does not set aside any specific bandwidth for TT&C transmissions. Instead, it requires only that these functions be conducted at the edges of the allocated band. In the case of DBS satellites, the ITU Radio Regulations' Region 2 BSS and feederlink Plans of Appendices 30 and 30A do designate 12 MHz guardbands at either edge of the allocated band, and our rules require DBS operations to be in accordance with the technical characteristics contained in these appendices.[187] However, the planned-band guardbands are set out in the larger context of a channelization scheme over the entire allocated bandwidth. Similarly, EchoStar makes its request for designated TT&C guardbands in the context of its more general request that the 24 MHz channelization scheme used for DBS satellites be applied to 17/24 GHz BSS satellites.[188] The possibility of channelization schemes are addressed in more detail in this Order below, where the Commission declines to enforce a particular channelization scheme for the 17/24 GHz BSS.[189]

63. Moreover, we do not believe that it is practicable to plan for TT&C operations in the 17.7-17.8 GHz band. Our rules require that TT&C operations take place at the edges of the *allocated band*. Although we may authorize operators to provide international service in the 17.7-17.8 GHz band, there is no domestic allocation to the BSS in the 17.7-17.8 GHz band, and we have declined to modify the Table of Allocations to provide for one. Accordingly, we do not propose to designate guardbands limited to on-station TT&C operations for 17/24 GHz BSS systems. For these reasons we will make no changes to Section 25.202(g).[190]

64. Both EchoStar and Intelsat urge the Commission not to permit TT&C operations at the band edge just below 17.7 GHz, arguing that such transmissions would fall within band for those operators seeking to use the entire 17.3-17.8 GHz band, and as a result, TT&C transmissions of one operator could be incompatible with the communications transmissions of another operator.[191] However, this request is made in conjunction with their assertions that the Commission should permit domestic BSS operations in the 17.7-17.8 GHz band. Commenters do not offer alternatives in the event that the Commission declines this request. In addition, although commenters believe TT&C operations should occur at edge of the 17.7-17.8 GHz band segment, they do not address where to accommodate the TT&C transmissions of future applicants who choose not to provide international service in the 17.7-17.8 GHz band. In addition, the *NPRM* recognized significant interference potential from both adjacent band and secondary in-band government radar systems at frequencies just above 17.3 GHz.[192] DIRECTV cautions that higher frequencies correspond with higher reliability for TT&C operations due to their separation from government radar systems.[193] For these reasons, we believe that operators should be afforded sufficient bandwidth, particularly at higher frequencies, to provide for flexibility and reliability in planning their TT&C operations.

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[187] *See* 47 C.F.R. § 25.148(f), § 3.9.2 of Annex 5 to Appendix 30 and § 4.1 of Annex 3 to Appendix 30A of the International Radio Regulations.

[188] *See* EchoStar Comments at A.6.1.

[189] *See* Section III.F.2. below.

[190] However, in the *International Bureau 2006 Biennial Review Staff Report*, the International Bureau recommended re-examining all the provisions in Part 25 to, among other things, determine whether any rules need to be updated to reflect the transition in satellite services from analog to digital traffic. *See International Bureau 2006 Biennial Review Staff Report*, IB Docket No. 06-154, DA 07-675 (released Feb. 14, 2007) at 27-28. In that context, the Commission may revisit the issue of whether to specify a particular amount of spectrum to be set aside at the edges of service bands for TT&C operations.

[191] *See* Intelsat Comments at 12, EchoStar Comments at Technical Annex at 28.

[192] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7568-7472, paras. 94-100.

[193] *See* DIRECTV Reply Comments at 32-33.

65. Moreover, we are not convinced that TT&C transmissions will present a significant interference problem to the communications transmissions of adjacent satellite operators using the 17.7-17.8 GHz band. The worst interference case likely will occur into small-diameter earth station antennas that receive off-axis telemetry signal transmissions from nearby 17/24 GHz BSS satellites. However, TT&C transmissions are relatively narrow-band – typically a few megahertz – and the resulting interference would be averaged across the much wider bandwidth of the typical BSS signal. In addition, at four degrees or greater of orbital separation the interfering telemetry signal power should be significantly reduced. A somewhat analogous situation occurs in the extended Ku-bands between 11.45-11.7 GHz and the standard Ku-band between 11.7-12.2 GHz. Although the adjacent, extended Ku-band (11.45-11.7 GHz) may be used to provide international service, and many operators choose to make use of the entire 11.45-12.2 GHz bandwidth, the Commission does not preclude TT&C operations at frequencies just above 11.7 GHz. Accordingly, we will not prohibit TT&C operations at frequencies just below 17.7 GHz.

