] *See infra* Appendix B, Final Rules, section 25.226(c).

[78] This mirrors the procedure for ESVs. *ESV Report and Order*, 20 FCC Rcd at 713, ¶ 91. General Dynamics proposes an alternative rule restricting transmission within specified TDRSS exclusion zones, with NASA and the VMES licensee maintaining documentation of effective coordination. General Dynamics Comments at 47. We decline to adopt this alternative. We find that it serves the public interest for the VMES licensee to notify the International Bureau of completed coordination so that the International Bureau can give effective public notice, as it does for ESVs.

NTIA.[79] We see no reason to treat VMES operators differently. Therefore, once NTIA notifies the International Bureau that these facilities are about to become operational, the International Bureau will issue a notice announcing the specific date for the commencement of operations of the Blossom Point facilities and requiring each VMES operator in the 14.0-14.2 GHz band to cease operations within 125 kilometers of the new Blossom Point facilities until the VMES operator has completed a coordination agreement with NASA, acceptable to both NTIA and the Commission, for the new TDRSS site. We expect that NASA will endeavor to design these new facilities to minimize the coordination impact on VMES and other FSS Ku-band services from TDRSS operations below 14.2 GHz.[80] We observe that, in addition to the E.I.R.P.-density mask requirements, VMES, like ESV, must meet specific E.I.R.P.-density requirements towards the horizon in the 14.0-14.2 GHz band.[81] These requirements, intended to control potential interference to NASA's TDRSS earth stations, must be met regardless of the power transmitted in any other direction.[82]

43. Finally, we note that SIA expects new state-of-the-art interference filtering to eliminate the need for the "150 MHz guard band that is specified in the rules for the older, existing sites."[83] ViaSat urges state-of-the-art antenna/receiver front end filtering to minimize "the required 150 MHz [megahertz] guard band."[84] We understand SIA and ViaSat to be referring to that portion of the band between 14.05 and 14.2 GHz, as the two existing TDRSS facilities operate with frequency assignments in the 14.0-14.05 GHz portion of the 14.0-14.2 GHz sub-band in which TDRSS has a secondary allocation.[85] To the extent that SIA and ViaSat may be suggesting that we amend Parts 2 and 25 of the rules in order to eliminate coordination requirements for VMES systems using the 14.05-14.2 GHz frequencies within 125 km of the Blossom Point TDRSS facilities, we do not consider that suggestion, for which there is not a sufficient record in this proceeding.

4. Coordination with RAS Stations in 14.47-14.5 GHz Band

44. As discussed below, we require VMES licensees proposing to operate in the 14.47-14.5 GHz band within certain distances of RAS facilities to coordinate with the National Science Foundation ("NSF") before beginning operations.

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[79] *International Bureau Announces New NASA TDRSS Earth Station Site, Report No. SPB-221*, Public Notice, DA 07-4028, 22 FCC Rcd 17321 (Int'l Bur. 2007) ("*Blossom Point Notice*"). *See also* 47 C.F.R. § 25.222(c) (formerly section 25.222(d), requiring all ESV networks operating in the 14.0-14.2 GHz band within 125 km of a new TDRSS earth station to cease operations upon commencement of the TDRSS operations, unless and until the ESV operator and NASA reach an agreement that both the Commission and NTIA approve).

[80] *See, e.g., Blossom Point Notice*, 22 FCC Rcd at 17321 (stating that the Blossom Point station will have improved radio frequency filtering), General Dynamics Comments at 48 (stating that General Dynamics built and currently operates much of the TDRSS ground infrastructure and that General Dynamics is confident current TDRSS earth station technology is sufficient to immunize TDRSS earth stations from potential VMES interference).

[81] 47 C.F.R. § 25.204(j). We discuss off-axis E.I.R.P.-density requirements in Section III.C.

[82] For ESVs, *see* 47 C.F.R. § 25.204(i).

[83] SIA Comments at 11.

[84] ViaSat Reply at 22 n. 62.

[85] *See supra* at ¶¶ 36-37; *see also* 47 C.F.R. § 25.222(c), formerly § 25.222(d) (requiring ESV licensees to coordinate through NTIA if they plan to operate in the 14.0-14.2 GHz sub-band within 125 km of existing or future TDRSS facilities); 47 C.F.R. § 2.106 (in column 4 of the U.S. Table – which sets out the Federal Table – listing the secondary Federal space research allocation at 14.0-14.2 GHz).

a. Coordination Procedure

45. *Background.* In the United States, the U.S. Table allocates the 14.4-14.5 GHz portion of the Ku-band on a primary basis to FSS for non-Federal operations and on a secondary basis to MSS for non-Federal operations.[86] In addition, the Federal government has secondary fixed and mobile allocations in the band. RAS operates in the 14.47-14.5 GHz sub-band on a permissive basis within the United States.[87]

46. The Commission's rules require Ku-band ESV licensees planning to operate within the 14.47-14.5 GHz sub-band to coordinate their proposed operations within the vicinity of three RAS facilities.[88] In the *NPRM*, the Commission sought comment on the feasibility of similar coordination between VMES and RAS operations to preclude harmful interference to the RAS.[89] Specifically, the Commission asked about conditioning VMES licenses to require VMES operators proposing operations in the 14.47-14.5 GHz band and planning to travel in the vicinities of the radio astronomy facilities listed in footnote US203 of the U.S. Table and of Arecibo, Puerto Rico, Mauna Kea, Hawaii, and St. Croix, U.S. Virgin Islands to coordinate their proposed operations to resolve any potential interference concerns prior to operating in these areas.[90] The Commission stated that requiring coordination as a condition to licensing, as opposed to a prerequisite to licensing, is the same procedure it had adopted for ESVs.[91]

47. The Commission also asked whether VMES licensees should coordinate directly with the NSF or work through the Commission.[92] It said that an NSF coordination process would require VMES operators to complete coordination and notify the International Bureau, which, upon receipt of such notification, would release a public notice stating that operations within the new coordination zone might commence in 30 days if no party had opposed such operations.[93] The Commission noted that this is the same approach it had taken for ESVs.[94]

48. Eight parties comment on and support requiring coordination with the RAS in the 14.47-14.5 GHz band as a condition, not prerequisite, of licensing.[95] CORF, however, urges us to make

[86] 47 C.F.R. § 2.106.

[87] Internationally, the RAS is allocated on a secondary basis in the 14.47-14.5 GHz band. In the United States, Footnote US203 of the U.S. Table permits RAS observations of the formaldehyde line frequencies in the 14.47-14.5 GHz sub-band at certain sites. *See* 47 C.F.R. § 2.106 Footnote US203; *see also* Footnote US342.

[88] *ESV Report and Order*, 20 FCC Rcd at 748, Appendix B, § 25.222(e); 47 C.F.R. § 25.222(d) (requiring coordination with RAS facilities at St. Croix, Mauna Kea, and Arecibo).

[89] *NPRM*, 22 FCC Rcd at 9667-68, ¶¶ 37-38.

[90] *NPRM*, 22 FCC Rcd at 9667-68, ¶ 37, 9698, Appendix B, Proposed Rules, proposed section 25.xxx(a)(12). Footnote US203 lists RAS facilities observing in the 4 GHz and 14 GHz bands and states that "Every practicable effort will be made to avoid the assignment of frequencies to stations in the fixed or mobile services in these bands." 47 C.F.R. § 2.106 Footnote US203. The *NPRM* proposed the following coordination zones: Arecibo, 90 km; Mauna Kea, 125 km; St. Croix, 45 km; Footnote US203 sites, 160 km. *Id*. at 9698.

[91] *NPRM*, 22 FCC Rcd at 9668, ¶ 37 n.83.

[92] *NPRM*, 22 FCC Rcd at 9668, ¶ 38.

[93] *NPRM*, 22 FCC Rcd at 9668, ¶ 38.

[94] *NPRM*, 22 FCC Rcd at 9668, ¶ 38, citing to *ESV Report and Order*, 20 FCC Rcd at 715, ¶ 96.

[95] *See, e.g*., Raysat Comments at 6; MTN Comments at 3; ViaSat Comments at 5-6 (stating that VMES should coordinate with RAS in sub-band, using same coordination procedures as adopted for ESVs); General Dynamics (continued....)

coordination a prerequisite to licensing or prohibit all VMES uplink transmissions in the 14.47-14.5 GHz band nationwide to protect RAS facilities, including US203 facilities, from in-band interference.[96] The eight commenters favoring coordination as a condition of licensing support coordination with NSF – as set out in the *NPRM*'s Appendix B, Proposed Rules, proposed section 25.xxx(a)(12) – or through NTIA.[97]

49. *Discussion*. We do not adopt CORF's proposal to exclude VMES from use of portions of the FSS uplink band.[98] We find that we can accomplish the necessary interference protection of these important RAS facilities through the less severe methods discussed below.

50. We require VMES licensees proposing to operate in the 14.47-14.5 GHz band and planning to travel within certain distances of relevant RAS facilities to coordinate their proposed operations with NSF prior to operating in these areas.[99] We discuss the relevant RAS facilities in Section III.B.4.b below.

51. Licensees shall notify the International Bureau once they have completed coordination and shall submit the applicable NSF-licensee coordination agreement to the Commission. If the VMES applicant submits the coordination agreement with its application, the 30-day public notice period for the application will provide opportunity for any public comment on the coordination agreement. Alternatively, upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the new coordination zone in 30 days if no party has opposed the operations.[100]

52. For future RAS sites, we adopt the procedure used for future TDRSS sites.[101] That is, once NTIA notifies the International Bureau that these facilities are about to become operational, the International Bureau will issue a notice requiring each VMES operator in the 14.47-14.5 GHz band to cease operations within the relevant geographic zone (160 kilometers for a radio observatory like Green Bank or Socorro and 50 kilometers for a Very Long Baseline Array, or "VLBA," site) of the new RAS facility until the VMES operator has completed a coordination agreement with NSF for the new RAS

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Comments at 50; NSMA Comments at 4 (agreeing with the Commission's approach to ESV); SIA Comments at 11, Americom Comments at 1 (supporting SIA Comments); Hughes Reply at 1 (endorsing SIA Comments).

[96] CORF Comments at 5-8 (urging the Commission to prohibit use of sub-band or make coordination a prerequisite of licensing unless technical measures require Global Positioning Satellite software or a control center to ensure coordination, and urging the Commission to require coordination of VMES use of 14.44-14.47 GHz if the Commission does not ban VMES use of 14.47-14.5 GHz). ViaSat, SIA, Americom, and Hughes oppose CORF's proposed requirements on using the 14.44-14.47 GHz frequencies. *See* ViaSat Reply at 22; SIA Reply at 6-7; Americom Reply at 1 (concurs with SIA Reply); Hughes Reply at 1 (endorses SIA Reply).

[97] *Compare* CORF Comments at 8; Raysat Comments at 6; NSMA Comments at 4-5; ViaSat Comments at 6 (all selecting NSF) *with* SIA Comments at 11 (should be through NTIA, not NSF); MTN Reply at 5 (same); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[98] Nor will we require, as suggested by CORF, coordination in the 14.44-14.47 GHz frequencies. As SIA observes, VMES terminals will be required to meet the unwanted emissions requirements of 47 C.F.R. § 25.202(f). SIA Comments at 12, Reply at 7.

[99] *See infra* Appendix B, section 25.226(d). The Commission has found the process of licensee coordination with NSF, followed by notification of the Commission, to work well. *See, e.g., Raysat LMSS Order*, 23 FCC Rcd at 1995-96, ¶¶ 30-31 (coordination agreement between NSF and Raysat).

[100] This notification procedure mirrors the procedure for ESVs. *ESV Report and Order*, 20 FCC Rcd at 715, ¶ 96.

[101] *See supra* ¶ 42.

site.[102] Licensees shall notify the International Bureau once they have completed coordination and shall submit the applicable coordination agreement to the Commission. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the new coordination zone in 30 days if no party has opposed the operations.

b. Relevant RAS Facilities

53. *Background*. In the *NPRM*, the Commission proposed VMES coordination with certain RAS facilities, including those listed in US203. Specifically, the Commission sought comment on requiring VMES operators proposing operations in the 14.47-14.5 GHz band and planning to travel in the vicinity of the radio observatories listed in US203 and of Arecibo, Mauna Kea, and St. Croix to coordinate their proposed operations to resolve any potential interference concerns.[103]

54. MTN, SIA, Americom and Hughes support a requirement to coordinate with RAS facilities at Arecibo, Mauna Kea and St. Croix.[104] At the same time, they assert that footnote US203 does not apply to satellites and there is no justification for adopting a VMES coordination zone around US203 facilities observing in the 14.47-14.5 GHz sub-band.[105] SIA states that the ESV rules are limited to coordination with RAS facilities at Arecibo, Mauna Kea and St. Croix and do not include coordination zones around the RAS facilities listed in US203.[106]

55. *Discussion*. We require VMES licensees to coordinate with a broader range of RAS facilities than required by the ESV rules. SIA is correct that the ESV rules list only three facilities, at Arecibo, Puerto Rico, Mauna Kea, Hawaii, and St. Croix, U.S. Virgin Islands. It was appropriate, for ESVs, to adopt coordination zones around the three observatories at Arecibo, Puerto Rico, Mauna Kea, Hawaii, and St. Croix, U.S. Virgin Islands, because, absent coordination, there was a possibility of ESV interference to radio observations in these zones as vessels carrying ESVs entered waters in proximity to these observatories.[107] We find that a similar circumstance exists for VMES terminals, which may operate on- and off-road near these three facilities. However, VMES, unlike ESV, also will be capable of traveling on- and off-road in close proximity to additional radio observatories, including those listed in US203, among others.[108]

56. Given the potential ubiquity of VMES terminals within the United States, we conclude that it is necessary to adopt new section 25.226(d) requiring VMES coordination with certain RAS facilities – a broader category of sites than the three coordination sites for ESVs – to protect these

[102] *See infra* Section III.B.4.c for a discussion of coordination zones.

[103] *NPRM*, 22 FCC Rcd at 9698, Appendix B, Proposed Rules, section 25.xxx(a)(12).

[104] *See, e.g.*, MTN Reply at 5-6 (urging requirement limited to St. Croix, Mauna Kea and Arecibo); SIA Comments at 11-12, Reply at 5 (urging requirement limited to three specific sites identified in what was section 25.222(e) of the rules and is now section 25.222(d)); Americom Comments at 1, Reply at 1 (supporting SIA Comments and Reply); Hughes Reply at 1 (endorsing SIA Comments and Reply).

[105] MTN Reply at 6; SIA Comments at 11-12 (observes that US203 applies expressly to avoiding 14.47-14.5 GHz assignments in fixed and mobile services, not in satellite services), Reply at 5-6; Americom Comments at 1, Reply at 1 (supports SIA Comments and Reply); Hughes Reply at 1 (endorses SIA Comments and Reply).

[106] SIA Comments at 12, Reply at 5.

[107] *See ESV Report and Order*, 20 FCC Rcd at 714-15, ¶¶ 95-97.

[108] *See also* CORF Comments at 5 (stating that there may be thousands, or tens of thousands, of VMES terminals operating throughout the United States, that every major RAS observatory has public roads nearby, and that VMES appears to be intended for off-road use as well).

important RAS sites from potential interference. In this regard, we also observe that footnote US342 of the U.S. Table states that, in making assignments to stations in the 14.47-14.5 GHz band, among other bands, the Commission shall take all practicable steps to protect the RAS from harmful interference.[109]

57. CORF proposes that the Commission update the list of RAS facilities in US203.[110] We agree with SIA that this is not the appropriate proceeding in which to update US203.[111] The Commission did not seek comment in the *NPRM* and we do not have a full record on the issue of updating US203. However, as noted, US342 requires the Commission, in making assignments in the 14.47-14.5 GHz band, among others, to take all practicable steps to protect RAS sites from harmful interference. We take cognizance of recent agreements between NSF and certain Commission licensees that include RAS facilities not listed in US203.[112] We also observe that the Commission previously has stated that it might need to update US203.[113] In an *ex parte* letter, NTIA provides the most recent list of RAS facilities making observations in the Ku-band and the contact information for initiating coordination with NSF.[114] We determine that reliance on the sites listed in the NTIA Letter is a practicable approach to protecting RAS sites from potential VMES interference. Thus, we adopt a rule that requires VMES licensees to coordinate with NSF for the following operational RAS sites, as identified by NTIA: St. Croix, Virgin Islands; Mauna Kea, Hawaii; Arecibo, Puerto Rico; Green Bank, West Virginia; Socorro, New Mexico; Stinchfield Woods, Michigan; Rosman, North Carolina; Brewster, Washington; Owens Valley,

[109] 47 C.F.R. § 2.106 Footnote US342.

[110] In particular, CORF states that the Five Colleges Radio Observatory and the Haystack Observatory no longer operate at 14 GHz and can be deleted from US203. CORF Comments at 9. CORF states that the Allen Telescope Array ("ATA"), located in Hat Creek, California, has replaced the Hat Creek Observatory, and urges us to replace "Hat Creek Observatory" with "ATA" and to delete the reference to observation at 14 GHz while retaining the reference to 4.8 GHz. *Id.* Additionally, CORF urges us to add the VLBA stations of the National Radio Astronomy Observatory, listed in Footnote US311, to US203 with the notation that they observe at 4.8 GHz and 14 GHz. *Id.* Finally, CORF states that the University of Michigan Radio Astronomy Observatory located at Stinchfield Woods, Michigan and the Pisgah Astronomical Research Institute located at Rosman, North Carolina observe at both 4.8 GHz and 14 GHz, and urges that us add both observatories to US203. *Id.*

[111] *See* SIA Reply at 6 n.14.

[112] *See, e.g., Raysat LMSS Order*, 23 FCC Rcd at 1995-96, ¶¶ 30-31 (discussing coordination agreement between NSF and Raysat); Raysat, Inc., Application for Authority to Operate 4,000 In-Motion Mobile Satellite Antennas in the 14.0-14.5 GHz and 11.7-12.2 GHz Frequency Bands, File Nos. SES-LIC-20060629-01083 *et al*., Application, Exhibit 3, Technical Operational Coordination Agreement for the Joint Usage of the Band 14.0-14.5 GHz between the National Science Foundation and Land Mobile Satellite Service Earth Stations (LMSS) Operated by Raysat, Inc. (May 25, 2006) ("NSF-Raysat Coordination Agreement") *available at* http://licensing.fcc.gov/ibfsweb/ib.page.FetchAttachment?attachment_key=-110808. The NSF-Raysat Coordination Agreement lists the following sites: Green Bank, West Virginia; Socorro, New Mexico; Brewster, Washington; Owens Valley, California; Kitt Peak, Arizona; Pie Town, New Mexico; Los Alamos, New Mexico; Fort Davis, Texas; North Liberty, Iowa; and Hancock, New Hampshire. NSF-Raysat Coordination Agreement at 3. US203 lists Green Bank and Socorro, plus additional sites not listed in the NSF-Raysat Coordination Agreement. 47 C.F.R. § 2.106 Footnote US203.

[113] *AMSS NPRM*, 20 FCC Rcd at 2923, ¶¶ 28-29, 2924-25, ¶ 33 (seeking comment on whether and how to update US203, based on comments that CORF had filed in that proceeding).

[114] *See* Letter from Karl Nebbia, NTIA to Julius Knapp, Chief, Office of Engineering and Technology, IB Docket No. 07-101 (dated Dec. 1, 2008) ("NTIA Letter") (listing RAS sites and proposed coordination zones and identifying NSF contact point).

California; Kitt Peak, Arizona; Pie Town, New Mexico; Los Alamos, New Mexico; Fort Davis, Texas; North Liberty, Iowa; and Hancock, New Hampshire.[115]

c. Coordination Zones

58. *Background*. In the *NPRM*, the Commission proposed a rule establishing certain VMES coordination zones around RAS facilities. In particular, the Commission proposed section 25.xxx(a)(12), as follows:

> (12) Operations of VMESs in the 14.47-14.5 GHz (Earth-to-space) frequency band within (1) 45 km of the radio observatory on St. Croix, Virgin Islands (latitude 17° 46' N, longitude 64° 35' W); (2) 125 km of the radio observatory on Mauna Kea, Hawaii (latitude 19° 48' N, longitude 155° 28' W); (3) 90 km of the Arecibo Observatory on Puerto Rico (latitude 18° 20' 46" N, longitude 66° 45' 11" W); and (4) 160 km of the radio observatories listed in US203 as observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF).[116]

The proposed VMES coordination zones around Arecibo, St. Croix and Mauna Kea were the same as those the Commission had adopted in 2005 in the ESV rules.[117]

59. SIA asserts that the *NPRM* offers no justification for the 160-kilometer coordination zone around US203 sites.[118] ViaSat contends that the radio horizon for VMES antennas will be approximately 18 kilometers as it states that VMES antennas typically will be less than 10 feet above ground level and signal path obstacles and foliage will attenuate signals, and that 160 kilometers is an unnecessarily large coordination area.[119]

60. *Discussion*. We take cognizance of the NTIA Letter as a useful model for delineating the appropriate geographic zones for VMES around RAS facilities. We also note that NSF and various Ku-band LMSS licensees have current coordination agreements that reflect many of the coordination zones set out in the NTIA letter.[120]

61. The NTIA Letter lists fifteen RAS sites. The NTIA Letter recommends 50-kilometer coordination zones around each of St. Croix and Mauna Kea, and a coordination zone of the Island of Puerto Rico for Arecibo; a 160-kilometer zone around each of five RAS sites (Green Bank, Socorro, Stinchfield Woods, Rosman, and Owens Valley); and a 50-kilometer zone around certain VLBA antenna systems (Brewster, Kitt Peak, Pie Town, Los Alamos, Fort Davis, North Liberty and Hancock).[121] We adopt for VMES the coordination zones set out in the NTIA Letter. We adopt 50-kilometer coordination zones around each of St. Croix and Mauna Kea, a coordination zone of the Island of Puerto Rico for

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[115] *See* NTIA Letter at 1. *See also* CORF Comments at 9.

[116] *NPRM*, 22 FCC Rcd at 9698, Appendix B, Proposed Rules, § 25.xxx(a)(12). *See also* 47 C.F.R. 1.106 Note US203.

[117] *See ESV Report and Order*, 22 FCC Rcd at 748, Appendix B. *See also* 47 C.F.R. § 25.222(d).

[118] SIA Comments at 12.

[119] ViaSat Reply at 21-22.

[120] *See, e.g.*, NSF-Raysat Coordination Agreement.

[121] NTIA Letter at 1; *see also* NSF-Raysat Coordination Agreement at 2-3 (stating that the Green Bank and Socorro observatories require more stringent levels of protection than the remaining eight sites associated with VLBA antenna systems).

Arecibo, and 160-kilometer coordination zones around each of Green Bank, Socorro, Stinchfield Woods, Rosman, and Owens Valley. For the purely VLBA sites, we adopt a maximum coordination zone of 50 kilometers.[122] This 50-kilometer zone will be less burdensome for VMES operators than the 160 kilometers proposed by the *NPRM* for RAS sites.

d. Notification versus Coordination

62. *Background*. SIA, which opposes the proposal in the *NPRM* to require VMES licensees to coordinate with US203 facilities, filed comments that seem to suggest that it would prefer us to require VMES operators to notify rather than coordinate with RAS facilities. In its comments, SIA referred to § 25.203(f) of the rules, which requires applicants (but excluding applicants for "mobile" station authorizations, among others) to notify the National Radio Astronomy Observatory of the technical parameters of an earth station that would operate within the "Quiet Zone" for radio astronomy.[123] SIA observed that the Commission had been considering a proposal, in the *Sixth Report and Order and Third Further Notice*, to replace the notification requirement with a coordination requirement for VSAT remote terminals that operate in the Quiet Zone.[124] SIA asserted that the Commission might condition the regulatory treatment of VMES on the outcome in the *Sixth Report and Order and Third Further Notice*.[125]

63. *Discussion*. Subsequent to the filing of SIA's comments in this proceeding, the Commission declined to amend § 25.203(f) in a separate proceeding. In the *Eighth Report and Order*, the Commission determined that it would not be in the public interest to require prior coordination to replace the Quiet Zone notification requirement for VSAT applicants.[126]

64. To the extent that SIA is recommending RAS notification in place of coordination for VMES, based on section 25.203(f) of the rules, we note that section 25.203(f) addresses non-mobile operations in the 14.47-14.5 GHz band. VMES earth stations, as a new mobile application of the FSS, are not covered by the terms of section 25.203(f).[127] Moreover, the "quiet zones" set out in section 25.203 do not encompass all of the RAS facilities that require coordination with VMES to protect the RAS from potential harmful interference.[128] We find that requiring VMES to coordinate with NSF, as the Commission proposed in the *NPRM*, instead of adopting a VMES notification requirement, as seemingly suggested by SIA, will provide the needed certainty that this new mobile application of the FSS will not cause unnecessary interference to important RAS assets.

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[122] *See* NTIA Letter at 1; *see also* NSF-Raysat Coordination Agreement at 2-3 (establishing 25 kms as exclusion zone around the Hancock, New Hampshire VLBA site).

[123] SIA Comments at 12 n.23, referring to 47 C.F.R. § 25.203(f) (defining the Quiet Zone as the area bounded by 39º15´ N on the north, 78º30´ W on the east, 37º30´ N on the south and 80º30´ W on the west).

[124] SIA Comments at 12 n.23, *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, Sixth Report and Order and Third Further Notice of Proposed Rulemaking, FCC 05-62, 20 FCC Rcd 5593, 5641-43, ¶¶ 138-142 (2005) ("*Sixth Report and Order and Third Further Notice*").

[125] SIA Comments at 12 n.23.

[126] *Eighth Report and Order*, 23 FCC Rcd at 15138, ¶ 91.

[127] 47 C.F.R. § 25.203(f). *See also* Green Bank Comments at 1 (stating that because the Quiet Zone protections do not pertain to mobile transmitters, additional protection would be required to keep VMES uplink signals from interfering with Ku-band RAS observations).

