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

2000 DEC 13 P 3:09

In the Matter of	)	
	)	
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 RM-9147 RM-9245
	)	
Amendment of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates; and	)	
	)	
Applications of Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd. to Provide A Fixed Service in the 12.2-12.7 GHz Band	)	

RECEIVED

FIRST REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULE MAKING

Adopted: November 29, 2000 **Released:** December 8, 2000

Comment Date: 45 days from date of publication in the Federal Register
Reply Comment Date: 60 days from date of publication in the Federal Register

By the Commission: Commissioner Furchtgott-Roth approving in part, dissenting in part, and issuing a statement; Commissioner Tristani issuing a statement.

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I. INTRODUCTION

1. In this First Report and Order ("First R&O"), we permit non-geostationary satellite orbit ("NGSO")[1] fixed-satellite service ("FSS") providers to operate in certain segments of the Ku-band,[2] and adopt rules and policies to govern such operations. We also adopt technical criteria so that NGSO FSS operations can share spectrum with incumbent services without causing unacceptable interference to them and without unduly constraining future growth of incumbent services or NGSO FSS system flexibility. Finally, we conclude that a new terrestrial fixed Multichannel Video Distribution and Data Service ("MVDDS") can operate in the 12.2-12.7 GHz band on a non-harmful interference basis with incumbent Broadcast Satellite Services ("BSS"), and on a co-primary basis with the NGSO FSS. We also adopt a Further Notice of Proposed Rule Making ("Further NPRM") to address technical and service rules for the MVDDS. By these actions, we provide for the introduction of new advanced services to the public, consistent with our obligations under section 706 of the 1996 Telecommunications Act,[3] and promote increased competition among satellite and terrestrial services.

II. SUMMARY

2. In this First Report and Order/Further Notice of Proposed Rule Making we make the following major determinations and proposals regarding NGSO FSS[4] at Ku-band and the fixed services ("FS") in the 12.2-12.7 GHz band.

- We permit NGSO FSS gateway earth stations to provide, on a primary basis, space-to-Earth transmissions ("downlinks") in the 10.7-11.7 GHz band and Earth-to-space transmissions ("uplinks") in the 12.75-13.15 GHz, 13.2125-13.25 GHz, and 13.75-14.0 GHz bands, thereby providing 1000 megahertz of spectrum for gateway downlink and 687.5 megahertz of spectrum for gateway uplink operations. Further, we permit gateway earth stations to operate in the 11.7-12.7 GHz downlink and 14.0-14.5 GHz uplink bands that will be predominantly used by NGSO FSS service links.
- We permit NGSO FSS to operate service downlinks in the 11.7-12.2 GHz band on a primary basis, and we allocate the 12.2-12.7 GHz band for NGSO FSS service downlinks on a primary basis. We also permit NGSO FSS to operate service uplinks in the 14.0-14.5 GHz band. This provides 1000 megahertz of spectrum for service downlink and 500 megahertz of spectrum for service uplink operations.

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[1] NGSO systems are characterized by a constellation of satellites continuously orbiting the earth, rather than remaining stationary relative to an earth station as geostationary satellites do. A geostationary satellite orbits at about 35,900 km (about 22,300 miles) above the Earth in the plane of the Earth's equator. At this altitude above the equator, the satellite revolves around the Earth at a rate of speed synchronous with the Earth's rotation, so that the satellite stays above the same place on the Earth's equator. NGSO satellites generally operate at lower altitudes than 35,900 km and revolve at a rate of speed greater than the Earth's rotation. An NGSO satellite therefore moves from horizon to horizon, and as it does so, transmits radio signals to, and receives radio signals from, those earth stations that are in the coverage area of the satellite.

[2] The Ku-band generally refers to frequencies in the vicinity of 10-14 GHz. The specific bands subject to this proceeding are the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.75-14.5 GHz, and 17.3-17.8 GHz bands. For the purposes of this proceeding, we use the term "Ku-band" to refer generally to all of the frequency bands listed above that are under consideration in this proceeding.

[3] 47 U.S.C. § 157.

[4] NGSO FSS systems will consist of space stations in a satellite constellation, gateway earth stations, and service link earth stations.

- We adopt technical sharing criteria (power flux density ("PFD") limits) for NGSO FSS and FS operations in the 10.7-11.7 GHz band, consistent with decisions taken at the 2000 World Radiocommunication Conference ("WRC-2000"). Although we tentatively conclude that we should identify geographic protection zones for incumbent FS operations in the 10.7-11.7 GHz and 12.75-13.25 GHz bands, we defer until a separate future proceeding a decision on what procedures to use for determining the size and location of such zones. We also defer until a separate future proceeding a decision on coordination procedures between NGSO FSS and FS authorized under Parts 74 and 78 in the 12.75-13.25 GHz band.
- We adopt technical sharing criteria (equivalent power flux density ("EPFD") uplink and downlink limits) for NGSO FSS and geostationary-satellite orbit ("GSO") FSS operations in all bands, consistent with decisions taken at WRC-2000.
- We conclude in the First Report and Order that the new MVDDS can operate in the 12.2-12.7 GHz band under the existing allocation, *i.e.*, on a non-harmful interference basis to incumbent BSS and on a co-primary basis to the new NGSO FSS. We also conclude that we can define MVDDS technical requirements that would avoid harmful interference to BSS and establish PFD limits for MVDDS/NGSO FSS sharing.
- We will permit MVDDS operations in the 12.2-12.7 GHz band, and seek comment on technical sharing criteria between the MVDDS and BSS and NGSO FSS, and on MVDDS service, technical, and licensing rules under Part 101 of the Commission's Rules.
- We seek comment on whether to license the 12.2-12.7 GHz band on the basis of geographic areas.
- We seek comment on whether to license MVDDS to one spectrum block of 500 megahertz per geographic area and to allow partitioning of MVDDS; we seek comment on whether to restrict disaggregation.
- We seek comment on the permitted services, eligibility requirements and regulatory status of MVDDS in the 12.2-12.7 GHz band, including whether licensees should be required to meet must-carry obligations and provide all local TV channels to every subscriber.
- We propose to require incumbent non-public safety Private Operational Fixed Service ("POFS") licensees in the 12.2-12.7 GHz band to protect MVDDS and NGSO FSS operations from harmful interference.
- We seek comment on the disposition of pending 12.2-12.7 GHz applications filed by Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd.
- If we auction MVDDS licenses in the 12.2-12.7 GHz band, we propose to do so in conformity with the general competitive bidding rules set forth in Part 1, Subpart Q, of the Commission's Rules.

III. BACKGROUND

3. In November 1998, the Commission released a *Notice of Proposed Rule Making* (*"NPRM"*) in this proceeding, which proposed to permit NGSO FSS operations in certain segments of the Ku-band.[5] NGSO FSS can provide a variety of new services to the public, such as high-speed Internet and on-line access, plus other types of high-speed data, video and telephony services. In the *NPRM*, the Commission proposed to allow NGSO FSS operations to use the 10.7-12.7 GHz band for NGSO downlinks on a co-primary basis and to use the 12.75-13.25 GHz and 13.8-14.5 GHz bands for NGSO uplinks on a co-

[5] *Notice of Proposed Rule Making ("NPRM")*, ET Docket No. 98-206, 14 FCC Rcd 1131 (1998). Comments on the *NPRM* were originally due on February 16,1999 and reply comments were originally due on March 15, 1999. However, on February 4, 1999, we extended those dates to March 2, 1999 and March 29, 1999, respectively. *See Order*, 14 FCC Rcd 3335 (1999). We received 33 comments and 24 reply comments in response to the *NPRM*. A list of commenting parties is provided in Appendix D. Supplemental comments and *ex parte* presentations were subsequently filed by numerous parties. Unless otherwise noted, "Comments" and "Reply Comments" refer to the 33 comments and 24 reply comments that were filed in direct response to the *NPRM*.

primary basis.[6] We took this action in response to a Petition for Rule Making ("Petition") filed by SkyBridge L.L.C. ("SkyBridge").[7] The proposals advanced in the *NPRM* were also promoted by actions taken at the 1997 World Radiocommunication Conference ("WRC-97"), which modified the International Telecommunication Union's Radio Regulations ("ITU RR") to permit NGSO FSS operations in various segments of the Ku-band. WRC-97 also outlined provisional criteria for NGSO FSS operations to protect existing services in these band segments from unacceptable interference.[8]

4. The *NPRM* also asked for comments on a Petition for Rule Making ("Petition") filed by Northpoint Technology, Ltd. ("Northpoint") that proposed to provide terrestrial retransmission of local television signals and data services on a secondary basis[9] to the incumbent BSS in the 12.2-12.7 GHz band,[10] which is one of the bands in which we proposed to authorize NGSO FSS operations. Finally, the *NPRM* proposed licensing and service rules for NGSO FSS systems. These proposals also will be addressed in a future proceeding.

5. The spectrum proposed in the *NPRM* for NGSO FSS downlink operations – 10.7-12.7 GHz – is exclusively non-Federal Government spectrum; *i.e.*, there are no Federal Government operations in these bands. The bands that comprise 10.7-12.2 GHz are allocated to the fixed-satellite service (space-to-Earth) on a primary basis and the 12.2-12.7 GHz band is allocated to the BSS (also referred to as "Direct Broadcast Satellite" or "DBS")[11] on a primary basis. The FSS downlink segments at 10.7-10.95 GHz and 11.2-11.45 GHz are subject to Appendix 30B/S30B of the ITU RR.[12] Similarly, the BSS downlink segment at 12.2-12.7 GHz is subject to Appendix S30 of the ITU RR. This means that these segments are internationally "planned bands" where each country is assigned frequencies at certain orbital

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[6] Except for the 12.2-12.7 GHz band, all of the bands proposed for NGSO FSS use are already allocated to the FSS on a primary or co-primary basis. The *NPRM* proposed a co-primary allocation for NGSO FSS in the 12.2-12.7 GHz band.

[7] SkyBridge Petition, RM-9147, filed July 3, 1997.

[8] The *NPRM* pointed out that WRC-97 developed spectrum sharing criteria for NGSO operations based on the avoidance of "unacceptable" interference to incumbent services. The Commission's Rules define "accepted" interference, rather than "acceptable" interference. The *NPRM* stated, however, that the two terms are substantially the same. "Unacceptable" interference are occurrences exceeding a defined "acceptable" level of interference. We also note that the term "acceptable" interference or "unacceptable" interference happens to be more commonly used for international satellite coordinations.

[9] A given frequency band may be allocated to one or more terrestrial or space radiocommunication services or the radio astronomy service on either a primary or secondary basis. "Stations of a secondary service: a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date; b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date; c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date." *See* International Telecommunication Union Radio Regulations, Edition of 1998, Article S5, Section II --Categories of services and allocations, S5.28 through S5.31.

[10] Northpoint Petition, RM-9245, filed March 6, 1998. *See NPRM* at ¶¶ 91-98 for a more detailed discussion of the Northpoint proposal and sharing with BSS and NGSO FSS operations.

[11] BSS, by definition, is in the downlink direction only. The corresponding feeder link frequencies for BSS are in FSS uplink allocations. The terms "BSS" and "DBS" have the same meaning, and in this item, we will use the terms interchangeably.

[12] *See* 47 C.F.R. § 2.106, footnote S5.441.

locations in the geostationary orbital arc. The use of the FSS downlink band at 10.7-11.7 GHz[13] is limited to international systems, *i.e.*, other than domestic systems.[14] Prior to WRC-2000, international regulations stipulated that use of the FSS downlink band at 11.7-12.2 GHz and the BSS band at 12.2-12.7 GHz was limited to national and subregional systems.[15]

6. In addition to space radiocommunication services, the bands comprising 10.7-12.7 GHz are allocated to and used by terrestrial radiocommunication services. Specifically, the 10.7-11.7 GHz band[16] is allocated to the FS on a primary basis and is available for use by both the POFS point-to-point microwave operations (Part 101, Subparts C and H)[17] and the Local Television Transmission Service ("LTTS," Part 101, Subpart J). LTTS use of the 10.7-11.7 GHz band is limited to television studio-to-transmitter links ("STLs").[18] The 11.7-12.1 GHz band is allocated to the FS on a secondary basis,[19] and the 11.7-12.2 GHz band is allocated to mobile except aeronautical mobile service on a secondary basis; *i.e.*, this band is available to the land mobile and maritime mobile services, but not to the aeronautical mobile service. Together, these two secondary services are used by television pickup and television non-broadcast pickup stations in the LTTS.[20] The 12.2-12.7 GHz band is allocated to the FS on a primary basis; however, the service is prohibited from causing harmful interference to the BSS.[21] The band is also available for POFS stations on a non-harmful interference basis. Further, POFS stations are required to make any and all adjustments necessary to prevent harmful interference to operating BSS systems. Table 1, below, summarizes incumbent operations in the proposed NGSO FSS downlink bands.

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[13] In the 10.7-11.7 GHz band, footnote US211 urges applicants for space station assignments to "take all practicable steps to protect radio astronomy observations in adjacent bands from harmful interference; however, US74 applies." US74 states that the radio astronomy service in the 10.68-10.7 GHz band "shall be protected from extraband radiation only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates."

[14] *See* 47 C.F.R. § 2.106, footnote NG104.

[15] *See* 47 C.F.R. § 2.106, footnote 839. WRC-2000 revised S5.488 (formerly RR-839) to eliminate the national and subregional restriction.

[16] Footnote NG41 states that frequencies in the 10.7-11.7 GHz band may also be assigned to stations in the international fixed public and international control services located in U.S. Possessions in the Caribbean area.

[17] One of the primary uses of the 10.7-11.7 GHz band is for analog and digital telephone and video transmission. The 10.7-11.7 GHz band is also one of the migration bands that the Commission identified for 2 GHz OFS incumbents that are displaced by Broadband Personal Communications Service ("PCS") operations.

[18] *See* 47 C.F.R. § 101.803(d).

[19] *See* 47 C.F.R. § 2.106, footnote 837, which reads as follows: "Different category of service: in Canada, Mexico and the United States, the allocation of the band 11.7-12.1 GHz to the fixed service is on a secondary basis (see No. 424)." *See* ITU-RR footnote S5.486. This footnote was revised by WRC-95. At that Conference, only Mexico and the United States were associated with that footnote.

[20] *See* 47 C.F.R. § 101.803(a).

[21] *See* 47 C.F.R. § 2.106, footnote 844 and Section 101.147(p).

Table 1: U. S. Incumbent Operations in the Bands Proposed for NGSO FSS Downlinks (Systems operate on a primary basis, except as noted)			
Band	10.7-11.7 GHz	11.7-12.2 Hz	12.2-12.7 GHz
Incumbent Operations	FSS (space-to-Earth)		BSS
	International systems only; 10.7-10.95 GHz and 11.2-11.45 GHz are planned bands		
	POFS and LTTS STLs	LTTS TV pickup and TV non-broadcast pickup stations (secondary)	POFS (secondary to BSS)
NPRM Proposal	NGSO gateways	NGSO service links	

7. Most of the spectrum proposed in the *NPRM* for NGSO FSS uplinks -- 12.75-13.25 GHz, 13.8-14.2 GHz, and 14.4-14.5 GHz -- is shared between Federal and non-Federal Government uses either on a co-primary or a primary/secondary basis; however, the bands comprising 14.2-14.4 GHz are non-Federal Government exclusive spectrum. All of the spectrum proposed for NGSO FSS uplinks (12.75-13.25 GHz and 13.8-14.5 GHz) is already allocated to the non-Federal Government fixed-satellite service (Earth-to-space) on a primary basis. The FSS uplink band at 12.75-13.25 GHz is limited to international systems and is subject to Appendix S30B of the ITU RR. The Commission has adopted special ITU developed requirements for FSS use of the 13.75-14 GHz band, such as minimum and maximum earth station equivalent isotropically radiated power ("e.i.r.p.") and a minimum antenna diameter in order to ensure compatibility with Federal Government systems. The bands comprising 13.75-14.2 GHz are allocated to the Federal and non-Federal Government space research service on a secondary basis, except for those geostationary space stations in the space research service that were advanced published prior to January 31, 1992, which shall operate on an equal basis with stations in the fixed-satellite service.[22] The bands comprising 13.8-14.2 GHz are also allocated to the Federal and non-Federal Government standard frequency and time signal-satellite service on a secondary basis.[23]

8. Other space radiocommunication services in the proposed NGSO FSS uplink bands are as follows. The 12.75-13.25 GHz band is allocated to the Federal and non-Federal Government space research service (deep space, space-to-Earth) on a primary basis, but its use is limited to Goldstone, California.[24] The bands comprising 14-14.5 GHz are allocated to the non-Federal Government land mobile-satellite service on a secondary basis.[25]

[22] *See* 47 C.F.R. § 2.106, footnote S5.503.