D. Orbital Spacing and Minimum Antenna Diameter and Performance Standards

1. Orbital Spacing

a. Background

66. ***Four Degree Spacing Framework Adopted:*** The *NPRM* sought comment on whether the Commission should adopt an orbital spacing policy in the 17/24 GHz BSS, and if so, what separation would be appropriate.[194] We asked specifically how best to balance our conflicting goals of making available the maximum GSO orbital capacity while simultaneously minimizing interference into small-diameter receiving antennas.[195] Most commenters recognize the importance of adopting a well-considered orbital spacing policy, noting the critical role that spacing plays in determining required receive antenna diameters, quality of service, efficiency of design and types of services possible to deliver that result as a consequence of orbital separation. Only Bermuda differs in its view, advocating that the Commission should remove the minimum orbital separation requirement from all services, including DBS services, and instead should allow operators to coordinate their services using the procedures in the ITU Radio Regulations.[196] Bermuda does not address how operators within the same administration should reconcile instances of interference arising among each other, which is a primary objective we seek to address by developing appropriate requirements within this proceeding.

67. In their comments, DIRECTV, SES Americom, and Intelsat all propose orbital-separation schemes of four degrees, expressing a preference for alignment with existing Ku- and Ka-band FSS locations, some of which are currently used to provide DTH-FSS services.[197] DIRECTV maintains that four degrees of orbital separation will support deployment of the 60 cm diameter antennas it plans to implement.[198] SES Americom and Intelsat maintain that a four-degree separation scheme will permit

[194] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7446, para. 42.

[195] *Id.*

[196] *See* Bermuda Comments at 8. Further, Bermuda's suggestion that we eliminate orbital separation requirements in all satellite services, including the two-degree spacing framework in place for GSO FSS satellites since 1983, is beyond the scope of this proceeding.

[197] *See* DIRECTV Comments at 3-8, Intelsat Comments at 7-8, and SES Americom Comments at 10-12.

[198] *See* DIRECTV Comments at 4-8.

their planned use of 45 cm antennas.[199] DIRECTV also argues that a separation scheme of four degrees will facilitate use of hybrid BSS-FSS satellites enabling operators to capture the inherent efficiencies associated with these platforms thereby significantly reducing the cost of providing services.[200] Intelsat supports a four-degree orbital separation scheme, stating that it offers a good balance between the use of small diameter antennas and the need to achieve good coverage of the United States from a reasonable number of orbital positions.[201]

68. In contrast, EchoStar, in its comments, advocates a 4.5-degree orbital separation scheme centered upon current DBS locations.[202] EchoStar plans to employ low-cost single-feed, dual-frequency (12/17 GHz) 45 cm diameter subscriber antennas, utilizing a system design predicated upon near co-location with its DBS satellites.[203] EchoStar argues that a spacing scheme based on four degrees is not workable due to heavy use of many of the integer orbital locations for FSS satellites, and that non-integer (constant offset) spacing would be incompatible with Region 2 BSS Plan assignments used by DBS satellites at many orbital locations.[204] However, in its Reply Comments, EchoStar relaxes its position, stating that what is of primary importance is *near* co-location with conventional DBS positions, and that the differences between four-degree and 4.5-degree spacing can easily be reconciled.[205]

69. To this end, EchoStar and SES Americom propose a mutually-agreed orbital assignment framework for the portion of the geostationary arc between 56.9° W.L. and 147.6° W.L.[206] This proposal seeks to reconcile the differing business models, system designs and accompanying concerns raised by the various commenters. The proposed orbital locations place new 17/24 GHz BSS satellites close enough to selected U.S. DBS locations to permit single-feed earth stations to simultaneously access downlink transmissions from both. Additionally, the proposal seeks to provide sufficient flexibility to allow alignment with FSS orbital positions as well as to permit any adjustments necessary to avoid other presumed unsuitable satellite positions, including those designated for non-U.S. DBS satellites.[207] The orbital positions proposed by EchoStar and SES Americom range from 4° to 5.9° in separation. In contrast, DIRECTV submits a proposal for the portion of the geostationary arc between 83° W.L. and 123° W.L. that assigns in-orbit satellites at four-degree spacing intervals. DIRECTV argues that this framework accommodates most commenters' proposals to co-locate 17/24 GHz BSS satellites with FSS satellites.[208] DIRECTV also submits that its proposed framework would preserve the flexibility to locate

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[199] *See* SES Americom Comments at 11, Intelsat Comments at 10. DIRECTV differs from SES Americom and Intelsat in their determination of minimum antenna diameter largely as a result of each operator's choice of acceptable C/I ratios in its system design.