[128] Section 25.203(f) covers Green Bank, and § 25.203(i) covers Arecibo. 47 C.F.R. § 25.203(f), (i).

5. Other Allocation Issues

a. Allocation in Conventional Downlink Band Based on Antenna Size

65. *Background.* In the *NPRM*, the Commission sought comment on a proposal from Qualcomm to allocate primary status in the conventional downlink band (11.7-12.2 GHz) based on antenna size.[129] Qualcomm had suggested an amendment to section 25.209 of the Commission's rules that would set an antenna size threshold, possibly 55 centimeters, above which the allocation would be primary and receive appropriate interference protection and below which it would be secondary and thus less protected.[130] Qualcomm had asserted that, for a system that employs ultra-small antennas – which, with their wider main lobes, may be more vulnerable to adjacent satellite interference – the operator's acceptance of the risk of adjacent satellite interference should be reflected in a license condition.[131]

66. General Dynamics, SIA, Boeing, Raysat, NSMA, Americom and Hughes concur that a primary-secondary threshold based on antenna size is unnecessary.[132] No commenter suggests a reason for adopting such a requirement. MTN notes that it would not object to Qualcomm's proposal so long as the VMES rules retain antenna pointing accuracy requirements.[133]

67. *Discussion.* We decline to adopt an antenna size criterion for VMES primary allocation. The Commission noted in the *NPRM* that the adoption of primary status for VMES and the application of section 25.209(c) of the rules might preclude the need for such a rule for VMES terminals.[134] We are adopting primary status for VMES in the conventional Ku-band frequencies. Further, we have decided to apply section 25.209(c) to VMES. As a result, VMES terminals will receive protection from radio interference caused by other space stations only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in section 25.209(a) and (b) and stationary at the location at which any interference occurred.[135] Thus, based on our review and analysis of the record, we do not adopt Qualcomm's proposal.

b. VMES as MSS in Conventional Ku-bands

68. *Background.* In the *NPRM*, the Commission sought comment on Qualcomm's suggestion that it allocate the conventional Ku-bands to VMES as an MSS operation on a primary basis, that is, by upgrading the secondary MSS allocation in the uplinks (14.0-14.5 GHz) to primary and adding a co-primary allocation for VMES as an MSS application in the conventional downlinks (11.7-12.2 GHz).[136] The Commission stated that it did not think it would be useful or necessary to adopt

[129] *NPRM*, 22 FCC Rcd at 9678-79, ¶ 65-66; Qualcomm, RM-11336, at 5 (filed Aug. 21, 2006) ("Qualcomm RM-11336 Comments").

[130] *NPRM*, 22 FCC Rcd at 9678, ¶ 65; Qualcomm RM-11336 Comments at 5.

[131] *NPRM*, 22 FCC Rcd at 9678, ¶ 65; Qualcomm RM-11336 Comments at 5.

[132] General Dynamics Comments at 42-43 (states VMES operators, like ESV operators, should have no less priority than other FSS services provided that transmissions have equivalent E.I.R.P.-density envelope); SIA Comments at 20 (supports proposed § 25.xxx(a)(14) and § 25.209(c)); Boeing Comments at ii, 10, 26-27 (supports protecting all antennas regardless of size as set out in § 25.209(c)); Raysat Comments at 14 (supports proposed § 25.xxx(a)(14)); NSMA Comments at 8 (supports § 25.209(a)-(b)); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[133] MTN Comments at 6 n.12.

[134] *NPRM*, 22 FCC Rcd at 9678, ¶ 66.

[135] *See* 47 C.F.R. § 25.209(c)(1). *See also* Appendix B, § 25.226(a)(8).

[136] *NPRM*, 22 FCC Rcd at 9662, ¶ 23; *see* Qualcomm RM-11336 Comments at 3, 5.

Qualcomm's suggestion because a decision to permit VMES to operate as a primary service with FSS satellites in the Ku-band would make co-primary status for VMES as an MSS system unnecessary.[137]

69. No commenter supports allocating VMES as primary MSS in the Ku-band. Those parties commenting on the issue agree that it is unnecessary to consider an MSS allocation for VMES.[138] SIA, for example, states that VMES terminals are FSS-like in character and use and that it is not necessary or useful to consider VMES as MSS.[139]

70. *Discussion*. Based on our analysis of the record, we conclude that there is no need for primary MSS status for VMES in the Ku-band because we are adopting primary status for VMES as an application of the FSS.

c. "Aircraft-Mounted Earth Stations"

71. *Background*. In 2005, in a separate proceeding, the Commission issued a notice of proposed rulemaking proposing service rules and procedures for AMSS systems communicating with FSS networks in the Ku-band.[140] That proceeding remains pending.

72. Boeing and ARINC propose that we expand the VMES proceeding to include so-called "Aircraft-Mounted Earth Stations" or "AMES," which, like ESV and VMES, would be a mobile application of the FSS.[141] In *ex parte* comments, Boeing proposes that we redefine the term "VMES" to include airborne terminals.[142]

73. MTN urges that we should not provide primary status for "AMES" in this proceeding.[143] MTN states that Boeing's request effectively asks the Commission to ignore a pending rulemaking proceeding that addresses the regulatory status of these airborne terminals.[144] MTN asserts that we did not provide adequate notice to the public that the elevation of "AMES" to primary status was a foreseeable outcome of the VMES proceeding.[145]

74. *Discussion*. As noted above, the regulatory status of earth stations on aircraft is the subject of a separate Commission proceeding.[146] Recognizing the ongoing status of the separate

[137] *NPRM*, 22 FCC Rcd at 9661-62, ¶ 23.

[138] SIA Comments at 8; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments); General Dynamics Comments at 13-14 (states VMES more similar to VSAT in signal structure that, unlike MSS, does not radiate in other directions and Commission should not complicate question of granting VMES primary FSS status).

[139] SIA Comments at 8.

[140] *AMSS NPRM, supra* note 28.

[141] *See, e.g.*, Boeing Comments at i, 8-9, Reply at 3-4; ViaSat Reply at 7; ARINC Reply at 1, 2-3; Boeing *Ex Parte* (filed Sept. 18, 2007) at 1-3; Boeing *Ex Parte* (filed Jan. 15, 2008) at Attachment 1-2 ; Boeing *Ex Parte* (filed July 24, 2008) at 1, Attachment.

[142] *See, e.g.*, Boeing *Ex Parte* (filed Jan. 15, 2008) at Attachment 1-2 (proposing that Commission redefine VMES to include airborne mobile terminals).

[143] MTN Reply at 2, 7-8.

[144] MTN Reply at 7.

[145] MTN Reply at 8 n.23.

[146] *See AMSS NPRM,* 20 FCC Rcd 2906 (proposing service rules and procedures for AMSS systems communicating with FSS networks in the Ku-band).

proceeding, the Commission did not propose to adopt rules for earth stations on aircraft in the *NPRM*. Earth stations on aircraft may implicate technical and policy considerations not relevant to VMES.[147] We find that we do not have a sufficient record in this proceeding to develop appropriate rules for earth stations on aircraft. We conclude that we should not consider "AMES" in this proceeding.

d. Federal Use in the Ku-band

75. *Background*. Because Federal policy promotes the use of commercial communications satellite systems, NTIA has filed a petition for rulemaking seeking to promote greater Federal use of non-Federal satellites.[148] Specifically, NTIA seeks primary status protection for some Federal earth stations communicating with non-Federal satellites in several frequency bands, including the FSS Ku-bands. Federal earth stations operating with non-Federal satellites generally operate on a non-interference basis. The *NPRM* sought comment on the effects that a grant of NTIA's petition might have on the General Dynamics proposal to adopt an allocation and licensing scheme for VMES.[149]

76. SIA, Raysat, and ViaSat state that they support primary status for Federal users of VMES if: (1) Federal users are subject to the same general regulatory obligations as non-Federal users with respect to the Commission's licensing, interference, and enforcement requirements; and (2) commercial and experimental earth station operators are not subject to additional NTIA, FCC, or other approval processes as a result of the co-primary status afforded Federal earth station operations.[150] Boeing supports regulatory parity for Federal earth stations, mobile or fixed, communicating with non-government FSS spacecraft, but states that the Commission must ensure that Federal earth stations are not provided super-primary status or other preferential treatment with respect to their operations in commercial FSS spectrum.[151] For example, Boeing states that Federal systems using VMES should not be permitted to evade Commission requirements for data logging and other interference protection measures.[152]

77. *Discussion*. The NTIA petition remains pending and we do not address its merits here. However, we note that, should the Commission subsequently grant Federal earth stations primary protection status in the conventional Ku-band downlinks (11.7-12.2 GHz), Ku-band FSS licensees, including VMES licensees, would be required to provide such Federal terminals protection to the extent required by the rules. Further, should the Commission grant Federal earth stations primary status in the conventional Ku-band uplinks (14.0-14.5 GHz), Ku-band FSS licensees, including VMES licensees, the target satellite licensee, and adjacent FSS system licensees would need to coordinate with these Federal earth stations under the applicable sharing rules. Unless and until the Commission acts to grant Federal earth stations primary status, Federal use of VMES-like terminals not part of a blanket or individual

[147] For example, unlike VMES, AMSS is both a domestic and international service, with an international secondary allocation, and there are technical considerations concerning communications with airborne mobile terminals that are not applicable to VMES systems operating on land. Additionally, the U.S. Department of Justice ("DOJ") filed comments in the AMSS proceeding concerning national security and law enforcement issues that are inapplicable to VMES. *See* DOJ Comments, IB Docket No. 05-20 (filed July 5, 2005).

[148] NTIA Petition, RM-11341, *supra* note 28.

[149] *NPRM*, 22 FCC Rcd at 9662, ¶ 23 n.52.

[150] SIA Comments at 26-27; Raysat Comments at 17, Reply at 8-9; ViaSat Reply at 25. *See also* Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[151] Boeing Comments at ii, 34-35.

[152] Boeing Comments at 35.

Commission license would continue to operate on a non-interference basis with respect to the Ku-band FSS.[153]

C. Technical and Licensing Rules for VMES

78. Part 25 of the Commission's rules contains the requirements governing transmit-only and transmit/receive earth stations.[154] As noted above, in the *ESV Report and Order*, released in 2005, the Commission adopted Part 25 rules that authorized ESV – a service with mobile capabilities operating with FSS space stations – as an application of the FSS. In its Petition, General Dynamics urged the Commission to expand the Ku-band ESV regulatory framework set out in section 25.222 of the rules to cover VMES.[155] As discussed below, we amend Part 25 by adding a new section 25.226 with technical and licensing rules for VMES.

1. The ESV Rules

79. *Background.* Section 25.222 of the rules sets out the technical and licensing requirements for ESV as an application of the FSS in the Ku-band.[156] Section 25.222 includes three principal types of rules pertaining to interference protection of adjacent Ku-band FSS satellites: (1) off-axis E.I.R.P.-density envelopes; (2) antenna pointing accuracy requirements; and (3) a requirement to cease, or mute, transmission if the antenna strays from its intended satellite.[157] The rules are intended to control possible interference from ESV terminals to FSS satellites stationed near the intended satellite. Section 25.222 also includes other technical rules and ESV licensing requirements. In an *ESV Order on Reconsideration* adopted today, we amend and reorder the provisions of section 25.222, and we incorporate those changes into the rules we adopt for VMES.

80. In the *NPRM*, the Commission sought comment on adopting technical and licensing rules for VMES – which, like ESV, is a mobile application that would operate with FSS space stations – potentially modeled on the rules for Ku-band ESVs. The Commission sought comment on whether, given the differences between ESV and VMES operations, the ESV technical rules, as applied to VMES, would provide sufficient protection to the FSS.[158] Appendix B of the *NPRM* included appropriate portions of the Ku-band ESV rules as a starting point for analysis.[159]

81. As discussed above, most commenters concur that compliant conventional Ku-band VMES systems will be sufficiently similar in operation to Ku-band ESV systems to support adoption of the Ku-band ESV rules to VMES without weakening the Commission's two-degree spacing environment.[160] General Dynamics, for example, states that there are no differences in radio frequency

[153] *See* 47 C.F.R. § 2.103(a)(3).

[154] 47 C.F.R. Part 25.

[155] *NPRM*, 22 FCC Rcd at 9670, ¶ 45; Petition at 10-12.

[156] 47 C.F.R. § 25.222. ESV, unlike VMES, also operates in the C-band under rules set out in a separate section, 47 C.F.R. § 25.221.

[157] *NPRM*, 22 FCC Rcd at 9670-71, ¶ 47; *see also* 47 C.F.R. § 25.222(a).

[158] *NPRM*, 22 FCC Rcd at 9670, ¶ 47. The *NPRM* noted potential differences in ubiquity of use, vessel and vehicle accelerations, and antenna tracking system complexities. *NPRM*, 22 FCC Rcd at 9670, ¶ 46.

[159] *NPRM*, 22 FCC Rcd at 9689-9700, Appendix B.

[160] *See supra* Section III.A.2.

signals between ESV and VMES, although antenna pointing will be more difficult for VMES.[161] However, APTS/PBS asserts that, unlike air and sea vessels, land vehicles move quickly, turn sharply and may not meet pointing accuracy, with interference to incumbent Ku-band users.[162] Various parties urge modifications to the ESV rules. For example, SIA asserts that ESV off-axis power-density, pointing accuracy and shutoff requirements are potential VMES rule components, but that the VMES rules should consider flexibility with respect to the latter two if an applicant demonstrates compliance with the first requirement.[163]

82. *Discussion*. We find that Ku-band VMES systems operating within the technical and licensing rules we adopt today, modeled after the Ku-band ESV technical and licensing rules, will be able to operate successfully within the Commission's two-degree spacing environment as an application of the FSS. We discuss below the application of the Ku-band ESV technical and licensing rules to VMES, radio frequency radiation hazard requirements and equipment certification, and other technical matters raised in the *NPRM*.

2. Off-Axis E.I.R.P.-Density Mask as Applied to VMES

83. As discussed below, we adopt VMES off-axis E.I.R.P.-density masks, or envelopes, along the GSO plane and in directions other than the GSO plane. Mirroring the ESV off-axis E.I.R.P.-density masks, we adopt a 1.5 degree starting angle along the GSO plane and a 3.0 degree starting angle in other directions. We also adopt a 10 dB escalation between the off-axis angles of 85 and 180 degrees, as we have done for ESV and other Ku-band FSS services. Additionally, as the Commission has done for ESV, we permit operations in excess of the E.I.R.P.-density mask where the VMES and target satellite operators coordinate higher levels with adjacent satellite operators. Further, we require a VMES applicant seeking to use an aggregate dynamic-power system to make a showing of the measures it proposes to apply to demonstrate that it will be able to operate at one dB below the E.I.R.P.-density mask adopted for single terminals and fixed-power aggregate systems regulated under the 10*log(N) rule. Finally, we permit VMES licensees to use contention protocols similar to those used by VSAT networks and require licensees to certify that the protocols are reasonable. We discuss each of these rules in turn, below.

84. As an initial matter, we note that E.I.R.P.-density is the combination of the power-density supplied to the antenna and the gain of the antenna.[164] It is at its maximum in the direction of the antenna main beam. In directions other than the main beam, the E.I.R.P.-density is directly related to the antenna gain pattern. For example, the antenna gain in the vicinity of two degrees off-axis – or two degrees measured from the line connecting the focal point of the antenna to the orbital location of the target satellite – provides a measure of the potential of the earth station to cause interference to satellites located approximately two degrees away in orbit from the satellite with which the earth station is communicating.[165]

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[161] General Dynamics Comments at 22-24. *See also* NSMA Comments at 5 (asserting that, from uplink interference perspective, VMES essentially is identical to ESV and VSAT).

[162] APTS/PBS Comments at 2-3.

[163] SIA Comments at 13. *See also* Americom Comments at 4 (contending that it may be difficult in off-road conditions for VMES to maintain strict pointing accuracy, but rules should allow systems not meeting accuracy requirement to demonstrate no harmful interference by reducing power).

[164] *See, e.g.*, 47 C.F.R. § 2.1, Terms and Definitions.

[165] *See generally NPRM*, 22 FCC Rcd at 9669, ¶ 42.

a. VMES Mask in GSO Plane

85. *Background.* Section 25.222 of the Commission's rules establishes the off-axis E.I.R.P.-density requirements for ESVs transmitting in the Ku-band.[166] The *NPRM* invited comment on an off-axis E.I.R.P.-density envelope, or mask, for VMES that would be based on the off-axis E.I.R.P.-density mask for Ku-band ESVs.[167] In the GSO plane, the Commission proposed the following mask:

> The off-axis EIRP spectral density for co-polarized signals, emitted from the VMES 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:
>
> $15 - 25\log(\theta) - 10*\log(N)$ dBW/4kHz for $1.25° \le \theta \le 7.0°$
> $-6 - 10*\log(N)$ dBW/4kHz for $7.0° < \theta \le 9.2°$
> $18 - 25\log(\theta) - 10*\log(N)$ dBW/4kHz for $9.2° < \theta \le 48°$
> $-24 - 10*\log(N)$ dBW/4kHz for $48° < \theta \le 180°$
>
> where (θ) is the angle in degrees from the axis of the main lobe. For a VMES network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one. For a VMES network using code division multiple access (CDMA) technique, N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.[168]

86. SIA, ARINC, Raysat, NSMA, Boeing, MTN, ViaSat, Americom, and Hughes favor adopting an off-axis E.I.R.P.-density mask for VMES based on the mask for ESVs.[169] SIA also asks us to revise the proposed VMES mask to incorporate the changes to the VSAT envelope proposed in the *Sixth Report and Order and Third Further Notice*.[170] For example, SIA notes that the *Sixth Report and Order and Third Further Notice* adopted but stayed the effectiveness of a 10 dB escalation in antenna gain between 85 and 180 degrees, which SIA recommends applying also to VMES.[171] Americom, Hughes, ViaSat, Boeing, Raysat, and NSMA agree.[172]

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[166] 47 C.F.R. § 25.222(a)(1)(i), formerly 47 C.F.R. § 25.222(a)(1)-(4).

[167] *NPRM*, 22 FCC Rcd at 9696-97, Appendix B, proposed § 25.xxx(a)(1)-(4). The terms "envelope" and "mask" refer to the equations that limit the E.I.R.P. spectral density over a range of angles, "θ". These equations are an upper limit to the E.I.R.P. spectral density that the VMES antenna may transmit in any direction and, therefore, form an envelope around the VMES antenna constraining the maximum E.I.R.P. spectral density radiated.

[168] *NPRM*, 22 FCC Rcd at 9696-97, Appendix B, proposed § 25.xxx(a)(1).

[169] SIA Comments at 13; ARINC Comments at iii, 1; Raysat Comments at 8; NSMA Comments at 5; Boeing Comments at 21; MTN Comments at 4; ViaSat Comments at 16; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[170] *Sixth Report and Order and Third Further Notice*, 20 FCC Rcd 5593.

[171] SIA Comments at 13-14. *See also Sixth Report and Order and Third Further Notice*, 20 FCC Rcd at 5656, Appendix C, Part IV (proposing off-axis power-density envelopes for Ku-band digital earth stations, including 10 dB escalation).

[172] Americom Comments at 1 (supporting SIA Comments); Hughes Reply at 1 (endorsing SIA Comments); ViaSat Reply at 18 (agreeing with SIA); Boeing Comments at 21 (stating that escalation, if adopted, should be equally applicable to all FSS earth stations on mobile platforms); Raysat Comments at 8-9 (stating that, if adopted, should

(continued....)

87. *Discussion*. Recent changes to Part 25 inform our decision today. In the *Eighth Report and Order*, the Commission put into effect the new 1.5 degree E.I.R.P.-density envelope starting angle and the 10 dB escalation between 85 and 180 degrees ("back lobe escalation") it had adopted in the *Sixth Report and Order and Third Further Notice* but stayed until resolution of the issues in the notice portion of that proceeding.[173] In the *ESV Order on Reconsideration*, we likewise modify section 25.222 of the rules to incorporate the starting angle and the back lobe escalation.[174]

88. We concur that it makes sense to adopt the ESV E.I.R.P.-density mask for VMES and to incorporate changes adopted for VSATs and ESVs into the VMES mask. As NSMA observes, the ESV mask is equivalent to the envelope for a routinely licensed VSAT antenna compliant with section 25.209 antenna performance standards and operating at maximum permissible input power.[175] Applying that mask to VMES will ensure that the operations of VMES antennas do not cause unacceptable interference to adjacent satellite systems under the Commission's two-degree Ku-band satellite spacing policy.

89. Thus, we adopt section 25.226(a)(1)(A) as the VMES mask, including the 10 dB escalation between 85 and 180 degrees. Additionally, we adopt 1.5 degrees as the starting angle for the VMES off-axis E.I.R.P.-density mask along the GSO. We discuss below the off-axis E.I.R.P.-density mask starting angle and envelope in directions away from the GSO plane.

90. Additionally, we note that, in the Part 25 *Eighth Report and Order* adopted a new definition for the reference angle, theta (θ), associated with the off-axis E.I.R.P.-density mask.[176] In the *ESV Order on Reconsideration* we also adopt the new definition for the reference angle.[177] This change in definition shifts the reference axis of the E.I.R.P.-density mask from "the main axis of the antenna" to "the line from the focal point of the antenna to the target satellite."[178] We adopt this new definition of the reference axis for VMES, to be consistent with the off-axis E.I.R.P.-density rules for Ku-band ESV and VSAT transmitters. Therefore, we adopt the following mask for the GSO plane:

> The off-axis EIRP spectral-density emitted from the VMES, in the plane of the geostationary satellite orbit (GSO) as it appears at the particular earth station location, shall not exceed the following values:

(...continued from previous page)
include in VMES mask); NSMA Comments at 6 (stating that, for regulatory parity, it may be appropriate to extend Part 25 streamlining rule changes to VMES).

[173] *Eighth Report and Order*, 23 FCC Rcd at 15110, ¶ 20, 15156-57, Appendix B, § 25.218, Off-Axis EIRP Envelopes for FSS Earth Station Operations; 47 C.F.R. § 25.218(e)(1), (f)(1).

[174] *ESV Order on Reconsideration*, Appendix B, § 25.222(a)(1)(i)(A).

[175] NSMA Comments at 5; *see* 47 C.F.R. § 25.209. The E.I.R.P.-density envelope for Ku-band ESV transmitters is consistent with the off-axis E.I.R.P.-density limits for routinely-licensed Ku-band VSAT transmitters for co-polarized signals transmitted toward the GSO. *See ESV Report and Order*, 20 FCC Rcd at 716, ¶ 99. The off-axis E.I.R.P.-density limits for Ku-band ESV transmitters are set out in 47 C.F.R. § 25.222(a)(1)(i)(A)-(D), formerly 47 C.F.R. § 25.222(a)(1)-(4).

[176] *Eighth Report and Order*, 23 FCC Rcd at 15112-13, ¶ 24 n.90.

[177] *ESV Order on Reconsideration*, ¶ 22. *See also* 47 C.F.R. **§** 25.222(a)(1)(i). We found that this revision would make the ESV rules more logically consistent with protecting adjacent FSS satellites from interference. *ESV Order on Reconsideration*, ¶ 22.

[178] *Eighth Report and Order*, 23 FCC Rcd at 15113, ¶ 24 n.90; *ESV Order on Reconsideration*, ¶ 22. *See also* 47 C.F.R. §§ 25.218(e)(1), (f)(1), 25.222(a)(1)(i).

15 - 10log(N) - 25logθ	dBW/4 kHz	for	$1.5° \leq \theta \leq 7°$
-6 -10log(N)	dBW/4 kHz	for	$7° < \theta \leq 9.2°$
18 -10log(N) - 25logθ	dBW/4 kHz	for	$9.2° < \theta \leq 48°$
-24 -10log(N)	dBW/4 kHz	for	$48° < \theta \leq 85°$
-14 -10log(N)	dBW/4 kHz	for	$85° < \theta \leq 180°$

where theta (θ) is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital location of the target satellite. For VMES networks using frequency division multiple access (FDMA) or time division multiple access (TDMA) techniques, N is equal to one. For VMES networks using multiple co-frequency transmitters that have the same EIRP, N is the maximum expected number of co-frequency simultaneously transmitting VMES earth stations in the same satellite receiving beam. For the purpose of this subsection, the peak EIRP of an individual sidelobe shall not exceed the envelope defined above for θ between 1.5° and 7.0°. For θ greater than 7.0°, the envelope shall be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.[179]

The VMES mask we adopt here mirrors the mask the Commission adopted for conventional Ku-band digital earth station operations and for Ku-band ESV.[180]

b. VMES Mask in Directions Other Than GSO Plane

91. *Background.* The E.I.R.P.-density mask in directions other than the GSO plane is designed to protect non-geostationary orbit ("NGSO") FSS systems, which, although not yet implemented in the Ku-band, are a permitted use.[181] In the *NPRM*, the Commission proposed the following mask in directions other than the GSO plane:

> In all other directions, the off-axis EIRP spectral density for co-polarized signals emitted from the VMES shall not exceed the following values:
>
18 – 25log(θ) – 10*log(N)	dBW/4kHz	for	$1.25° \leq \theta \leq 48.0°$
–24 – 10*log(N)	dBW/4kHz	for	$48.0° < \theta \leq 180°$
>
> where θ and N are defined as set forth in paragraph (a)(1) of this section.[182]

The Commission asked whether it should adopt variations of the E.I.R.P.-density mask rule in directions other than the GSO plane: first, it asked whether the VMES rule should start the off-axis E.I.R.P.-density envelope at 3.0 degrees from the antenna main lobe, as adopted but stayed for VSATs in the *Sixth Report*

[179] Appendix B, *infra*, at § 25.226(a)(1)(i)(A). *See also* Appendix B, § 25.226(a)(1)(i)(C)-(D).

[180] *Eighth Report and Order*, 23 FCC Rcd at 15156-57, Appendix B, § 25.218(f); *ESV Order on Reconsideration*, Appendix B, § 25.222(a).

[181] *See Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, ET Docket No. 98-206, First Report and Order and Further Notice of Proposed Rule Making, FCC 00-418, 16 FCC Rcd 4096 (2000).