[23] Footnote S5.502 states that "In the band 13.75-14 GHz, the e.i.r.p. of any emission from an earth station in the fixed-satellite service shall be at least 68 dBW, and should not exceed 85 dBW, with a minimum antenna diameter of 4.5 metres. In addition, the e.i.r.p. averaged over one second, radiated by a station in the radiolocation or radionavigation services towards the geostationary orbit shall not exceed 59 dBW." *See also* footnote S5.503, which limits the e.i.r.p. density in the 13.772-13.778 GHz band.

[24] *See* 47 C.F.R. § 2.106, footnote US251.

[25] *See* 47 C.F.R. § 2.106, footnote US287.

9. In addition to space communication services, the bands proposed for NGSO FSS uplinks are allocated to and used by terrestrial radiocommunication services. The 12.75-13.25 GHz band is allocated to the non-Federal Government FS and mobile[26] services on a co-primary basis. Frequencies throughout the 12.70-13.25 GHz band are available for use by POFS stations and by television broadcast auxiliary service ("BAS") stations.[27] Additionally, frequencies in the 13.2-13.25 GHz segment are available for assignment to LTTS television pickup stations, television non-broadcast pickup stations, and STLs.[28] The 13.8-14 GHz band is allocated to the Federal Government radiolocation service on a primary basis and to the non-Federal Government radiolocation service on a secondary basis. The 14-14.2 GHz band is allocated to the Federal and non-Federal Government radionavigation service on a primary basis, with the caveat that radionavigation stations "shall operate on a secondary basis to the fixed-satellite service."[29] The 14.2-14.4 GHz band is allocated to the non-Federal Government mobile except aeronautical mobile service on a secondary basis and is available for use by LTTS television pickup and television non-broadcast pickup stations. The 14.4-14.5 GHz band is allocated to the Federal Government fixed and mobile services on a secondary basis. Finally, radio astronomy observations may be made in the 14.47-14.5 GHz segment at Federal and non-Federal Government licensed facilities.[30]

10. In making our proposals, we sought to ensure that NGSO FSS operations do not cause unacceptable interference to existing users and do not unduly constrain future growth of incumbent services. In this regard, we noted that sharing between NGSO FSS and incumbent services was not feasible in certain bands sought by SkyBridge for NGSO uplinks. Specifically, we noted that sharing between NGSO FSS uplinks and the National Aeronautics and Space Administration ("NASA") tracking data and relay satellite system ("TDRSS") in the 13.75-13.80 GHz band requested by SkyBridge, and between NGSO FSS uplinks and BSS downlinks and Federal Government radiolocation operations in the 17.3-17.8 GHz band would raise significant interference concerns.[31] Accordingly, we did not propose to permit NGSO FSS uplink operations in those bands. However, at WRC-2000, ITU-RR footnote S5.503 was revised with the consent of the United States to establish e.i.r.p. density limits to protect TDRSS from NGSO FSS interference. Table 2, below, summarizes incumbent operations in the proposed NGSO FSS uplink bands.

[26] In the 12.7-13.15 GHz segment, the Commission has previously specified in footnote NG53 that television pickup stations and CARS pickup stations shall be assigned channels on a co-equal basis and that these pickup stations shall operate on a secondary basis to fixed stations operating in this segment; *see* 47 C.F.R. § 2.106, footnote NG53. The Commission further specified that in the 13.15-13.2 GHz segment, television pickup stations and CARS pickup stations shall be assigned on an exclusive basis in the top one hundred markets, as set out in Section 76.51 of the Commission's Rules.

[27] *See* 47 C.F.R. Part 74, Subpart F.

[28] *See* 47 C.F.R. § 101.803(a) and (d).

[29] *See* 47 C.F.R. § 2.106, footnote US292.

[30] *See* 47 C.F.R. § 2.106, footnotes 862, US203.

[31] *NPRM* at ¶¶ 43, 50, and 51.

<table>
<tr><td colspan="6">Table 2: U. S. Incumbent Operations in the Bands Proposed for NGSO FSS Uplinks (Systems operate on a primary basis, except as noted)</td></tr>
<tr><td>Band</td><td>12.75-13.25 GHz</td><td>13.8-14 GHz</td><td>14-14.2 GHz</td><td>14.2-14.4 GHz</td><td>14.4-14.5 GHz</td></tr>
<tr><td rowspan="6">Incumbent Operations</td><td colspan="5">Non-Govt. FSS uplinks</td></tr>
<tr><td>International systems only and is a planned band</td><td>Special FSS spectrum sharing requirements</td><td colspan="3"></td></tr>
<tr><td>POFS</td><td>Govt. radiolocation</td><td>Govt. and non-Govt. radionavigation (secondary to FSS)</td><td>LTTS TV pickup and TV non-broadcast pickup stations (secondary)</td><td>Govt. fixed and mobile (secondary)</td></tr>
<tr><td>TV BAS; LTTS may use only 13.2-13.4 GHz</td><td>Non-Govt. radiolocation (secondary)</td><td colspan="3">Non-Govt. land mobile-satellite uplinks (secondary)</td></tr>
<tr><td>NASA's Goldstone deep space receive site</td><td colspan="2">Space research service and standard frequency and time signal-satellite service (secondary, except for some GSO space research space stations)</td><td></td><td>Radio astronomy observations may be made in 14.47-14.5 GHz band</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>NPRM Proposal</td><td colspan="2">NGSO gateways</td><td colspan="2">NGSO service links</td><td>NGSO gateways</td></tr>
</table>

11. In addition to its Petition, SkyBridge also filed an application for authority to launch and operate an NGSO FSS system.[32] Certain characteristics of the proposed SkyBridge network, such as gateway earth stations, were discussed in the *NPRM* to facilitate the development of a complete record. In November 1998, the Commission issued a Public Notice, which established a cut-off date for filing NGSO FSS system applications in portions of the Ku-band ("*Ku Band Cut-Off Notice*").[33] There are applications pending for eight different NGSO FSS systems requesting access to all or some portion of the proposed bands, including applications from the Boeing Company ("Boeing") and Denali Telecom, LLC ("Denali"), that were filed in response to other previous cut-off notices.[34] The applicants propose a

[32] SkyBridge Application, File No. 48-SAT-P\LA-97, February 28, 1997; Amendment, File No. 89-SAT-AMEND-97, July 2, 1997; SAT-AMEND-19980630-00056 S2241 (January 1999) (SkyBridge Application). SkyBridge initially proposed 64 NGSO satellites for its system, but subsequently amended its application to increase the number to 80 NGSO satellites.

[33] Report No. SPB-141, released November 2, 1998. The filing cut-off was for NGSO FSS applications in the 10.7-12.7, 12.75-13.25, 13.75-14.5, and 17.3-17.8 GHz frequency bands. In the Public Notice, we stated that "applicants should be aware that because of outstanding Commission proceedings and Government use of certain frequency bands, not all bands proposed by the applicants in this Public Notice will necessarily be available for NGSO FSS use."

[34] Portions of those prior cut-off notices included frequency bands subject to the *Ku-Band Cut-Off Notice*. Boeing also filed an application for an NGSO FSS system to operate in the Ku-band.

variety of orbit constellations and network designs, and a wide range of services, including high-speed Internet and on-line access, video conferencing, telephony, and entertainment services. These proposals offer an opportunity for competition to both satellite and terrestrial services. A brief description of each system is provided in Appendix C. While this proceeding focuses on NGSO FSS systems in general and discusses certain characteristics of proposed systems as appropriate, the applications will be addressed in a separate proceeding.

12. *WRC-97/2000.* In the *NPRM*, we noted that WRC-97 adopted power limits for certain segments of the Ku and Ka[35] frequency bands to promote spectrum sharing between NGSO FSS systems and other systems and services. Specifically, WRC-97 *provisionally* adopted EPFD and aggregate power flux density ("APFD") limits in certain band segments to protect incumbent GSO FSS and BSS operations. EPFD is the sum of the PFD levels of all potential interfering satellites of a particular NGSO constellation into a particular GSO earth station receiver.[36] EPFD limits are intended to control the level of signal energy on the earth's surface. Because each EPFD limit applies to a particular GSO earth station receiver with a specific antenna diameter and sidelobe pattern, different sized GSO FSS earth station receivers may require different EPFD protection requirements. APFD is the sum of the PFD levels at a location on the GSO arc created by all potentially interfering earth station transmitters of an NGSO FSS system. Because the technical studies justifying these power limits had not been fully considered in the ITU Radiocommunication Sector ("ITU-R") study group process, as is customary, they were deemed provisional until they could be analyzed by the relevant ITU-R study groups and reviewed at WRC-2000. Moreover, the provisional EPFD and APFD limits adopted by WRC-97 applied only to a single NGSO FSS system ("single-entry" limits) and did not consider the impact of multiple NGSO FSS systems for GSO BSS and FSS systems.

13. As we discuss in more detail below, the *NPRM* sought comment on WRC-97's provisional EPFD and APFD limits and on alternative values for these limits. We note that since the *NPRM* was adopted, international working groups have recommended changes to the definition of APFD limits, including referring to them as "$EPFD_{up}$" limits (see discussion below). Consequently, we will adopt that terminology in this First R&O, and we will refer to "$EPFD_{down}$" for power limits applicable to NGSO FSS space stations within an NGSO FSS system and $EPFD_{up}$ for power limits applicable to NGSO FSS earth stations within an NGSO FSS system or GSO BSS and FSS systems.

14. In addition, to protect terrestrial services and facilitate operation of co-primary satellite and terrestrial services, the ITU RR include PFD limits to control the level of satellite signal energy on the Earth's surface. Although the PFD limits currently in use were developed to protect terrestrial services from GSO FSS downlinks, WRC-97 concluded that these limits should also apply to NGSO FSS downlinks. While the PFD limits to protect terrestrial services from NGSO FSS are not provisional, they were subject to review and possible modification at WRC-2000 based on the determination of whether they adequately protect terrestrial services from the aggregate of multiple NGSO FSS systems. As we discuss in more detail below, for protection of terrestrial services the *NPRM* proposed to adopt the WRC-97 PFD limits.[37]

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[35] The Ka-band generally refers to the 17.7-20.2 GHz (downlink) and 27.5-30.0 GHz (uplink) bands.

[36] PFD is a measure of the amount of energy emitted by a transmitter that is present over a unit area at the Earth's surface or at the satellite, and is a critical factor in determining whether satellite systems can successfully share spectrum with other services or satellite systems.

[37] *NPRM* at ¶¶ 18-20.

15. As we noted in the *NPRM*, the U.S., with representation from the terrestrial, NGSO FSS and GSO FSS industries, was an active participant in the ITU-R technical study groups tasked with conducting analyses of these sharing issues in preparation for WRC-2000.[38] ITU-R working groups made significant progress on NGSO FSS sharing issues. Additionally, a WRC-2000 Conference Preparatory Meeting ("CPM") was held in November 1999.[39] The final output of the CPM was a report containing information on technical, operational and regulatory/procedural issues relevant to items on the WRC-2000 agenda. This report reflected among other issues on the WRC-2000 Agenda, input from various ITU-R working parties and study groups, individual Administrations, and international organizations regarding NGSO FSS sharing issues, and provided the technical basis for decisions on these issues taken by WRC-2000. WRC-2000 affirmed the outcomes in the CPM report that are relevant to this proceeding.[40] The CPM report, the ITU-R work, and the decisions taken at WRC-2000 are discussed in more detail below, and relevant documents have been included in the docket file. Nonetheless, as we noted in the *NPRM*, ITU-R deliberations are based on the technical input of many Administrations that often have different domestic spectrum uses than those in the United States.[41] Thus, while the conclusions of the CPM, the ITU-R study groups, and WRC-2000 may have general technical applicability, based on each Administration's input and the resultant compromise, they may not adequately address specific, domestic sharing conditions such as those prevalent in the U.S. Consequently, in the *NPRM* we sought comment on a variety of techniques that could be used to facilitate operation of both NGSO FSS and incumbent services in the U.S. where the Ku-band is extensively used.

16. Throughout this proceeding, we will discuss the impact of new satellite and terrestrial operations in the Ku Band. In some instances, these new operations may cause interference events, but it is our intention to minimize these interference events to an acceptable level for the services at issue. At present, the ITU-R recommends that the GSO FSS network should be designed to accept an aggregate interference equal to 20 percent of the total system noise power from all other GSO FSS networks and a further 10 percent for interference from co-primary terrestrial radio services.[42]

17. The ITU-R further recommends that each adjacent GSO FSS network should not contribute more than 6 percent of the total system noise power. The makeup of the remaining 70 percent includes allocations for uplink and downlink thermal noise, intra-network self interference noise (such as intermodulation and cross-polarization) and earth station equipment noise. The allocation for each noise component depends on the specificity of each network and each type of transmission.

18. On November 29, 1999, the Satellite Home Viewer Improvement Act ("SHVIA") was enacted.[43] The SHVIA legislation generally seeks to place satellite carriers on equal footing with local

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[38] Following WRC-97, ITU-R JTG 4-9-11 was created to analyze NGSO FSS sharing with GSO FSS, fixed service and GSO BSS services in the Ku and Ka bands. The numbers "4," "9," and "11" refer to ITU-R study group designations: 4 – fixed satellite; 9 – fixed service; and 11 – broadcasting (television). Other ITU-R study groups dealing with the issue of NGSO FSS sharing include WP4A (FSS issues, both GSO and NGSO), JWP 10-11S (BSS), and JWP 4-9S (sharing between FSS and terrestrial services).

[39] The CPM was held in Geneva, Switzerland, November 15-26, 1999.

[40] WRC-2000 was held in Istanbul, Turkey, May 8-June 2, 2000.

[41] *NPRM* at ¶ 11.

[42] *See* ITU-R S.523-4 and ITU-R S.735-1.

[43] *See* Act of Nov. 29, 1999, Pub.L. 106-113 Stat. 1501 (enacting S. 1948, including the Satellite Home Viewer Improvement Act of 1999 ("SHVIA"), Title I of the Intellectual Property and Communications Omnibus (continued....)

cable operators concerning the availability of broadcast programming, and thus is intended to give consumers more and better choices in selecting a multichannel video programming distributor ("MVPD").[44] In conjunction with the 1999 SHVIA legislation, Congress passed a provision entitled "Rural Local Broadcast Signal Act."[45] Among other things, this law requires the Commission to make a determination by November 29, 2000, regarding licenses or other authorizations for facilities that will utilize, for delivering local broadcast television signals to satellite television subscribers in unserved and underserved local television markets, spectrum otherwise allocated to commercial use.[46] After an exhaustive analysis and the time-consuming development on the international front of a consensus regarding critical technical issues, we have made a major threshold determination to authorize a new service, MVDDS, that will be capable of delivering local broadcast television station signals to satellite television subscribers in unserved and underserved local television markets.[47] Moreover, we have

(Continued from previous page)

Reform Act of 1999 ("IPACORA"), relating to copyright licensing and carriage of broadcast signals by satellite carriers, codified in scattered sections of 17 and 47 U.S.C.). *See generally* Implementation of the Satellite Home Viewer Improvement Act of 1999: Application of Network Nonduplication, Syndicated Exclusivity, and Sports Blackout Rules to Satellite Retransmissions, CS Docket No. 00-2, *Notice of Proposed Rule Making*, 65 Fed. Reg. 4927 (Feb. 2, 2000); Implementation of the Satellite Home Viewer Improvement Act of 1999, CS Docket No. 99-363, *Notice of Proposed Rule Making*, 14 FCC Rcd 21736 (1999) (*1999 SHVIA Implementation NPRM*).

[44] *See 1999 SHVIA Implementation NPRM*, 14 FCC Rcd 21736 at ¶1.

[45] *See* Act of Nov. 29, 1999, Pub. L. 106-113, 113 Stat. 1501, 1537. (enacting S. 1948, Title II of the Intellectual Property and Communications Omnibus Reform Act of 1999 (IPACORA)), to be codified at 47 U.S.C. § 338.

[46] *Id.* The Rural Local Broadcast Signal Act is written as follows:

(a) In General.- Not later than 1 year after the date of the enactment of this Act, the Federal Communications Commission ("the Commission") shall take all actions necessary to make a determination regarding licenses or other authorizations for facilities that will utilize, for delivering local broadcast television station signals to satellite television subscribers in unserved and underserved local television markets, spectrum otherwise allocated to commercial use.