[200] *See* DIRECTV Comments at 5-6.

[201] *See* Intelsat Comments at 7.

[202] *See* EchoStar Comments at 9. EchoStar also proposes an allowance of up to 0.4 degrees between co-located satellites.

[203] *See* EchoStar Comments at A.3.

[204] *See* EchoStar Comments at 11.

[205] *See* EchoStar Reply Comments at 2.

[206] *See* EchoStar Reply Comments at 6-9, SES Americom Reply Comments at 4-9.

[207] The jointly-proposed plan does not rely on constant offset between adjacent orbital locations. However, the minimum separation between any two adjacent locations is four degrees.

[208] *See* DIRECTV Reply Comments at 3-6. This plan presumes a constant four degrees of separation between adjacent orbital positions.

17/24 GHz BSS satellites near certain U.S. DBS locations[209] while avoiding orbital locations that are too close to Appendices 30 and 30A[210] Plan assignments of other Region 2 administrations. Intelsat similarly supports assigning satellites at four-degree spacing. Later, in an *ex parte* statement, DIRECTV, EchoStar, and Intelsat proposed another spacing scheme, in which the proposed orbital positions ranged from 4° to 6.5° in separation between 81° and 124° W.L.[211]

b. Discussion

70. All operators agree that orbital separations as small as four degrees are feasible and will permit deployment of consumer antennas of a size consistent with their system designs and marketing strategies. Even EchoStar, who initially argued for a 4.5-degree separation requirement, agrees that four degrees of separation can be implemented if we allow some flexibility and in this context supports use of 45 cm antennas.[212] After studying the technical discussions presented, we concur that a minimum orbital separation of four degrees between 17/24 GHz BSS satellites is feasible, and that it best affords all applicants the flexibility to design and deploy systems consistent with their stated plans. Moreover, we believe that such a minimum spacing requirement realizes our mutual goals of maximizing orbital capacity while accommodating small-diameter receiving antennas. Accordingly, we will require that BSS satellite networks operating in the 17/24 GHz BSS be capable of operating at four-degree orbital spacing.

71. In discussing orbital spacing policy, all commenters stress the need for some flexibility relative to mandating adherence to a rigid in-orbit spacing grid.[213] While we agree that some flexibility is beneficial, uniform orbital spacings maximize use of scarce orbital resources and opportunities for competitive entry. Indeed, uniform two-degree spacing has been the cornerstone of the Commission's licensing framework for GSO FSS satellites since 1983, and has served to create a competitive and interference-free operating environment.[214] Therefore, we will require 17/24 GHz BSS licensees to place their satellites in orbit so that all 17/24 GHz BSS satellites are placed at multiples of four degrees away from each other, as set forth in Appendix F of this Order. Allowing complete flexibility in orbital spacing would result in inefficient use of scarce geostationary satellite orbit resources and limit opportunities for competitive entry.

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[209] DIRECTV's scheme would allow location at or near the 110° W.L. and 119° W.L. locations. *See* Reply Comments of DIRECTV at 4.

[210] *See* Appendices 30 and 30A of the ITU Radio Regulations,

[211] In this orbital spacing scheme, each of the parties joining in the *ex parte* statement recommend assigning two orbital locations to themselves. Intelsat would be assigned 89° W.L. and 95° W.L. DIRECTV would be assigned 99° W.L. and 103° W.L. EchoStar would be assigned 109.5° W.L. and 119° W.L. *See* Letter from William M. Wiltshire, Counsel to DIRECTV, to Marlene H. Dortch, Secretary, FCC, dated March 15, 2007 (*March 15 Joint Ex Parte Statement*). In response to the *March 15 Joint Ex Parte Statement,* Pegasus noted that the proposal does not take into account its three pending applications, and stated that, because it has not yet discussed the proposal with Intelsat, DIRECTV, and EchoStar, it is not in a position to concur with the proposal. *See* Letter from Bruce D. Jacobs and Tony Lin, Counsel to Pegasus, to Marlene H. Dortch, Secretary, FCC, dated March 26, 2007.

[212] *See* EchoStar Reply Comments at Technical Annex at 3.

[213] *See* EchoStar Comments at 9, Intelsat Comments at 7, SES Americom Reply Comments at 4-6, and DIRECTV Reply Comments at 4.