[182] *NPRM*, 22 FCC Rcd at 9697, Appendix B, proposed § 25.xxx(a)(2).

and Order and Third Further Notice, rather than at the 1.25 degree start angle then in the ESV rules;[183] and, second, it sought comment on relaxing the off-axis E.I.R.P.-density envelope.[184]

92. Boeing and SIA support starting the mask at 3.0 degrees off-axis.[185] ViaSat asserts that existing low-profile antennas may require a larger starting angle than 3.0 degrees and proposes 7.0 degrees.[186] ViaSat asserts that increasing the allowable off-axis E.I.R.P.-density outside the GSO plane would promote the use of small and low-profile antennas.[187] ViaSat observes that reducing the size of the antenna in height axis necessarily will increase the beam width in the elevation (or vertical) plane.[188] Raysat states that low-profile antennas – as opposed to larger, circular parabolic antennas – transmit at higher off-axis E.I.R.P.-density levels in directions other than the GSO plane.[189] Raysat, like ViaSat, urges greater (but unspecified) off-axis E.I.R.P.-density limits in directions other than the GSO plane to promote deployment of low-profile VMES terminals.[190] Raysat and ViaSat state that co-primary Ku-band NGSO systems may never be deployed.[191] SIA urges against relaxing E.I.R.P.-density requirements in directions other than the GSO plane, beyond the 3.0 degree off-axis start angle, stating that such relaxations preemptively could impact future co-primary FSS NGSO systems.[192] General Dynamics contends that the only significant reason for increasing permitted E.I.R.P.-density values to and from VMES terminals would be to permit a significant reduction in the size of the VMES antennas, recommends against permitting E.I.R.P.-density levels in any direction that are higher than the level for routinely-authorized FSS Ku-band transmissions, and urges non-routine processing rather than general rule changes that would impose obligations on all existing and future GSO and NGSO FSS Ku-band operations.[193]

93. *Discussion*. In the *Sixth Report and Order and Third Further Notice*, the Commission adopted but stayed the effectiveness of an antenna gain starting angle for Ku-band VSATs of 3.0 degrees in directions other than the GSO.[194] In the *Eighth Report and Order* and the *ESV Order on Reconsideration*, the Commission implemented 3.0 degrees as the starting angle in directions other than

[183] *NPRM*, 22 FCC Rcd at 9679-80, ¶ 69. *See also* 47 C.F.R. § 25.222(a)(2) (2007) (ESV 1.25° start angle in directions other than GSO); *Sixth Report and Order and Third Further Notice*, 20 FCC Rcd at 5610, ¶¶ 37-38 (revising start of antenna gain pattern envelope to 3.0 degrees off-axis outside GSO orbital plane for earth stations operating in conventional Ku-band to facilitate development of more advanced elliptical antennas without creating additional interference issues).

[184] *NPRM*, 22 FCC Rcd at 9679-80, ¶ 69.

[185] Boeing Comments at ii, 23; SIA Comments at 20.

[186] ViaSat Reply at 19.

[187] ViaSat Reply at 18-19.

[188] ViaSat Reply at 18.

[189] Raysat Comments at 15.

[190] Raysat Comments at 15.

[191] Raysat Reply at 8; ViaSat Comments at 20.

[192] SIA Comments at 20-21.

[193] General Dynamics Comments 43-44.

[194] *Sixth Report and Order and Third Further Notice*, 22 FCC Rcd at 5614, ¶ 49.

the GSO plane for, respectively, Ku-band VSATs and ESVs.[195] We adopt, for VMES, a 3.0 degree off-axis starting angle – measured from the line of the focal point of the antenna to the target satellite – in directions other than the GSO plane.[196] We find this consistent with the Commission's approach toward VSATs and ESVs.

94. We agree with SIA that we do not have a sufficient record in this proceeding to adopt other relaxations of the starting angle in directions other than the GSO plane.[197] A chief objective in this proceeding is to ensure that VMES can operate in the Ku-band FSS frequencies without causing interference to other co-primary FSS operations. VMES will be a viable mobile application of the FSS only if it can operate without causing unacceptable interference to FSS satellite systems also operating on a primary basis. Although we do not adopt general rules further relaxing the starting angle in directions other than the GSO plane, it may be possible for individual applicants to demonstrate that their systems merit a waiver of the technical rules.[198]

95. In the *Eighth Report and Order*, the Commission also adopted a 10 dB back lobe escalation in directions other than the GSO plane.[199] The *ESV Order on Reconsideration* adopts a similar 10 dB back lobe escalation.[200] SIA and Raysat support adjusting the VMES mask to take into account the changes the Commission adopted but stayed in the *Sixth Report and Order and Third Further Notice* – and that the Commission subsequently implemented in the *Eighth Report and Order* – which include the 10 dB escalation between 85 and 180 degrees.[201] We adopt the 10 dB back lobe escalation in directions other than the GSO plane. Therefore, we adopt the following mask in directions other than the GSO plane:

> In all directions other than along the GSO, the off-axis EIRP spectral-density for co-polarized signals emitted from the VMES shall not exceed the following values:
>
> | | | | |
> |---|---|---|---|
> | $18 - 10\log(N) - 25\log\theta$ | dBW/4 kHz | for | $3.0° \le \theta \le 48°$ |
> | $-24 - 10\log(N)$ | dBW/4 kHz | for | $48° < \theta \le 85°$ |
> | $-14 - 10\log(N)$ | dBW/4kHz | for | $85° < \theta \le 180°$ |
>
> where θ and N are defined in (a)(1)(A)(i). This off-axis EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the orbital location of the target satellite with the exception of the plane of the GSO as defined in

[195] *Eighth Report and Order*, 23 FCC Rcd at 15110, ¶ 20; *ESV Order on Reconsideration*, Appendix B, § 25.222(a)(1)(i)(B).

[196] Therefore, we do not adopt ViaSat's proposal for a 7° starting angle. We find that the 3° start angle adopted for VMES, like that adopted for VSATs, appropriately balances a goal of facilitating more advanced elliptical antennas with the objective of preventing additional harmful interference.

[197] *See* SIA Reply at 9 (stating that the showings and claims made in support of unspecified relaxations of the limits that preemptively could impact co-primary FSS applications are not compelling).

[198] *See, e.g.*, SIA Reply at 9 (stating that it may be possible for VMES applicants to make specific showings regarding increased allowances that could lead to authorization of antennas of the type loosely described by ViaSat and Raysat on a non-interfering basis with regard to future users of the co-primary NGSO allocations in the Ku-band FSS frequencies). *See also* General Dynamics Comments at 43-44 (urging non-routine processing).

[199] *Eighth Report and Order*, 23 FCC Rcd at 15156, 15157, Appendix B, § 25.218(e)(2), (f)(2).

[200] *ESV Order on Reconsideration*, Appendix B, § 25.222(a)(1)(i)(B).

[201] SIA Comments at 20-21; Raysat Comments at 8.

paragraph (a)(1)(A)(i) of this section. For the purpose of this subsection, the envelope shall be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.[202]

c. Operations in Excess of E.I.R.P-Density Mask

96. *Background.* In the *ESV Order on Reconsideration*, we adopt new rule provisions for ESVs that operate at off-axis E.I.R.P-densities in excess of the limits in the Commission's rules. Of particular relevance to domestic U.S. VMES operations, we allow ESV licensees to operate domestically at higher off-axis power-density levels where ESV operators are able to coordinate higher off-axis power-density levels with adjacent satellite operators.[203] We conclude that allowing U.S.-licensed ESVs to transmit at higher off-axis E.I.R.P.-density levels based on compliance with coordination agreements between the target satellite and adjacent satellite operators will foster greater operational flexibility without causing harmful interference to adjacent satellites.[204]

97. *Discussion.* As discussed above, we are modeling VMES off-axis power-density requirements on the ESV off-axis E.I.R.P.-density rules, including certain changes to the rules adopted in the *ESV Order on Reconsideration*. Therefore, we will allow U.S.-licensed VMES operators to transmit at off-axis power-density levels that exceed the off-axis E.I.R.P.-density limits as long as they comply with the certification and cessation of emission requirements set out in section 25.226(a)(2) and (b)(2) of the VMES rules. We note that, although the Commission did not seek specific comment in the *NPRM* on operating at off-axis power-densities in excess of the E.I.R.P.-density mask, it did seek comment on following the ESV technical rules generally.[205] The rules we discuss in this section are comparable to the rules for ESVs we adopt in the *ESV Order on Reconsideration*.[206]

98. We find that adoption of these rules will serve the public interest by providing greater operational flexibility while ensuring that adjacent satellite operators are protected from harmful interference. Target satellite operators already may have coordinated higher off-axis power-density levels for other, non-VMES, earth stations. Thus, allowing VMES to operate at the agreed upon off-axis power-density levels should not cause harmful interference to adjacent satellites. If the target satellite operator is unable to complete a coordination agreement with future adjacent satellite operators located within six degrees of the target satellite operator, we require the VMES operator to operate at off-axis power-density levels in accordance with the off-axis E.I.R.P.-density limits set out in the VMES rules.[207] Applicants seeking to operate at higher off-axis power-density levels may not access satellites pursuant to ALSAT

[202] Appendix B, § 25.226(a)(1)(i)(b). *See also* Appendix B, § 25.226(a)(1)(i)(C)-(D).

[203] *ESV Order on Reconsideration*, ¶¶ 8-16. The *ESV Order on Reconsideration* also permits higher off-axis power-density levels in areas where 2° spacing is not common, such as in Asia and Europe. *ESV Order on Reconsideration*, ¶¶ 8-16.

[204] *ESV Order on Reconsideration*, ¶ 11. *See also Fifth Report and Order*, 20 FCC Rcd at 5092, ¶ 65 (in streamlining Part 25 rules, the Commission stated that "…[if an] earth station operator can successfully coordinate its operations with an [off-axis E.I.R.P.]-density greater than [a Commission-imposed limit], then we see no reason to preclude the earth station from operating at that [off-axis] power-density level with the particular target satellite that has been coordinated.").

[205] *See, e.g., NPRM*, 22 FCC Rcd at 9670-71, ¶¶ 47-48.

[206] *See* 47 C.F.R. § 25.222(a)(2), (b)(2).

[207] *See* 47 C.F.R. § 25.226(a).

authority – authority to use "all U.S.-licensed space stations" – and therefore, must specifically list in their applications all of the satellites that they plan to access at higher off-axis power-density levels.[208] We observe that our decision to allow VMES operators greater flexibility to transmit at higher off-axis power-density levels does not alter the obligation of VMES operators to comply with section 25.204(j), to protect SRS operators.

99. We require VMES applicants seeking to operate at higher E.I.R.P.-density levels to file the following certifications: (1) a statement from the target satellite operator acknowledging that the proposed VMES operation has the potential to create interference to adjacent satellite networks that may be unacceptable; (2) a statement from the target satellite operator that the VMES operations will not violate existing coordination agreements with adjacent satellites within six degrees longitude of the target satellite; and (3) a statement from the target satellite operator that it will include the off-axis power-density levels of the VMES applicant in all future coordination agreements.[209] These certifications, obtained from the target satellite operator, will be based upon coordination agreements that exist between the target satellite operator and potentially affected operators of satellites within six degrees longitude of the target satellite. The certification requirement ensures that the higher off-axis power-density levels will not cause harmful interference to adjacent satellite operations but precludes the need for the VMES applicant to file entire coordination agreements with the Commission. This comports with the Ku-band ESV rules.[210]

100. We envision that the VMES applicant, in its effort to operate at higher off-axis power-density levels and obtain certifications from the target satellite operator, will provide the target satellite operator with information about the VMES operator's proposed operations. This information will allow the target satellite operator to determine if the VMES operator's proposed higher off-axis power-density levels fall within the parameters of the coordination agreements that exist between the target satellite operator and satellites operating within six degrees longitude of the target satellite. This information may take a number of forms, but must be sufficient for the target satellite operator to determine the off-axis power-density values of the relevant VMES transmitters. If the VMES operator's proposed power-density levels exceed the parameters of the coordination agreements, then we expect that the target satellite operator either will negotiate with the operators of neighboring satellites to modify the coordination agreements to include the VMES operational parameters or inform the VMES operator that it cannot operate pursuant to the proposed parameters given to the target satellite operator.

101. Because the VMES applicant may not have access to the details of the target satellite operator's coordination agreements, we will require the VMES applicant, once authorized to operate, to remain within the power-density values that it gives to the target satellite operator. We also require the VMES licensee to cease transmission within 100 milliseconds if it exceeds the off-axis power-density values it has given to the target satellite operator.[211] If the VMES licensee were to exceed the power-

[208] For more on ALSAT, *see Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States*, IB Docket No. 96-111, First Reconsideration Order, FCC 99-325, 15 FCC Rcd 7207 (1999) ("*DISCO II First Reconsideration Order*"). *See also infra* Section III.C.5.

[209] *See infra* Appendix B, Final Rules, § 25.226(b)(2)(i)-(iii).

[210] *See* 47 C.F.R. § 25.222(b)(2).

[211] Because VMES terminals operating within the VMES off-axis E.I.R.P.-density limits and antenna pointing rules must cease emissions within 100 milliseconds, we require VMES terminals that operate at power levels that exceed the off-axis E.I.R.P.-density limits also to cease emissions within 100 milliseconds. *See infra* Appendix B, §§ 25.226(a)(2)(iii), (b)(2)(iv).

density values given to the target satellite operator, there is the potential that the VMES licensee would be in violation of the target satellite operator's coordination agreements and possibly could cause harmful interference to neighboring satellites. Thus, if a VMES transmitter exceeds the off-axis power-density values given to the target satellite operator – whether due to an excessive antenna pointing error or some other factor – the VMES transmitter must cease transmitting until it again is in compliance with the relevant coordination agreement. This comports with the Ku-band ESV rules.[212]

d. Aggregate Power-Density Limits and the 10*log(N) Rule

102. As discussed below, we adopt a new aggregate power-density rule for VMES systems that use co-frequency dynamic-power transmissions. In doing so, we require VMES applicants that seek to use aggregate dynamic power-densities to demonstrate that their operations will meet the VMES E.I.R.P.-density mask minus one dB. There currently are no aggregate power-density rules for co-frequency dynamic-power ESV transmissions similar to what we adopt today for VMES.

103. *Background.* The Ku-band ESV rules permit several ESV terminals to transmit simultaneously on the same frequency in a single satellite receive beam, so long as the ESV operator uses the 10*log(N) rule to reduce each of the individual earth station emissions by a fixed amount, such that the aggregate emission from all co-frequency transmitters does not exceed the E.I.R.P.-density limits established for a single ESV terminal.[213]

104. The rules the Commission adopted in the *ESV Report and Order*, including the off-axis E.I.R.P.-density limits, were based on single channel per carrier ("SCPC") ESV systems that had operated pursuant to STA for several years.[214] In an SCPC system, each ESV transmitter could be expected to emit the maximum level of E.I.R.P. spectral density. As a result, the rules limiting the E.I.R.P. spectral density towards adjacent satellites are applied to each of the ESV transmitters within the ESV system and each of the transmitters operates on a different channel or frequency.

105. In addition to using SCPC, VSATs and ESVs may make use of a number of other multiple access techniques. Included in these techniques are those, such as Code Division Multiple Access ("CDMA"), which permit several transmitters to transmit simultaneously on the same channel. When multiple transmitters simultaneously use the same channel to transmit to the same satellite it is the sum of the E.I.R.P. spectral density from all of the transmitters that forms the potential interference source to adjacent satellites. To keep within the two-degree spacing guidelines, the sum or "aggregate" E.I.R.P. spectral density should be no greater than that produced by a single SCPC transmitter operating at the maximum permitted E.I.R.P. spectral density.

106. In the *Sixth Report and Order and Third Further Notice*, the Commission modified the Ku-band E.I.R.P.-density envelope it had adopted in the *ESV Report and Order* to accommodate co-frequency CDMA ESV systems by adding the 10*log(N) term to section 25.222.[215] As a result, section 25.222 of the rules provides that, for an ESV network using frequency division multiple access ("FDMA") or time division multiple access technique, "N" is equal to one, and, for an ESV network

[212] *See* 47 C.F.R. § 25.222(a)(2).

[213] 47 C.F.R. § 25.222(a)(1)(i)(A).

[214] *See NPRM*, 22 FCC Rcd at 9674, ¶ 57.

[215] *See NPRM*, 22 FCC Rcd at 9674-75, ¶ 57; *Sixth Report and Order and Third Further Notice*, 20 FCC Rcd at ¶ 63 n.177 (incorporating 10*log(N) into § 25.222).

using CDMA technique, "N" is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.[216]

107. Thus, the 10*log(N) rule for Ku-band ESVs requires CDMA systems to reduce the E.I.R.P.-density of co-frequency earth stations simultaneously transmitting to the same satellite, in order to ensure that the overall system meets, in the aggregate, the E.I.R.P-density limits established for a single ESV terminal.[217] If each of the CDMA transmitters has the same E.I.R.P.-density, each transmitter will radiate the maximum E.I.R.P.-density reduced by a factor of 10*log(N), in dB, where, as noted, "N" represents the peak number of co-frequency CDMA earth stations simultaneously transmitting in the same satellite receiving beam.[218]

108. In the proceeding leading up to the *NPRM*, ViaSat and Qualcomm urged the Commission to change the 10*log(N) term, as applied to VMES.[219] They stated that 10*log(N) presupposes a VMES network will employ homogeneous transmitters, prevents variable data rates (and thus variable power-density systems) from being accommodated unless the system operates with a significant loss of capacity, and favors other techniques such as FDMA.[220]

109. In the *NPRM*, the Commission sought comment on proposals to revise the Ku-band ESV power-density limits, as applied to VMES, to accommodate VMES networks employing aggregate system power control.[221] As explained above, certain multiple access techniques permit multiple transmitters, within the same system, to operate simultaneously on the same channel and, in this situation, it is the aggregate E.I.R.P. spectral power density from all of the co-frequency transmitters that forms the potential interference source to adjacent satellites. The 10*log(N) rule applies when all of the co-frequency transmitters operate at the same E.I.R.P. spectral power density. The maximum data rate a transmitter is capable of transmitting depends on the maximum E.I.R.P. it can transmit. By using the same E.I.R.P. spectral power density, each transmitter within the system has the same maximum data rate.

110. An alternative system implementation would be to have a central control and monitoring station allow each transmitter to use a different data rate depending on the instantaneous requirements at each transmitter. In a VMES system where different terminals required varying data rates, the overall data flow from all of the co-frequency terminals could be optimized by dynamically allocating to each terminal a different E.I.R.P. spectral density depending on the amount of data that needed to be transmitted from that terminal. However, to avoid interference to adjacent satellites, the central control and monitoring station would need to maintain control of all of the co-frequency transmitters to ensure that the sum of the dynamically changing E.I.R.P. spectral density did not exceed the E.I.R.P. spectral density from a single VSAT terminal operating at the maximum E.I.R.P. spectral density limit.

111. Because the time a control signal takes to go from an earth station through a GSO satellite to another earth terminal is a significant portion of a second, the central control and monitoring station would, at times, have to rely on complicated techniques to ensure that the two-degree spacing

[216] 47 C.F.R. § 25.222(a)(1).

[217] *See* 47 C.F.R. §§ 25.222(a)(1)(i)(A) (applicable to Ku-band ESV CDMA systems). *See also* 47 C.F.R. §§ 25.134(g), 25.218 (applicable to VSAT-like CDMA systems).

[218] *See* 47 C.F.R. § 25.222(a)(1).

[219] *NPRM*, 22 FCC Rcd at 9675, ¶ 57; Comments of ViaSat, RM-11336, at 7 (filed Aug. 21, 2006) ("ViaSat RM-11336 Comments"); Qualcomm RM-11336 Comments at 4.

[220] *NPRM*, 22 FCC Rcd at 9675, ¶ 57; ViaSat RM-11336 Comments at 7; Qualcomm RM-11336 Comments at 4.

[221] *NPRM*, 22 FCC Rcd at 9674-75, ¶¶ 56-57.

criteria were met for these dynamic, variable power-density systems. The Commission asked commenters to suggest specific changes to the rules that would allow the efficient use of variable power-density spread spectrum systems while still ensuring that the systems meet the E.I.R.P.-density mask in the aggregate.[222]

112. SIA states that it would be desirable to accommodate variable-power spread spectrum VMES systems provided the aggregate off-axis E.I.R.P.-density of all such terminals does not exceed the off-axis E.I.R.P.-density of a compliant terminal in a system where "N" equals one.[223] SIA supports a rule requiring VMES applicants to demonstrate that particular measures, including but not limited to 10*log(N), could satisfy the off-axis E.I.R.P.-density limits required to ensure protection of adjacent satellite networks.[224]

113. Raysat, Boeing, and ViaSat argue that 10*log(N) is unnecessarily restrictive, potentially limits VMES technologies for spread spectrum systems, and simplistically assumes that a VMES network will be made up of homogeneous co-frequency transmitters.[225] Raysat suggests it may be desirable to accommodate systems with multiple, co-frequency VMES terminals having differing E.I.R.P.-density levels that comply, in the aggregate, with the mask for compliant SCPC terminals.[226] Boeing supports using the section 25.222(a) power limits as aggregate limits.[227] ViaSat states the rules should allow VMES licensees to determine whether a network control center manages off-axis E.I.R.P. on a network-wide or individual terminal basis, and proposes a formula to replace 10*log(N) for individual variable-power VMES terminals.[228]

114. General Dynamics urges that any change to 10*log(N) ensure that the aggregate power in a CDMA network not exceed the power of an individual FDMA transmitter operating in the maximum off-axis E.I.R.P.-density envelope.[229] General Dynamics states that two satellite access techniques allow earth station antennas simultaneous access to, and use of, the same frequencies. These are, according to General Dynamics: (1) CDMA systems, where each transmission occupies the same spectrum simultaneously but is separated from other co-frequency transmissions through the use of a distinct spreading code; and (2) uplink-cancellation systems that use a sample of the uplink signal to "cancel" the uplink effects of an earth station transmission as seen in the single downlink from overlapping earth stations.[230] For CDMA systems, General Dynamics states that "N" properly should be the maximum

[222] *NPRM*, 22 FCC Rcd at 9675, ¶ 57.

[223] SIA Comments at 16-17.

[224] SIA Comments at 16-17.

[225] Raysat Comments at 11-12; Boeing Comments at 22-23; ViaSat Comments at 16-19.

[226] *See, e.g.*, Raysat Comments at 12 (notes that the VMES applicant would have the burden of demonstrating that its system would comply with an aggregate off-axis E.I.R.P.-density envelope);

[227] Boeing Comments at ii, 22-23.

[228] ViaSat Comments at 16, 19. ViaSat observes that 10*log(N) presents operational and efficiency considerations for licensees when, for example, terminals at differing locations require varying power levels to close the link with the satellite. ViaSat Comments at 18-19, 18 n. 24 and Attachment 1, Figures 4-5. ViaSat asks the Commission to revise 10*log(N) to define the aggregate off-axis E.I.R.P.-density of a non-homogeneous network of "N" technically different VMES terminals, each operating at different parameters, as the sum of the individual VMES off-axis E.I.R.P.-densities. The aggregate off-axis E.I.R.P.-density of the network as calculated by ViaSat's formula would not be permitted to exceed the proposed off-axis E.I.R.P.-density mask. ViaSat Comments at 19.

[229] General Dynamics Comments at 37.

[230] General Dynamics Comments at 36.

number of earth stations having the capability to transmit simultaneously, but suggests that "N" might be lower than the total number of licensed earth stations if a VMES system were to limit the possible number of simultaneously-transmitting stations to some smaller number, "M."[231] General Dynamics asserts, however, that without a rigorous test and validation methodology there could be no assurance that more than "M" simultaneous transmissions might not occur and thus cause the licensee to exceed the off-axis E.I.R.P.-density mask.[232]

115. *Discussion*. There are considerable differences in complexity between a VMES system using fixed-power transmitters (as regulated under the 10*log(N) rule) and a dynamic E.I.R.P.-density VMES system.[233] As ViaSat observes, an aggregate dynamic-power system requires the applicable network control and monitoring center to manipulate a relatively large set of factors, with the inherent time delays in relaying commands and monitoring the various VMES terminals through a GSO satellite.[234] Additionally, while the E.I.R.P.-density limit for SCPC and fixed-rate aggregate VMES systems is oriented around the main-beam direction of the VMES antenna, dynamic CDMA VMES systems would need to be subject to an aggregate E.I.R.P. envelope limit. Thus, the rules could not specify, as they do now, the power limit from any particular VMES antenna.[235]

116. Moreover, the current rules for VSAT and ESV earth stations do not include specific provisions for variable power-density systems. VMES is a new service that does not yet have as extensive a track record as VSAT and ESV earth stations in meeting the two-degree spacing interference avoidance requirements of the Ku-band FSS. Therefore, we conclude that a one-dB reduction below the VMES mask is a prerequisite condition for VMES systems employing dynamic power-density systems. We find that this margin is an effective mechanism for controlling aggregate off-axis E.I.R.P.-density and for ensuring that such operations – despite their complexities – will not exceed the power-density envelopes established for VSAT, ESV and VMES networks.

117. Therefore, we require a VMES applicant that seeks to use an aggregate dynamic power-density system to make a showing of the measures it proposes to apply to demonstrate that its system will be able to operate at one dB below the E.I.R.P.-density mask adopted for single terminals or fixed-power aggregate system transmitters regulated under the 10*log(N) rule.[236] The International Bureau will place

[231] General Dynamics Comments at 37. General Dynamics states that, in the case of the uplink-cancellation technique, "N" would be 2. *Id.*

[232] General Dynamics Comments at 38. General Dynamics concedes that confirmation testing of such a network scheme might be difficult. *Id*. at 38.

[233] The time lags inherent in a dynamic system require the control center to use predictive algorithms to estimate the power-density on the GSO orbit and manipulate the data rates and other factors to ensure that all co-frequency operations remain at or below the power-density envelope for a single VSAT terminal. This will result in dynamic systems that are far more complex than those electing to use simple fixed-characteristic transmitters.