(b) Rules. –

(1) Form of Business. – To the extent not inconsistent with the Communications Act of 1934 and the Commission's Rules, the Commission shall permit applicants under subsection (a) to engage in partnerships, joint ventures, and similar operating arrangements for the purpose of carrying out subsection (a).

(2) Harmful Interference. – The Commission shall ensure that no facility licensed or authorized under subsection (a) causes harmful interference to the primary users of that spectrum or to public safety spectrum use.

(3) Limitation on Commission. – Except as provided in paragraphs (1) and (2), the Commission may not restrict any entity granted a license or other authorization under subsection (a) from using any reasonable compression, reformatting, or other technology.

(c) Report.- Not later than January 1, 2001, the Commission shall report to the Agriculture, Appropriations, and the Judiciary Committees of the Senate and the House of Representatives, the Senate Committee on Commerce, Science, and Transportation, and the House of Representatives Committee on Commerce, on the extent to which licenses and other authorizations under subsection (a) have facilitated the delivery of local signals to satellite television subscribers in unserved and underserved local television markets. The report shall include –

(1) an analysis of the extent to which local signals are being provided by direct-to-home satellite television providers and by other multichannel video program distributors;

(2) an enumeration of the technical, economic, and other impediments each type of multichannel video programming distributor has encountered; and

(3) recommendations for specific measures to facilitate the provision of local signals to subscribers in unserved and underserved markets by direct-to-home satellite television providers and by other distributors of multichannel video programming service.

[47] *See infra* ¶¶ 213, 290.

identified a band for this service – 12.2-12.7 GHz – and have determined that MVDDS can co-exist with the incumbent services and with the newly authorized NGSO-FSS operations. Finally, with the Further NPRM, we have set in motion the final regulatory process for licensing MVDDS. In light of these determinations, we conclude that we have met the deadline for action set forth in the Rural Local Broadcast Signal Act.

IV. FIRST REPORT AND ORDER

19. We conclude that the public interest will be served by permitting NGSO FSS use of the Ku-band. The implementation of NGSO FSS systems will allow new advanced services to be provided to the public, as well as provide increased competition to existing satellite and terrestrial services. Indeed, the NGSO FSS, because of its ability to serve large portions of the earth's surface, can bring advanced services to rural areas.[48] We also conclude that it is possible for the NGSO FSS to share spectrum with incumbent services without causing unacceptable interference to them and without unduly constraining their future growth. Accordingly, we are adopting technical criteria for NGSO FSS operations that will allow this new service to operate on a co-primary basis with incumbent services in the designated bands.

20. The ITU-R, including Joint Task Group ("JTG") 4-9-11 and the CPM in preparation for WRC-2000, reached consensus agreements on a number of NGSO FSS sharing issues.[49] Moreover, interested parties subsequently reached a compromise solution to the outstanding NGSO FSS/GSO FSS and NGSO FSS/BSS sharing issues at the CPM. These results were affirmed by WRC-2000. The numerous technical analyses undertaken by the ITU-R and CPM represent the most comprehensive and current studies on NGSO FSS protection of GSO FSS networks, FS operations and BSS systems available to date. Considering the agreements reached within the international arena and the record developed in response to these international agreements, we find that we have an adequate basis to adopt rules governing co-frequency operation of NGSO FSS systems in certain frequency bands.

21. We conclude that the new MVDDS can operate in the 12.2-12.7 GHz band on a non-harmful interference basis with the incumbent BSS service, and on a co-primary basis with the NGSO FSS. We note that extensive technical information and the results of experimental tests have been filed concerning sharing of the 12.2-12.7 GHz band by NGSO FSS, BSS, and MVDDS operations.[50] We find that we have an adequate record to conclude that the MVDDS can operate in the band on a non-harmful interference basis to the BSS and on a co-primary basis with the NGSO FSS. The *NPRM* did not propose specific technical, service or licensing rules for the MVDDS. These proposed rules will be the subject of the Further NPRM.

A. NGSO FSS Gateway Bands

22. In the *NPRM*, we proposed to allow NGSO FSS gateway downlink operations on a co-primary basis in the 10.7-11.7 GHz band; and to allow NGSO FSS gateway uplink operations on a co-primary basis in the 12.75-13.25 GHz, 13.8-14.0 GHz, and 14.4-14.5 GHz bands. In addition, the *NPRM* proposed to apply the WRC-97 PFD limits, existing coordination procedures and other techniques

[48] *See* February 18, 2000 *ex parte* filing of SkyBridge at 3.

[49] We note that the JTG 4-9-11 had previously reached agreement on NGSO FSS PFD limits to protect fixed services. In addition, while the JTG 4-9-11 was able to reach agreement on appropriate EPFD limits to protect smaller size GSO/FSS and BSS earth station antennas, the JTG did not reach consensus on EPFD limits for larger size earth station antennas. The latter issues were addressed by WRC-2000.

[50] *See, e.g.*, March 17, 2000 and March 22, 2000 *ex parte* filings of Northpoint and Technical Annex to Northpoint March 2, 1999 Comments.

to facilitate sharing between NGSO operations and terrestrial services. The *NPRM* also sought comment on the WRC-97 provisional EPFD limits for NGSO sharing with GSO operations and requested thorough analysis concerning the adequacy of these limits. The 13.75-13.8 GHz band was not proposed for NGSO FSS gateway uplink operations due to potential interference with Federal Government operations, and the 17.3-17.8 GHz band was not proposed due to a conflict with use of the band for BSS and Federal Government radiolocation services. We will address each of these bands and any relevant issues below.

1. Gateway Definition

23. *Proposal.* In order to facilitate the coordination process between NGSO FSS earth stations and terrestrial operations, the *NPRM* proposed to permit only gateway operations in bands shared with terrestrial operations allocated on a co-primary basis. For the purpose of NGSO FSS in the Ku-band, the *NPRM* proposed to define gateway operations as earth station operations that are not intended to originate or terminate traffic but are primarily intended for interconnecting to other networks.[51] The *NPRM* invited comment on whether the Commission should establish minimum antenna size requirements for gateway earth stations. The *NPRM* also asked whether it would be necessary to limit the number of NGSO FSS gateway stations in bands shared with terrestrial operations, and whether gateway operations should meet minimum antenna size requirements.

24. *Comments.* Although many commenters agree that only NGSO FSS gateway earth stations should be permitted to share Ku-band frequencies with terrestrial operations, some argue that there should not be a rigid distinction between gateway and service links. Teledesic LLC ("Teledesic") states that service links should be allowed to share with FS operations as long as they meet certain technical requirements.[52] Similarly, Virtual Geosatellite, L.L.C. ("Virgo") argues that service links should be permitted in the 11.2-11.7 GHz portion as long as they switch to other spectrum if terrestrial interference occurs.[53] FS interests and SkyBridge oppose allowing service links in the gateway bands. In its initial comments, SkyBridge suggests that the Commission clarify that gateways are not intended to handle traffic at user sites so that a gateway station does not act as an intermediary between the NGSO FSS satellite and a group of users connected terrestrially to that user earth station.[54] Boeing and SkyBridge also oppose the proposal that, for coordination purposes, a single gateway must be contained within an area of one second longitude by one second latitude.[55] They argue that this requirement would be overly restrictive and would not allow individual gateway antennas sufficient room to avoid blocking one another's signals.

25. PanAmSat Corporation ("PanAmSat") and Boeing support establishing a minimum antenna size requirement for NGSO FSS gateway stations in the Ku-band as a means of facilitating sharing, but in its initial comments SkyBridge opposes minimum antenna size requirements as arbitrary.[56] Boeing and

[51] *Id.* at ¶ 15.

[52] Teledesic Comments at 7.

[53] Virgo Comments at 13.

[54] SkyBridge Comments at 68, SkyBridge Reply Comments at 47, and FWCC Reply Comments at 13.

[55] Boeing Comments at 80 and SkyBridge Comments at 69.

[56] Boeing Comments at 79, PanAmSat Comments at 16, and SkyBridge Comments at 49.

SkyBridge also advise against establishing limits on the number of satellite earth stations permitted to operate in the Ku-band, asserting that any limit would be arbitrary.[57]

26. PanAmSat argues that the Commission should not subject GSO FSS systems in these frequency bands to the gateway station definition because it is designed as a particular component of an NGSO FSS system and is not relevant to GSO FSS systems. PanAmSat also contends that it would be inequitable to use the gateway definition to limit GSO FSS deployment in these bands.[58]

27. In November 1999, SkyBridge and the Fixed Wireless Communications Council ("FWCC") filed a joint *ex parte* letter indicating that they had negotiated an agreement on appropriate rules to govern the shared use of the 10.7-11.7 GHz band by the FS and NGSO FSS.[59] In December 1999, SkyBridge and the FWCC submitted the agreement as a proposal in this proceeding.[60] One of the areas addressed in the SkyBridge/FWCC proposal is the definition of an NGSO FSS gateway earth station. SkyBridge and FWCC propose the following definition:

> A Gateway operating in the 10.7-11.7 GHz band shall consist of an earth station complex providing radio frequency resources to NGSO FSS space stations which allow customer-premises earth stations to interconnect with long distance or other intercity networks or other non-collocated customer-premises earth stations; a Gateway shall not connect directly to customer-owned or customer-operated private distribution networks. Gateways shall have no less than three operational earth station antennas, each of which shall be no less than 2.5 meters in diameter; for non-parabolic antenna designs, the mainbeam beamwidth of the antenna shall not exceed the mainbeam beamwidth of a standard 2.5 meter parabolic antenna.[61]

28. In comments regarding this proposed definition, Boeing states that a minimum Gateway antenna size of 4.5 meters would best enhance sharing among inhomogeneous NGSO FSS systems in the Ku-band. However, Boeing states that because sharing between NGSO systems is not at issue in this proceeding, it simply requests that the inclusion of the 2.5 meter minimum Gateway antenna size not foreclose the possibility that we may determine that the inclusion of a 4.5 meter minimum Gateway antenna size best serves sharing among co-frequency NGSO systems.[62]

29. *Decision*. We find that we can permit deployment of NGSO FSS gateway earth stations in the proposed bands and also protect the continued use and growth of those bands by terrestrial operations. However, for reasons discussed in Section A3, we are limiting gateway use of the 12.75-13.25 GHz band to the 12.75-13.15 GHz and 13.2125-13.25 GHz band segments. Further, as discussed in Section A4, we are permitting gateway use of the 13.75-13.8 GHz band. Finally, as discussed in Section A5, we will permit service link, as well as gateway, use of the 14.4-14.5 GHz band. We recognize, however, that deployment of service links in the 10.7-11.7 GHz, 12.75-13.15 GHz, 13.2125-

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[57] SkyBridge Comments at 69 and Boeing Reply Comments at 18.

[58] PanAmSat Comments at 20.

[59] *See* November 12, 1999 *ex parte* letter to Dale Hatfield, Chief of the Office of Engineering and Technology from SkyBridge LLC and the FWCC.

[60] *See ex parte* letter filed by SkyBridge and FWCC on December 8, 1999 and supplemented on December 22, 1999.

[61] *See* December 8, 1999 *ex parte* of SkyBridge and FWCC at 3.

[62] Boeing Comments of January 12, 2000 at 2-3.

13.25 GHz, and 13.75-14.0 GHz bands could hinder future terrestrial service deployment in those bands. Therefore, we find it appropriate to allow only gateway earth station operations for NGSO FSS in those four bands. This will avoid the ubiquitous deployment of earth stations in those bands. Further, gateway earth stations will be located at sites readily identified to other users of the bands, thus increasing the potential for co-frequency operation. We define NGSO FSS gateway earth stations as those earth stations that do not originate or terminate traffic, but interconnect multiple non-collocated user earth stations operating in frequency bands other than designated gateway bands, through a satellite with other primary networks, such as the public switched telephone network and Internet networks. That is, gateway earth stations will be required to operate in a manner that supports the switching and routing functions of the NGSO FSS system as a whole, as do feeder links for mobile-satellite systems or hub operations for very small aperture terminal ("VSAT") networks.

30. Thus, we are adopting a functional definition for earth station use of this band, which should provide for various NGSO FSS system designs, regardless of what terminology is used by an applicant to describe the facility.[63] We note that this definition is similar to the one proposed by SkyBridge and the FWCC without establishing a limit on the number of earth stations per complex or on the size of the earth stations. Moreover, as discussed below, each NGSO gateway antenna will be required to meet an antenna performance standard of 29-25 log theta (θ) dBi in all directions.[64] We find that adopting this antenna performance standard will ensure that NGSO gateway antennas focus their signals in the desired direction without the need for minimum antenna size requirements, which could hinder innovation and flexibility. Additionally, to facilitate coordination with terrestrial facilities, we adopt our proposal requiring a single gateway complex to be located within an area of one second latitude by one second longitude. This requirement, which also applies to GSO FSS earth station sitings, facilitates earth station and terrestrial coordination in shared bands by specifying very limited areas for gateway antennas. Gateway antennas outside of these areas will be considered as separate gateway complexes for the purposes of coordination with terrestrial services and for licensing purposes. Nevertheless, these interconnected gateway antennas could be under multiple licenses, or considered as a single gateway complex.

31. We do not find it is necessary at this time to limit the number of NGSO FSS earth stations that should be allowed to use the 10.7-11.7 GHz, 12.75-13.15 GHz, 13.2125-13.25 GHz, and 13.75-14.0 GHz bands. The applications that have been filed for Ku-band NGSO FSS systems do not reflect a need for a significant number of gateway stations.[65] Therefore, the gateway earth station definition adopted here should be sufficient to prevent ubiquitous deployment of NGSO FSS earth stations in those bands. Nevertheless, as the NGSO FSS service grows to meet increasing capacity demands, any NGSO FSS network architecture changes resulting in a significant increase in the number of gateway stations can be addressed at that time. Finally, we clarify that this gateway definition applies only to NGSO FSS earth stations and not to GSO FSS operations in these bands. Although GSO FSS systems may operate gateway or hub earth stations that have some of the same characteristics as NGSO FSS gateway earth stations, GSO FSS earth stations operating in these bands are subject to separate requirements, which are discussed further below.

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[63] The network design of each proposed NGSO FSS system is unique, but all proposed systems have common elements that may be called by different names.

[64] Theta (θ) is the earth station antenna off-axis angle relative to the main lobe of the antenna. This angle is measured in all directions since the NGSO FSS satellites can be located anywhere above the earth station.

[65] See Appendix C for a brief description of each of the Ku-band NGSO operation applications. While most of the applicants propose to deploy less than 5 NGSO Gateway stations in the U. S., we note that SkyBridge proposed to deploy between 30 and 40 NGSO Gateway stations in the U.S.

2. NGSO FSS Gateway Downlink Band: 10.7-11.7 GHz

32. The 10.7-11.7 GHz band is currently allocated on a co-primary basis to the FS, licensed under Part 101 of the Commission's Rules; and to the FSS for international systems (downlinks),[66] licensed under Part 25 of the Commission's Rules.[67] The FS links in this band support a wide array of communication services used by utilities, railroads, telephone companies, state and local governments, public safety agencies, and others.[68] Moreover, this band was identified in 1993 in the Emerging Technologies proceeding and in 1997 in the Mobile-Satellite Service ("MSS") 2 GHz allocation proceeding as a future home for fixed point-to-point operations to be relocated from the 2 GHz band.[69] There are also several GSO FSS earth stations for international systems in this band.[70] Further, this band is also used for telemetry, tracking, and control ("TT&C") functions for GSO FSS satellites.[71]

33. The *NPRM* proposed to allow domestic/regional, as well as international, NGSO FSS gateway downlinks in the 10.7-11.7 GHz band, but to maintain the international systems only requirement for GSO FSS. The *NPRM* stated that NGSO FSS gateway downlink operations should be able to share the 10.7-11.7 GHz band with incumbent FS and GSO FSS operations provided the gateway stations are not extensively deployed and proper coordination is performed.[72] To facilitate this spectrum sharing, the *NPRM* proposed PFD and EPFD limits for NGSO FSS satellites to protect FS and GSO FSS earth station operations, respectively. Additionally, coordination procedures between FS transmitters and NGSO FSS earth stations were proposed, as well as NGSO FSS gateway siting restrictions to protect FS growth in the 50 most populated metropolitan areas. The NPRM also proposed that any gateway siting restrictions have a sunset date.[73] Further, the *NPRM* sought comment on the appropriate means to protect

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[66] *See* 47 C.F.R. § 2.106, footnote NG104.

[67] The GSO FSS operations in the 10.7-10.95 GHz and 11.2-11.45 GHz bands must adhere to the requirements specified in Appendix 30B of the ITU Radio Regulations and are referred to as "planned band" operations. GSO FSS operations are typically less extensively deployed in the Appendix 30B planned bands, as compared to non-planned bands. *See* 47 C.F.R. § 2.106 of the Commission's Rules, footnote 792 A; and ITU RR Footnote No. S5.441 and Appendix 30B of the ITU-R Radio Regulations *Provisions and Associated Plan for the Fixed-Satellite Service in the Frequency Bands 4500-4800 MHz, 6725-7025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz.* Use of these frequency bands is also governed by Resolution 130 (WRC-97).

[68] *NPRM* at ¶ 16.

[69] *See* Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile Satellite Service, ET Docket No. 92-9, Second Report and Order, 8 FCC Rcd 6495 (1993) ("Emerging Technology proceeding"). *See also* First Report and Order & Further Notice of Proposed Rule Making, ET Docket No. 95-18, 12 FCC Rcd 7388 (1997) ("2 GHz MSS allocation proceeding").

[70] Our records indicate that there are approximately 113 authorizations issued for GSO FSS earth stations in the 10.7-11.7 GHz band. These authorizations do not indicate the actual number of antennas that a licensee might deploy.

[71] The GSO FSS operations in this band perform TT&C communications to provide data on the spacecraft's functions via a two-way telemetry link between the satellite and the controlling earth station. TT&C communications are used throughout the satellite's life, including the launch and deployment phase. The TT&C function allows the earth station to control both the physical orbital position and internal functioning of the spacecraft.

[72] *NPRM* at ¶ 17.

[73] *NPRM* at ¶ 25.

GSO FSS service and TT&C links from new NGSO FSS downlink operations. These issues and others that were raised by commenters in this proceeding are addressed below.

a. NGSO FSS/FS Downlink Sharing

(i) Protection of FS receivers (PFD limits)

34. *Proposal.* The *NPRM* indicated that long-term interference from NGSO FSS downlinks into terrestrial FS receivers could be controlled by requiring that satellite transmissions not exceed the PFD limits adopted at WRC-97.[74] These limits are already in place for GSO FSS systems sharing with terrestrial FS and are included in Article S21 of the ITU Radio Regulations.[75] Because NGSO FSS systems have different operating characteristics than GSO FSS systems and because WRC-97 recognized that further studies were needed to assess the impact of multiple NGSO FSS systems, the *NPRM* sought comment on the adequacy of these limits. Additionally, the *NPRM* sought comment regarding whether short-term interference limits are necessary, particularly for FS operations with high look angles.[76]

35. *Comments.* Since the adoption of the *NPRM*, the ITU-R has determined that the PFD limits adopted at WRC-97 are adequate to protect terrestrial FS operations from the aggregate interference from both GSO FSS and NGSO FSS satellite systems.[77] While many commenters generally defer to the decisions of the ITU-R regarding PFD limits,[78] terrestrial FS interests argue that the interference potential from NGSO FSS satellites is greater than that from GSO FSS satellites, even under a common set of PFD limits.[79] In particular, FS proponents are concerned that the proposed PFD limits are not adequate to protect terrestrial FS links operating with a higher elevation angle to the horizon from NGSO FSS interference due to potential mainbeam-to-mainbeam[80] interference.[81] FWCC argues that the mainbeam-

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[74] *See* Article S21 of the ITU Radio Regulations, *see also* Recommendation ITU-R F-758-1, *Considerations in the Development of criteria for sharing between the Terrestrial Fixed Service and Other Services*. This Recommendation sets an interference criteria for protection of terrestrial stations based on an interference-to-noise ratio of -10 dB for 20% of the time. This recommendation does not contain short-term criteria.

[75] *See* ITU RR S21 at Table S21-4 (1998).

[76] The *NPRM* noted that "some terrestrial fixed links operate over mountains, where the mainbeam of the fixed receiver antenna is point well above the horizon. It appears that mainbeam to mainbeam interference could occur under such circumstances." *See NPRM* at ¶ 20.

[77] SkyBridge Reply Comments at 61.

[78] FWCC Comments at 16; EMS Technologies, Inc. Reply Comments at 5; and Boeing Reply Comments at 17.

[79] *See, e.g.*, FWCC Comments at 16.

[80] In relation to directional antennas, the term mainbeam often refers to the focal point where the antenna directs its signal to achieve signal directionality. Similarly, directional receive antennas generally focus their "mainbeam" in the direction of the desired incoming signal. Signal energy outside of the mainbeam direction are generally suppressed and can be considered undesirable. For the purposes of this section, a mainbeam to mainbeam interference situation would occur when an NGSO satellite's downlink mainbeam signal is aligned with a FS link's receive antenna mainbeam. This results in the amplification of the undesired satellite signal within the FS link receiver.

[81] SBC Comments at 3 and FWCC Comments at 12. Further, FWCC states that the high interference levels for more than 2 seconds can cause carrier group alarms ("CGA") which terminate traffic for a minimum of (continued....)

to-mainbeam interference issue is complicated because the PFD limits do not adequately account for Automatic Transmitter Power Control ("ATPC") in FS stations, a technique that allows FS stations to operate with minimal interference margins.[82]

36. Boeing replies that FS links that use a high elevation angle will not be affected because these terrestrial link transmission paths are much shorter than those used on flat terrain and the terrestrial signal will be robust enough to overcome any NGSO FSS transmission.[83] SkyBridge contends that mainbeam-to-mainbeam interference to FS links will not occur at less than 6 degrees elevation, which it claims protects 95.7% of all FS receivers.[84] Further, SkyBridge argues that FS receivers at higher elevations will be protected by the short term protection criteria agreed to within the ITU-R,[85] which will result in NGSO FSS transmissions that would never exceed a 20 dB interference to noise ratio.[86] Regarding ATPC in terrestrial FS links, SkyBridge states that the ITU study groups have developed a protection criteria to account for an ATPC range of up to 13 dB and that terrestrial interests have not demonstrated that the PFD limits are not adequate to protect terrestrial operations.[87]

37. FS proponents also argue that promises to protect FS operations will be difficult to enforce because an interfering signal can cause complete loss of synchronization and still not be visible on a spectrum analyzer. They also argue that it is not realistic to expect NGSO FSS licensees to willingly shut down if interference occurs. Therefore, regulations to protect FS operations must be established at the outset.[88] SBC Communications, Inc. ("SBC") claims that FS licensees should not bear any burden for correcting interference caused by NGSO FSS and should be reimbursed for the cost of investigating interference caused by NGSO FSS operations.[89] SkyBridge replies that NGSO FSS licensees will have co-primary status in the bands and, therefore, they should not be solely responsible for fixing problems.[90]

(Continued from previous page)
20 seconds. Further, this may also require a reboot and it may take 10-30 minutes to recover from a 2 second CGA and several hours to achieve whole operation. FWCC states that interference levels NGSO FSS proponents consider acceptable represent a serious public hazard to many fixed operations.

[82] Fixed systems are coordinated at the maximum power for which they will operate. ATPC allows a link to typically operate at less than maximum power using a minimal margin several decibels below maximum power until the desired signal is impeded (*e.g.*, rain-induced fade). Once the desired signal is impeded, the ATPC allows the link to operate at maximum power in order to maintain communications. ATPC can lower the fixed link's operating power by 10-15 dB in clear sky conditions to allow the link to conserve energy and equipment life. *See* FWCC Comments at 13.

[83] Boeing Reply Comments at 16.

[84] SkyBridge Reply Comments at 61.

[85] *See* ITU-R F. [Doc. 9A/TEMP/65] entitled "Draft new Recommendation on performance degradation criteria in 11/12 GHz." *See also* section 3.1.4.1.1of the CPM Report.

[86] *Id.*

[87] SkyBridge Reply Comments at 62.

[88] FWCC Comments at 15.

[89] SBC Comments at 4.

[90] SkyBridge Reply Comments at 63.

38. *Decision.* We note that the ITU-R studied the necessary criteria and PFD limits to allow NGSO FSS satellite downlinks to share spectrum with terrestrial FS operations.[91] In particular, Working Party 4-9S reached agreement on a set of PFD limits in April 1999 that are adequate for the protection of the FS in the 10.7-12.75 GHz band from the aggregate of interference from GSO FSS systems and multiple NGSO FSS systems. The ITU-R studies considered various sharing issues between FS operations and NGSO FSS operations, including typical FS operation margins with ATPC, the aggregate effect of multiple NGSO satellites, and other factors leading to interference concerns.[92] The PFD limits agreed upon within the ITU-R for the 10.7-11.7 GHz band have been affirmed by WRC-2000[93] and are listed below for various angles above the horizontal plane (δ).

Table 3: ITU-R Recommended PFD Limits for 10.7-11.7 GHz Band

PFD Limit	Angle of arrival above the horizontal plane
-126 dB(W/m^2/ MHz)	$0° \leq \delta < 5°$
-126 +(δ-5)/2 dB(W/m^2/ MHz)	$5° \leq \delta < 25°$
-116 dB(W/m^2/ MHz)	$25° \leq \delta < 90°$

39. These PFD limits were derived based on the operating characteristics of a majority of the FS links in the 10.7-12.75 GHz band.[94] Based on the findings of the ITU-R, the decision taken at WRC-2000, and the record in this proceeding, we find that these PFD limits are adequate to protect the vast majority of terrestrial FS operations in the 10.7-11.7 GHz band from NGSO FSS satellite transmissions. Therefore, we adopt the PFD limits in Table 3 for NGSO FSS systems operating in the 10.7-11.7 GHz band. Additionally, we note that these PFD values are the same as those governing GSO operations in this band, except the NGSO PFD limits must be met in a 1 megahertz rather than a 4 kilohertz reference bandwidth.[95] We are also modifying the GSO PFD limits to protect terrestrial services in Section 25.208(b) of the Commission's Rules[96] to a 1 megahertz reference bandwidth.

40. While the PFD limits discussed above appear to be adequate for most operating situations, we find that these PFD limits may not be adequate to protect terrestrial operations with high elevation look angles and ATPC from receiving unacceptable mainbeam-to-mainbeam interference.[97] We note that

[91] More specifically, these studies have been carried out within ITU-R Working Party 9A (WP 9A) and Joint Working Party 4-9S (JWP 4-9S). WP 9A is titled the "Performance and availability, interference objectives and analysis, effects of propagation and terminology for the fixed service;" and JWP 4-9S is titled "Frequency sharing between the fixed-satellite service and fixed service."

[92] *See* Section 3.1.4 of the CPM Report to WRC-2000.

[93] *See* WRC-2000 *Provisional Final Acts* at Article S21.

[94] *Id.* at 3.1.4.1.1 (a).

[95] The reference bandwidth is the bandwidth over which emission limits are measured. Converting the reference bandwidth of measurements for pfd limits from four kilohertz to one megahertz does not impact any party because the pfd limits are scaled accordingly.

[96] All references to the Commission's Rules in this item refer to Title 47 of the U.S. Code of Federal Regulations (47 C.F.R.).

[97] Specifically, the record is insufficient to determine whether the ATPC circuitry would lower the fixed operation's margin to a sufficient level to cause an outage from a mainbeam NGSO satellite signal occurrence. *See* SBC Comments at 3 and FWCC Comments at 12.

the minimum operating angle for each proposed NGSO system varies to as low as 6 degrees above the horizon and each system will have different operating characteristics. Therefore, the impact of each NGSO system on terrestrial operations will vary. Further, we agree with satellite commenters that FS links operating under these circumstances represent a small percentage of the total links in the 10.7-11.7 GHz band. For example, out of the 6612 links authorized in the 10.7-11.7 GHz band, 214 links have receive antennas looking at higher than 5 degrees above the horizon.[98] For the worst case interference to occur, these links: (1) would have to be perfectly aligned with the satellite's mainbeam transmissions; and (2) the FS link must not have adequate margin to compensate for the NGSO FSS interference. We note that FS terrestrial links that have high elevation look angles typically have short transmission paths, and the power margins may be sufficient to overcome rain attenuation of the transmission signals. Therefore, we believe the occurrences of mainbeam-to-mainbeam interference between NGSO FSS and terrestrial FS links would be rare.

41. We conclude that the PFD limits adopted here do not need to be tightened to address mainbeam-to-mainbeam interference situations. Tighter PFD limits might overly constrain the NGSO FSS operations. Instead, any protection needed for the small number of FS links that might suffer from mainbeam interference can be accomplished on a case-by-case basis. For example, depending on the specific circumstances, several techniques may be used to mitigate mainbeam interference situations: (1) the FS link could be modified so that the operating margins or antennas can overcome any satellite interference; (2) NGSO FSS satellites could avoid transmitting mainbeam signals in the direction of the incumbent FS links pointed at their orbital path; (3) FS operations may be moved slightly to avoid mainbeam interference alignment; and (4) the FS link could be adjusted so that the ATPC level allows sufficient margin to overcome satellite interference.

42. In frequency bands with co-primary services, new entrants in a band must coordinate their operations with incumbent operations in order to minimize the possibility of harmful interference between the sharing services.[99] Therefore, new NGSO FSS applicants that operate in bands used by the FS must ensure that their operations will not result in harmful interference to incumbent operations. In most cases, the PFD limits we are adopting should ensure this result. Because NGSO FSS systems will have different operational characteristics (*e.g.*, different minimum angles of operation), each NGSO FSS licensee will have to determine whether incumbent FS operations with elevation angles more than 5 degrees above the horizon will be affected and will be responsible for avoiding interference to incumbents, including possible mainbeam to mainbeam alignments. Likewise, if FS links are to be licensed after commencement of NGSO FSS operations, the FS applicant will be responsible for designing the link to be compatible with satellite operations, including possible mainbeam to mainbeam alignments. We are particularly concerned with incumbent FS operations that are used for public and other types of safety services. For these types of services, even rare interference occurrences could create an unacceptable public or safety hazard; thus, these operations should be protected from harmful interference.[100]

[98] *See* October 28, 1999 *ex parte* filing of FWCC.

[99] *See e.g.*, 47 C.F.R. §§ 25.203 and 101.103.

[100] Harmful interference is that which endangers the functioning of a radionavigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Commission rules. *See* 47 C.F.R. § 2.1.

(ii) Coordination of NGSO FSS with FS stations

43. *Proposal.* The *NPRM* proposed that NGSO FSS gateway receivers in the downlink (10.7-11.7 GHz) band would be protected from terrestrial transmitters through coordination.[101] In the coordination process, new facilities from either service are responsible for determining the location of existing operations within a specified distance and using various techniques, such as antenna directionality, terrain shielding, "RF" shielding, or frequency or geographic separation, to ensure that new operations can be accommodated without causing unacceptable interference to existing operations. The *NPRM* proposed to apply the existing prior coordination procedures used for GSO FSS earth stations and terrestrial stations, as set forth in Parts 25 and 101 of the Commission's Rules, to NGSO FSS operations.[102] The *NPRM* also sought comment on whether we should adopt ITU recommendations, which are now under development, concerning coordination areas for NGSO systems that are generally smaller than coordination areas for GSO systems.[103] This is because interference occurrences between NGSO FSS gateway stations and terrestrial stations are of a time-varying nature due to the continuous motion of the NGSO FSS satellite, as opposed to the constant interference signal level between GSO FSS and terrestrial stations. Finally, the *NPRM* proposed to establish 100 km radius exclusion zones around the 50 most populated U.S. cities, wherein gateways would be excluded for a specified number of years so as not to inhibit FS growth.

44. *Comments.* Comsearch, SkyBridge and Boeing support applying to NGSO FSS gateways the existing coordination procedures for GSO FSS earth stations, with some modifications to account for the technical differences in NGSO FSS systems.[104] For example, Comsearch indicates that our rules on earth station coordination information, contained in Section 25.203(c)(2), need to consider NGSO FSS system characteristics such as antenna pointing information. Comsearch also suggests that the Commission allow industry groups such as the National Spectrum Managers Association ("NSMA") to suggest the appropriate rule changes and coordination data sufficient to account for NGSO FSS systems. Comsearch also recommends that NGSO FSS coordination contours be calculated using the ITU-R Recommendation IS.849 modification procedure to the ITU-R Recommendation IS.847 method.[105] SkyBridge states that the IS.849 procedure can be used until revisions to the ITU's RR Appendix 28/Appendix S7[106] ("App. S7") coordination method to account for NGSO satellite systems are considered at WRC-2000. SkyBridge notes that although NGSO satellite systems have a greater range of pointing azimuths, the area

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[101] *NPRM* at ¶ 22.