[234] ViaSat Comments at 17-18 (listing factors including satellite performance contours, range to the satellite, rain and atmospheric attenuation, antenna pointing, transmitted data rates, chip rate of the spreading code, and number of simultaneous transmitters).

[235] That is, although the SCPC E.I.R.P.-density envelope is topocentric in nature, a CDMA E.I.R.P.-density envelope would need to be geocentric because it would represent the aggregate E.I.R.P.-density, at the satellite, from a number of different CDMA transmitters scattered over the surface of the Earth. The E.I.R.P.-density at the adjacent satellites, not the actual radiated E.I.R.P.-density from any specific antenna, would be the relevant limit.

[236] The Commission has conditioned certain FSS Ku-band mobile licenses by requiring the licensee to reduce its off-axis E.I.R.P.-density by at least one dB below the applicable regulatory envelope. *See, e.g., ARINC Incorporated, Application for Blanket Authority for Operation of Up to One Thousand Technically Identical Ku-band Transmit/Receive Airborne Mobile Stations Aboard Aircraft Operating in the United States and Adjacent Waters*, (continued....)

this showing on Public Notice along with the application in order to obtain industry comment. Dynamic power-density system applicants and licensees are precluded from seeking ALSAT authority,[237] and must file a report one year following license issuance demonstrating that the system has met the power-density requirements.[238] We conclude that these measures are prudent steps to protect other FSS systems from possible harmful interference.

118. We recognize that a minus one-dB requirement for dynamic power-density systems will impact the capacity and robustness of the relevant VMES networks, by limiting the flexibility of such dynamic-power systems to operate up to the mask for single carrier and fixed- power systems. Therefore, we will allow a VMES applicant employing a dynamic-power system and its target satellite licensee to coordinate higher power levels with adjacent satellite operators and to file a certification that the target satellite operator and adjacent satellite operators up to six degrees away from the target satellite have completed a coordination agreement to this effect.[239] If the VMES applicant and target satellite licensee cannot reach a coordination agreement, then the VMES licensee employing dynamic power must operate at an E.I.R.P.-density envelope that is one dB below the envelope adopted for single carrier and fixed-power systems. A VMES applicant that coordinates higher power levels (and in effect operates without regard to the minus one-dB margin) and files a certification to take advantage of this exception to the minus one-dB requirement also must specify the particular satellites with which its system will operate.[240]

119. Finally, we agree that, given the E.I.R.P.-density mask, and the antenna limitation and emission cessation requirements discussed below, a one-dB reduction of the E.I.R.P.-density mask for

(...continued from previous page)
Order and Authorization, 20 FCC Rcd 7553, 7573, ¶ 58(k) (Int'l Bur. & OET 2005) (conditioning authorization to limit probability of exceeding -1 dB margin for aggregate off-axis E.I.R.P.-density to within 0.001%); The Boeing Company, Radio Station Authorization, E000723, File No. SES-MFS-20050701-00853 (granted Dec. 20, 2005), at Special Provision 5411 (conditioning authorization to require aggregate off-axis E.I.R.P. spectral density for co-polarized signals, emitted from all simultaneously transmitting aircraft earth station antennas in the GSO plane, not to exceed 1 dB margin below specified E.I.R.P.-density envelope); *ViaSat, Inc., Application for Blanket Authority for Operation of 1,000 Technically Identical Ku-band Aircraft Earth Stations in the United States and Over Territorial Waters*, Order and Authorization, 22 FCC Rcd 19964, 19974, ¶ 28(l) (Int'l Bur. & OET 2007) (conditioning authorization to reduce aggregate off-axis radiation from AES terminals to levels 1 dB below the routine-processing envelope, in event another co-frequency FSS satellite comments operation within 6 degrees of the ViaSat system target satellite, pending demonstration of coordination with operator of new satellite); *Raysat LMSS Order*, 23 FCC Rcd at 2000, ¶ 51 (conditioning authorization to reduce aggregate off-axis radiation from METs to levels 1 dB below routine processing envelope, in event another co-frequency FSS satellite commences operation within 6 degrees longitude of Raysat system target satellite, pending demonstration of coordination with operator of new satellite).

[237] *See infra* Section III.C.5.

[238] *See infra* Appendix B, section 25.226(b)(3)(iii). The report should evaluate, through the use of operational statistics or actual measurements or a combination thereof, the aggregate power-density at the GSO from all simultaneously active co-frequency transmitters. The aggregate power-density at the GSO should be compared with the power-density at the GSO that would result from a single VSAT operating at 1 dB below the maximum permitted power-density. The report should include information on the average and maximum number of simultaneous co-frequency transmitters, an analysis of the E.I.R.P.-spectral density at the GSO, and a discussion of the factors taken into account at the network control center to manage the aggregate power-density of the system.

[239] *See infra* Appendix B, section 25.226(b)(3)(ii).

[240] *See infra* Section III.C.5.

VMES is not necessary as a general rule for all VMES systems.[241] As commenters note, a general one-dB reduction in the off-axis E.I.R.P.-density mask for VMES is not necessary where VMES operations are equivalent, from an interference perspective, to the operations of VSATs and ESVs.[242] However, notwithstanding the absence of a general rule, particular circumstances, in addition to aggregate variable-power systems, may require us to condition a future license to manage uplink operations through a one-dB or other margin.[243] We anticipate that this would not be the case for most applications under the VMES rules.

e. Contention Protocols

120. As discussed below, we adopt a new rule provision that permits VMES applicants to use contention protocols similar to those used by VSAT networks. We require VMES applicants seeking to use contention protocols to certify that the protocols are "reasonable."

121. *Background.* Section 25.134 of the rules establishes specific limits for individual VSAT earth station antenna input power densities.[244] The power-density limits are designed to limit the interference power received at space stations adjacent to the target satellite. Contention protocol use may result in aggregate power densities in the adjacent satellite receivers that exceed the limits produced by a single VSAT transmitter operating with a power density specified in section 25.134.[245]

122. In the *NPRM*, the Commission described contention protocols as multiple access techniques that permit users to transmit on a random or near-random basis with transmissions from one or more users that occasionally overlap, causing "collision."[246] The Commission stated that the probability of collisions is determined by the length of user transmission, number of transmissions per unit of time, and number of users transmitting on the same frequency.[247] It noted that, when collisions occur, the

[241] In the *NPRM* the Commission asked whether it should consider a 1-dB or other reduction below the ESV or VSAT mask to accommodate concerns about potential VMES antenna mispointing under rough off-road conditions. *NPRM*, 22 FCC Rcd at 9672, ¶ 50 (noting that the authorizations for certain Ku-band AMSS systems limit the aggregate E.I.R.P.-density to 1 dB less than the E.I.R.P.-density envelope defined for routinely-authorized VSATs).

[242] *See, e.g.*, Raysat Comments at 9, Reply at 7; Boeing Comments at ii, 22, Reply at 5. In lieu of a lower mask, Raysat suggests that we require a VMES operator to demonstrate that it meets the E.I.R.P.-density mask for VSAT-like earth stations under all potential operating conditions. Raysat Comments at 9. Raysat contends, for example, that rapid antenna acceleration due to vehicle movement in off-road conditions would be a rare occurrence and could be addressed through requirements on the speed and accuracy of pointing angle calculation and correction, operation at lower transmit power, spread spectrum modulation, and/or cessation of transmission. Raysat Comments at 9. *See also* SIA Comments at 15 (stating that it would be reasonable to use an envelope lower than the VSAT or ESV envelope, but arguing against defining any specific reduction; rather, urging us to require applicant to demonstrate that its system's proposed density and pointing accuracy would provide equivalent protection to the mask set out in the *NPRM*'s Appendix B, proposed § 25.xxx(a)); Americom Comments at 1 (supporting SIA Comments); Hughes Reply at 1 (endorsing SIA Comments).

[243] *See, e.g.*, Raysat Comments at 9 (stating that "The one circumstance cited by the Commission that might warrant consideration of a lower mask (*i.e.*, rapid antenna acceleration due to vehicle movement or 'jarring' in off-road conditions), [citation omitted] would be rare and can be addressed via other means (*e.g.*, speed and accuracy of pointing angle calculation and correction, operation at lower transmit power, spread spectrum modulation schemes, cessation of transmission, etc.).").

[244] 47 C.F.R. § 25.134.

[245] *Eighth Report and Order*, 23 FCC Rcd at 15132-33, ¶ 77.

[246] *NPRM*, 22 FCC Rcd at 9676, ¶ 59.

[247] *NPRM*, 22 FCC Rcd at 9676, ¶ 59.

E.I.R.P.-density at the GSO may exceed the E.I.R.P.-density that would be created by a single user.[248] It stated that the *Sixth Report and Order and Third Further Notice* had proposed adopting a contention table that would specify the percentage of time that collisions would be allowed to result in higher levels of E.I.R.P.-density.[249] The Commission proposed, rather than seeking additional comment on the use of contention protocols, to await the results of the Part 25 streamlining proceeding before considering the use of contention tables for VMES operations.[250]

123. In the streamlining proceeding, in the *Eighth Report and Order*, the Commission subsequently found that use of contention protocols tends to decrease the likelihood of harmful interference in almost all cases.[251] It concluded that there was no current need to develop detailed regulations to govern the use of contention protocols in VSAT networks where demand statistics normally allow for significant percentages of time during which no transmissions occur.[252] The Commission relied in part on a SIA study that found that a contention protocol system operating at reasonable loading factors produces less outage for neighboring satellites than a static system transmitting at the maximum power density.[253] The Commission adopted an exception to section 25.134 that permits a VSAT system to exceed the maximum VSAT digital earth station input power density in the aggregate when multiple earth stations simultaneously transmit, for purposes of "reasonable use" of a contention protocol.[254] It stated that VSAT applicants proposing to use contention protocols must certify that their contention protocol usage will be reasonable.[255]

124. SIA, Raysat, Americom, and Hughes filed comments supporting our proposal to await the results of the Part 25 streamlining.[256] Thus, no party filed substantive comments in this proceeding on the contention protocol issue.

125. *Discussion*. We find that the reasoning underlying our rules governing contention protocol usage in VSAT networks also is applicable to VMES networks, Therefore, we include language in section 25.226(a)(4) and (b)(5) of the rules to require an applicant seeking to operate a Ku-band VMES

[248] *NPRM*, 22 FCC Rcd at 9676, ¶ 59.

[249] *NPRM*, 22 FCC Rcd at 9676, ¶ 59, *citing to Sixth Report and Order and Third Further Notice*, 20 FCC Rcd at 5635-36, ¶ 119.

[250] *NPRM*, 22 FCC Rcd at 9676, ¶ 60.

[251] *Eighth Report and Order*, 23 FCC Rcd at 15133, ¶ 79. This results because, for any contention system with randomly-timed requests for access, there will be a portion of the time when there is no demand for access and thus no transmission to the satellite for part of the time. This reduces the outages caused to neighboring satellites by the system with the contention protocol. The reduction mostly offsets outages that may be caused by multiple simultaneous transmissions occurring when multiple earth stations simultaneously seek access. *Id.* at ¶ 79. In the *Eighth Report and Order*, the Commission referenced a SIA study showing a decrease in unavailability in five of six case studies, ranging from 1.3% to 5.1%, with the sixth case study showing a *de minimis* increase in unavailability. *Id.* at ¶ 79, citing to SIA Comments in IB Docket No. 00-248, App. 1 at 19.

[252] *Eighth Report and Order*, 23 FCC Rcd at 15134, ¶ 80.

[253] *Eighth Report and Order*, 23 FCC Rcd at 15134, ¶ 80. *See supra* note 251. By "static" system, the *Eighth Report and Order* referred to VSAT systems operating continuously at the applicable power limit set out in the rules. *Id.* at 15134, ¶ 79 n.241.

[254] *Eighth Report and Order*, 23 FCC Rcd at 15134, ¶ 81.

[255] *Eighth Report and Order*, 23 FCC Rcd at 15135, ¶ 83; 47 C.F.R. § 25.134(g)(4).

[256] SIA Comments at 17; Raysat Comments at 12; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

system and planning to use a contention protocol to certify that its contention protocol usage will be reasonable.[257]

3. Antenna Pointing Accuracy and Cessation Requirements

126. As discussed below, we adopt a 0.2 degree antenna pointing accuracy requirement for VMES applications. As an alternative, we will permit applicants to declare, justify and abide by a maximum antenna pointing error that may be larger than 0.2 degrees but will be achieved without exceeding the off-axis E.I.R.P.-density limits, mirroring the alternative rule we adopt today for ESV.

127. *Background.* In the *NPRM*, the Commission sought comment on whether to adopt the Ku-band ESV rules for antenna pointing accuracy and cessation or to modify the ESV rules as proposed by Americom, ViaSat and Qualcomm in response to the Petition, which had preceded the *NPRM*.[258] At the time that Americom, ViaSat and Qualcomm made their proposals, section 25.222(a)(6) required each Ku-band ESV antenna to have a pointing error of less than 0.2 degrees between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna.[259] Section 25.222(a)(7) required the ESV operator to automatically cease all emissions from the ESV within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna exceeded 0.5 degrees and not to resume transmission until the angle decreased to less than 0.2 degrees.[260]

128. The *NPRM* also sought comment on a proposal by Americom to adopt, for VMES, an exception to section 25.222(a)(6) that would be based on two conditions. The first condition Americom proposed would require the VMES applicant to demonstrate that its proposed system complied with the off-axis E.I.R.P.-density limits set out in section 25.222(a), notwithstanding its failure to comply with specified antenna pointing accuracy requirements. The second proposed condition would require the applicant to obtain and submit affidavits from potentially affected satellite operators agreeing to the applicant's proposed operations.[261] The *NPRM* sought comment on whether adoption of Americom's proposal would provide sufficient protection to adjacent FSS systems.[262]

129. In addition, in response to the Petition, ViaSat proposed that systems using spread spectrum modulation techniques in which individual antennas operate at extremely low E.I.R.P.-densities – and in which there is central control of aggregate power density – not be subject to pointing accuracy rules.[263] For antennas that cannot control interference through spread spectrum and/or power control technology, ViaSat and Qualcomm supported pointing accuracy limits that are a function of antenna beam width rather than of a specified fixed angular limit applied equally to all sizes of antennas.[264] The *NPRM* asked whether adopting a "fraction of the antenna beam width" approach seemed reasonable, how the Commission should determine the fraction that would apply, whether this approach should be limited to

[257] 47 C.F.R. § 25.226(a)(4) and (b)(5).

[258] *NPRM*, 22 FCC Rcd at 9673-74, ¶¶ 52-55. *See also* 47 C.F.R. § 25.222(a)(1)(ii)-(iii), formerly § 25.222(a)(6)-(7) (Ku-band ESV antenna pointing accuracy and cessation provisions); Comments of SES Americom, Inc. and Americom Government Services, RM-11336, at 5-6 (filed Aug. 21, 2006) ("Americom RM-11336 Comments"); ViaSat RM-11336 Comments at 5-6.

[259] 47 C.F.R. § 25.222(a)(6). This provision is revised and renumbered as 47 C.F.R. § 25.222(a)(1)(ii)(A).

[260] 47 C.F. R. § 25.222(a)(7). This provision is revised and renumbered as 47 C.F.R. § 25.222(a)(1)(iii)(A).

[261] *NPRM*, 22 FCC Rcd at 9673, ¶ 52; Americom RM-11336 Comments at 5-6.

[262] *NPRM*, 22 FCC Rcd at 9673, ¶ 52.

[263] *NPRM*, 22 FCC Rcd at 9673, ¶ 53; ViaSat RM-11336 Comments at 5-6.

[264] *NPRM*, 22 FCC Rcd at 9673, ¶ 53; ViaSat RM-11336 Comments at 6; Qualcomm RM-11336 Comments at 4.

peak E.I.R.P.-densities from a single terminal or to the aggregate emissions from multiple, co-frequency terminals, and, if so, with which value.[265]

130. With respect to Americom's proposal, Raysat, SIA, ViaSat, Boeing, NSMA, Americom, Hughes, and MTN favor granting applicants some flexibility on antenna pointing accuracy if the pointing error is taken into account in satisfying the mask or if there has been coordination with adjacent satellites to allow higher power levels.[266] General Dynamics, APTS/PBS, and ARINC, however, seek to apply a pointing accuracy requirement more strictly.[267] Only ViaSat itself spoke in favor of its own proposal to replace a pointing accuracy limit based on fixed angles with a limit that is a function of antenna beam width.[268] General Dynamics and MTN oppose making pointing accuracy a function of antenna beam width.[269]

131. *Discussion*. We adopt an antenna pointing accuracy requirement for VMES applications that is based on the modifications we make today to the ESV antenna pointing accuracy rule. In the *ESV Order on Reconsideration*, we modify and reorder section 25.222(a)(6) as section 25.222(a)(1)(ii).[270] Although declining to remove the antenna pointing requirement, we agree that the 0.2 degree antenna pointing limit is excessive for ESV systems that transmit below the off-axis E.I.R.P.-density limits contained in section 25.222(a).[271] We determine that such systems may allow any single ESV antenna to

[265] *NPRM*, 22 FCC Rcd at 9674, ¶ 54.

[266] *See, e.g.*, Raysat Comments at 10-11, Reply at 6-7 (stating Raysat's Stealthray has nominal pointing accuracy of 0.35°, but takes pointing error into account such that at +/-0.5° off-axis E.I.R.P. is below mask); SIA Comments at 6, 14-16, Reply at 2-3 (stating rules should treat as fully conforming those terminals with lower E.I.R.P. and lower pointing accuracy if combination provides equivalent protection, and allow higher power levels if coordination with adjacent satellites); ViaSat Comments at 8, 10, Reply at 14 (stating no pointing accuracy requirement should apply to antennas that operate at power density level sufficiently below mask, while pointing accuracy limit may be appropriate for VMES antenna that operates at power density levels close to mask, provided that mask varies in accordance with beam width and input power level of antenna); Boeing Comments at ii, 2, 21, 23-25, Reply at 4-5 (stating rules should permit operator to demonstrate equivalent protection from combination of power level and pointing accuracy or no pointing accuracy); NSMA Comments at 6 (stating separate pointing accuracy requirement may not be necessary for terminals taking into account mispointing to control off-axis E.I.R.P.-density); Intellicom Comments at 2 (stating rule should rely on off-axis E.I.R.P.); Americom Comments at 4 (stating rule should provide opportunity to demonstrate no harmful interference); Hughes Reply at 1 (supporting SIA Comments); MTN Comments at 5, Reply at 3-4 (stating it is unacceptable risk to eliminate requirements, but that MTN does not oppose consideration of licensing for VMES operators willing to operate with reduced power and less efficiency).

[267] General Dynamics Comments at 3-4, 30 (supports treating non-conforming terminals as non-routine, requiring coordination to license); APTS/PBS Comments at 3 (urges demonstration, through prototype testing, that each antenna meets 0.2°accuracy requirement); ARINC Reply at 2-3 (supports General Dynamics' contention that VMES should be strictly required to meet ESV requirements in order to minimize interference issues potentially caused by operation of VMES in Ku-band).

[268] ViaSat Comments at 12 and Attachment 3, Reply at 14 (supporting proposal for antennas that operate at power density levels close to off-axis E.I.R.P. limit).

[269] General Dynamics Comments at 31, 33 (stating Commission should not reduce ESV antenna pointing accuracy requirements for VMES, but could consider in different class of terminals with different signal structure); MTN Comments at 6 (stating it is unnecessary to adopt change because of readily available antennas that comply with existing antenna pointing requirements).

[270] *ESV Order on Reconsideration*, ¶¶ 21-22.

[271] *ESV Order on Reconsideration*, ¶ 23.

have a pointing error that is more than 0.2 degrees away from the target satellite without exceeding the off-axis E.I.R.P.-density limits that protect adjacent satellites from harmful interference.[272]

132. Thus, the rules adopted in the *ESV Order on Reconsideration* require ESV operators that seek relaxed pointing restrictions to declare, justify, and abide by a maximum antenna pointing error that may be larger than 0.2 degrees and will be achieved without exceeding the off-axis E.I.R.P.-density limits.[273] These low power-density ESV transmitters also must cease transmissions within 100 milliseconds after exceeding the declared antenna pointing error maximum.[274]

133. Similarly, we adopt the 0.2 degree antenna pointing requirement for VMES. In this regard, we decline to adopt ViaSat's proposal to eliminate antenna pointing accuracy requirements for systems using spread spectrum modulation techniques in which individual antennas operate at extremely low E.I.R.P.-densities and in which there is central control of aggregate power-density. We also decline to replace the angular pointing accuracy requirement with a rule based on beam width.[275] VMES, like ESV, is a service with mobile capabilities operating in the Ku-band FSS frequencies. In the *ESV Order on Reconsideration*, we observe that ESV antennas are subject to motion and vibrations that may cause rapid movement and antenna mispointing.[276] We retain the antenna pointing error requirement for ESVs to ensure that satellites adjacent to the target satellite are not subject to harmful interference.[277] The record in this VMES proceeding demonstrates that VMES is subject to greater accelerations, directional changes, and vibrations than ESVs.[278] Thus, we find that the 0.2 degree antenna pointing requirement is necessary for VMES operations that transmit at off-axis power-density levels close to the E.I.R.P.-density mask, in order to protect adjacent FSS satellite systems from harmful interference.

134. The VMES applicant must provide a certification from the equipment manufacturer stating that the antenna tracking system will maintain a pointing error of less than or equal to 0.2 degrees between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna and that the antenna tracking system is capable of ceasing emissions within 100 milliseconds if the angle

[272] *ESV Order on Reconsideration*, ¶ 24.

[273] *ESV Order on Reconsideration*, ¶¶ 23, 25. *See also* 47 C.F.R. § 25.222(a)(1)(ii)(B).

[274] *ESV Order on Reconsideration*, ¶ 26. *See also* 47 C.F.R. § 25.222(a)(1)(iii)(B).

[275] As noted, no commenter except ViaSat spoke in favor of this approach. Adopting a "fraction of the antenna beam width" alternative instead of a fixed value to specify pointing accuracy would lower the required pointing accuracy for small antennas. As an antenna becomes smaller, the beam becomes wider. Thus, a pointing accuracy rule based on beam width would permit greater pointing inaccuracies as the width of the beam increased with smaller-sized antennas. *See NPRM*, 22 FCC Rcd at 9674, ¶ 54.

[276] *ESV Order on Reconsideration*, ¶ 21.

[277] *ESV Order on Reconsideration*, ¶ 21.

[278] *See, e.g., NPRM*, 22 FCC Rcd at 9659, ¶ 19, 9670-72, ¶¶ 46-50; APTS/PBS Comments at 2-3 (stating that, unlike sea and air vessels, land vehicles move quickly on rough terrain, take sharp turns, hit obstructions); Americom Comments at 5 (contending that it may be difficult for VMES to meet ESV antenna pointing and cessation requirements due to terrain variations encountered by vehicles, particularly during off-road operations); ARINC Comments at 4-5 (asserting that it is improper to equate VMES platforms with stable ESV platforms unaffected by terrain variations); General Dynamics Comments at 6 (stating that VMES terminal hardware costs are significantly higher than costs of current VSAT and ESV systems because VMES operations require highly sophisticated antenna tracking and pointing systems), 24 (stating that accurate antenna pointing is more difficult for VMES than ESV because shipboard environment is less rigorous and determination of absolute spatial reference with VMES target satellite is more complex).

between the orbital location of the target satellite and the axis of the main lobe of the antenna exceeds 0.5 degrees.[279]

135. Although we do not eliminate the pointing accuracy requirement for low power-density systems as requested by ViaSat, we will permit flexibility for implementing low power-density VMES systems that choose not to meet the 0.2 degree pointing error requirement. We require VMES applicants with such systems to declare, justify and abide by a maximum antenna pointing error that shall be achieved without exceeding the off-axis E.I.R.P. mask.[280] In this regard, we apply the new ESV rules, and the rationale for adopting them, to VMES. The applicant shall demonstrate technically how the overall system will operate within the mask, taking into account the declared pointing error and low power-density emissions.[281] The applicant shall demonstrate how it will correct the E.I.R.P.-density at adjacent satellites in the event that emissions inadvertently exceed the permissible level.[282] The licensee is required to initiate corrective action and shut down within 100 milliseconds if its antenna exceeds the declared pointing error.[283] An applicant electing not to meet the 0.2 degree pointing error requirement also must specify the particular satellites with which its system will operate.[284]

4. Data Collection, Retention and Availability

136. As discussed below, we adopt requirements for the collection, retention, and availability of data to assist in identifying and resolving sources of interference. We model these requirements on similar requirements for Ku-band ESVs, but change the recordation time interval for VMES systems to five minutes.

a. Applying ESV Rules to VMES

137. *Background.* In the *ESV Report and Order*, the Commission adopted a requirement that ESV operators maintain data logs on the operation of each ESV terminal, including terminals operating in the Ku-band, retain that data for a year, and share the data with a relevant list of entities.[285] In the *NPRM*, the Commission sought comment on applying the data collection, retention and availability requirements set out in the Ku-band ESV rules to VMES.[286]

[279] 47 C.F.R. §§ 25.226(a)(1)(iii)(A), 25.226(b)(1)(iii). *See also* 47 C.F.R. § 25.226(a)(9) (like 47 C.F.R. § 25.134(h) for VSATs, § 25.226(a)(9) requires VMES terminals to automatically cease transmitting upon loss of reception of satellite downlink signal).

[280] 47 C.F.R. § 25.226(a)(1)(ii)(B).

[281] 47 C.F.R. § 25.226(b)(1)(iv). The precise value of the declared antenna pointing error will depend on the off-axis E.I.R.P.-density pattern, the characteristics of the VMES transmitters, the number of co-frequency operating transmitters, and the statistical accuracy of the antenna tracking system. *See ESV Order on Reconsideration*, ¶ 25 n.66.

[282] 47 C.F.R. § 25.226(b)(1)(iv)(B).

[283] 47 C.F.R. § 25.226(a)(1)(iii)(B).

[284] *See infra* Section III.C.5.

[285] *ESV Report and Order*, 20 FCC Rcd at 695-96, ¶ 48. *See also* 47 C.F.R. § 25.222(a)(4), formerly § 25.222(c)(1)-(3).

[286] *NPRM*, 22 FCC Rcd at 9677, ¶ 64.

138. APTS/PBS, SIA, Boeing, ViaSat, ARINC, and Hughes support applying the ESV requirements to VMES.[287] Intellicom suggests applying the requirements to VMES and then perhaps removing them in the future if few interference events occur.[288]

139. General Dynamics asks the Commission to decline to apply such requirements because, it states, the most likely operators in the near term will be military and other Federal users.[289] MTN urges us to excuse both VMES and ESV from the requirements.[290] Raysat asserts that such requirements are of limited benefit to Ku-band adjacent satellite interference resolution, raise national security concerns, and would be unnecessarily burdensome.[291] Americom states it may be inappropriate to adopt requirements because of national security concerns.[292]

140. *Discussion.* Based on our analysis of the record, we conclude that it is appropriate to adopt a modified version of the ESV data logging requirement for VMES. This requirement will ensure that VMES operators, like ESV operators, have the capability to track certain data that will be available in the event we are presented with an interference concern. We discuss each aspect of the requirement below.

b. Collection

141. *Background.* The ESV rules require Ku-band ESV network operators to collect data on the satellites each vessel uses, the operating frequencies and bandwidths used, the time of day, and the vessel location in longitude and latitude.[293] ESV licensees record data at time intervals of no greater than every twenty minutes while the ESV is transmitting.[294] In the *NPRM*, the Commission proposed adopting the relevant ESV requirements for VMES.[295]

142. Boeing, Hughes and ViaSat commented on collection intervals for VMES. They suggest shorter collection intervals of five to six minutes.[296] They suggest this shorter timeframe because VMES terminals are more likely than ESVs to change direction abruptly and experience higher speeds that result in more frequent antenna pointing changes.[297] Raysat, which urges us not to adopt data requirements for

[287] *See, e.g.*, APTS/PBS Comments at 3-4; SIA Comments at 18-19, Boeing Comments at iii, 27; ViaSat Comments at 22, Reply at 19; ARINC Reply at 3; Hughes Reply at 4-6.

[288] Intellicom Comments at 2.

[289] General Dynamics Comments at 39-41.

[290] MTN Comments at 7, Reply at 5.

[291] Raysat Comments at 13.

[292] Americom Comments at 4.

[293] 47 C.F.R. § 25.222(a)(4), formerly § 25.222 (c)(1).

[294] 47 C.F.R. § 25.222(a)(4), formerly § 25.222(c)(1).

[295] *NPRM*, 22 FCC Rcd at 9698, Appendix B, proposed section 25.xxx(a)(10)(i) ("for each VMES transmitter a record of the vehicle location (*i.e.*, latitude/longitude), transmit frequency, channel bandwidth, and satellite used shall be time annotated" and "Records will be recorded at time intervals no greater than every 20 minutes while the VMES is transmitting.").

[296] Boeing Reply at ii, 8 (no longer than 5 minutes); Hughes Reply at 6 (6 minutes); ViaSat Reply at 19 (5 minutes).

[297] Boeing Comments at 29 (20-minute interval adequate for ESVs on slow moving ships where movements are highly predictable, but likely inadequate for vehicles, which can travel at greater speeds and with much less predictability due to curves and grade changes in roads), Reply at 9 (collection of data in 5-minute intervals would achieve interference protection goals and not overly burden VMES operators); Hughes Reply at 6 (if VMES travels (continued....)

VMES operations, suggests that the proposed twenty-minute logging interval may not be meaningful and that decreasing the interval could create a data retention and processing burden with little associated benefit.[298]

143. *Discussion*. Based on our analysis of the record, we agree with Boeing, Hughes and ViaSat that we should reduce the collection interval from twenty minutes to take into account the more frequent directional changes and relevant speeds that are likely to result in more frequent VMES antenna pointing changes. We revise and adopt proposed section 25.xxx(a)(10)(i) – now denominated section 25.226(a)(6) – to require collection of the relevant data in no greater than five-minute intervals while the VMES terminal is transmitting.[299]

c. Retention

144. *Background*. The ESV rules require Ku-band ESV operators to retain the collected data for not less than one year.[300] In the *NPRM*, the Commission proposed adopting the same retention requirement for VMES.[301]

145. APTS/PBS and ViaSat support a one-year interval.[302] Boeing proposes 90 days; Hughes recommends 30 days but states that it could accept 90 days.[303] SIA states that if the purpose of the rules is to enable operators of other networks and systems that are experiencing unexpected interference to obtain location information on mobile transmitters, then retention of less than one year may be sufficient.[304] SIA further suggests that the Commission should study the matter, taking into account ESV experience and objectives.[305] Raysat agrees with Boeing that some level of data retention may be useful for the internal purposes of VMES network operators, but recommends that we allow VMES licensees to develop data retention policies that best meet their particular needs and network architecture.[306]

146. *Discussion*. We apply the ESV one-year retention rule to VMES licensees.[307] We note that, in the proceeding leading up to the *ESV Report and Order*, the Commission considered but rejected a

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while transmitting at top speed of 110 km/hour, point taken every 6 minutes would be adequate to determine whether VMES was in ellipse at time of interference event); ViaSat Reply at 5 (even assuming worst case vehicle speed of 80 mph, 5-minute logging interval would update location once every 6.6 miles).

[298] Raysat Comments at 13-14.

[299] *See infra* Appendix B, section 25.226(a)(6).

[300] 47 C.F.R. § 25.222(a)(4), formerly § 25.222(c)(1).

[301] *NPRM*, 22 FCC Rcd at 9698, Appendix B, proposed § 25.xxx(a)(10)(i).

[302] APTS/PBS Comments at 3; ViaSat Reply at 20 (at least one year).

[303] Boeing Comments at 30 (asserting that 90 days should be adequate to address interference concerns because network operators generally raise them at time of interference event rather than weeks or months later); Hughes Reply at 4-5 (asserting that retention for 30 days is sufficient because interference events would be reported to the VMES operator within a few days of the occurrence and resolution should be effected shortly thereafter, but that 90 days is acceptable compromise that would allow sufficient time for analysis of data to respond to interference claims in even the most complex situations).

[304] SIA Comments at 18.

[305] SIA Comments at 18. SIA itself did not provide such historical analysis.

[306] Raysat Reply at 8.

[307] *See infra* Appendix B, section 25.226(a)(6).

shorter, 90-day retention period, opting instead for one-year retention to provide additional time for investigating incidences and patterns of interference.[308] We have not modified the one-year retention rule in the *ESV Order on Reconsideration*, which revises and reorders the ESV rules. We find that a one-year retention rule for VMES likewise will assist with investigations of interference incidents and incident patterns.

d. Availability

147. *Background.* The ESV rules state that an ESV operator will make the collected and retained data available upon request to a coordinator, FS operator, FSS system operator, NTIA, or the Commission within twenty-four hours of the request.[309] In the *NPRM*, the Commission proposed to adopt the ESV requirement for VMES.[310]

148. Hughes and SIA suggest withholding the data from non-government entities.[311] Boeing argues against real-time availability via the Internet, but supports provision of the data to the Commission and NTIA upon request.[312] ViaSat opposes a publicly-accessible data base.[313] ViaSat supports our proposal to require response within twenty-four hours, and APTS/PBS argues for a one-hour response interval.[314] SIA suggests that a twenty-four hour response time for all data may be unrealistic.[315]

149. *Discussion.* In adopting ESV rules, the Commission required licensees to provide data to relevant entities within twenty-four hours of request.[316] In the proceeding leading up the *ESV Report and Order*, the Commission considered but rejected a longer response time.[317] In the *ESV Order on Reconsideration*, in revising and reordering the Ku-band ESV rules, we retain the requirement that ESV licensees provide data upon request to a coordinator, FS operator, FSS operator, NTIA or the Commission within twenty-four hours of the request.[318] Based on the Commission's ESV approach and on the record

[308] *See* 47 C.F.R. § 25.222(a)(4); *ESV Report and Order*, 20 FCC Rcd at 695-96, ¶ 48 (C-band), 721, ¶ 112 (Ku-band).

[309] 47 C.F.R. § 25.222(a)(4), formerly § 25.222(c)(1).

[310] *NPRM*, 22 FCC Rcd at 9698, Appendix B, proposed § 25.xxx(a)(10)(i).

[311] Hughes Reply at 4 (supports withholding from non-government); SIA Comments at 19 (states there is no need to supply data to non-government; could supply to Commission or NTIA if verification needed). *See also* Americom Comments at 1 (supports SIA Comments).

[312] Boeing Comments at 28-29, Reply at 10-11 (opposes availability to any party other than applicable regulatory bodies).

[313] ViaSat Comments at 23 (asserts that in other mobile services network operators have demonstrated that parties are able to cooperate and often voluntarily provide necessary information to resolve interference incidents and that public database of tracked locations may raise privacy and security concerns without adding benefit to process that works today).

[314] ViaSat Reply at 20; APTS/PBS Comments at 3-4. *But see* Hughes Reply at 5 (stating that one-hour response time is untenable).

[315] SIA Comments at 19. *See also* Hughes Reply at 1 (endorses SIA Comments); Americom Comments at 1 (supports SIA Comments).

[316] *See* 47 C.F.R. § 25.222(a)(4), formerly 47 C.F.R. § 25.222(c)(1).

[317] In the *ESV Report and Order*, the Commission considered but rejected a 72-hour response time, opting instead for a 24-hour response to help to ensure quicker resolution of interference problems. *See, e.g., ESV Report and Order*, 20 FCC Rcd at 696, ¶ 49 (C-band), 721, ¶ 113 (Ku-band).

[318] *See* 47 C.F.R. § 25.222(a)(4).

here, we require VMES licensees to make data available to coordinators, system operators, NTIA, and the Commission within twenty-four hours of request. We find that this rule, as applied to VMES, will assist with any applicable investigation of interference complaints.

e. National Security Exception/Waiver

150. *Background.* The ESV data retention rule does not provide an exception for national security. In the *NPRM*, the Commission did not propose such an exemption for VMES. As discussed below, various commenters propose that the Commission adopt a national security exception or waive the rule for national security reasons.

151. Raysat and General Dynamics argue against adopting a VMES data logging requirement because of national security concerns.[319] Americom, Hughes, SIA and ViaSat suggest that we establish a national security exception or waive the rule for national security reasons.[320] Boeing states that national security concerns are serious but that we should address the issue with a requirement limiting who can see the data.[321] SIA observes that a general non-application of the requirement to provide data upon request could hinder the ability of a secondary MSS operator to rapidly refute a claim of interference that otherwise could require the MSS operator to shut down preemptively.[322] SIA proposes supplying sensitive customer data only to the Commission or NTIA, if needed for verification, after the VMES operator makes prompt analysis of the data in response to the interference claim.[323] SIA states that, should the Commission grant a waiver, the target satellite licensee and VMES operator would not be absolved from the obligation to cooperate with the operator of the victim satellite to identify the source of the interference and correct it.[324] APTS/PBS argues that the government should use the 7 GHz band if it can not comply with data logging.[325]

152. *Discussion*. The Commission did not adopt a national security exception or waiver of the data collection, retention or availability requirements when it released the ESV rules in 2005. Nor do we add one as we revise and reorder the ESV rules in the *ESV Order on Reconsideration* adopted today. Similarly, based on the record here, we think there continues to be good reason for these requirements for VMES. In asking us to adopt no requirements because VMES initially may be used for U.S. military training and other Federal uses, Raysat and General Dynamics are asking us to speculate on the uses to which VMES may be applied and to limit the scope of the ESV rules, as applied to VMES, based on that assumption.

[319] Raysat Comments at 14 (asserts there should not be data logging requirement in part because VMES primarily will be used for military and other government operations); General Dynamics Comments at 39-41, 41 n. 35 (states separate classified system would be required because information should not be forwarded to agencies without security clearance).

[320] Americom Comments at 4 (urges granting exemption or waiver); Hughes Reply at 4 (urges availability of waivers); SIA Comments at 18 (suggests waiving recordation rule if public interest showing is made); ViaSat Comments at 22-23 (urges exception for certain government and law enforcement applications where disclosure could have security considerations).

[321] Boeing Comments at 28-29.

[322] SIA Comments at 19.

[323] SIA Comments at 19.

[324] SIA Comments at 19 n.37.

[325] APTS/PBS Comments at 4.

153. We follow the procedures the Commission adopted in the ESV rules. We do not adopt an explicit national security exception for VMES licensees. We find that a better approach would be to consider an applicable request to waive the availability component of the rule for national security reasons.

154. We observe that section 1.3 of the Commission's rules authorizes the Commission to waive its rules for "good cause shown."[326] 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.[327] 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 otherwise would serve the public interest.[328] If a VMES applicant or licensee seeks a waiver of the rules on data availability, we will review the waiver request pursuant to this standard.

5. Point of Contact

155. As discussed below, we adopt an operating rule requiring VMES licensees to maintain a point of contact in the United States with authority and ability to cease all emissions from their VMES terminals.

156. *Background.* The ESV rules require an ESV operator to maintain a point of contact in the United States with authority and ability to cease all emissions from its ESV terminals, either directly or through the facilities of a U.S. hub (or hub located in another country with which the United States has a bilateral agreement that enable such cessation of emissions).[329] In the *NPRM*, the Commission proposed that, whether or not an applicant requests a VMES license that includes a hub, the VMES rules would require the licensee to maintain in the United States both a network control and monitoring center and a twenty-four-hours-per day, seven-days-per-week point of contact.[330] Thus, the Commission proposed, in the *NPRM*'s Appendix B, proposed section 25.xxx(a)(8), that "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, 7 days a week, with authority and ability to cease all emissions from the VMES."[331] The Commission also proposed, in Appendix B, proposed section 25.xxx(a)(10)(ii), that "VMES operators shall control all VMESs by a hub earth station located in the United States."[332]

157. SIA, General Dynamics, ViaSat, Boeing, Americom and Hughes support a U.S. point of contact with authority to cease operations twenty-four hours of the day and seven days of the week.[333]

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[326] 47 C.F.R. § 1.3. *See also WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969) ("*WAIT Radio*"); *Northeast Cellular Telephone Co*., 897 F.2d 1164 (D.C. Cir. 1990) ("*Northeast Cellular*").

[327] *Northeast Cellular*, 897 F.2d at 1166.

[328] *WAIT Radio*, 418 F.2d at 1157.

[329] 47 C.F.R. § 25.222(a)(3), formerly § 25.222(a)(8). *See also* 47 C.F.R. § 25.222(a)(6), formerly § 25.222(c)(3) (ESVs operators shall control all ESVs by a hub earth station located in the United States except that an ESV on U.S.-registered vessels may operate under control of a hub location outside the United States provided that the ESV operator maintains a point of contact within the United States with the capability and authority to cause an ESV on a U.S.-registered vessel to cease transmitting if necessary).

[330] *NPRM*, 22 FCC Rcd at 9683, ¶ 78.

[331] *See* 22 FCC Rcd at 9698, Appendix B, proposed § 25.xxx(a)(8).

[332] *See* 22 FCC Rcd at 9698, Appendix B, proposed § 25.xxx(a)(10)(ii).

[333] SIA Comments at 19, 26, Reply at 10; General Dynamics Comments at 60-61 (supports both U.S. network control and monitoring center and U.S. 24/7 point of control as prerequisite to U.S. operations to ensure rapid

(continued....)

SIA questions the need for also requiring a U.S. hub, stating that so long as there is "absolute control" from a U.S. network operation center and U.S. point of contact, a U.S. hub is not essential.[334] Boeing and ViaSat assert that so long as there is a U.S. point of contact with authority to cease operations or a network control monitoring center in the United States, a U.S. hub is not necessary.[335]

158. *Discussion*. We agree that it is not necessary to require a U.S. hub at this time. We adopt proposed section 25.xxx(a)(8) – reordered here as section 25.226(a)(5) – requiring each VMES licensee to provide a 24/7 point of contact that shall have the authority and ability to cease all VMES operations, as necessary.[336] We are adopting technical and licensing rules for the domestic, U.S. use of VMES. In the future, if we should authorize VMES to operate internationally, we will consider appropriate modifications of the rules to take into account international operations.

159. We observe that Part 25 licensees have responsibility for proper operation and maintenance of earth stations, and that authority to operate transmitting earth stations by remote control is contingent on compliance with certain conditions.[337] Thus, VMES systems that operate by remote control are subject to section 25.271 of the rules and must complete items E61 through E66 in Schedule B of FCC Form 312. We recognize that most VMES terminals will operate by remote control although we do not explicitly use the term "remote control" in the VMES rules.

6. Licensing Issues

a. Blanket Licensing

160. *Background*. The ESV rules provide for blanket licensing of ESV systems.[338] In the *NPRM*, the Commission proposed to provide applicants with the option of seeking a VMES system

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resolution of any potential interference issues); ViaSat Reply at 23 (supports U.S. network control and monitoring center); Boeing Comments at iii, 30-31 (supports 24/7 U.S. point of contact with authority to cease operations); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments). *See also* Intellicom Comments at 2 (silent on 24/7 and whether hub must be in United States, but urges hub with positive control and no transmit unless demodulated unique carrier originating from hub specifies time and frequency of transmissions); APTS/PBS Comments at 3-4 (silent on 24/7 and whether hub must be in United States, but would require hub master monitoring station held responsible for terminals' operations).

[334] SIA Comments at 26. SIA also states, however, that it has no difficulty with the suggestion that a hub master station, or network control center for stations operated remotely, be held responsible for operations of VMES terminals. SIA Reply at 10.

[335] Boeing Comments at iii, 30-31 (stating that Boeing does not support requirement for U.S. hub, but supports 24/7 U.S. point of contact with authority to cease operations); ViaSat Reply at 23 (states no need for U.S. hub so long as network control monitoring center control point in United States for both individual and multiple VMES antennas).

[336] *See infra* Appendix B, § 25.226(a)(5). We require each VMES terminal to be capable to receive 'enable transmission' and 'disable transmission' commands from the network control center/point of contact and to cease transmission immediately upon receipt of any 'parameter change' demand, until it receives an 'enable transmission' command from the network control center/point of contact. We expect a VMES licensee's network control center/point of contact to monitor operations of the network's VMES terminals to determine if any terminal is malfunctioning. We also expect the VMES terminal to self-monitor and automatically cease transmission upon detecting an operational fault that could cause harmful interference to other FSS networks.

[337] *See* 47 C.F.R. § 25.271 (requiring a trained operator to be present at the transmitting earth station or, under applicable conditions, at the designated remote control point for the earth station, at all times that the earth station is transmitting).

[338] 47 C.F.R. § 25.222 (Blanket Licensing Provisions for Earth Stations on Vessels in Ku-bands). *See also ESV Report and Order*, 20 FCC Rcd at 722, ¶ 115 (adopting blanket licensing approach is both consistent with approach (continued....)

license consisting of a hub located in the United States and/or a blanket earth station license.[339] The Commission considered blanket licensing for VMES terminals because the number and mobility of VMES locations may make it impractical to license VMES terminals on a unit-by-unit basis.[340]

161. SIA, Boeing, Raysat, NSMA, ViaSat, General Dynamics, MTN, Americom and Hughes support blanket licensing.[341] Boeing states that blanket licensing is necessary because deployment of large numbers of technically identical terminals would make individual licensing of antennas burdensome and inefficient.[342] Raysat and NSMA support blanket licensing for technically identical VMES terminals, stating that a requirement for individual licensing would be cumbersome and a burden on applicants and the Commission.[343] MTN supports blanket licensing because of the large number and ubiquity of system terminals.[344] ViaSat supports our proposal to allow both blanket licensing and individual licensing of VMES terminals, stating that blanket licensing is the most efficient way to license networks of widely-deployed terminals.[345]

162. *Discussion*. We adopt our proposal to provide for blanket licensing of VMES.[346] Under a blanket licensing approach, we will require applicants to file a narrative describing the overall system operations as well as specific information on the antennas, power density, and emission characteristics of each class of earth station comprising the network. We will issue a VMES system license (consisting of a U.S. hub and/or blanket earth station license) to applicants that demonstrate they are capable of controlling all aspects of the VMES network. As noted above, we require a point of contact with the authority and ability to control the emissions of individual VMES terminals.

b. Individual Licensing

163. *Background*. In the *NPRM*, the Commission also proposed to provide for the licensing of individual earth stations, using the same technical criteria that are applied to the antennas in a blanket-licensed VMES network.[347] This proposal varies from the Commission's approach in the ESV

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for Ku-band VSATs and takes into account unique operational characteristics of ESVs, including deployment of large numbers of technically identical earth stations operating over wide geographic area).

[339] *NPRM*, 22 FCC Rcd at 9683, ¶ 78.

[340] *NPRM*, 22 FCC Rcd at 9683, ¶ 79.

[341] SIA Comments at 25; Boeing Comments at iii, 32; Raysat Comments at 16; NSMA Comments at 8; ViaSat Comments at 21; General Dynamics Comments at 60; MTN Comments at 8; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[342] Boeing at 32-33.

[343] Raysat Comments at 16; NSMA Comments at 8.

[344] MTN Comments at 8.

[345] ViaSat Comments at 21.

[346] *See infra* Appendix B, § 25.226 (Blanket Licensing Provisions for Domestic, U.S. Vehicle-Mounted Earth Stations in Ku-band).

[347] *NPRM*, 22 FCC Rcd at 9683, ¶ 80.

proceeding, where the Commission declined to include specific provisions for individual, as opposed to blanket, earth station licensing.[348]

164. General Dynamics and ViaSat support individual licensing. General Dynamics states that, as VMES will be interoperable with other Ku-band FSS operations, there probably will be applications for single terminals.[349] ViaSat states that it should not matter whether an operator seeks a license to operate a single terminal or to deploy numerous identical terminals over the United States, so long as the operation and management of the terminals comply with the rules.[350] ViaSat adds that we should evaluate applications for single VMES terminals to determine whether the antenna will be operated within a network of separately licensed terminals and will meet off-axis E.I.R.P-density network limits on an aggregate basis.[351] SIA, Raysat, NSMA, Boeing, Americom and Hughes comment that an individual licensing requirement would be cumbersome.[352]

165. *Discussion*. We will permit VMES applicants to seek licensing of an individual VMES earth station where the applicant does not propose to operate multiple technically identical terminals over a wide geographic area. In response to ViaSat's comments, we will require each licensee to meet the applicable off-axis E.I.R.P.-density requirements. We do not encourage the separate licensing of single terminals that will be operated in a VMES "network." Rather, we would anticipate that any network of technically identical antennas – or classes of technically identical antennas – would be licensed under blanket authority.

c. ALSAT Authority

166. *Background*. In the *NPRM*, the Commission sought comment on whether to authorize Ku-band VMES operators to operate with any U.S.-licensed satellite and those non-U.S. satellites on the Permitted Space Station List using the parameters consistent with earth stations, specifically the proposed off-axis E.I.R.P.-density requirements.[353] This ALSAT authority permits an earth station operator providing FSS services in the Ku-band to access any U.S. satellite and any foreign satellite on the Permitted Space Station List without additional Commission action, provided that its communications are in accordance with the same technical parameters and conditions established in the earth stations' licenses.[354] Because ALSAT authority is not available to FSS earth station applicants whose operations must be coordinated with adjacent satellite operators, the *NPRM* proposed to deny ALSAT authority to

[348] *See ESV Report and Order*, 20 FCC Rcd at 722, ¶117 n.304 (because there was no comment on need for individual earth station licensing and the Commission viewed demand for individual as opposed to network ESV earth station use as limited, the Commission declined to adopt individual licensing provisions for ESV).

[349] General Dynamics Comments at 61.

[350] ViaSat Comments at 21.

[351] ViaSat Comments at 21.

[352] SIA Comments at 25 (individual licensing would be cumbersome; it would be helpful if VMES could be included as a class of antennas on network licenses); Raysat Comments at 16 (individual licensing cumbersome and should not be required); NSMA Comments at 8 (individual licensing burdensome and no benefit from requiring individual licensing); Boeing Comments at 32 (individual antenna licensing burdensome); Americom at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[353] *NPRM*, 22 FCC Rcd at 9683, ¶ 81.

[354] *See DISCO II First Reconsideration Order*, 15 FCC Rcd at 7210-11, ¶ 6, 7215-16, ¶ 19.

those VMES applicants whose operations require coordination with adjacent satellite operators, especially if the VMES terminals were to exceed the proposed off-axis E.I.R.P.-density requirements.[355]

167. SIA, Boeing, Raysat, NSMA, ViaSat, General Dynamics, MTN, ARINC, Americom, and Hughes support ALSAT authority for antennas that conform to the relevant requirements for a two-degree Ku-band spacing environment.[356] ARINC, NSMA and Raysat state that non-compliant VMES should coordinate on a satellite-by-satellite basis.[357]

168. *Discussion*. We will allow Ku-band VMES to receive authority to operate with any U.S. licensed satellite and non-U.S. satellite on the Permitted Space Station List. As discussed above, we find significant support in the record for granting ALSAT authority. We will allow ALSAT authority if the VMES application meets the off-axis E.I.R.P.-density and antenna pointing requirements. Conversely, we will not permit ALSAT authority when the VMES applicant proposes to operate at a higher off-axis E.I.R.P.-density level coordinated with the target and adjacent space station operators, chooses not to meet the 0.2 degree pointing error requirement, or uses an aggregate dynamic power-density system. Additionally, we will not permit ALSAT authority for the use of the extended Ku-bands (10.95-11.2 and 11.45-11.7 GHz).

d. License Terms

169. *Background*. In the *NPRM*, the Commission sought comment on whether to license VMES operations for terms of fifteen years, noting that other licensed networks of earth stations have fifteen-year license terms.[358]

170. Three commenters address this issue. General Dynamics states that there is nothing inherent in VMES operations that should distinguish VMES from any other class or type of FSS Ku-band earth stations.[359] MTN favors a fifteen-year term as providing the regulatory certainty accorded other licensed earth station networks.[360] SIA suggests that the fifteen-year term should run with the class of antenna, as opposed to running with the particular vehicle on which the antenna is mounted.[361]

171. *Discussion*. The Commission adopted a fifteen-year term for ESVs because it agreed with commenters in that proceeding that such a license term would provide ESVs with regulatory certainty and is consistent with the Commission's licensing approach for other networks of earth

[355] *NPRM*, 22 FCC Rcd at 9684, ¶ 81.