[102] *See, e.g.*, 47 C.F.R. §§ 25.130, 101.103.

[103] *See* ITU-R Recommendation ITU-R IS.849-1, Determination of the Coordination Area for Earth Stations Operating with Non-Geostationary Spacecraft in Bands Shared with Terrestrial Services.

[104] Comsearch Comments at 2, Boeing Reply Comments at 14, and SkyBridge Reply Comments at 50.

[105] Comsearch Comments at 2. *See also*, ITU Recommendation ITU-R IS.847-1, *Determination of the Coordination Area of an Earth Station Operating with a Geostationary Space Station and Using the Same Frequency Band as a System in a Terrestrial Service*; and ITU Recommendation ITU-R IS.849-1, *Determination of the Coordination Area for Earth Stations Operating with Non-Geostationary Spacecraft in Bands Shared with Terrestrial Services.*

[106] WRC-95 changed the ITU RR numbering scheme. Therefore, the ITU RR procedures for determining the coordination distance around an earth station for bands shared between space and terrestrial radiocommunication services that were previously in Appendix 28 are now in Appendix S7. We will modify Section 25.251 of our rules to reflex this change. *See* 1998 ITU RR, Appendix S7, *Method for the determination of the coordination area around an earth station in frequency bands between 1 GHz and 40 GHz shared between space and terrestrial radiocommunication services.*

of coordination for NGSO satellite operations would be smaller than that of GSO satellite operations.[107] SkyBridge predicts that the WRC-2000 revisions to App. S7 will account for the time varying nature of the horizon gain for a given azimuth, thereby resulting in smaller coordination areas for NGSO FSS earth stations. Further, it contends that the size of the coordination area does not necessarily preclude FS operations from a geographic area, but defines the area over which interference analysis needs to be performed and potential interference needs to be addressed among the affected parties.

45. FWCC opposes using GSO FSS coordination procedures for NGSO FSS operations and relying on WRC-2000 changes to the ITU's App. S7 coordination methods. Specifically, FWCC argues that coordination with NGSO FSS operations will require more stringent procedures to account for NGSO transmissions in multiple directions, and should take into account all of the factors likely to affect the actual incidence of interference, such as antenna directionality, terrain shielding, radio frequency ("RF") shielding, and frequency or geographic separation.[108] FWCC also proposes that FS operators be required to coordinate only over the azimuths actually used by the NGSO FSS gateway. FWCC further proposes that, if an NGSO FSS earth station accepts a higher-than-desired interference objective when coordinating, any subsequent FS applicant should be allowed to coordinate to the same higher level.[109] FWCC also urges the adoption of rules to improve the equity of the licensing process between FSS earth stations and FS operations. Specifically, FWCC contends that the Commission often licenses FSS earth stations for a band without inquiry into the actual amount of traffic to be carried.[110] Earth station licensees thus maintain preemption rights for that unused spectrum over many square miles. FWCC also maintains that while the Commission has spectrum efficiency requirements for FS links, no similar requirements exist for satellite operations that share the same spectrum.[111] In addition to raising these issues in this proceeding, FWCC also filed a Request for Declaratory Ruling and Petition for Rule Making ("Petition") requesting similar changes to our rules for other bands where FS operations share with FSS operations.[112]

46. In response to FWCC's concerns, SkyBridge asserts that it will have to coordinate for all azimuths because all azimuths will be used by NGSO FSS gateway stations, even though minimum elevation angles may vary.[113] SkyBridge agrees with FWCC that subsequent coordinations of either service should be able to benefit from prior coordination agreements with higher-than-desired

[107] SkyBridge Reply Comments at 51.

[108] FWCC Reply Comments at 11.

[109] Specifically, FWCC states that if a gateway earth station accepts a higher level of interference because it does not plan to use the frequencies on which the interference is present, it must specify that a future incoming Fixed station need not coordinate on those frequencies. If a gateway accepts a higher level of interference because it is shielded by a local feature such as a building or a hill, it must accept a new Fixed station coordinated at the same higher level, if it is shielded by the same feature. If a gateway station accepts a higher level of interference without explanation, then a future incoming Fixed station located in the same general area can coordinate at the same higher level. *See* FWCC Comments at 20-21.

[110] FWCC Comments at 19.

[111] *Id.* at 10. FWCC proposes that NGSO FSS systems be required to use at least the equivalent of 16-QAM or a spectral efficiency of 4 bits/second/hertz.

[112] *See* Request for Declaratory Ruling and Petition for Rule Making of the Fixed Wireless Communications Coalition, RM-9649, filed May 5, 1999. FWCC's filing was placed on public notice June 11, 1999. *See Public Notice*, Report No. 2334.

[113] SkyBridge Reply Comments at 51.

interference objectives. SkyBridge opposes any modulation and efficiency constraints because it claims that higher order modulation techniques to be more spectrum efficient would force satellite systems to increase the power of their operations and make spectrum sharing more difficult.[114]

47. FWCC also asserts that NGSO FSS gateway stations should be required to specify half of the band to be left available for FS growth to improve the equity of the Commission's FSS-FS coordination and licensing process.[115] Similarly, Comsearch argues that authorizing NGSO FSS earth stations to use either the 10.7-10.95/11.2-11.45 GHz or the 10.95-11.2/11.45-11.7 GHz segments, but not both in any given area, would allow new FS systems to gain frequency separation from earth stations in the coordination process.[116] FWCC points out, however, that if neighboring gateway stations choose different bands, they would, between them, foreclose FS operations in a geographic area.[117] SkyBridge opposes limiting NGSO FSS systems to half of the band because it would unnecessarily constrain NGSO FSS systems without any demonstrated benefit for FS systems.[118]

48. FS commenters also urge the Commission to require mandatory RF shielding with a required minimum of 18 dB of shielding in all directions around NGSO FSS gateway stations to facilitate the coordination and sharing process.[119] SkyBridge states that there is no reason to require mandatory 18 dB of shielding for all earth stations, but that shielding should be an option operators consider in order to achieve coordination with either incumbent or new FS facilities. SkyBridge also argues that the cost of shielding must be shared and proposes that NGSO FSS operators pay for shielding to protect incumbent operations, but that new FS links in the band pay for any shielding to an NGSO FSS earth station if such shielding is needed to achieve coordination.[120]

49. FWCC states that SkyBridge's shielding proposals could significantly reduce the FS's ability to add new links. FWCC argues that FS entities should be able to benefit from RF shielding in the coordination process.[121] Therefore, FWCC proposes the concept of "virtual shielding" whereby an FS applicant can assume 18 dB of "virtual shielding" around each NGSO FSS gateway, whether it is there or not. Under this proposal, the NGSO provider retains the option to build the shielding or site its gateway facility with natural shielding to meet this 18 dB requirement. FWCC contends that this method would allow FS entities reasonable flexibility in the coordination process and, if necessary, NGSO FSS entities would be allowed to meet the requirement through terrain shielding or actual shielding along the necessary azimuths of the gateway operation.

50. *Decision.* We conclude that coordination is important for sharing between NGSO gateway stations and terrestrial operations, and that both NGSO FSS and terrestrial interests will rely equally on coordination to protect their operations. The coordination procedures for FSS and terrestrial FS

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[114] *Id.* at 53.

[115] FWCC Comments at 19.

[116] Comsearch Comments at 7.

[117] FWCC Reply Comments at 4.

[118] SkyBridge Reply Comments at 53.

[119] FWCC Comments at 9.

[120] SkyBridge Reply Comments at 55.

[121] FWCC Comments at 10-11.

operations are specified in Parts 25 and 101 of our rules, respectively.[122] These procedures outline the steps that an applicant must take in the coordination process, and are explained in more detail below. After reviewing the record and current coordination rules, we conclude that the current procedures, with some modification, shall be used to coordinate NGSO FSS and FS operations.

51. The coordination procedures for terrestrial FS operations with satellite operations are set forth in Sections 101.21(f) and 101.103 of the Commission's Rules. Generally, Section 101.103 requires entities to complete coordination prior to filing an application for authorization. The applicant must, through appropriate analysis, select operating characteristics to avoid interference in excess of permissible levels to other spectrum users. Section 101.103 also outlines the notification and response elements of the coordination process, where applicants provide relevant information on their proposed operation to other potentially affected entities. Section 101.21(f) further outlines the coordination process for FS links sharing spectrum with satellite services. The FS applicant must first determine if its proposed link would lie within the coordination contour of existing satellite service earth stations. The applicant must also ensure that its proposed operations would not exceed the permissible level of interference allowed by our rules. We find that the information specified and the process outlined in Part 101 of our rules are adequate for coordination between FS operations and satellite operations and do not need modification.

52. We are revising here some of the Part 25 coordination rules for satellite operations to accommodate new NGSO FSS systems.[123] The *Report and Order* in IB Docket No. 95-117 removed Sections 25.252-25.256 from our rules. Those sections specified the method for determining certain necessary coordination information such as coordination distances, rain scatter coordination distances, permissible interference levels and other coordination parameters.[124] The Commission found that because the international coordination procedures contained in Appendix S7 of the ITU RR changed frequently, it would simply reference Appendix S7 in our rules. Therefore, we amend Section 25.203 to reflect that information regarding calculation of coordination information can be found in Appendix S7 of the ITU RR and to reflect the relevant NGSO gateway station coordination information that must be provided to terrestrial users.

53. Appendix S7 has been modified at WRC-2000 to account for coordination between NGSO FSS operations and FS operations.[125] As noted by several commenters, the ITU has developed modified procedures Recommendation ITU-R IS.849 ("IS.849") to the ITU method of calculating coordination

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[122] We require prior coordination for licensing of FSS earth stations and terrestrial fixed stations. Under these procedures, the earth station applicant must, before filing an application with the Commission, identify all potentially affected terrestrial licensees in the vicinity of their proposed earth stations and resolve all potential interference problems with existing terrestrial licensees in the band. In its application, the applicant must certify that coordination has been achieved with affected licensees. The Commission places the applications on public notice, and existing licensees may file petitions to deny if coordination has not been completed. The earth station license will not be granted until all interference issues are resolved. Similar procedures are followed when a terrestrial station application is filed in shared frequency bands.

[123] We are also taking the opportunity in this proceeding to revise some of the Part 25 rules to comport with previous Commission decisions, including, for example, correcting cross-references to revised coordination rules.

[124] *See* Streamlining the Commission's Rules and Regulations for Satellite Application and Licensing Procedures, *Report and Order*, IB Docket No. 95-117, 11 FCC Rcd 21581, at ¶ 52 (1996).

[125] *See Provisional Final Acts of the World Radiocommunication Conference ("Istanbul 2000, WRC-2000")* at Appendix S7.

contours to account for the characteristics of NGSO versus GSO systems. If FS entities believe that changes to Appendix S7 are not sufficient to address the coordination situation in the United States, they can request that we revisit the coordination procedures for this band.[126] Therefore, other than amending Part 25 to consider NGSO FSS sharing with FS systems, we will make no other changes in our coordination process for operations in the 10.7-11.7 GHz portion at this time.

54. We recognize that the ITU coordination contour calculation methodologies in App. S7, IS847 and IS849 do not consider the effects of terrain shielding and RF shielding; these issues were raised by FWCC. However, coordination contours are used to identify those operations where further interference analysis must be done. Our rules require licensees and applicants to cooperate fully and make reasonable efforts to resolve technical problems and conflicts that may inhibit efficient use of the spectrum.[127] Therefore, we find that it is unnecessary to consider localized characteristics such as terrain and RF shielding in coordination contour calculations. These issues may be considered in the subsequent coordination analysis to ensure that adequate protection is provided to incumbent operations.

55. Regarding the issues raised in FWCC's Comments and Petition concerning the equity of the licensing and coordination of satellite operations sharing spectrum with FS operations, we will be considering these issues in a separate proceeding because the issues are relevant to several bands where satellite services and the FS share spectrum. On October 24, 2000, the Commission adopted a *Notice of Proposed Rule Making* in IB Docket 00-203 to address the FWCC petition.[128] That item made proposals to address FWCC's concerns about effective and equitable use of spectrum in bands shared by the FS and FSS.

56. Regarding the use of RF shielding, we find that RF and terrain shielding will be useful tools in the coordination and deployment of NGSO FSS gateway stations. However, we find that mandatory shielding requirements would be unnecessarily burdensome on NGSO FSS operations. Further, although "virtual shielding" may encourage NGSO FSS entities to site their gateways to take advantage of natural terrain shielding, it would place the burden solely on the NGSO entity to provide for shielding in order to share with FS operations. Our coordination and service rules already require Commission applicants and licensees to deploy their operations in such a manner as to avoid harmful interference to other spectrum users, to cooperate fully and make reasonable efforts to resolve technical problems that may inhibit the most efficient use of the spectrum, and to avoid blocking the growth of systems as prior coordinated.[129] Therefore, we encourage entities that wish to use the 10.7-11.7 GHz band to use various types of shielding to meet these requirements. In particular, because NGSO FSS gateway operations do not focus their signals in a single direction like FS operations, we encourage them to accept shielding by subsequent FS entrants if the FS entity agrees to pay for it, as suggested by SkyBridge.

b. Gateway Siting Restrictions

57. *Proposal.* In the *NPRM*, we proposed to establish exclusion areas around the 50 most populated cities, as defined by the 1990 Census, in which NGSO FSS gateway stations could not be located.[130] Each exclusion area would consist of a 100 km radius around the city center. The exclusion

[126] We note that terrestrial operators have participated in proceedings regarding U.S. preparations for WRC-2000.

[127] *See* 47 C.F.R. §101.103(d)(1).

[128] *Notice of Proposed Rule Making*, IB Docket No. 00-203, FCC 00-369, (released October 24, 2000).

[129] *Id.*

[130] *NPRM* at ¶¶ 23-25.

zone proposal was intended to provide a workable compromise to FS growth and NGSO FSS gateway deployment based on the premise that satellite gateway stations did not have the geographical limitations of terrestrial operations and could operate without being located in major metropolitan areas, where most terrestrial operations are deployed. Further, because the relocation of some FS links to the 10.7-11.7 GHz band from other bands was the primary factor in proposing exclusion zones, the *NPRM* proposed that any exclusion area requirement have a sunset date. Specifically, we proposed to require NGSO FSS gateway stations to avoid deployment in the designated areas for a specified number of years (*e.g.*, 5 or 10 years) to permit FS relocation. After this date, new NGSO FSS gateway stations would be able to locate facilities within these areas and standard coordination procedures would apply.[131]

58. While sharing between NGSO FSS and terrestrial interests in the 12.75-13.25 GHz band will be discussed below, we believe that it is appropriate to discuss here comments regarding exclusion zones and their benefit for incumbent terrestrial operations in the 12.75-13.25 GHz band. The 12.75-13.25 GHz band is allocated on a co-primary basis to FS, FSS uplink, and mobile operations, and is used primarily by Part 74 BAS and cable television relay ("CARS") service and Part 101 fixed microwave service. As the commenters point out, exclusion zones in the 10.7 GHz downlink band would act as *de facto* exclusion zones in the 12.75 GHz uplink band because the gateway earth station will typically provide links for all authorized bands.[132] In the NPRM, however, we tentatively concluded that exclusion areas are not needed in the 12.75-13.25 GHz band, given the maturity and use of the spectrum and that it is not targeted for relocated systems.[133] With the information provided in the record, we will address exclusion zones for both the 10.7-11.7 GHz and 12.75-13.25 GHz bands jointly to determine their ability to facilitate spectrum sharing between NGSO FSS gateways and terrestrial operations.

59. *Comments.* In initial comments filed in response to the *NPRM*, terrestrial FS interests argue that exclusion zones are justified and necessary to promote the future growth of terrestrial services. FWCC states that NGSO stations have greater geographic flexibility in the 10.7 GHz band than FS links, whose sites are tied to customer locations and line of site.[134] Comsearch and FWCC state that most new terrestrial fixed stations in the 10.7 GHz band are due to expansion of existing FS operations in the band, not relocation of FS links from other bands, so no sunset date should apply to exclusion zones.[135] Comsearch argues that the 11 GHz band is the only short haul band where the channel bandwidths and available equipment support transmission above 45 megabits per second ("Mb/s") and is extensively used by local telecommunications access providers and cellular companies.[136] FWCC states that normal growth of the FS includes an additional coordination of 2000 frequencies per year.[137]

60. In its initial comments, SkyBridge argues that all exclusion zone proposals are arbitrary and without technical justification. SkyBridge also states that gateway siting restrictions are unnecessary because NGSO FSS gateways will be coordinated and shielding may be applied. SkyBridge further maintains that the proposed exclusion zones do not accurately define those geographic regions that could

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[131] *Id.* at ¶¶ 24-25.