[356] SIA Comments at 25; Boeing Comments at iii, 33; Raysat Comments at 16 (asserts that VMES systems authorized to operate at different technical characteristics, such as higher power levels, should designate specific satellite points of communication); NSMA Comments at 8 (asserts that VMES systems authorized to operate with different technical characteristics, such as higher power levels, should designate specific satellite points of communications); ViaSat Comments at 21; General Dynamics Comments at 61 (urges ALSAT status for VMES operations that are fully compliant with the VMES regulations); MTN Comments at 8; ARINC Comments at 6 (urges ALSAT only for compliant VMES and states that non-compliant should coordinate on satellite-by-satellite basis); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[357] ARINC Comments at 6; NSMA Comments at 8; Raysat Comments at 16.

[358] *NPRM*, 22 FCC Rcd at 9684, ¶ 82, *citing to* 47 C.F.R. § 25.121 (which, at paragraph (c), states that, for earth stations, the license term will be specified in the instrument of authorization).

[359] General Dynamics Comments at 62.

[360] MTN Comments at 8.

[361] SIA Comments at 25. *See also* Americom Comments at 1 (supporting SIA Comments); Hughes Reply at 1 (endorsing SIA Comments).

stations.[362] For similar reasons, we adopt a fifteen-year term for VMES licenses. In response to SIA's comments, we observe that the term will run from the licensing of the applicable system, and not from the licensee's installation of the antennas on particular vehicles.[363]

e. Form 312

172. *Background.* In the *NPRM*, the Commission observed that applications for new or modified transmitting and/or receiving earth stations must be filed on FCC Form 312 and invited comment on necessary modifications to FCC Form 312 to accommodate applications for VMES systems.[364]

173. SIA and General Dynamics commented on this issue. SIA recommends that the Commission provide space on Form 312 to indicate whether a proposed antenna or VSAT network will be VMES or include a VMES terminal.[365] General Dynamics proposes the addition of "Type of Service" boxes for 3/6 GHz ESV, 12/14 GHz ESV, and 12/14 GHz VMES, if we think such a clarification would be beneficial.[366] General Dynamics also suggests augmenting the instructions on providing a Schedule B for each size or type of remote unit in the network to direct ESV and VMES applicants to submit a separate Schedule B for each size and type of VMES and ESV in the network.[367]

174. *Discussion.* We do not adopt changes to Form 312 in this proceeding. Until we have adopted a new consolidated Form 312 applicable to VMES, among other services, we require a VMES blanket licensee applicant to pay the VSAT blanket application fee, choose "other" on Form 312 and enter "VMES" in the appropriate block.[368] An applicant for an individual VMES terminal license shall pay the application fee for an FSS transmit/receive earth station, choose "other" on Form 312 and enter "VMES" in the appropriate block.[369] VMES applications shall include, in addition to the particulars of operation identified on Form 312 and associated Schedule B, the applicable technical demonstrations set out in section 25.226(b)(1), (b)(2), or (b)(3) and the documentation identified in paragraphs (b)(4) through (b)(8) of section 25.226.[370] VMES applicants may submit the off-axis E.I.R.P.-density tables and other demonstrations and documentation required by section 25.226(b) as exhibits attached to Form 312 until we revise Form 312.

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[362] *ESV Report and Order*, 20 FCC Rcd at 723, ¶ 118.

[363] *See, e.g.*, SIA Comments at 25.

[364] *NPRM*, 22 FCC Rcd at 9683, ¶ 80 and ¶ 80 n.168.

[365] SIA Comments at 25. *See also* Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[366] General Dynamics Comments at 62-63.

[367] General Dynamics Comments at 63.

[368] *See* 47 C.F.R. § 1.1107, Schedule of Charges for Applications and Other Filings for the International Services (Item 6.a, $9,330 VSAT blanket license fee for initial application). *See also Amendment of the Schedule of Application Fees Set Forth in Sections 1.1102 through 1.1109 of the Commission's Rules*, GEN Docket 86-285, Order, FCC 08-209, 23 FCC Rcd 14192, 14229, Appendix B (2008). The appropriate block on Form 312 is on the Main Form at question 25(g), "other," under "Type of Station."

[369] *See supra* note 368. *See also* 47 C.F.R. § 1.1107 (Item 3.a, $2,530/individual FSS transmit/receive earth station filing fee for initial application)

[370] *See infra* Appendix B, § 25.226(b)(1).

7. Radio Frequency Radiation Hazard and Equipment Certification Requirements

175. As discussed below, we require VMES applicants to submit a routine environmental evaluation for radio frequency ("RF") exposure demonstrating whether VMES terminals, or classes of VMES terminals, will result in power-densities that would exceed the Commission's RF exposure criteria. We require VMES applicants with VMES terminals that exceed the radiation guidelines of section 1.1310 of the rules to provide an environmental assessment and a plan of mitigation of radiation exposure to the extent required to meet those guidelines. We adopt a rule requiring VMES terminals that operate in the United States to be installed by qualified installers and properly labeled. We do not require equipment certification.

a. Radio Frequency Radiation Hazard Requirements

(i) VMES Terminals as Mobile Devices

176. *Background.* Section 2.1091 of the rules makes Part 25 mobile devices operating at frequencies above 1.5 GHz with an effective radiated power ("ERP") of 3 watts or greater subject to routine environmental evaluation for RF exposure prior to equipment authorization or use.[371] Section 2.1091 defines a "mobile device" as a transmitting device designed to be used in other than fixed locations and generally to be used in such a way that a separation distance of at least 20 centimeters is maintained between the radiating structure and the body of the user or nearby persons.[372]

177. In the *NPRM*, the Commission directed commenters to section 1.1310 of our rules and asked commenters to discuss how this rule should be applied to the potential uses for VMES.[373] SIA, Raysat and ViaSat state that VMES terminals are not likely to be used within 20 centimeters of an operator's body, but will be mounted on the outside of vehicles, away from the operator.[374]

178. *Discussion*. Based on licenses for services similar to VMES that the Commission has issued in the past, we expect that VMES terminals will be used in such a way that a separation distance of at least 20 centimeters is normally maintained between a transmitter's radiating structures and the body of the user or nearby persons.[375] We also expect VMES terminals to operate with an ERP of more than 3 watts.[376] Thus, we find that VMES terminals are mobile devices subject to routine environmental evaluation under section 2.1091.

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[371] 47 C.F.R. §§ 2.1091(c); *see also* 47 C.F.R. §§ 1.1307(b)(2) (subjecting Part 25 mobile devices to routine environmental evaluation for RF exposure prior to equipment authorization or use).

[372] 47 C.F.R. § 2.1091 (including operating at frequencies above 1.5 GHz with effective radiated power of 3 watts or more). *See also* 47 C.F.R. §§ 25.129, 2.1093 (certification requirements for "portable earth station transceivers" located within 20 centimeters of the body of a user or nearby person when the terminal is transmitting).

[373] *NPRM*, 22 FCC Rcd at 9680, ¶ 70.

[374] SIA Comments at 22; Raysat Comments at 15-16; ViaSat Reply at 23.

[375] *See, e.g.*, Raysat, Inc., Application for Authority to Operate 4,000 In-Motion Mobile Satellite Antennas in the 14.0-14.5 GHz and 11.7-12.2 GHz Frequency Bands, File No. SES-LIC-20060629-01083 (filed June 29, 2006), *available at* http://licensing.fcc.gov/cgi-bin/ws.exe/prod/ib/forms/reports/swr031b.hts?q_set=V_SITE_ANTENNA_FREQ.file_numberC/File+Number/%3D/SESLIC2006062901083&prepare=&column=V_SITE_ANTENNA_FREQ.file_numberC/File+Number ("Raysat LMSS Application").

[376] *See id*.

(ii) Mitigation of RF Exposure

179. *Background.* Section 2.1091 provides that the limits to be used for evaluation are those specified in section 1.1310 of the Commission's rules.[377] Section 1.1310 lists the criteria used to evaluate the environmental impact of human exposure to RF radiation.[378] The RF exposure rules applicable to Ku-band FSS operations contain maximum limits for the general public and for occupational exposure.[379] These rules define the maximum permissible exposure to non-ionizing radiation for the general public in an uncontrolled environment in the 14.0-14.5 GHz band to be 1.0 mW/cm².[380] For individuals in a controlled occupational environment, the maximum permissible exposure is 5.0 mW/cm² averaged over any six minute period.[381]

180. In the *NPRM*, the Commission sought comment on which steps, including requirements for cautionary labeling and professional installation, it should take to resolve any potential RF exposure concerns related to the mounting and operation of earth stations on vehicles.[382] The Commission asked commenters to discuss how exposure concerns and rules for military applications might differ from VMES use as a general commercial application.[383] It also proposed requiring a VMES applicant with a VMES terminal that exceeds the radiation guidelines of section 1.1310 to provide, with its environmental assessment, a plan for mitigation of radiation exposure that would meet these requirements.[384] This proposal modeled the rule in section 25.222, which requires applications for ESV systems that exceed the radiation guidelines of section 1.1310 to provide an environmental assessment and a plan for mitigation of radiation exposure to the extent required to meet those guidelines.[385]

181. SIA observes that an analysis of RF exposure risks from VMES terminals must consider the volume of space within the vehicle and potential obstructions along the boresight of the antenna.[386] General Dynamics states that a principal difference between VMES operations and VSAT operations, in terms of RF energy density, is the mounting location of the antennas.[387] General Dynamics notes VSAT terminals typically rest on building roof structures or in other isolated areas, in order to obtain a continuous unobstructed view towards the satellite of interest.[388] For the same reason, General Dynamics expects vehicle rooftop mounting for VMES terminals.[389] It asserts that vehicle rooftop placement will

[377] 47 C.F.R. § 2.1091(d).

[378] 47 C.F.R. § 1.1310 Table 1. *See also* 47 C.F.R. §§ 2.1091, 2.1093 (RF radiation exposure evaluation for portable devices and Part 25 mobile devices).

[379] *See* 47 C.F.R. §§ 1.1310, 2.1093.

[380] 47 C.F.R. § 1.1310. Section 2.1091(d)(2) of our rules allows only source-based time averaging to determine compliance. 47 C.F.R. § 2.1091(d)(2).

[381] 47 C.F.R. § 1.1310.

[382] *NPRM*, 22 FCC Rcd at 9680, ¶ 70.

[383] *NPRM*, 22 FCC Rcd at 9680, ¶ 70.

[384] *NPRM*, 22 FCC Rcd at 9698, Appendix B, proposed § 25.xxx(a)(9).

[385] 47 C.F.R. §§ 25.222(a)(9), 1.1310.

[386] SIA Comments at 21.

[387] General Dynamics Comments at 52-53.

[388] General Dynamics Comments at 52.

[389] General Dynamics Comments at 53.

provide as much protection as possible to vehicle occupants.[390] SIA asserts that qualified installers should reject installations that exceed the 1.0 mW/cm² general public threshold in the vehicle or in the space around the vehicle where a six-foot-six-inch-tall adult would be expected to stand.[391] Boeing suggests the possibility of imposing a license condition to limit minimum elevation angles of VMES mounted on vehicles that may operate adjacent to higher profile vehicles on city streets or highways in the United States.[392]

182. General Dynamics strongly urges professional installation both to ensure acceptable antenna pointing error and to accomplish a higher level of RF safety for maintenance and operations personnel.[393] SIA supports requiring VMES installation by qualified installers with an understanding of the radiation environment and the measures best suited to maximize protection.[394] ViaSat states that, due to the complexity of VMES systems, professional installation likely will be required from a technical perspective and also would resolve radiation safety concerns.[395] Boeing supports professional installation.[396]

183. SIA, Boeing, and ViaSat support cautionary labeling on VMES terminals.[397] General Dynamics views VMES terminal labeling as impractical and unnecessary, although it recommends RF safety labeling in VMES operator and maintenance documentation.[398] General Dynamics also asserts that precautionary labeling can be a physical security hazard in a military environment.[399]

184. General Dynamics states that transmitter shut-off upon downlink signal loss effectively will mitigate general population RF exposure from energy radiated in the VMES antenna's main beam.[400] SIA suggests that it may be appropriate for the Commission to adopt rules ensuring that a VMES terminal ceases transmission upon losing connectivity with the relevant satellite.[401] ViaSat agrees that the Commission should require VMES terminals to cease transmission upon loss of forward link

[390] General Dynamics Comments at 53.

[391] SIA Comments at 21.

[392] Boeing Comments at 6-7, 31-32.

[393] General Dynamics Comments at 57.

[394] SIA Comments at 21. *See also* Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[395] ViaSat Reply at 24.

[396] Boeing Comments at 32.

[397] SIA Comments at 21 (states that conspicuous markings need to be placed on the vehicle surface to denote all areas where the 1 mW/cm² threshold for protection of the general public is exceeded); Boeing Comments at 32 (supports labeling requirements); ViaSat Reply at 24 (supports precautionary signage, flashing lights or other clearly visible warnings).

[398] General Dynamics Comments at 57-58.

[399] General Dynamics Comments at 57 and 57 n.55.

[400] General Dynamics Comments at 55. General Dynamics also observes that, with respect to the occupational/controlled category of RF exposure, the military has safety procedures that involve transmitter mute during maintenance, when personnel are on rooftops, and when downlink signals are degraded due to obstructions or unknown causes. *Id.* at 55-56.

[401] SIA Comments at 22. SIA notes that, for an antenna on a vehicle in motion, the loss of connectivity when the antenna signal encounters a building, bridge or other obstacle would lead to rapid cessation of transmission. *Id.*

connectivity, as it does for VSATs.[402] Boeing supports a rule requiring transmission cessation after signal loss from the satellite.[403]

185. *Discussion*. We adopt new section 25.226(b)(8).[404] Pursuant to this rule, VMES applicants must comply with sections 1.1310 and 2.1091 of the rules.[405] Thus, applicants must submit a routine environmental evaluation for RF exposure demonstrating whether VMES terminals, or classes of VMES terminals, will result in power densities that would exceed the Commission's RF exposure criteria. VMES terminals not complying with the Commission's RF exposure limits must submit an environmental assessment. Applicants with VMES terminals that will exceed the guidelines in section 1.1310 for RF radiation exposure shall provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines.

186. Further, we require VMES licensees to ensure installation of terminals on vehicles by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons within the vehicle. We also require the licensee of any VMES terminal exhibiting radiation exposure levels exceeding 1.0 mW/cm² in accessible areas, such as outside of the terminal's radome, to attach to the surface of the terminal a label with a warning about the radiation hazard and a diagram showing the regions around the VMES terminal and vehicle where the levels could exceed 1.0 mW/cm². In response to General Dynamics' concern that labeling can be a security hazard in battlefield environments, we observe that this proceeding is limited to rules for the licensing of VMES for domestic, U.S. uses, including U.S. military training operations within the United States.[406]

187. ViaSat supports an RF hazard analysis in each application.[407] ViaSat also urges special consideration of the RF hazards related to parked VMES terminals.[408] Our analysis of three types of operational antennas suggests that RF hazard concerns seem to be limited to the near-field region within a foot to two feet of the antenna.[409] If an exposure level equal to or exceeding the uncontrolled limit of 1.0 mW/cm² extends beyond the weather-protective radome covering the antenna, the rules we adopt require the VMES terminal to carry appropriate warning labels. We conclude that the labeling requirement,

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[402] ViaSat Reply at 24.

[403] Boeing Comments at iii, 32.

[404] *See infra* Appendix B, § 25.226(b)(8).

[405] 47 C.F.R. §§ 1.1310, 2.1091.

[406] *See also* ViaSat Reply at 24-25 (stating that within the United States the battlefield conditions that General Dynamics notes do not exist and that we should not except certain government vehicles from labeling).

[407] ViaSat Reply at 23-24 (supports requirement that each VMES application include radiation hazard analysis detailing expected power levels in and around VMES terminal).

[408] ViaSat Reply at 24 and 24 n.72 (supports more careful consideration of the hazards related to parked vehicles because, it states, a VMES terminal operating from a parked vehicle might present greater hazard to the general population through longer signal exposure).

[409] *See* Raysat LMSS Application, *available at* http://licensing.fcc.gov/ibfsweb/ib.page.FetchAttachment?attachment_key=-110738; Qualcomm Incorporated, Application for Earth Station Authorizations, File No. SES-LIC-20040310-00359 (filed Mar. 10, 2004), *available at* http://licensing.fcc.gov/ibfsweb/ib.page.FetchAttachment?attachment_key=-62854; HNS License Sub, LLC, Application for Earth Station Modification, File No. SES-MOD-20080229-00216 (filed Feb. 29, 2008), *available at* http://licensing.fcc.gov/ibfsweb/ib.page.FetchAttachment?attachment_key=-143807.

along with the required RF hazard analysis and mitigation plan, should address ViaSat's concern about protecting the general public from parked vehicle RF emissions.

188. For the same reason we do not adopt Boeing's suggestion to impose a minimum antenna elevation angle. Boeing states that, for VMES as opposed to ESV, it may be impossible to limit the physical access of the public to areas surrounding the earth station and that VMES use of relatively low elevation angles in the United States might result in inadvertent transmissions into adjacent vehicles with higher profiles or into adjacent buildings.[410] As discussed above, our analysis of applications for VMES-like terminals demonstrates that the emitted power densities are expected to be low enough that no radiation exposure dangers will exist for the general public at any significant distance from the VMES terminal.

189. Finally, we address the suggestions of General Dynamics, SIA, ViaSat and Boeing for a transmission cessation requirement on downlink signal loss as a mitigation technique for RF radiation exposure. We agree with commenters that requiring VMES terminals to cease transmitting upon loss of the downlink signal would be an important interference protection feature, to assist in limiting interference to neighboring satellites. However, ceasing transmission upon loss of the downlink signal would not be a guaranteed method of avoiding radiation exposure to the general public. A partial downlink blockage situation could exist in which a person would be within the VMES transmit beam while the VMES terminal had sufficient downlink signal to maintain operation. Rather, as discussed above, we find that the approach adopted here of requiring VMES systems to comply with sections 1.1310 and 2.1091 of the rules will ensure the public safety. At the same time, we take into account commenters' arguments and find that we should adopt a general interference protection rule similar to the rule for VSATs.[411] Thus we adopt, in section 25.226(a)(9), a requirement for the VMES terminal to cease transmitting upon loss of the downlink signal.[412]

b. Equipment Certification

190. *Background.* In the *NPRM*, the Commission proposed to require equipment certification of VMES terminals pursuant to the Part 2 rules to ensure that they comply with the technical rules adopted for the service.[413] The Communications Act authorizes the Commission to make regulations to ensure that, before an RF device enters the stream of commerce, it complies with the appropriate technical rules to ensure that it will not cause harmful interference.[414] Pursuant to that authority, the Commission has adopted rules to establish the current device authorization policy that is known as the Commission's "certification" or "marketing" rules.[415] Under these rules, the majority of devices that "intentionally radiate" radio waves must be authorized as compliant with the rules before being marketed, sold, deployed or imported into the United States. The rules require certification of "portable earth station transceivers" and certain other small-aperture terminals.[416]

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[410] Boeing Comments at 31-32.

[411] *See* 47 C.F.R. § 25.134(h) (prohibiting VSAT operators from using remote earth stations in their networks that are not designed to stop transmissions when synchronization with the target satellite fails).

[412] *See* Appendix B, § 25.226(a)(9).

[413] *NPRM*, 22 FCC Rcd at 9681, ¶ 71.

[414] 47 U.S.C. § 302.

[415] *See* 47 C.F.R. §§ 2.1201-2.1207, 2.801 *et seq*.

[416] Portable earth station transceivers are those that are likely to be used within 20 centimeters of the body of the user or nearby persons. 47 C.F.R. §§ 25.129(b), 2.1093(b).

191. Commenters urge us to apply the same rules to VMES as are applicable to VSATs.[417] Raysat, SIA, and General Dynamics, for example, assert that VMES terminals will not be located within 20 centimeters of the body of a user or nearby person when the terminal is transmitting and thus by definition are not "portable earth station transceivers" pursuant to sections 25.129 and 2.1093 of the Commission's rules.[418] General Dynamics observes that the Commission's rules do not require equipment certification for FSS Ku-band terminals, including ESVs authorized under section 25.222.[419] It asserts that VMES terminals should be considered more analogous to FSS Ku-band VSAT operations than ancillary terrestrial components ("ATC") because ATC operations reasonably can be expected to result in radiating structures within 20 centimeters of the operator's body.[420] As to very small, very low-gain antennas with broader beam widths, where operators would be within the main beam even if several tens of degrees off boresight, General Dynamics asserts that the Qualcomm OmniTracs system, which the Commission licensed as an narrowband LMSS operator in 1989, has operated successfully for several years without unacceptable RF safety issues or equipment certification.[421]

192. *Discussion*. As discussed above, we agree with the parties that VMES antennas are unlikely to be used within 20 centimeters of the operator's body when the transceiver is in operation. Based on the record in this proceeding, we would expect that VMES terminals will be mounted on the exterior of vehicles in locations that are greater than 20 centimeters from an operator's body. Therefore, we agree with commenters that VMES terminals are not "portable devices" under section 25.129 of the rules and thus are not subject to equipment certification as portable earth station transceivers.[422] Where parties wish to seek certification of devices we will permit voluntary certification of VMES terminals.

8. Other Considerations

a. Limitations on Use of VMES

193. *Background*. In the *NPRM*, the Commission asked whether the aggregate emissions from large numbers of ultra-small VMES terminals used by the general public in varying locations throughout the United States might affect adjacent satellites farther than six degrees from the target satellite.[423] The Commission noted that, in adopting the interference avoidance requirements for a two-degree satellite

[417] SIA Comments at 22; Raysat Comments at 16; General Dynamics Comments at 58-60; ViaSat Reply at 23; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[418] Raysat Comments at 16; SIA Comments at 22; General Dynamics Comments at 58. *See also* 47 C.F.R. §§ 25.129(b), 2.1093(b) (defining "portable device").

[419] General Dynamics Comments at 58.

[420] General Dynamics Comments at 58-59 and 58 n.56.

[421] General Dynamics Comments at 59-60. General Dynamics states that the E.I.R.P.-density on the main beam of such terminals would be reduced significantly below the power-density of a larger antenna. General Dynamics Comments at 60. Thus, General Dynamics asserts that the proposed VMES E.I.R.P.-density limits already have inherent RF safety advantages that become more restrictive as antenna apertures are reduced. General Dynamics Comments at 60. *See also Qualcomm, Inc., Application for Blanket Authority to Construct and Operate a Network of 12/14 GHz Transmit/Receive Mobile and Transportable Earth Stations and a Hub Earth Station*, Memorandum Opinion, Order and Authorization, FCC 89-24, 4 FCC Rcd 1543 (1989) (authorizing Qualcomm to construct and operate a two-way satellite-based narrowband data communication network of mobile and transportable transmit/receive earth stations and to operate a fixed transmit/receive earth station serving as a hub for the network communicating with FSS satellites in the 12/14 GHz frequency bands).

[422] 47 C.F.R. § 25.129.

[423] *NPRM*, 22 FCC Rcd at 9681, ¶ 72.

spacing environment, it did not focus on the accuracy of antenna tracking systems mounted on moving cars or trucks.[424]

194. The Commission asked for comment on whether the scenario is likely and, if so, whether it should adopt rules to prevent such potential interference concerns.[425] For example, it asked whether it should: (1) adopt an E.I.R.P.-density envelope for VMES that takes into account possible interference to adjacent satellites farther than six degrees from the target satellite; or (2) prohibit general public use and allow only government use – such as military testing/training, homeland security and civil emergency applications – under the assumption that such applications likely would involve somewhat larger and better tracking antennas as well as operator training to mitigate against interference to neighboring satellites.[426]

195. Parties comment both on the likelihood of interference to fourth adjacent satellites and on the feasibility of restricting VMES to government use. SIA asserts that there is no need for VMES protection requirements extending beyond the immediately adjacent, second adjacent, and third adjacent satellites.[427] SIA states that doubling interference to a fourth adjacent satellite would result in a reduction in carrier-to-interference ratio of less than 0.1 dB.[428] General Dynamics states that the rules should not omit antenna pointing requirements because this omission might allow pointing excursions greater than six degrees.[429] CORF asserts that restricting Ku-band VMES use to government applications would reduce RAS interference.[430] SIA, Boeing, MTN, Americom, and Hughes, however, do not support restricting licensing to governmental uses.[431]

196. *Discussion*. We conclude that the technical rules we adopt today take a sufficiently conservative approach to the licensing of full-scale VMES operations that we do not need to adopt additional limitations on the use of ultra-small VMES terminals in order to protect adjacent FSS satellites, including those farther than six degrees from the target satellite. Thus, we decline, as a general rule, to adopt an E.I.R.P.-density envelope for VMES that is different from the envelope for ESVs or to limit use of VMES only to commercial contracts for government uses such as military testing/training, homeland security, and civil emergency applications.

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[424] *NPRM*, 22 FCC Rcd at 9681, ¶ 73, *citing generally to Two-Degree Spacing Order*, 54 Rad. Reg. 2d (P&F) 577 (1983). As noted, the current two-degree spacing rules limit the E.I.R.P.-density radiated from an FSS earth station antenna to the E.I.R.P.-density envelope and, with relatively large antennas, the radiated E.I.R.P.-density will approach the E.I.R.P.-density envelope within a degree or two of the main beam of the earth station antenna. *See NPRM*, 22 FCC Rcd at 9681-82, ¶ 73 and ¶ 73 n.163. In the *NPRM*, the Commission observed that, for very small antennas, the limiting E.I.R.P.-density may occur farther than six degrees away from the antenna main beam. *NPRM*, 22 FCC Rcd at 9681-82, ¶ 73 and ¶ 73 n.163. It stated that such a situation, if it should occur, would represent a departure from the long-standing assumptions underlying the two-degree spacing environment. *NPRM*, 22 FCC Rcd at 9681-82, ¶ 73.

[425] *NPRM*, 22 FCC Rcd at 9682, ¶ 74.

[426] *NPRM*, 22 FCC Rcd at 9682, ¶ 74-75.

[427] SIA Comments at 22-23.

[428] SIA Comments at 23.

[429] General Dynamics Comments at 31.

[430] CORF Comments at 9-10.

[431] SIA Comments at 24, Reply at 7; Boeing Comments at iii, 27; MTN Comments at 6, Reply at 3; Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

b. ATIS

197. As discussed below, we will not require VMES to use automatic transmitter identification systems ("ATIS").

198. *Background.* Since 1991, the Commission has required satellite uplink transmissions carrying broadband video information to use ATIS.[432] In the *NPRM*, the Commission sought comment on whether the VMES rules should include a requirement for ATIS.[433] The Commission sought comment on the format, information and structure of the characteristics of the identifying signal if ATIS were to be required for VMES systems.[434]

199. APTS/PBS and ARINC support an ATIS requirement for VMES.[435] APTS/PBS voices concern that VMES use of spread spectrum technology will result in an increase in transponder noise level. It states that the source of interference will be nearly impossible to locate using standard interference location systems.[436] ARINC asserts that we should require a VMES licensee to use ATIS and report VMES terminal locations to assist with determining interference sources.[437]

200. SIA, ViaSat, Americom and Hughes assert that ATIS is not necessary, as easily implemented for digital carriers, or beneficial.[438] SIA asserts that: (1) the geolocation information that network operators will capture can be used to accomplish the same purpose as ATIS; (2) ATIS is not as easily implemented for digital carriers as it is in the analog video generator used in the United States because, in any digital carrier, it is necessary to remove error control coding, scrambling, the spreading sequence, and possibly encryption to gain access to the information stream in which the terminal identification is located; and (3) under appropriate regulations, there will not be an influx of ultra-small antennas with unreliable tracking accuracies.[439] SIA contends that the application process provides sufficient opportunity to expose and reject proposals that may negatively impact existing FSS providers and their customers and thus will allow full achievement of the objectives sought by APTS/PBS without adopting ATIS and certain other proposals.[440] ViaSat opposes adoption of an ATIS requirement as an

[432] *See* 47 C.F.R. § 25.281 (requiring all satellite uplink transmissions carrying broadband video information to be identified through the use of a subcarrier modulation with ATIS information for the primary purpose of resolving interference). ATIS transmits an encoded subcarrier message including, at a minimum, the earth station's call sign, a telephone number providing immediate access to someone capable of resolving interference problems, and a unique ten-digit serial number. *See An Automatic Transmitter Identification System for Radio Transmitting Equipment*, First Report and Order, GEN Docket No. 86-337, 5 FCC Rcd 3256 (1990).

[433] *NPRM*, 22 FCC Rcd at 9682, ¶ 76.

[434] *NPRM*, 22 FCC Rcd at 9682, ¶ 76.

[435] APTS/PBS Comments at 3; ARINC Reply at 3.

[436] APTS/PBS Comments at 3.

[437] ARINC Reply at 3.

[438] SIA Comments at 24, Reply at 10; ViaSat Comments at 23 (stating ATIS requirement to radiate identifying signal strong enough to be detected would render moot the many benefits of using spread spectrum technology which, by transmitting extremely low-density signals not detectable to adjacent satellites, can prevent potential for adjacent satellite interference); Americom Comments at 1 (supports SIA Comments); Hughes Reply at 1 (endorses SIA Comments).

[439] SIA Comments at 24 and 24 n.46.

[440] SIA Reply at 10.

identifying mechanism, asserting that a requirement to radiate an identifying signal strong enough to be detected would negate the benefits of using spread spectrum technology.[441]

201. *Discussion.* We agree with SIA, ViaSat, Americom and Hughes that ATIS is unnecessary for VMES. We find that the data logging rules we adopt today will provide the basis to identify and resolve sources of interference.[442] Thus, we do not adopt an ATIS requirement for VMES.

c. Global Positioning Satellite ("GPS") Software for TDRSS and RAS Coordination

202. *Background.* In the *NPRM*, the Commission solicited comment on whether to require VMES terminals to incorporate specific technical measures, such as GPS-related software technology, to assist VMES operators in meeting coordination obligations.[443]

203. General Dynamics, MTN and Green Bank agree that it will be useful and relatively easy to implement GPS-related software technology to assist with TDRSS and RAS coordination. General Dynamics states that all VMES terminals are anticipated to make use of GPS-related technology to ensure signal acquisition and accurate antenna pointing.[444] Thus, General Dynamics asserts it would be practical for the Commission to mandate GPS-related technology to assist VMES operators to meet their coordination obligations and provide for automatic validation of any required geographic exclusion zones.[445] Likewise, Green Bank states that, as GPS receivers are already a part of VMES systems, adding exclusion zones would be a simple matter of programming the systems to disable transmissions while they are within an exclusion zone.[446] MTN states that GPS software designed to control transmissions can be used to implement coordination agreements.[447]

204. CORF asserts that the Commission should require technical measures such as GPS software, but asks the Commission to ensure that the relevant hardware or software is impervious to unauthorized modification by end users.[448] SIA replies that CORF's proposal for embedded hardware or software that is "reasonably impervious to unauthorized modification by end users" is both vague and unnecessary.[449]

205. General Dynamics proposes a rule provision stating that "VMES operators are required to utilize GPS-related or other similar position location technology to ensure mandated geographic non-

[441] ViaSat Comments at 23.

[442] *See supra* Section III.C.4.

[443] *NPRM*, 22 FCC Rcd at 9666, ¶ 32, 9668, ¶ 38.

[444] General Dynamics Comments at 45.

[445] General Dynamics Comments at 45.

[446] Green Bank Comments at 1.

[447] MTN Comments at 3-4.

[448] CORF Comments at 6-7. CORF also questions whether technical measures such as GPS software, among other things, will be sufficient to protect RAS facilities. *Id.* at 7-8. As discussed *supra* in Section III.B.4, CORF alternatively seeks other requirements, such as prohibiting VMES altogether in the 14.47-14.5 GHz band and requiring coordination as a prerequisite to licensing.

[449] SIA Reply at 6.

transmission regions are automatically observed without the need for operator intervention."[450] No commenter opposed the rule provision suggested by General Dynamics.

206. *Discussion*. We adopt General Dynamics' proposed rule provision, as set forth in Appendix B to this Report and Order, at section 25.226(e). Moreover, we agree with SIA that requiring embedded hardware or software to be "reasonably impervious to unauthorized modification by end users" is vague and unnecessary and do not adopt CORF's proposal.[451]

IV. CONCLUSION

207. In this Report and Order, we adopt new domestic, U.S. allocations and technical and licensing rules for VMES terminals operating in the conventional and extended Ku-band frequencies within the United States. The rule changes will promote innovative and flexible uses of satellite technology that have the potential to increase broadband communications capabilities that will benefit various U.S. emergency preparedness and commercial objectives.

208. We define VMES as an earth station operating from a motorized vehicle that travels primarily on land, receives from and transmits to Ku-band GSO FSS space stations, and operates within the United States pursuant to the requirements set out in Part 25 of the Commission's rules. We adopt two non-Federal footnotes to the U.S. Table: (1) in the conventional Ku-bands, VMES as regulated under a revised Part 25 of our rules is an application of the FSS and licensees may be authorized to communicate with space stations of the FSS on a primary basis; and (2) in the relevant extended Ku-bands, VMES licensees must accept interference from stations in the FS operating in accordance with Commission rules. We require VMES licensees to coordinate their proposed operations with Federal SRS and RAS stations in, respectively, the 14.0-14.2 GHz and 14.47-14.5 GHz bands. We adopt a VMES off-axis E.I.R.P.-density mask that reflects recent changes to Part 25. We adopt antenna pointing requirements and other technical and licensing rules.

V. PROCEDURAL MATTERS

A. Final Regulatory Flexibility Analysis

209. Pursuant to the Regulatory Flexibility Act ("RFA"),[452] the *NPRM* incorporated an Initial Regulatory Flexibility Analysis ("IRFA"). The Commission sought written public comments on the possible significant economic impact of the proposed policies and rules on small entities in the *NPRM,* including comments on the IRFA. No one commented specifically on the IRFA. Pursuant to the RFA, Appendix C provides a Final Regulatory Flexibility Analysis. It assesses the effects of adopting new allocation and licensing rules on small business concerns, and finds that the point of contact and data logging requirements set out in the new rules will assist in investigating radio frequency interference claims without expected significant costs or burden of compliance for smaller entities.

[450] General Dynamics Comments at 46.

[451] We observe that unauthorized end user modification of transmitting hardware, causing interference, would be an enforcement matter than could result in seizure of such hardware. The data collection, retention and availability requirements discussed above will ensure the availability of data in the event we are presented with an interference concern. *See supra* Section III.C.4. We also note that CORF's proposal would be impractical and counterproductive to ongoing VMES-RAS coordination if, for example, it were to require VMES operators to update the software through physical installation in each VMES unit, rather than downloading and storing new software data within each unit's reprogrammable memory.

[452] *See* 5 U.S.C. § 603. The RFA has been amended by the Contract with America Advancement Act of 1996, Pub. L. No. 104-121, 110 Stat. 847 (1996) ("CWAAA"). Title II of the CWAAA is the Small Business Regulatory Enforcement Fairness Act of 1996.

B. Final Paperwork Reduction Act of 1995 Analysis

210. In the *NPRM*, the Commission analyzed the actions we now adopt in this Report and Order with respect to the Paperwork Reduction Act of 1995. The Report and Order modifies the data collection frequency intervals from the 20 minutes proposed in the *NPRM* to five minutes, based on the comments received from parties to the proceeding. This modification takes into account the more frequent directional changes and relevant vehicle speeds that are likely to result in more frequent VMES antenna pointing changes. This document contains new information collection requirements subject to the Paperwork Reduction Act of 1995 ("PRA"), Public Law 104-13. It will be submitted to the Office of Management and Budget ("OMB") for review under section 3507(d) of the PRA. OMB, the general public, and other Federal agencies are invited to comment on the new information collection requirements contained in this proceeding.

VI. ORDERING CLAUSES

211. Accordingly, IT IS ORDERED that, pursuant to the authority contained in Sections 4(i), 4(j), 7(a), 302(a), 303(c), 303(e), 303(f), 303(g), 303(j), 303(r), and 303(y) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 154(j), 157(a), 302(a), 303(c), 303(e), 303(f), 303(g), 303(j), 303(r), 303(y), this Report and Order in IB Docket No. 07-101 IS ADOPTED.

212. IT IS FURTHER ORDERED that Parts 2 and 25 of the Commission's rules ARE AMENDED as set forth in Appendix B. An announcement of the effective date of these rule revisions will be published in the Federal Register.

213. IT IS FURTHER ORDERED that the final regulatory flexibility analysis, as required by section 604 of the Regulatory Flexibility Act, IS ADOPTED.

214. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center SHALL SEND a copy of this Report and Order, including the final regulatory flexibility analysis, to the Chief Counsel for Advocacy of the Small Business Administration, in accordance with section 603(a) of the Regulatory Flexibility Act, 5 U.S.C. § 601, *et seq*.

215. IT IS FURTHER ORDERED that the Commission SHALL SEND a copy of this Report and Order in a report to be sent to Congress and the General Accountability Office pursuant to the Congressional Review Act, 5 U.S.C. § 801(a)(1)(A).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

List of Comments and Commenters

Comments
Americom (filed Aug. 20, 2007 with Motion to Accept Late-Filed Comments)
APTS/PBS
ARINC
Boeing
CORF
FWCC
General Dynamics
Green Bank
Intellicom (filed August 23, 2007 with Aug. 29, 2007 Motion to Accept Comments)
MTN
NSMA
Raysat
SIA
ViaSat

Reply Comments
Americom
ARINC
Boeing
Hughes
MTN
Raysat
SIA
ViaSat

Ex Parte Filings
Boeing
General Dynamics
Hughes
NTIA
ViaSat

APPENDIX B

Final Rules

For the reasons set forth in the preamble, parts 2 and 25 of title 47 of the Code of Federal Regulations are amended as follows:

PART 2 – FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS

1. The authority citation for part 2 continues to read as follows:

Authority: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

2. Section 2.106 is amended as follows:

a. Revise pages 45, 46, and 47.

b. In the list of Non-Federal Government (NG) Footnotes, add footnotes NG186 and NG187.

§ 2.106 Table of Frequency Allocations.

The additions and revisions read as follows:

* * * * *

International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
10-10.45 FIXED MOBILE RADIOLOCATION Amateur 5.479	10-10.45 RADIOLOCATION Amateur 5.479 5.480	10-10.45 FIXED MOBILE RADIOLOCATION Amateur 5.479	10-10.45 RADIOLOCATION G32 5.479 US58 US108	10-10.45 Amateur Radiolocation 5.479 US58 US108 NG42	Private Land Mobile (90) Amateur (97)
10.45-10.5 RADIOLOCATION Amateur Amateur-satellite 5.481			10.45-10.5 RADIOLOCATION G32 US58 US108	10.45-10.5 Amateur Amateur-satellite Radiolocation US58 US108 NG42 NG134	
10.5-10.55 FIXED MOBILE Radiolocation	10.5-10.55 FIXED MOBILE RADIOLOCATION		10.5-10.55 RADIOLOCATION US59		Private Land Mobile (90)
10.55-10.6 FIXED MOBILE except aeronautical mobile Radiolocation			10.55-10.6	10.55-10.6 FIXED	Fixed Microwave (101)
10.6-10.68 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) Radiolocation 5.149 5.482			10.6-10.68 EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) US265 US277	10.6-10.68 EARTH EXPLORATION-SATELLITE (passive) FIXED US265 SPACE RESEARCH (passive) US277	
10.68-10.7 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.483			10.68-10.7 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY US74 SPACE RESEARCH (passive) US246 US355		
10.7-11.7 FIXED FIXED-SATELLITE (space-to-Earth)	10.7-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 5.484A MOBILE except aeronautical mobile		10.7-11.7	10.7-11.7 FIXED FIXED-SATELLITE (space-to-	Satellite Communications (25) Fixed Microwave (101)

5.441 5.484A (Earth-to-space) 5.484 MOBILE except aeronautical mobile			US211	Earth) 5.441 US211 US355 NG104 NG182 NG186	
11.7-12.5 FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE	11.7-12.1 FIXED 5.486 FIXED-SATELLITE (space-to-Earth) 5.484A Mobile except aeronautical mobile 5.485 5.488	11.7-12.2 FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE	11.7-12.2	11.7-12.2 FIXED-SATELLITE (space-to- Earth) NG143 NG145 NG183 NG187	Satellite Communications (25)
	12.1-12.2 FIXED-SATELLITE (space-to-Earth) 5.484A 5.485 5.488 5.489	5.487 5.487A 5.492		5.488 NG184	

5.487 5.487A 5.492	12.2-12.7 FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE 5.487A 5.488 5.490 5.492	12.2-12.5 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile BROADCASTING 5.484A 5.487	12.2-12.75	12.2-12.7 FIXED BROADCASTING-SATELLITE 5.487A 5.488 5.490	Satellite Communications (25) Fixed Microwave (101)
12.5-12.75 FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.494 5.495 5.496	12.7-12.75 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE except aeronautical mobile	12.5-12.75 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A MOBILE except aeronautical mobile BROADCASTING-SATELLITE 5.493		12.7-12.75 FIXED NG118 FIXED-SATELLITE (Earth-to-space) MOBILE	TV Broadcast Auxiliary (74F) Cable TV Relay (78) Fixed Microwave (101)
12.75-13.25 FIXED FIXED-SATELLITE (Earth-to-space) 5.441 MOBILE Space research (deep space) (space-to-Earth)			12.75-13.25 US251	12.75-13.25 FIXED NG118 FIXED-SATELLITE (Earth-to-space) 5.441 NG104 MOBILE US251 NG53	Satellite Communications (25) TV Broadcast Auxiliary (74F) Cable TV Relay (78) Fixed Microwave (101)
13.25-13.4 EARTH EXPLORATION-SATELLITE (active) AERONAUTICAL RADIONAVIGATION 5.497 SPACE RESEARCH (active) 5.498A 5.499			13.25-13.4 EARTH EXPLORATION-SATELLITE (active) AERONAUTICAL RADIONAVIGATION 5.497 SPACE RESEARCH (active) 5.498A	13.25-13.4 AERONAUTICAL RADIONAVIGATION 5.497 Earth exploration-satellite (active) Space research (active)	Aviation (87)
13.4-13.75 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.501A Standard frequency and time signal-satellite (Earth-to-space)			13.4-13.75 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION G59 SPACE RESEARCH 5.501A Standard frequency and	13.4-13.75 Earth exploration-satellite (active) Radiolocation Space research Standard frequency and	Private Land Mobile (90)

5.499 5.500 5.501 5.501B	time signal-satellite (Earth-to-space) 5.501B	time signal-satellite (Earth-to-space)	
13.75-14 FIXED-SATELLITE (Earth-to-space) 5.484A RADIOLOCATION Earth exploration-satellite Standard frequency and time signal-satellite (Earth-to-space) Space research 5.499 5.500 5.501 5.502 5.503	13.75-14 RADIOLOCATION G59 Standard frequency and time signal-satellite (Earth-to-space) Space research US337 US356 US357	13.75-14 FIXED-SATELLITE (Earth-to-space) US337 Standard frequency and time signal-satellite (Earth-to-space) Space research Radiolocation US356 US357	Satellite Communications (25) Private Land Mobile (90)
14-14.25 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504C 5.506A Space research 5.504A 5.505	14-14.2 Space research	14-14.2 FIXED-SATELLITE (Earth-to-space) NG183 NG187 Mobile-satellite (Earth-to-space) Space research	Satellite Communications (25)

International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
(See previous page)			14.2-14.4	14.2-14.47 FIXED-SATELLITE (Earth-to-space) NG183 NG187 Mobile-satellite (Earth-to-space)	Satellite Communications (25)
14.25-14.3 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.506A 5.508A Space research 5.504A 5.505 5.508 5.509					
14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.506A 5.509A Radionavigation-satellite 5.504A	14.3-14.4 FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B Mobile-satellite (Earth-to-space) 5.506A Radionavigation-satellite 5.504A	14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.506A 5.509A Radionavigation-satellite 5.504A			
14.4-14.47 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.506A 5.509A Space research (space-to-Earth) 5.504A			14.4-14.47 Fixed Mobile	NG184	
14.47-14.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radio astronomy 5.149 5.504A			14.47-14.5 Fixed Mobile US203 US342	14.47-14.5 FIXED-SATELLITE (Earth-to-space) NG183 NG187 Mobile-satellite (Earth-to-space) US203 US342	
14.5-14.8			14.5-14.7145	14.5-14.8	

FIXED FIXED-SATELLITE (Earth-to-space) 5.510 MOBILE Space research	FIXED Mobile Space research 14.7145-14.8 MOBILE Fixed Space research		
14.8-15.35 FIXED MOBILE Space research	14.8-15.1365 MOBILE SPACE RESEARCH Fixed US310	14.8-15.1365 US310	
	15.1365-15.35 FIXED SPACE RESEARCH Mobile	15.1365-15.35 	
5.339	5.339 US211	5.339 US211	

* * * * *

NON-FEDERAL GOVERNMENT (NG) FOOTNOTES

* * * * *

NG186 In the bands 10.95-11.2 GHz and 11.45-11.7 GHz (space-to-Earth), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 may be authorized to communicate with geostationary satellite orbit space stations of the fixed-satellite service but must accept interference from stations of the fixed service operating in accordance with the Commission's Rules.

NG187 In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), Vehicle-Mounted Earth Stations (VMES) as regulated under 47 CFR part 25 are an application of the fixed-satellite service and may be authorized to communicate with geostationary satellite orbit space stations of the fixed-satellite service on a primary basis.

* * * * *

PART 25 – SATELLITE COMMUNICATIONS

3. The authority citation for Part 25 continues to read as follows:

AUTHORITY: 47 U.S.C. 701-744. Interprets or applies Sections 4, 301, 302, 303, 307, 309 and 332 of the Communications Act, as amended, 47 U.S.C. Sections 154, 301, 302, 303, 307, 309 and 332, unless otherwise noted.

4. Part 25 is amended by adding new Section 25.226 to the Table of Contents to read as follows:

* * * * *

§ 25.226 Blanket Licensing provisions for domestic, U.S. Vehicle-Mounted Earth Stations (VMESs) receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), and 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.

* * * * *

5. Section 25.115 is amended by revising paragraph (a)(2)(iii) to read as follows:

§ 25.115 Application for earth station authorizations.

* * * * *

(a)(2)(iii) The earth station is not an ESV or a VMES.

* * * * *

6. Section 25.130 is amended by revising paragraph (a) to read as follows:

§ 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 Vehicle-Mounted Earth Stations are described in § 25.226 of this part. In addition, applicants not required to submit applications on Form 312EZ, other than ESV or VMES 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:

* * * * *

7. Section 25.132 is amended by revising paragraph (b)(3) to read as follows:

§ 25.132 Verification of earth station antenna performance standards.

* * * * *

(b)(3) Applicants seeking authority to use an antenna that does not meet the standards set forth in §§ 25.209(a) and (b), pursuant to the procedure set forth in § 25.220, § 25.221, § 25.222, § 25.223 or § 25.226 of this part, are required to submit a copy of the manufacturer's range test plots of the antenna gain patterns specified in paragraph (b)(1) of this section.

* * * * *

8. Section 25.201 is amended by adding the following definition in alphabetical order to read as follows:

§ 25.201 Definitions.

* * * * *

Vehicle-Mounted Earth Station (VMES). A VMES is an earth station, operating from a motorized vehicle that travels primarily on land, that receives from and transmits to geostationary satellite orbit fixed-satellite service space stations and operates within the United States pursuant to the requirements set out § 25.226 of this part.

* * * * *

9. Section 25.202 is amended by adding paragraph (a)(10) to read as follows:

§ 25.202 Frequencies, frequency tolerance and emission limitations.

* * * * *

(a)(10) The following frequencies are available for use by Vehicle-Mounted Earth Stations (VMESs):

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)

VMESs shall be authorized as set forth in § 25.226 of this chapter.

* * * * *

10. Section 25.203 is amended by revising paragraphs (d) and (k) and the introductory language in paragraph (c) to read as follows:

§ 25.203 Choice of sites and frequencies.

* * * * *

(c) Prior to the filing of its application, an applicant for operation of an earth station, other than an ESV or a VMES, 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 a VMES, 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 a VMES, 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.

* * * * *

11. Section 25.204 is amended by adding paragraph (j) to read as follows:

§ 25.204 Power limits.

* * * * *

(j) Within 125 km of the Tracking and Data Relay System Satellite (TDRSS) sites identified in § 25.226(c) of this chapter, VMES transmissions in the 14.0-14.2 GHz (Earth-to-space) band shall not

exceed an EIRP spectral density towards the horizon of 12.5 dBW/MHz, and shall not exceed an EIRP towards the horizon of 16.3 dBW.

12. Section 25.205 is amended by adding paragraph (c) to read as follows:

§ 25.205 Minimum angle of antenna elevation.

* * * * *

(c) VMESs making a special showing requesting angles of elevation less than 5° measured from the horizontal plane to the direction of maximum radiation pursuant to (a) of this section must still meet the EIRP and EIRP density towards the horizon limits contained in § 25.204(**j**) of this chapter.

13. Section 25.209(f) is amended to read as follows:

§ 25.209 Antenna performance standards.

* * * * *

(f) An earth station with an antenna not conforming to the standards of paragraphs (a) and (b) of this section will be authorized only if the applicant meets its burden of demonstrating that its antenna will not cause unacceptable interference. For ESVs in the C-band, this demonstration must comply with the procedures set forth in § 25.221. For ESVs in the Ku-band, this demonstration must comply with the procedures set forth in § 25.222. For VMES, this demonstration shall comply with the procedures set forth in § 25.226. For feeder-link earth stations in the 17/24 GHz BSS, this demonstration must comply with the procedures set forth in § 25.223. For other FSS earth stations, this demonstration must comply with the procedures set forth in §§ 25.218 or 25.220. In any case, the Commission will impose appropriate terms and conditions in its authorization of such facilities and operations.

* * * * *

14. Section 25.218 is amended by modifying paragraph (a)(1) to read as follows:

§ 25.218 Off-Axis EIRP envelope for FSS earth station operators.

* * * * *

(a)(1) ESV and VMES applications

* * * * *

15. Section 25.220 is amended by amending the introductory language to paragraph (a)(1) to read as follows:

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

* * * * *

(a)(1) This section applies to earth station applications other than ESV, VMES and 17/24 GHz BSS feeder link applications in which the proposed earth station operations do not fall within the applicable off-axis EIRP envelope specified in Section 25.218 of this Chapter.

* * * * *

16. Part 25 is amended by adding new Section 25.226 to read as follows:

§ 25.226 Blanket Licensing provisions for domestic, U.S. Vehicle-Mounted Earth Stations (VMESs) receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), and 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.

(a) The following ongoing requirements govern all VMES licensees and operations 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) and 14.0-14.5 GHz (Earth-to-space) frequency bands receiving from and transmitting to geostationary orbit satellites in the fixed-satellite service. VMES licensees shall comply with the requirements in either paragraph (a)(1), (a)(2) or (a)(3) of this section and all of the requirements set forth in paragraphs (a)(4)-(a)(9) and paragraphs (c), (d), and (e) of this section. Paragraph (b) of this section identifies items that shall be included in the application for VMES operations to demonstrate that these ongoing requirements will be met.