[132] Comsearch Comments at 5.

[133] *NPRM* at ¶ 34.

[134] FWCC Reply Comments at 8.

[135] Comsearch Comments at 5 and FWCC Reply Comments at 7.

[136] Comsearch Comments at 3.

[137] FWCC Reply Comments at 8.

benefit from an FS head-start and would significantly constrain NGSO FSS operators in selecting the most appropriate gateway sites.[138]

61. As previously discussed, in November 1999 SkyBridge and the FWCC filed a joint *ex parte* letter indicating that they had negotiated an agreement on appropriate rules to govern the shared use of the 10.7-11.7 GHz band by the FS and NGSO FSS.[139] In December 1999, SkyBridge and FWCC submitted the agreement as a proposal in this proceeding. In two *ex parte* communications, SkyBridge/FWCC describe the proposal as differing in several important respects from both the NGSO FSS/FS regulatory scheme set out in the *NPRM* and from the views they expressed in their initial comments. Specifically, SkyBridge and FWCC propose, in lieu of exclusion zones, criteria for identifying FS "growth zones." Under the proposal, the location of NGSO FSS gateway earth stations would not be restricted, but the NGSO FSS operator would assume certain obligations during coordination that would protect incumbent FS facilities from interference on existing and possible future channels in the growth zones.[140] A growth zone would be defined as any county in which, based on a semi-annual determination, at least 30 FS frequencies are licensed to transmit in the 10.7-11.7 GHz band. SkyBridge and FWCC recommend that the Commission issue at 6-month intervals a list of counties that qualify as growth zones. The suggested coordination procedures within growth zones would, for example, protect FS facilities on all transmit channels in the frequency band, even if the facility was not operating on some of the channels at the time of coordination; require NGSO FSS stations to mitigate interference from new FS stations attempting to locate within a growth zone; and require NGSO FSS stations to apply to all fixed stations entering the growth zone the same aggregate level of interference that it agrees to accept on any given azimuth from any one fixed station.[141]

62. In December 1999, the Commission issued a *Public Notice* soliciting comment on the SkyBridge/FWCC proposal.[142] Commenting parties generally support the proposal; however, some express concern that county boundaries may not accurately reflect FS use in a particular geographic area. The Association of American Railroads ("AAR") states that it believes that the SkyBridge/FWCC proposal represents a reasonable compromise that balances the continued ability of the FS to use the band with the ability of the NGSO FSS proponents to deploy their earth stations.[143] Nonetheless, AAR, Bell Atlantic, and SBC argue that basing growth zones on county boundaries will produce anomalous results since small counties would require more dense FS use to qualify as growth zones, whereas larger counties would require less dense FS use to qualify.[144] SBC points out that far fewer growth zones would be identified on the East Coast than the West Coast, and is concerned that the plan would not adequately

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[138] SkyBridge Reply Comments at 58.

[139] *See* November 12, 1999 *ex parte* letter to Dale Hatfield, Chief of the Office of Engineering and Technology from SkyBridge LLC and the FWCC.

[140] *See ex parte* letter filed by SkyBridge and FWCC on December 8, 1999 and supplemented on December 22, 1999.

[141] *See* December 8, 1999 and December 22, 1999 *ex partes* from SkyBridge and FWCC.

[142] *See Public Notice*, released December 27, 1999, DA 99-3008.

[143] AAR Comments of January 12, 2000 at 1.

[144] As an example, Bell Atlantic cites San Bernardino County, CA, which, Bell Atlantic maintains, covers over 20,000 square miles and is equivalent to 61 counties between New York City and Northern Virginia. Bell Atlantic Comments of January 12, 2000 at 1-3. *See also* AAR Comments of January 12, 2000 at 2; SBC Comments of January 12, 2000 at 3-4.

accommodate FS facilities that have to relocate from the 2 GHz band to the 11 GHz band.[145] AAR and Hughes Communications, Inc. ("Hughes") recommend that if we adopt the proposal we should be flexible and entertain favorably requests for waiver of the rules where necessary for the continued viability of FS incumbents.[146] Hughes notes that the agreement does not explain why "30" licensed FS frequencies is the threshold for identifying a growth zone, questions whether this number is appropriate, and asserts that implementing the concept of licensed "frequencies" is unclear since licensed bandwidths vary.[147] Although it applauds the efforts of SkyBridge and FWCC to establish reasonable band sharing arrangements, Bell Atlantic prefers that the coordination procedures suggested for growth zones actually be applied everywhere to protect FS facilities.[148]

63. Comsearch states that the use of growth zones, while somewhat arbitrary in definition and scope, reflects an improvement over exclusion zones. However, Comsearch recommends that private coordinators, rather than the Commission, administer the procedure. Comsearch states that frequency coordinators can readily identify growth zones on a real-time basis at the time of the coordination request, and that this procedure would be more effective at tracking changes in 11 GHz usage than a list issued once every 6 months.[149] SBC also believes that the identification of growth zones should be ongoing and part of the coordination process.[150] Comsearch also claims that some of the suggested coordination procedures for use within growth zones need clarification, and prefers that existing coordination procedures for FSS facilities be improved (*e.g.*, earth station location and mitigation techniques, maximizing antenna discrimination, specifying frequencies actually required, limiting pointing azimuths, disclosing terms of coordination agreements).[151]

64. Although it generally supports the growth zone concept, Virgo contends that limiting the 11 GHz band to gateway earth stations is not justified for all NGSO FSS networks, even though it may be appropriate with respect to sharing among SkyBridge earth stations and FS.[152] Virgo maintains that NGSO FSS systems that employ satellite technology that differs markedly from SkyBridge's sub-

[145] SBC Comments of January 12, 2000 at 3-4. The 10.7-11.7 GHz band was identified for future use by fixed operations that must be relocated from the 2 GHz band. *See* Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum for Use by the Mobile Satellite Service, *Second Report and Order*, ET Docket No. 92-9, 8 FCC Rcd 6495 (1993) ("Emerging Technology Proceeding"). *See also, First Report and Order and Further Notice of Proposed Rule Making*, ET Docket No. 95-18, 12 FCC Rcd 7388 (1997) ("2 GHz MSS Allocation Proceeding").

[146] AAR Comments of January 12, 2000 at 1-2; Hughes Comments of January 12, 2000 at 7.

[147] Hughes Comments of January 12, 2000 at 6-7.

[148] Bell Atlantic Comments of January 12, 2000 at 1.

[149] Comsearch Comments of January 12, 2000 at 2-3.

[150] SBC Comments of January 12, 2000 at 4.

[151] Comsearch Comments of January 12, 2000 at 6.

[152] Hughes also argues that the 11 GHz band should not be limited to gateway earth stations, and recommends a numeric limit on FSS earth stations of any type as well as limits on receive antenna gain to protect FS facilities, as requirements that would be easier to administer than other proposals. Hughes Comments of January 12, 2000 at 3-5.

geostationary circular orbit model will not pose the same interference threat to fixed operations and should not be constrained by the suggested coordination agreement if it is adopted.[153]

65. The Society of Broadcast Engineers, Inc. ("SBE") also supports the growth zone proposal, but argues that further analysis must be done for gateway uplinks wishing to operate in the 12.75-13.25 GHz portion of the TV Broadcast Auxiliary Services and Community Television Relay Service bands. For example, further analysis would be needed to determine what minimum number of BAS or CARS facilities would trigger a growth zone designation at 13 GHz. Given the presence of mobile or portable BAS operations, SBE recommends that gateway uplinks in the 13.15-13.25 GHz portion of that band be precluded from locating within 50 km of the top 100 TV markets. Since BAS and CARS links may cross county boundaries, SBE also recommends that for a given link that crosses county boundaries, both the transmit and receive facilities count in each county in determining growth zones at 13 GHz.[154]

66. *Decision.* We conclude that the record supports the adoption of some restrictions on NGSO FSS deployment in the 11 GHz and 13 GHz gateway bands in specified geographic areas in order to protect incumbent services' use of the bands. Because any restrictions on gateway stations using downlink bands would apply as a practical matter to their corresponding uplink bands, any regulatory scheme to promote spectrum sharing between NGSO FSS gateway operations and incumbent operations needs to address the needs of incumbent operations in both the uplink and downlink bands. The record indicates that geographic protection zones will not only benefit FS operations in the 11 GHz band, including both incumbent operations and those that will relocate from other bands, but also BAS and CARS operations in the 12.75-13.25 GHz band. TV stations in major metropolitan areas, for example, may need some form of protection in specified geographic areas to ensure that TV stations will be able to deploy new BAS operations to accommodate the transition to digital TV.[155]

67. We agree with the majority of commenters that the growth zone concept, which focuses on coordination procedures to protect incumbent services within specified geographic areas, would provide a more efficient and flexible approach to band sharing than exclusion zones in most cases. We also concur with commenters that the implementation of the growth zone concept would appropriately be included in existing coordination procedures, which would not require direct Commission involvement. Nonetheless, we conclude that, based on the record here, the growth zone concept needs further analysis in order to address better the needs of all affected parties. For example, most commenters would prefer that the boundaries for growth zones be based on a uniform measurement so that density of FS use be the primary factor in identifying growth zones, including the possible relocation of FS facilities from other bands to the 11 GHz band. We also must analyze whether, in order to provide equitable band sharing with mobile and temporary fixed BAS and CARS operations in the 13 GHz band, the growth zone concept has to include some exclusion areas for siting NGSO FSS gateway stations or whether other coordination methods may promote band sharing between these services. Thus, in a future separately docketed proceeding, we will evaluate methods for defining growth zones that serve all interested parties in the NGSO FSS gateway bands (10.7-11.7 GHz, 12.75-13.25 GHz, and 13.8-14.0 GHz bands).

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[153] Virgo Comments of January 12, 2000 at 3-4.

[154] SBE states that it hopes to resolve issues relating to the 12.75-13.25 GHz band through negotiations with SkyBridge. SBE Comments of January 12, 2000 at 2-4.

[155] For example, we note that the number of television stations could double with the conversion to digital television, so an increase in TV BAS operations could result. While the date for conversion to digital television is December 31, 2006, there are provisions for extension beyond this date. *See Balanced Budget Act of 1997*, adding new paragraph 47 U.S.C. §309(j)(14)(b).

c. Restrictions on GSO FSS Operations

68. *Proposal.* As noted above, the 10.7-11.7 GHz band is allocated on a co-primary basis to the FSS for international systems (downlinks).[156] The international system only requirement is set forth in footnote NG104 of the Table of Allocations,[157] and is designed to limit the number of FSS earth stations to enable sharing of the band with the FS. To further promote sharing, our rules limit FSS operations to the 10.95-11.2 GHz and 11.45-11.7 GHz portions of the band.[158] Although the *NPRM* proposed to remove the international requirement for NGSO FSS gateway downlinks and also proposed to allow such gateways to operate in the entire 10.7-11.7 GHz band, we did not propose any changes for GSO FSS systems in this band.[159]

69. *Comments.* GSO FSS providers argue that NG104 should be modified to also allow GSO FSS systems to operate domestically and in the entire 10.7-11.7 GHz band. Loral Space and Communications Ltd. ("Loral") states that removal of the international system only requirement would allow GSO FSS systems to enhance network productivity and maximize use of the Ku-band.[160] PanAmSat argues that we should not place GSO FSS operations at a competitive disadvantage by allowing domestic NGSO FSS, but not domestic GSO FSS, stations in the Ku-band. PanAmSat further argues that we should not subject GSO FSS systems to the rules proposed for NGSO FSS systems. In particular, PanAmSat contends that the large exclusion zones proposed for NGSO FSS earth stations are not appropriate for GSO FSS stations because the latter may have to be integrated into existing sites, such as video production facilities, corporate offices, or Internet access points. Accordingly, PanAmSat proposes that GSO FSS earth stations be permitted inside NGSO FSS exclusion zones on a case-by-case basis, if a need is demonstrated for a station within a zone and if the station is fully coordinated with existing FS facilities and will not constrain future FS use of the band.[161]

70. Comsearch and FWCC state that allowing GSO operations in the entire 10.7-11.7 GHz band would eliminate coordination by frequency separation and would inhibit new FS installations.[162] FWCC states that limiting GSO operations to international systems will control the number of earth stations and facilitate sharing of the band.[163] FWCC further states that there is no need to permit GSO operations on a comparable basis to NGSO operations in the band to maintain competitiveness because there are technical, regulatory, and market differences between the two satellite services.[164]

71. *Decision.* We are adopting our proposals to remove the international requirement for NGSO FSS systems in the 10.7-11.7 GHz band and to permit such systems to use the entire band. These

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[156] *See* Table 1 following ¶ 6, *supra.*

[157] *See* 47 C.F.R. §2.106, footnote NG104.

[158] *See* 47 C.F.R. §25.202 (a)(1)

[159] *NPRM* at ¶ 17. We note that in Appendix A of the *NPRM* we inadvertently proposed to amend Section 25.202 to allow GSO FSS systems to operate in the entire 10.7-11.7 GHz band.

[160] Loral Comments at 4.

[161] PANAMSAT Comments at 20-21.

[162] Comsearch Comments at 7 and FWCC Reply Comments at 3.

[163] FWCC Reply Comments at 4.

[164] *Id.* at 4-5.

proposals were broadly supported, and the record demonstrates that the band can be shared by the NGSO FSS and FS. We also find persuasive the arguments of the FS community that expanded GSO FSS use of this band should not be permitted. We believe that FS growth could be significantly inhibited if we were to authorize domestic and international GSO FSS use of the entire band because of the large number of GSO earth stations that would likely be deployed. Further, we find that other bands that are available for FSS downlink use are adequate to ensure GSO FSS growth.[165] Accordingly, we adopt our proposals and limit domestic and international FSS use of the entire 10.7-11.7 GHz band to NGSO FSS gateways. GSO FSS earth stations will continue to operate internationally in accordance with NG104.

d. NGSO/GSO FSS Downlink Sharing

72. After evaluating the extensive record in this proceeding, including the work of the ITU-R study groups and the results of the WRC-2000, we find that the compromise solutions reached in the international meetings provide the basis to allow NGSO FSS operations to share successfully with GSO FSS networks without causing unacceptable interference.[166] The specific technical conclusions from these meetings, which are included in the record in this proceeding and have been incorporated into the Provisional Final Acts of WRC-2000, represent the most comprehensive and current studies on NGSO FSS and GSO FSS co-frequency operations to date. We conclude that these power limits, which include single-entry $EPFD_{down}$ limits and aggregate $EPFD_{down}$ limits for NGSO FSS operations, adequately protect GSO FSS operations and we will require NGSO FSS systems to comply with each type of limit, as appropriate. In addition, we find that the single-entry and aggregate EPFD limits we are adopting also define the level of acceptable interference from a NGSO FSS system into a GSO FSS system under our rules, as proposed in the *NPRM*.[167]

73. Further, we note that WRC-2000 modified footnotes S5.441 and S5.484A to indicate that NGSO FSS applications are subject to standard ITU coordination under S9.12 with other NGSO FSS systems. These footnotes also state that NGSO FSS systems shall not claim protection from GSO systems operating in accordance with the ITU Radio Regulations and that NGSO FSS systems shall operate in such a way that any unacceptable interference that may occur during their operations shall be rapidly eliminated. We find that the modifications to footnotes S5.441 and S5.484A are consistent with our decisions in this document and, accordingly, adopt the WRC-2000 version of these footnotes in our Table of Frequency Allocations.

(i) Single-Entry $EPFD_{down}$ Limits

74. Single-entry limits define the $EPFD_{down}$ limits that must be met by each NGSO FSS system resulting from emissions from all satellites in the system. There are 3 elements comprising the single-entry limits that must be met by each NGSO FSS system: (1) "validation" $EPFD_{down}$ limits, as well as more stringent "validation" $EPFD_{down}$ limits for specific size antennas located at high latitudes; (2) "operational" $EPFD_{down}$ limits, which protect against synchronization loss ("sync loss")[168] in GSO FSS

[165] Those other bands are 3.7-4.2 GHz, 11.7-12.2 GHz, 18.3-18.8 GHz, and 19.7-20.2 GHz. *See* 47 C.F.R. §25.202 (a)(1).

[166] In this section, we address only the NGSO FSS downlink bands. Many of the same sharing principles discussed herein are also applicable to the NGSO FSS service uplink band at 14.0-14.5 GHz.

[167] *NPRM* at ¶ 28.

[168] *See* Provisional Final Acts WRC-2000, Article S22 Table S-22-4A. The ITU-R agreed upon sync loss criterion is contained in recommends 3.2 of ITU-R Recommendation S.1323. Sync loss is generally defined as the disruption in the transmission of a digital signal resulting in either lost data or reduced transmission capacity. The impact of sync loss on GSO FSS networks can be significant because the total outage time exceeds the duration of (continued....)

earth stations between 3 and 18 meters in diameter; and (3) "additional operational" $EPFD_{down}$ limits, or "operational masks" for 3 meter and 10 meter GSO FSS earth stations. It is the combination of these single entry limits with the aggregate limits discussed below that provides adequate protection of GSO FSS networks from NGSO FSS interference. As discussed in more detail below, the ITU Radiocommunication Bureau ("ITU-BR") will perform an assessment on each NGSO FSS system to verify that the system does not exceed the validation limits. The ITU-BR will not make any similar such finding regarding NGSO FSS system compliance with the operational and additional operational limits; however, these limits must be met by each NGSO FSS system in operation.

75. *Proposal.* In the *NPRM*, we indicated that the $EPFD_{down}$ limits needed to adequately protect GSO FSS operations would probably not vary greatly from the provisional $EPFD_{down}$ limits adopted at WRC-97.[169] We stated that "[i]f no acceptable alternative is developed, we believe these provisional limits would be adopted as the international sharing criteria at WRC-2000." Further, we requested comment on the WRC-97 provisional $EPFD_{down}$ limits.[170]

76. *Comments.* Some commenters initially expressed concern over the adequacy of the WRC-97 provisional limits and during the course of the technical studies the GSO FSS and NGSO FSS proponents proposed different sets of single-entry $EPFD_{down}$ limits.[171] The supplemental filings, however, from members of the GSO FSS and NGSO FSS communities demonstrate support for the single-entry $EPFD_{down}$ limits agreed to at the CPM and eventually adopted by WRC-2000.[172] The commenters recognize that each of the elements of the single-entry $EPFD_{down}$ limits agreed upon at the CPM addresses a separate requirement of NGSO FSS or GSO FSS operators and that it is a combination of these limits, as well as the aggregate limits, that will adequately protect GSO FSS networks.

77. *Decision.* The limits adopted by WRC-2000 were developed using the agreed upon criteria developed by the ITU-R. The JTG 4-9-11 (1) studied the characteristics of the GSO FSS systems to be protected, (2) defined protection criteria for GSO FSS systems,[173] and (3) based on these parameters,

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interference due to the additional "recovery" period needed to reacquire the signal. For example, as noted by PanAmSat, sync loss of a radio path in a telephone network could result in a large number of users having to redial dropped connections. Sync loss of a cable or broadcast feed could cause loss of video information to a large viewing audience. *See* PanAmSat Comments at 22.

[169] The WRC-97 provisional limits were incorporated into Article S22 of the ITU Radio Regulations. It should be noted that the WRC-97 provisional EPFD limits are only comprised of the validation EPFD limits.

[170] *NPRM* at ¶ 26.

[171] *See* PanAmSat Comments at 9-13 and Appendix A, GE Comments at 20, and Satellite Coalition Comments of July 29, 1999. *See also* SkyBridge Comments at 32-36, 39; and SkyBridge Reply Comments at 27-28.

[172] *See, e.g.,* Hughes Supplemental Comments at 2, Lockheed Martin Supplemental Comments at 4-5, PanAmSat Supplemental Comments at 2, GE Supplemental Comments at 2, and SkyBridge Supplemental Comments at 12-14.

[173] The ITU-R reached agreement that aggregate NGSO FSS transmissions not be responsible for more than 10% of the amount of time for which the link C/(N+I) ratio is permitted to fall below the shortest-term performance threshold defined for the considered link. *See* Section 3.1.2.1.2 (b) of the CPM Report to WRC-2000. This criterion is defined in ITU-R Recommendation S.1323. *See* ITU-R Recommendation S.1323, "Maximum Permissible Levels of Interference in a Satellite Network (GSO/FSS; NON-GSO/FSS; NON-GSO/MSS Feeder Links) in the Fixed-Satellite Service Caused by other Co-directional Networks below 30 GHz." Several commenters accept the use of this criterion in developing appropriate $EPFD_{down}$ limits to be met by NGSO (continued....)

determined the level of interference that could be accepted from NGSO FSS systems. We find, based upon the technical work adopted by the WRC-2000 and the record developed in this proceeding, that the international consensus single-entry $EPFD_{down}$ limits for 0.6, 1.2, 3, and 10 meter GSO FSS receive earth station antennas are appropriate for adoption domestically.[174] Specifically, we believe that NGSO FSS adherence to the three elements of the single entry limits (*i.e.*, validation limits, operational limits, and additional operational limits), as well as the aggregate limits discussed below, will adequately protect GSO FSS networks. We adopt these limits as new rule Section 25.208(d), Section 25.208(f), and Section 25.208(g) of the Commission's Rules, contained in Appendix A of this First R&O.[175] Below we discuss the importance of each of the three elements that comprise the single-entry limits.

78. The first set of limits are the "validation" $EPFD_{down}$ limits or validation masks.[176] These validation limits represent the maximum allowed EPFD, for a specific earth station antenna size, at any point on the surface of the Earth resulting from the worst case statistical interference levels of a single NGSO FSS system.[177] The ITU-BR will determine whether an NGSO FSS system meets these limits using software developed in accordance with the ITU agreed upon methodology.[178] NGSO FSS systems that were submitted to the ITU-BR prior to WRC-2000 must submit supplemental information to allow the ITU-BR to assess compliance with the validation limits.[179] Any NGSO FSS system that fails the ITU-BR validation test would receive an unfavorable finding from the ITU-BR, and would therefore not be entitled to international frequency protection. The WRC-2000 adopted more stringent validation limits, also verified by the ITU-BR, to protect GSO FSS earth stations located at extreme latitudes.[180] We

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FSS systems. *See, e.g.*, SkyBridge Comments at 25-26 and 32; PanAmSat Comments at 5 and 9; Telesat Canada Comments at 4.

[174] We note that in the 11.7-12.2 GHz band, the Commission routinely authorizes GSO FSS earth stations having an antenna diameter of 1.2 meters or greater. Nevertheless, for the 0.6 meter GSO FSS earth stations, the $EPFD_{down}$ limits adopted represent the protection level that would theoretically be required.

[175] *See* Appendix A.

[176] These validation limits must be met by each NGSO FSS system individually and are therefore considered "single-entry" validation limits.

[177] *See* Provisional Final Acts WRC-2000, Table S22-1A.

[178] ITU-R Recommendation BO.1503 contains the specification for the software which the ITU-BR will use to determine whether a NGSO system meets the single-entry $EPFD_{down}$ validation limits. *See* ITU-R Recommendation BO.1503 entitled, "Functional Description to be Used in Developing Software Tools for Determining Conformity of non-GSO FSS Networks With Limits Contained in Article S22 of the Radio Regulations." The output of the software is represented by continuous curves of cumulative density function (CDF) as a function of percentage of time which will be compared to the single-entry validation limits contained in Article S22, Table S22-1A.

[179] *See* Resolution COM 5/31 of the Provisional Final Acts of WRC-2000, which addresses implementation dates for the actions taken at WRC-2000.

[180] The validation limits for NGSO FSS satellites that are above 57.5 degrees Northern latitude and below 57.5 degrees Southern latitude are more stringent because of the increased susceptibility of GSO FSS earth stations operating at these latitudes to receive NGSO FSS interference. The wanted signal level received by GSO FSS earth stations at extreme latitudes is attenuated significantly due to the increased transmission path (from GSO orbit to earth station location) and the use of edge-of-beam satellite transmissions to serve these geographic areas. In addition, the relatively light population density at these latitudes allows NGSO FSS systems to direct fewer active satellite beams to these areas, thereby, generating less power and reducing the level of interference.

find that these validation limits are appropriate for adoption domestically because they provide an upper bound on the NGSO FSS interference received by a GSO FSS earth station anywhere on Earth.

79. The "operational" $EPFD_{down}$ limits protect GSO FSS links from sync loss. Operational $EPFD_{down}$ limits are specified as a maximum $EPFD_{down}$ limit that may never be exceeded into an operational GSO FSS earth station antenna equal to or greater than 3 meters in diameter; that is, these limits are applicable 100% of the time.[181] These limits are more stringent than the validation limits. The ITU-BR, however, does not make a finding with respect to NGSO FSS compliance with operational limits.

80. The "additional operational" $EPFD_{down}$ limits, or as referred to by some parties, "operational masks," afford GSO FSS operators further assurance that NGSO FSS systems will not cause them unacceptable interference. Additional operational limits, which apply only to 3 meter and 10 meter GSO FSS earth station antennas,[182] represent the actual, rather than worst case, interference levels from a NGSO FSS system.[183] These limits are also more stringent than the validation limits and will not be verified by the ITU-BR. However, Administrations implementing NGSO FSS systems are required to commit to the ITU that its system(s) will meet the additional operational $EPFD_{down}$ limits.[184]

(ii) GSO FSS Reference Earth Station Antenna Pattern

81. The GSO FSS earth station antenna pattern is an important component in the assessment of interference from NGSO satellites into GSO FSS earth station receivers. This is because of the highly directional nature of GSO FSS earth station antennas. Indeed, $EPFD_{down}$ is defined as a function of the GSO FSS earth station receive antenna pattern.[185] The ITU-R has also developed a new GSO FSS reference pattern to be used in sharing studies between NGSO FSS and GSO FSS systems, which takes into account the time-varying nature of NGSO FSS interference.[186] The new GSO FSS reference pattern

[181] This is because susceptibility to NGSO FSS induced sync loss only occurs during an "in-line" event. An "in-line" event is a physical phenomena in which a GSO FSS satellite, NGSO FSS satellite and GSO FSS earth station are aligned in a straight line. During an in-line event, the GSO FSS earth station would receive the highest interference level from the transmitting NGSO FSS satellite through the mainbeam of the GSO FSS earth station antenna.

[182] Generally, the larger the GSO FSS earth station antenna, the more stringent the required NGSO FSS $EPFD_{down}$ limits. This need for the more stringent limits is due to the higher main beam gain associated with larger GSO earth station antennas. Adopting $EPFD_{down}$ limits for protection of 3 and 10 meter GSO FSS earth station antenna sizes should also protect GSO FSS earth stations between 3 and 10 meters in diameter.

[183] The actual interference from a NGSO FSS system is represented by a continuous curve of $EPFD_{down}$ levels not to be exceeded for percentages of time from 0% to 100%.

[184] Administrations implementing NGSO FSS satellite networks in frequency bands where additional operational limits have been established are required to commit that the NGSO FSS system will meet the additional operational $EPFD_{down}$ limits that are specified in Table S22-4A1 under No. S22.5I. WRC-2000 included this additional requirement in Appendix S4, Item A.15 of the Radio Regulations. *See* Provisional Final Acts of WRC-2000, Appendix S4, Annex 2A. *See also* Resolution COM 5/31.

[185] Section 25.201 of the Commission's Rules, 47 C.F.R. §25.201, is amended to include the definition of EPFD.

[186] *See* ITU-R Recommendation S.1428, "Reference FSS Earth –Station Radiation Patterns for Use in Interference Assessment Involving NON-GSO Satellites in Frequency Bands Between 10.7 GHz and 30 GHz," June 25, 1999.

differs from the requirement currently specified in Section 25.209 of the Commission's Rules. The Section 25.209 requirement was developed to facilitate GSO to GSO sharing where a constant level of interference is present. The new reference pattern, on the other hand, takes into account the transient nature of NGSO FSS interference by averaging the peaks and nulls of a GSO FSS earth station antenna, rather than conservatively specifying an envelope of the sidelobe peaks. SkyBridge supports the use of the new GSO FSS reference antenna pattern.[187] No parties objected to the use of this new pattern in the international process or within the domestic proceeding.

82. Accordingly, we will incorporate the new GSO FSS reference antenna pattern in the rules for $EPFD_{down}$.[188] This new pattern will be assumed whenever interference assessments between GSO FSS and NGSO FSS systems are performed. We do not see the need, however, to modify the antenna performance standards contained in Section 25.209 of the Commission's Rules. This requirement remains applicable to sharing scenarios involving a constant level of interference (*e.g.*, GSO to GSO sharing) and will continue to be the standard used for FSS earth station licensing.

(iii) Domestic Implementation of Single-Entry Limits

83. Many of the GSO FSS interests emphasize the importance of the Commission adopting detailed rules and procedures to ensure compliance with the appropriate limits of each NGSO FSS system licensed by the Commission or authorized by the Commission to provide service in the United States.[189] GE American Communications, Inc. ("GE") and PanAmSat, in particular are concerned that the $EPFD_{down}$ limits must be accompanied by adequate monitoring and enforcement measures to ensure that NGSO systems comply with the limits.[190] In addition, Hughes, an applicant for two NGSO FSS systems in the Ku-band, states that it will provide the Commission with the available information to help the Commission devise workable validation and enforcement mechanisms for NGSO system compliance with the limits and encourages the Commission to require these same commitments from all NGSO FSS applicants.[191]

84. SkyBridge and Boeing assert that the Commission should conform to the framework of the compromise CPM agreement as it develops additional regulatory measures and should not impose new, excessive burdens that hinder the provision of NGSO FSS services to the public.[192] SkyBridge suggests that the Commission incorporate by reference into its rules the assessment procedures for the operational limits ultimately developed by the ITU-R.[193] Virgo and Lockheed Martin state that the nature of the compromise arrangement with its reliance on "operational" and "additional operational" limits that are

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[187] SkyBridge Comments at 99.

[188] *See* 47 C.F.R. § 25.208(d) (EPFD definition which include reference earth station antenna pattern); *see* footnote 1 to Table 1D in Section 25.208(d) (ITU Rec. S.1428 shall be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems).

[189] Hughes Supplemental Comments at 2, Lockheed Martin Supplemental Comments at 4-5, PanAmSat Supplemental Comments at 2-3, and GE Supplemental Comments at 3.

[190] GE Supplemental Comments at 3 and PanAmSat Supplemental Comments at 11-12.

[191] Hughes Supplemental Comments at 2-3.

[192] Boeing Supplemental Comments at 4 and SkyBridge Supplemental Comments at 3.

[193] SkyBridge Supplemental Comments at 15.

not subject to verification by the ITU places much of the burden of ensuring compliance with the regulations on each government's Administration.[194]

85. As discussed below, we are adopting implementation procedures for single-entry validation limits and a separate set of procedures for operational and additional operational limits. We believe that the specific implementation measures discussed below will ensure that NGSO FSS systems will indeed adhere to the applicable EPFD limits. In addition to ensuring protection of GSO FSS networks, the implementation framework will assist the Commission in its need to confirm to the ITU that the appropriate limits are being met. Further, it will enable the quick identification of any NGSO FSS operations in excess of the single-entry limits.

(iv) Domestic Implementation of Single-Entry Validation $EPFD_{down}$ limits

86. *Proposal.* In the *NPRM*, we noted the importance of establishing an accepted method for validating within the United States that a NGSO FSS system meets the appropriate EPFD limits, as well as for confirming the information about the NGSO system that is sent to the ITU. We also proposed that the NGSO FSS applicants provide the Commission with sufficient information on their respective NGSO FSS system characteristics to allow proper modeling of the system in computer simulations.[195] We noted that the ITU-R was developing a functional description for software to be used by the ITU-BR to determine whether a NGSO FSS system meets the required limits.

87. *Comments.* SkyBridge and Loral assert that the Commission should incorporate the validation limits agreed to at the CPM into our rules and require all NGSO FSS applicants to provide all of the information required by the ITU-BR for validation.[196] In terms of how compliance could be met, SkyBridge supports the proposal that the Commission either rely on the validation conducted by the ITU-BR or that we undertake such validation using the same software "tool" (specification) as the ITU-BR.[197] PanAmSat asserts that there is no need to incorporate the validation limits into the Commission's Rules. Instead, PanAmSat proposes we impose as a license condition that an NGSO FSS system may not begin operations until the ITU confirms in writing that the licensee has met the validation mask requirement and this determination is forwarded to the Commission.[198]

88. Boeing and STA support the idea of a software simulation tool being used to verify compliance of NGSO FSS systems, however, they discourage the Commission from adopting any one of the currently existing simulation tools, until all of the various software tools that have been developed have undergone further analysis.[199] STA agrees that we should adopt a validation process for domestic use and require NGSO FSS applicants to disclose the requisite system parameters and provide any

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[194] Lockheed Supplemental Comments at 6-7 and Virgo Supplemental Comments at 3-4.