(1) The following requirements shall apply to a VMES that uses transmitters with off-axis EIRP spectral-densities lower than or equal to the levels in paragraph (a)(1)(i) of this subsection. A VMES, or VMES system, operating under this subsection shall provide a detailed demonstration as described in paragraph (b)(1) of this section. The VMES transmitter also shall comply with the antenna pointing and cessation of emission requirements in paragraphs (a)(1)(ii) and (a)(1)(iii) of this subsection.

(i) A VMES system shall not exceed the off-axis EIRP spectral-density limits and conditions defined in paragraphs (a)(1)(A)-(D) of this subsection.

(A) The off-axis EIRP spectral-density emitted from the VMES, in the plane of the geostationary satellite orbit (GSO) as it appears at the particular earth station location, shall not exceed the following values:

15 - 10log(N) - 25logθ	dBW/4 kHz	for	$1.5° \leq \theta \leq 7°$
-6 -10log(N)	dBW/4 kHz	for	$7° < \theta \leq 9.2°$
18 -10log(N) - 25logθ	dBW/4 kHz	for	$9.2° < \theta \leq 48°$
-24 -10log(N)	dBW/4 kHz	for	$48° < \theta \leq 85°$
-14 -10log(N)	dBW/4 kHz	for	$85° < \theta \leq 180°$

where theta (θ) is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital location of the target satellite. For VMES networks using frequency division multiple access (FDMA) or time division multiple access (TDMA) techniques, N is equal to one. For VMES networks using multiple co-frequency transmitters that have the same EIRP, N is the maximum expected

number of co-frequency simultaneously transmitting VMES earth stations in the same satellite receiving beam. For the purpose of this subsection, the peak EIRP of an individual sidelobe shall not exceed the envelope defined above for θ between 1.5° and 7.0°. For θ greater than 7.0°, the envelope shall be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.

(B) In all directions other than along the GSO, the off-axis EIRP spectral-density for co-polarized signals emitted from the VMES shall not exceed the following values:

18 - 10log(N) - 25logθ	dBW/4 kHz	for	$3.0° \leq \theta \leq 48°$
-24 - 10log(N)	dBW/4 kHz	for	$48° < \theta \leq 85°$
-14 - 10log(N)	dBW/4kHz	for	$85° < \theta \leq 180°$

where θ and N are defined in (a)(1)(i)(A). This off-axis EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the orbital location of the target satellite with the exception of the plane of the GSO as defined in paragraph (a)(1)(i)(A) of this section. For the purpose of this subsection, the envelope shall be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.

(C) In all directions, the off-axis EIRP spectral-density for cross-polarized signals emitted from the VMES shall not exceed the following values:

5 - 10log(N) - 25logθ	dBW/4 kHz	for	$1.8° \leq \theta \leq 7.0°$
-16 - 10log(N)	dBW/4 kHz	for	$7.0° < \theta \leq 9.2°$

where θ and N are defined as set forth in paragraph (a)(1)(i)(A) of this section. This EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the target satellite.

(D) For non-circular VMES antennas, the major axis of the antenna shall be aligned with the tangent to the arc of the GSO at the orbital location of the target satellite, to the extent required to meet the specified off-axis EIRP spectral-density criteria.

(ii) Each VMES transmitter shall meet one of the following antenna pointing requirements:

(A) Each VMES transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna, or

(B) Each VMES transmitter shall declare a maximum antenna pointing error that may be greater than 0.2° provided that the VMES does not exceed the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section, taking into account the antenna pointing error.

(iii) Each VMES transmitter shall meet one of the following cessation of emission requirements:

(A) For VMESs operating under paragraph (a)(1)(ii)(A) of this section, all emissions from the VMES shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds 0.5°, and transmission shall not resume until such angle is less than or equal to 0.2°, or

(B) For VMES transmitters operating under paragraph (a)(1)(ii)(B) of this section, all emissions from the VMES shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds the declared maximum antenna pointing error and shall not resume transmissions until such angle is less than or equal to the declared maximum antenna pointing error.

(2) The following requirements shall apply to a VMES that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) of this section. A VMES, or VMES system, operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraph (b)(2) of this section.

(i) The VMES shall transmit only to the target satellite system(s) referred to in the certifications required by paragraph (b)(2) of this section.

(ii) If a good faith agreement cannot be reached between the target satellite operator and the operator of a future satellite that is located within 6 degrees longitude of the target satellite, the VMES operator shall accept the power-density levels that would accommodate that adjacent satellite.

(iii) The VMES shall operate in accordance with the off-axis EIRP spectral-densities that the VMES supplied to the target satellite operator in order to obtain the certifications listed in paragraph (b)(2) of this section. The VMES shall automatically cease emissions within 100 milliseconds if the VMES transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator.

(3) The following requirements shall apply to a VMES system that uses variable power-density control of individual simultaneously transmitting co-frequency VMES earth stations in the same satellite receiving beam. A VMES system operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraph (b)(3) of this section.

(i) Except as defined under subsection (a)(3)(ii) below, the effective aggregate EIRP-density from all terminals shall be at least 1 dB below the off-axis EIRP-density limits defined in (a)(1)(i)(A)-(C). In this context the term “effective” means that the resultant co-polarized and cross-polarized EIRP-density experienced by any GSO or non-GSO

satellite shall not exceed that produced by a single VMES transmitter operating 1 dB below the limits defined in (a)(1)(i)(A)-(C). A VMES system operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraphs (b)(3)(i) and (b)(3)(iii) of this section.

(ii) The following requirements shall apply to a VMES that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(3)(i) of this section. A VMES system operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraphs (b)(3)(ii) and (b)(3)(iii) of this section.

(A) If a good faith agreement cannot be reached between the target satellite operator and the operator of a future satellite that is located within 6 degrees longitude of the target satellite, the VMES shall operate at an EIRP-density defined in (a)(3)(i) of this section.

(B) The VMES shall operate in accordance with the off-axis EIRP spectral-densities that the VMES supplied to the target satellite operator in order to obtain the certifications listed in paragraph (b)(3)(ii) of this section. The individual VMES terminals shall automatically cease emissions within 100 milliseconds if the VMES transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator. The overall system shall be capable of shutting off an individual transmitter or the entire system if the aggregate off-axis EIRP spectral-densities exceed those supplied to the target satellite operator.

(C) The VMES shall transmit only to the target satellite system(s) referred to in the certifications required by paragraph (b)(3) of this section.

(iii) The VMES shall file a report one year following license issuance detailing the effective aggregate EIRP-density levels resulting from its operation, in compliance with paragraph (b)(3)(iii) of this section.

(4) An applicant filing to operate a VMES terminal or system and planning to use a contention protocol shall certify that its contention protocol use will be reasonable.

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

(6) For each VMES transmitter, a record of the vehicle 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 one (1) year. Records shall be recorded at time intervals no greater than every five (5) minutes while the VMES is transmitting. The VMES operator shall make this data available upon request to a coordinator, fixed system operator, fixed-satellite system operator, NTIA, or the Commission within 24 hours of the request.

(7) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands VMESs 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.

(8) A VMES terminal receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth) and 11.7-12.2 GHz (space-to-Earth) bands shall receive protection from interference caused by space stations other than the target space station only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in paragraphs (a) and (b) of section 25.209 and stationary at the location at which any interference occurred.

(9) Each VMES terminal shall automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal.

(b) Applications for VMES operation in the 14.0-14.5 GHz (Earth-to-space) band to GSO satellites in the fixed-satellite service shall include, in addition to the particulars of operation identified on Form 312, and associated Schedule B, the applicable technical demonstrations in paragraphs (b)(1), (b)(2) or (b)(3) and the documentation identified in paragraphs (b)(4) through (b)(8) of this section.

(1) A VMES applicant proposing to implement a transmitter under paragraph (a)(1) of this section shall demonstrate that the transmitter meets the off-axis EIRP spectral-density limits contained in paragraph (a)(1)(i) of this section. To provide this demonstration, the application shall include the tables described in paragraph (b)(1)(i) of this section or the certification described in paragraph (b)(1)(ii) of this section. The VMES applicant also shall provide the value N described in paragraph (a)(1)(i)(A) of this section. A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall provide the certifications identified in paragraph (b)(1)(iii) of this section. A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall provide the demonstrations identified in paragraph (b)(1)(iv) of this section.

(i) Any VMES applicant filing an application pursuant to paragraph (a)(1) of this section shall file three tables showing the off-axis EIRP level of the proposed earth station antenna in the direction of the plane of the GSO; the co-polarized EIRP in the elevation plane, that is, the plane perpendicular to the plane of the GSO; and cross-polarized EIRP. Each table shall provide the EIRP level at increments of 0.1° for angles between 0° and 10° off-axis, and at increments of 5° for angles between 10° and 180° off-axis.

(A) For purposes of the off-axis EIRP table in the plane of the GSO, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital position of the target satellite.

(B) For purposes of the off-axis co-polarized EIRP table in the elevation plane, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the elevation plane is defined as the plane perpendicular to the plane of the GSO defined in paragraph (b)(1)(i)(A) of this section.

(C) For purposes of the cross-polarized EIRP table, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite and the plane of the GSO as defined in paragraph (b)(1)(i)(A) of this section will be used.

(ii) A VMES applicant shall include a certification, in Schedule B, that the VMES antenna conforms to the gain pattern criteria of § 25.209(a) and (b), that, combined with the maximum input power density calculated from the EIRP density less the antenna gain, which is entered in Schedule B, demonstrates that the off-axis EIRP spectral density envelope set forth in paragraphs (a)(1)(i)(A) through (a)(1)(i)(C) of this section will be met under the assumption that the antenna is pointed at the target satellite.

(iii) A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall provide a certification from the equipment manufacturer stating that the antenna tracking system will maintain a pointing error of less than or equal to 0.2º between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna and that the antenna tracking system is capable of ceasing emissions within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds 0.5°.

(iv) A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall:

(A) declare, in its application, a maximum antenna pointing error and demonstrate that the maximum antenna pointing error can be achieved without exceeding the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section; and

(B) demonstrate that the VMES transmitter can detect if the transmitter exceeds the declared maximum antenna pointing error and can cease transmission within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds the declared maximum antenna pointing error, and will not resume transmissions until the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna is less than or equal to the declared maximum antenna pointing error.

(2) A VMES applicant proposing to implement a transmitter under paragraph (a)(2) of this section and using off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) of this section shall provide the following certifications and demonstration as exhibits to its earth station application:

(i) A statement from the target satellite operator certifying that the proposed operation of the VMES has the potential to create harmful interference to satellite networks adjacent to the target satellite(s) that may be unacceptable.

(ii) A statement from the target satellite operator certifying that the power density levels that the VMES applicant provided to the target satellite operator are consistent with the existing coordination agreements between its satellite(s) and the adjacent satellite systems within 6° of orbital separation from its satellite(s).

(iii) A statement from the target satellite operator certifying that it will include the power-density levels of the VMES applicant in all future coordination agreements.

(iv) A demonstration from the VMES operator that the VMES system is capable of detecting and automatically ceasing emissions within 100 milliseconds when the transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator.

(3) A VMES applicant proposing to implement a VMES system under paragraph (a)(3) of this section and using variable power-density control of individual simultaneously transmitting co-frequency VMES earth stations in the same satellite receiving beam shall provide the following certifications and demonstration as exhibits to its earth station application:

(i) The applicant shall make a detailed showing of the measures it intends to employ to maintain the effective aggregate EIRP-density from all simultaneously transmitting co-frequency terminals operating with the same satellite transponder at least 1 dB below the EIRP-density limits defined in paragraphs (a)(1)(i)(A)-(C) of this section. In this context the term "effective" means that the resultant co-polarized and cross-polarized EIRP-density experienced by any GSO or non-GSO satellite shall not exceed that produced by a single VMES transmitter operating at 1 dB below the limits defined in paragraphs (a)(1)(i)(A)-(C) of this section. The International Bureau will place this showing on Public Notice along with the application.

(ii) An applicant proposing to implement a VMES under (a)(3)(ii) of this section that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(3)(i) of this section shall provide the following certifications, demonstration and list of satellites as exhibits to its earth station application:

(A) A detailed showing of the measures the applicant intends to employ to maintain the effective aggregate EIRP-density from all simultaneously transmitting co-frequency terminals operating with the same satellite transponder at the EIRP-density limits supplied to the target satellite operator. The International Bureau will place this showing on Public Notice along with the application.

(B) A statement from the target satellite operator certifying that the proposed operation of the VMES has the potential to create harmful interference to satellite networks adjacent to the target satellite(s) that may be unacceptable.

(C) A statement from the target satellite operator certifying that the aggregate power density levels that the VMES applicant provided to the target satellite operator are consistent with the existing coordination agreements between its satellite(s) and the adjacent satellite systems within 6° of orbital separation from its satellite(s).

(D) A statement from the target satellite operator certifying that it will include the aggregate power-density levels of the VMES applicant in all future coordination agreements.

(E) A demonstration from the VMES operator that the VMES system is capable of detecting and automatically ceasing emissions within 100 milliseconds when an individual transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator and that the overall system is capable of shutting off

an individual transmitter or the entire system if the aggregate off-axis EIRP spectral-densities exceed those supplied to the target satellite operator.

(F) An identification of the specific satellite or satellites with which the VMES system will operate.

(iii) The applicant shall acknowledge that it will maintain sufficient statistical and technical information on the individual terminals and overall system operation to file a detailed report, one year after license issuance, describing the effective aggregate EIRP-density levels resulting from the operation of the VMES system.

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

(5) Any VMES applicant filing for a VMES terminal or system and planning to use a contention protocol shall include in its application a certification that will comply with the requirements of paragraph (a)(4) of this section.

(6) The point of contact referred to in paragraph (a)(5) of this section shall be included in the application.

(7) Any VMES applicant filing for a VMES terminal or system shall include in its application a certification that will comply with the requirements of paragraph (a)(6) of this section.

(8) All VMES applicants shall submit a radio frequency hazard analysis determining via calculation, simulation, or field measurement whether VMES terminals, or classes of terminals, will produce power densities that will exceed the Commission's radio frequency exposure criteria. VMES applicants with VMES terminals that will exceed the guidelines in Section 1.1310 for radio frequency radiation exposure shall provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines. All VMES licensees shall ensure installation of VMES terminals on vehicles by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons operating the vehicle and equipment. A VMES terminal exhibiting radiation exposure levels exceeding 1.0 mW/cm² in accessible areas, such as at the exterior surface of the radome, shall have a label attached to the surface of the terminal warning about the radiation hazard and shall include thereon a diagram showing the regions around the terminal where the radiation levels could exceed 1.0 mW/cm². All VMES licensees shall ensure that a VMES terminal ceases transmission upon encountering an obstruction that degrades the VMES downlink signal.

(c) (1) Operations of VMESs in the 14.0-14.2 GHz (Earth-to-space) frequency band within 125 kms of the NASA TDRSS facilities on Guam (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 with the National Aeronautics and Space Administration (NASA) through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.

(2) 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's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band VMES licensees shall cease operations in the 14.0-14.2 GHz band within 125 kms of the new TDRSS site until the licensees complete coordination with NTIA/IRAC for the new TDRSS facility. Licensees shall notify the International Bureau once they have completed coordination for the new TDRSS site. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The VMES licensee then will be permitted to commence operations in the 14.0-14.2 GHz band within 125 kms of the new TDRSS site, subject to any operational constraints developed in the coordination process.

(d) (1) Operations of VMESs in the 14.47-14.5 GHz (Earth-to-space) frequency band in the vicinity of radio astronomy service (RAS) observatories observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF). The appropriate NSF contact point to initiate coordination is Electromagnetic Spectrum Manager, NSF, 4201 Wilson Blvd., Suite 1045, Arlington VA 22203, fax 703-292-9034, email esm@nsf.gov. Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of the coordination agreement from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.

(2) Table 1 provides a list of each applicable RAS site, its location, and the applicable coordination zone.

Table 1 Applicable Radio Astronomy Service (RAS) Facilities and Associated Coordination Distances.

Observatory	Latitude (North)	Longitude (West)	Radius (km) of Coordination Zone
Arecibo Observatory, Arecibo PR	18° 20' 37"	66° 45' 11"	Island of Puerto Rico
Green Bank WV	38° 25' 59"	79° 50' 23"	160
Very Large Array, near Socorro NM	34° 04' 44"	107° 37' 06"	160
Pisgah Astronomical Research Institute, Rosman NC	35° 11' 59"	82° 52' 19"	160
U of Michigan Radio Astronomy Observatory, Stinchfield Woods MI	42° 23' 56"	83° 56' 11"	160
Very Long Baseline Array (VLBA) stations:			
Owens Valley CA	37° 13' 54"	118° 16' 37"	160*
Mauna Kea HI	19° 48' 05"	155° 27' 20"	50
Brewster WA	48° 07' 52"	119° 41' 00"	
Kitt Peak AZ	31° 57' 23"	111° 36' 45"	
Pie Town NM	34° 18' 04"	108° 07' 09"	
Los Alamos NM	35° 46' 30"	106° 14' 44"	
Fort Davis TX	30° 38' 06"	103° 56' 41"	
North Liberty IA	41° 46' 17"	91° 34' 27"	

Hancock NH	42° 56' 01"	71° 59' 12"	
St. Croix VI	17° 45' 24"	64° 35' 01"	

* Owens Valley CA operates both a VLBA station and single-dish telescopes.

(3) When NTIA seeks to provide similar protection to future RAS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band VMES licensees shall cease operations in the 14.47-14.5 GHz band within the relevant geographic zone (160 kms for single-dish radio observatories and Very Large Array antenna systems and 50 kms for Very Long Baseline Array antenna systems) of the new RAS site until the licensees complete coordination for the new RAS facility. Licensees shall notify the International Bureau once they have completed coordination for the new RAS site and shall submit the coordination agreement to the Commission. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The VMES licensee then will be permitted to commence operations in the 14.47-14.5 GHz band within the relevant coordination distance around the new RAS site, subject to any operational constraints developed in the coordination process.

(e) VMES licensees shall use Global Positioning Satellite-related or other similar position location technology to ensure compliance with paragraphs (c) and (d) of this section.

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APPENDIX C

Final Regulatory Flexibility Analysis

As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] the Notice of Proposed Rulemaking (*NPRM*) in this proceeding, *Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum and Adopt Service Rules and Procedures to Govern the Use of Vehicle-Mounted Earth Stations in Certain Frequency Bands Allocated to the Fixed-Satellite Service*, IB Docket No. 07-101, adopted on May 9, 2007 and released on May 15, 2007, incorporated an Initial Regulatory Flexibility Analysis (IRFA).[2] The Commission sought written public comment on the proposals in the *NPRM,* including comment on the IRFA. This present Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.[3]

A. Need for, and Objectives of, the Report and Order

The *NPRM* sought to promote innovative and flexible use of satellite technology to provide advanced communications capabilities from Vehicle-Mounted Earth Stations (VMES) that would operate as a licensed application of the Fixed-Satellite Service (FSS) in certain Ku-band frequencies within the United States. It sought comment and developed a record on the capability of VMES to meet the interference avoidance requirements of the Ku-band FSS.

The objective of the Report and Order is to adopt domestic U.S. allocation, service and licensing rules to permit the licensing of VMES in the conventional and extended Ku-band frequencies where such systems will meet the Commission's two-degree satellite spacing interference avoidance requirements of the Ku-band FSS. In this regard, the "conventional" Ku-band refers to frequencies in the 11.7-12.2 GHz (downlink) and 14.0-14.5 GHz (uplink) bands and the covered "extended Ku-band" includes the 10.95-11.2 GHz and 11.45-11.7 GHz (downlink) bands. The rules will permit VMES to operate as a primary application of the FSS in the conventional bands. In the extended band frequencies, VMES may be authorized to communicate with geostationary satellite orbit FSS space stations but must accept interference from stations of the Fixed Service (FS) operating in accordance with the Commission's rules. The rules promote spectrum sharing with certain secondary operations in the uplink bands, including government space research service and radio astronomy service stations.

B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

No parties filed comments that separately or specifically addressed the IRFA.

C. Description and Estimate of the Number of Small Entities to Which Rules Will Apply

[1] *See* 5 U.S.C. § 603. The Small Business Regulatory Enforcement Fairness Act of 1996, Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996) amended the RFA (*see* 5 U.S.C. § 601–612).

[2] *See NPRM*, 22 FCC Rcd 9649, 9701-9704 (2007).

[3] *See* 5 U.S.C. § 604.

The RFA directs agencies to provide a description of and, where feasible, an estimate of the number of small entities that may be affected by the rules adopted herein.[4] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[5] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[6] A small business concern is one that: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (SBA).[7] Below, we further describe and estimate the number of small entity licensees that may be affected by the adopted rules.

Satellite Telecommunications and All Other Telecommunications. These two economic census categories address the satellite industry. The first category has a small business size standard of $15 million or less in average annual receipts, under SBA rules.[8] The second has a size standard of $25 million or less in annual receipts.[9] The most current Census Bureau data in this context, however, are from the (last) economic census of 2002, and we will use those figures to gauge the prevalence of small businesses in these categories.[10]

The category of Satellite Telecommunications "comprises establishments primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."[11] For this category, Census Bureau data for 2002 show that there were a total of 371 firms that operated for the entire year.[12] Of this total, 307 firms had annual receipts of under $10 million, and 26 firms had receipts of $10 million to $24,999,999.[13] Consequently, we estimate that the majority of Satellite Telecommunications firms are small entities that might be affected by our action.

The second category of All Other Telecommunications comprises, *inter alia*, "establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation. This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or

[4] 5 U.S.C. § 604(a)(3).

[5] 5 U.S.C. § 601(6).

[6] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small business concern" in 15 U.S.C. § 632). Pursuant to the RFA, the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after the opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register." 5 U.S.C. § 601(3).

[7] Small Business Act, 15 U.S.C. § 632 (1996).

[8] 13 C.F.R. § 121.201, NAICS code 517410.

[9] 13 C.F.R. § 121.201, NAICS code 517919.

[10] 13 C.F.R. § 121.201, NAICS codes 517410 and 517910 (2002).

[11] U.S. Census Bureau, 2007 NAICS Definitions, "517410 Satellite Telecommunications"; http://www.census.gov/naics/2007/def/ND517410.HTM.

[12] U.S. Census Bureau, 2002 Economic Census, Subject Series: Information, "Establishment and Firm Size (Including Legal Form of Organization)," Table 4, NAICS code 517410 (issued Nov. 2005).

[13] *Id.* An additional 38 firms had annual receipts of $25 million or more.

more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems."[14] For this category, Census Bureau data for 2002 show that there were a total of 332 firms that operated for the entire year.[15] Of this total, 303 firms had annual receipts of under $10 million and 15 firms had annual receipts of $10 million to $24,999,999.[16] Consequently, we estimate that the majority of All Other Telecommunications firms are small entities that might be affected by our action.

Space Station Licensees (Geostationary). Commission records reveal that there are 20 space station licensees and operators in the Ku-band. We do not request or collect annual revenue information concerning such licensees and operators, and thus are unable to estimate the number of geostationary space station licensees and operators that would constitute a small business under the SBA definition cited above, or apply any rules providing special consideration for geostationary space station licensees and operators that are small businesses.

Fixed-Satellite Service Transmit/Receive Earth Stations. Currently there are approximately 2,879 operational fixed-satellite service transmit/receive earth stations authorized for use in the Ku-band. The Commission does not request or collect annual revenue information, and thus is unable to estimate the number of earth stations that would constitute a small business under the SBA definition.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements

The *NPRM* sought comment on whether to extend the current rules for Earth Stations on Vessels (ESVs) – an existing mobile application of the FSS – to VMES, a new mobile application of the FSS. The ESV rules, and the VMES rules adopted in the Report and Order, require satellite telecommunications operators to establish a database for tracking the location of VMES remote earth stations. This database will assist investigations of radio frequency interference claims. Application of the ESV rules to VMES requires VMES operators to name a point of contact to maintain information about location and frequencies used by VMES terminals. Such information will assist in investigating radio frequency interference claims. The Commission does not expect significant costs associated with these proposals. Therefore, we do not anticipate that the burden of compliance will be greater for smaller entities.

E. Steps Taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

The RFA requires that, to the extent consistent with the objectives of applicable statutes, the analysis shall discuss significant alternatives such as: (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance and reporting requirements under the rule for

[14] U.S. Census Bureau, 2007 NAICS Definitions, "517919 All Other Telecommunications"; http://www.census.gov/naics/2007/def/ND517919.HTM#N517919.

[15] U.S. Census Bureau, 2002 Economic Census, Subject Series: Information, "Establishment and Firm Size (Including Legal Form of Organization)," Table 4, NAICS code 517910 (issued Nov. 2005).

[16] *Id.* An additional 14 firms had annual receipts of $25 million or more.

small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.[17]

This *NPRM* solicited comment on alternatives for more efficient processing of VMES applications and simplification of VMES procedures, for example, by migrating from non-conforming use licensing to a licensing method that would provide for licenses with terms of fifteen years. The *NPRM* also sought comment on streamlining the application process for VMES operations by permitting blanket licensing of multiple VMES terminals in a single application, as an alternative to requiring all VMES terminals to be licensed individually. In adopting blanket licensing with fifteen-year terms for conforming VMES terminals, the Report and Order simplifies the application process for VMES and establishes licensing terms consistent with other satellite-based services, such as ESV. Thus, adoption of the rules should reduce the costs associated with obtaining and maintaining authority to operate a VMES network.

F. Federal Rules that May Duplicate, Overlap, or Conflict With the Proposed Rules

None.

Report to Congress: The Commission will send a copy of the Report and Order, including this FRFA, in a report to be sent to Congress pursuant to the Congressional Review Act. In addition, the Commission will send a copy of the Report and Order, including this FRFA, to the Chief Counsel for Advocacy of the SBA. A copy of the Report and Order and FRFA (or summaries thereof) also will be published in the Federal Register.[18]

[17] 5 U.S.C. § 603(c)(1), (c)(4).

[18] *See* 5 U.S.C. § 604(b).