[195] Specifically, we proposed that each NGSO FSS applicant provide its hand-over and satellite switching strategies, satellite beam patterns, and earth station antenna patterns. Further, we proposed that each NGSO FSS applicant provide the orbital parameters required to comply with the U.S. international obligations required in Section A.4 of APS4 of the ITU Radio Regulations. *NPRM* at ¶ 81.

[196] SkyBridge Supplemental Comments at 13 and Loral Supplemental Comments at 5.

[197] SkyBridge Supplemental Comments at 13-14.

[198] PanAmSat Supplemental Comments at 13.

[199] Boeing Comments at 84 and STA Comments at 8.

software elements necessary to supplement the core validation software.[200] STA further asserts that the core validation software under development by the ITU-R for use by the ITU Radiocommunication Bureau be used for consistency. Telesat Canada asserts that, in addition to having a software tool to ensure that a NGSO FSS licensee will meet applicable limits, a supplementary procedure is needed to validate the actual hardware performance of an NGSO FSS satellite while in orbit.[201]

89. *Decision.* As the notifying Administration to the ITU for U.S.-licensed NGSO FSS systems, we need to be confident that the NGSO FSS system information we send to the ITU-BR is accurate and that the validation test used domestically is the same as that used by the ITU-BR and other Administrations. These assurances will provide consistency in the output of the validation test and enable these results to be reproduced by all affected Administrations.[202] Therefore, we will require each NGSO FSS applicant to demonstrate *prior to licensing* that it meets the $EPFD_{down}$ validation limits. Further, we agree with commenters that the software used for the validation test should be developed in accordance with the ITU software specification contained in ITU-R Recommendation BO.1503.

90. Specifically, each NGSO FSS applicant shall provide the following information, detailed in Section 25.146(a)(1)[203] of the Commission's Rules, to the Commission: (1) output of the validation test consisting of cumulative density function curves of $EPFD_{down}$ as a function of percentage of time not to be exceeded;[204] (2) comparison of output/results to "validation" $EPFD_{down}$ limits; (3) PFD mask used as input parameter in simulation; (4) identification and description of assumptions and conditions used in generating the PFD mask; (5) other NGSO FSS system input parameters required for the execution of the software, and (6) actual software used by the NGSO FSS operator in implementing the ITU-R Recommendation BO.1503 software specification, including the source code and the compiled executable program. The Commission will verify this information. Once we are satisfied that the NGSO FSS applicant has demonstrated its ability to comply with the validation $EPFD_{down}$ limits, we will submit the required information to the ITU-BR. As noted above, the ITU-BR will then use this information to make its own determination of compliance with the validation limits.

(v) . Domestic Implementation of Operational and Additional Operational $EPFD_{down}$ Limits

91. During the course of the ITU-R technical discussions, Administrations recognized that the single-entry validation $EPFD_{down}$ limits alone might not adequately protect 3 and 10 meter GSO FSS earth station antennas from unacceptable interference. In an attempt to balance the requirements of both

[200] STA Comments at 8.

[201] Telesat comments at 6, citing ITU-R WP4A/TEMP/92 (Rev.1).

[202] Results of the validation process will also be useful, in part, in determining the aggregate interference from multiple NGSO FSS systems operating co-frequency.

[203] *See* Appendix A.

[204] To demonstrate compliance with the validation limits, an NGSO FSS system operator must derive the NGSO FSS $EPFD_{down}$ distribution levels as a function of percentage of time using software developed in accordance with the ITU software specification. This software specification requires the NGSO FSS operator to supply the NGSO satellite PFD mask, which defines an envelope of the maximum power radiated by each individual NGSO space station, independent of the resource allocation scheme used by the NGSO FSS system and the traffic carried by the NGSO FSS system. This PFD mask approach makes some conservative assumptions with regard to the NGSO FSS system's traffic patterns and beam switching strategy.

GSO FSS and NGSO FSS operators,[205] WRC-2000 adopted single-entry operational and additional operational $EPFD_{down}$ limits that would not be subject to verification by the ITU-BR.[206] Our endorsement of the WRC-2000 operational and additional operational limits essentially transfers the burden of compliance verification with the single-entry limits from the ITU-BR to the U.S. Administration.

92. *Comments.* Representatives from both the GSO FSS and NGSO FSS industries clearly support the operational and additional operational $EPFD_{down}$ limits agreed upon at the CPM.[207] In fact, PanAmSat states that it would not have agreed to the compromise had the operational limits not been included and further states that the operational limits "should form the cornerstone of the Commission's NGSO FSS rules."[208] Commenters specifically addressed: (1) the need for NGSO pre-operational demonstration of compliance with operational limits; (2) the need for NGSO pre-operational demonstration of compliance with additional operational limits; and (3) NGSO post-operational compliance with both the operational and the additional operational limits. We discuss each category below.

93. *Pre-operational Compliance with Operational Limits.* GE states that the Commission, as a pre-grant requirement, must require each NGSO FSS applicant to make a full demonstration that its system is capable of complying with all operational limits.[209] GE asserts that this information should include: a demonstration that the NGSO FSS system will meet the operational masks ($EPFD_{down}$ vs. percentage of time) using a software program provided by the NGSO FSS applicant, and showing the actual expected NGSO downlink power levels from the NGSO satellites' sidelobes under worst-case loading; and documentation showing the probability density functions of the $EPFD_{down}$ for specific geographic locations in the U.S. (chosen by the FCC and GSO FSS operators) under maximum traffic loading.[210] GE further argues that any verification software relied upon by the NGSO FSS entity must be available and the assumptions underlying the program must be adequately described.

94. Boeing argues that it is unnecessary to seek advance verification of the operational limits prior to the operation of the NGSO FSS system.[211] Further, Boeing states that advance verification of

[205] From the GSO FSS perspective, it is desirable to make a worst-case assessment of the NGSO FSS interference potential in order to provide incumbent operators with a level of assurance that the new interference environment will be acceptable. An NGSO FSS applicant, on the other hand, would prefer a more realistic assessment of the interference potential because that would permit it greater flexibility in implementing its system.

[206] The ITU-R is developing procedures for Administrations and operators implementing NGSO FSS and GSO FSS systems to ensure compliance with the single-entry operational and additional operational limits in Section II of Article S22. *See* Resolution COM 5/23 in the Provisional Final Acts of WRC-2000. If an operating NGSO FSS system exceeds the operational $EPFD_{down}$ or the additional operational $EPFD_{down}$ limits into an operational GSO FSS earth station, the NGSO FSS system would need to take all necessary steps to ensure that the interference is immediately restored to levels at or below the operational $EPFD_{down}$ limits. *See* CPM Report Section 3.1.2.4.7. *See also* S5.441 and S5.484A of the ITU RR.

[207] *See, e.g.,* Hughes Supplemental Comments at 2, Lockheed Supplemental Comments at 4-5, PanAmSat Supplemental Comments at 2, GE Supplemental Comments at 2, and SkyBridge Supplemental Comments at 12-14.

[208] PanAmSat Supplemental Comments at 21.

[209] GE Supplemental Comments at 4.

[210] *Id.* at 4. The probability density function describes the distribution of interference levels as a function of antenna size and the percentage of time.

[211] Boeing Supplemental Comments at 5.

operational limits has the potential of creating a long and contentious process between spectrum users. Boeing claims that the operational limits are, by definition, meant to apply to systems in operation and that the purpose of these limits is to prevent harmful interference to GSO FSS systems. Boeing further claims that, if an NGSO FSS system is operating within the verification and operational limits, there will be no unacceptable interference to a GSO network and therefore no need to demonstrate compliance with the operational limit values using software that needs to be developed and approved. Boeing also asserts that, if the NGSO system exceeds these values and unacceptable interference occurs, the GSO system operator will be aware of that interference without software.[212]

95. *Pre-operational Compliance with Additional Operational Limits.* PanAmSat asserts that the Commission should adopt a software compliance procedure for the additional operational limits. PanAmSat proposes that the Commission adopt criteria for the additional operational software in its rules and require NGSO FSS system applicants and gateway earth station applicants to make a showing of compliance and make the software program available to the public.[213] SkyBridge counters that software cannot be used as a regulatory tool in this case because the actual $EPFD_{down}$ statistics from an NGSO FSS system will change over time.[214] Rather, SkyBridge proposes that the Commission require each NGSO FSS system to commit, as part of the application process, to meeting the additional operational limits once in service. SkyBridge argues that the basis for such commitment will presumably be detailed simulations of the NGSO FSS satellite constellation, employing actual operational parameters. SkyBridge suggests that the Commission require that each NGSO FSS licensee be prepared to demonstrate the technical basis for its commitment to the Commission, on request, in the course of any investigation into an alleged violation of the additional operational limits.[215]

96. *Decision.* We will require each NGSO FSS licensee to demonstrate that it meets the operational and additional operational limits *prior* to the NGSO FSS system being placed into service, as suggested by some commenters. Indeed, much of the critical protection to GSO FSS networks comes from the operational and additional operational limits that will not be subject to ITU verification. We find this demonstration is necessary prior to the NGSO FSS becoming operational because it: (1) provides the FCC assurance that the NGSO FSS system will be built in accordance with FCC rules; (2) provides incumbent operators assurance that they will not receive unacceptable interference; (3) in the case of the additional operational limits, enables the Commission to make the required commitment to the ITU-BR; and (4) reduces the likelihood that the Commission would need to apply remedial measures to bring an operational system into compliance. Moreover, we believe a comprehensive demonstration of compliance with both the operational and additional operational limits is warranted due to the infancy of NGSO FSS systems. Once the Commission and industry gain experience through actual operation of these new systems, the Commission may choose to revisit the requirement for such a detailed demonstration prior to an NGSO FSS system becoming operational.

97. We recognize that the tools required to make this demonstration may not be available to NGSO FSS licensees before they receive their space station authorizations from the Commission. In particular, certain NGSO FSS licensees will need to make use of more accurate system information (*e.g.*, actual measured NGSO FSS satellite antenna performance, expected satellite/earth station resource allocation scheme, spacecraft antenna switching algorithm) that has not yet been finalized at the space

[212] *Id.* at 6.

[213] PanAmSat Supplemental Comments at 14-15.

[214] SkyBridge Supplemental Comments at 19.

[215] *Id.* at 17.

station licensing stage.[216] This is why we will not require this demonstration prior to space segment licensing. Instead, authority to operate the space station segment will be conditioned on the NGSO FSS licensee submitting to the Commission 90 days prior to the initiation of service, a demonstration that its system is expected to meet the operational and additional operational limits.[217]

98. Specifically, each NGSO FSS licensee shall provide the following information as outlined in Section 25.146(b) of the Commission's Rules[218] 90 days prior to the initiation of service: (1) the satellite/earth station resource allocation strategy, spacecraft antenna switching algorithm and the measured spacecraft antenna patterns; (2) a description of how this resource strategy/algorithm and the spacecraft antenna patterns are being used in the software program; (3) the software program used to verify the commitment to meet the operational and additional operational limits and the assumptions used in the structure of the computer program; (4) an identification and description of other input parameters necessary for the execution of the computer program; and, (5) an analysis of the results of the computer simulation and the pass/fail nature of the commitment test. This demonstration should be made at the three worst case test points within the United States and the three worst case test points on each continent, except Antarctica. Once the Commission is satisfied that the NGSO FSS operator has demonstrated its ability to comply with the operational and additional operational $EPFD_{down}$ limits, the U.S. will then be able to certify with confidence to the ITU-BR and other Administrations that U.S. licensed NGSO FSS systems will meet both sets of limits.

99. *NGSO FSS Post-operational Compliance.* Commenters also addressed what procedures and remedies should be taken by the Commission if an NGSO FSS satellite, when in actual operation, exceeds the operational $EPFD_{down}$ limits.[219] PanAmSat argues that the Commission should adopt a fast, reliable process to ensure that the NGSO FSS system's signal is returned to the proper level.[220] GE states that the Commission should determine the elements necessary for a GSO FSS system to make a satisfactory *prima facie* showing that it has been harmed by NGSO FSS operations and establish sanctions for repeated violations by any NGSO FSS system.[221] SkyBridge supports the efforts to develop a means of measuring the actual $EPFD_{down}$ limits generated by an NGSO FSS system into operational

[216] Since the additional operational limits are more stringent than the validation limits, it is likely that the NGSO FSS operator will need more precise software to verify that its system does not exceed the additional operational limits. Further, more exact system parameters (*e.g.*, satellite antenna performance, satellite/earth station resource allocation scheme, spacecraft antenna beam switching algorithm) will need to be used in order to simulate actual NGSO FSS interference levels. The NGSO FSS licensees may need to submit certain data it believes is proprietary business information. If this is the case, a licensee(s) may request confidential treatment of this specific information in accordance with Section 0.459 of the Commission's Rules. *See* 47 C.F.R. § 0.459. We do expect, however, that some information required for the compliance demonstration as well as the results of the compliance demonstration with operational and additional operational limits will be made available to the public.

[217] This demonstration will be included in the milestone requirements of the NGSO FSS space station authorization. Earth station applicants seeking access to a non-U.S. licensed NGSO FSS system will have a similar milestone requirement in its U.S. earth station authorization.

[218] *See* Appendix A.

[219] *See e.g.*, GE Supplemental Comments at 3 and PanAmSat Supplemental Comments at 21.

[220] PanAmSat Supplemental Comments at 21.

[221] GE Supplemental Comments at 6.

GSO FSS earth stations in order to assist operators and Administrations in determining compliance with the operational limits in the event of a dispute.[222]

100. In addition, some commenters argue that we should require each NGSO FSS applicant to provide to the Commission, for public disclosure, all data necessary to determine the location of the satellites in each NGSO FSS constellation at any given time.[223] Boeing disagrees, stating that there is no need for NGSO FSS applicants to publish the exact location of their satellite orbital elements on a regular basis. Boeing asserts that, if a GSO network operator suspects that an earth station terminal is receiving unacceptably high levels of interference from a NGSO FSS satellite, that operator can check existing databases to determine the location of all NGSO FSS satellites.[224]

101. *Decision.* We find that there is no need for the Commission to develop additional procedures or remedies in cases where NGSO FSS systems exceed the operational and additional operational $EPFD_{down}$ limits that we are adopting. NGSO FSS operations that exceed these limits will be in violation of Sections 25.208(f) and (g) of the Commission's Rules,[225] as well as in violation of its Commission authorization. Therefore, the NGSO FSS licensee will already be subject to appropriate sanctions by the Commission.[226]

102. We do believe, however, that in the event that a NGSO FSS satellite exceeds the operational or additional operational $EPFD_{down}$ limits, it is important that GSO FSS operators have the information necessary to locate satellites in each NGSO FSS constellation at any given time. Such information will allow the GSO FSS operator to correlate any alleged interference with a specific satellite in an NGSO FSS system. This information, or ephemeris data, is already used by NGSO FSS customers to establish the communications link between the user terminal and the NGSO satellite as it moves across the horizon, and so it should not be an additional burden on NGSO FSS system operators. Therefore, we will require that NGSO FSS licensees publish their satellites' orbital elements in the North American Aerospace Defense Command (NORAD) 2-line element format on an Internet web site maintained by the NGSO FSS licensee. The 2-line element format for many existing satellites is already being generated by NORAD and distributed by NASA via the NASA Prediction Bulletin. Moreover, the 2-line element set can be used together with NORAD's Simplified General Perturbation-4 (SGP4) orbital model, or similar programs, to determine the position and velocity of the associated satellite. We recognize that the NGSO FSS constellation is constantly moving, and so we will require that the NORAD 2-line element data be updated every three days so that the most accurate information is published. These procedures are outlined in new Section 25.271(e) of the Commission's Rules.[227]

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[222] SkyBridge Supplemental Comments at 9, citing the CPM-99 Report Sections 3.1.2.4.7 and 3.1.2.4.8. GE agrees that the Commission should take into account the results of WP4A efforts in devising regulatory measures applicable to the measurement of NGSO FSS power levels. *See* GE Supplemental Comments at 5.

[223] GE Supplemental Comments at 5 and PanAmSat Supplemental Comments at 21.

[224] Boeing Supplemental Comments at 7.

[225] *See* Appendix A.

[226] *See, e.g.*, 47 C.F.R. §25.160.

[227] *See* Appendix A.