[214] *See* Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations, *Report and Order*, CC Docket No. 81-704, FCC 83-184, 54 Rad. Reg. 2d 577 (released Aug. 16, 1983); *summary printed in* Licensing Space Stations in the Domestic Fixed-Satellite Service, 48 F.R. 40233 (Sept. 6, 1983) (*Two Degree Spacing Order*). *See also* Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations, *Report and Order*, CC Docket No. 81-704, 99 FCC 2d 737 (1985) (*Two Degree Spacing Reconsideration Order*).

72. Parties opposing uniform four-degree orbital spacing do not provide adequate justification for their positions. First, we find concerns regarding co-location with DBS to be unpersuasive. In the *FNPRM* below, we note that commenters argue that DBS and 17/24 GHz BSS satellites should be able to operate as close as 0.2° to 0.4° away from each other. Furthermore, we find concerns that the orbital assignment plan may need revision in the future to be speculative at best. In any case, the potential need for revision at some time in the future does not warrant allowing inefficient use of the geostationary orbit and limiting opportunities for competitive entry in the interim. Finally, we conclude that parties' concerns regarding potential physical interference between satellites operating with overlapping station-keeping volumes are misplaced. 17/24 GHz BSS satellite licensees will be able to offset their satellites in order to address any undesirable operational constraints arising from satellite co-location.

73. Consequently, we will adopt the orbital spacing framework set forth in Appendix F of this Order. This orbital spacing scheme is consistent with the locations of FSS satellites in the Ku-band and Ka-band, as recommended by DIRECTV and Intelsat.[215] Moreover, we agree with DIRECTV that this framework will accommodate most commenters' proposals for the portion of the geostationary arc between 83° W.L. and 123° W.L.[216] No one has suggested in the record another four-degree spacing configuration that accommodates other commenters' proposals better than DIRECTV's proposal.

74. However, we also agree to some extent with the commenters who argue for some flexibility in orbital assignments. In particular, we recognize that it may not be possible to locate a 17/24 GHz BSS satellite precisely at some of the orbital locations specified in Appendix F, *e.g.*, because there are undesirable operational constraints required to coordinate physical operations with co-located satellites, or because there is a DBS or other ITU Region 2 BSS satellite receiving feeder-link signals in the 17.3-17.8 GHz band at or very near that location. Thus, we will not require that 17/24 GHz BSS satellites be located precisely at the orbital locations specified in Appendix F. However, an applicant seeking an authorization to operate a 17/24 GHz BSS satellite at a location offset from an orbital location specified in Appendix F will be required to make a technical showing that the proposed satellite will not cause any more interference to any 17/24 GHz BSS satellite operating at a location specified in Appendix F, and in compliance with the rules for this service, than if the proposed satellite were positioned precisely at the Appendix F orbital location. In addition, such applicants must also agree to accept any increased interference that may result from adjacent 17/24 GHz BSS space stations that are operating in compliance with the rules for this service. As with all applicants, such applicants must also make a technical showing demonstrating that their system design accommodates any additional interference from adjacent 17/24 GHz BSS space stations operating at the maximum allowed pfd levels, and otherwise in compliance with the rules for this service, that may result from the location offset of their proposed satellite. Applicants that have reached a coordination agreement with an operator at an Appendix F 17/24 GHz BSS orbital location up to 10° away from the location listed in Appendix F from which their proposed satellite is offset to allow that operator to exceed the pfd levels specified in the rules for this service must use those higher pfd levels for the purposes of this showing.[217]

2. Reference Interference Baseline

75. ***DIRECTV's Reference Interference Baseline Not Adopted:*** In its reply comments, DIRECTV advocates a broad approach proposing that the Commission define a "reference interference

[215] DIRECTV Reply Comments at 3-8, Intelsat Comments at 7-8.

[216] DIRECTV Reply Comments at 3-6.

[217] *See* para. 104 below.

baseline" for the 17/24 GHz BSS.[218] Under this proposal, we would establish routine processing standards for satellite applications. A 17/24 GHz BSS satellite applicant would be allowed to receive routine processing even if it deviates from standard parameters set forward in the rules, provided it makes offsetting changes to create no additional interference beyond the reference situation. DIRECTV also advocates that applicants be able to receive routine processing by obtaining consent through coordination to operate outside of the reference situation parameters, and that more flexible requirements would apply outside of the domestic arc (*i.e.*, at least four degrees below 83° W.L. or above 123° W.L.).[219] DIRECTV argues that this approach would create opportunities for individual flexibility, eliminate the burden and delay of unnecessary coordination while maintaining the stability of the overall environment.[220]

76. We decline to adopt DIRECTV's approach of defining a reference interference baseline to be used for routine processing of satellite applications in this proceeding. There is little information or comment on the record to develop or to support what would amount to a rather extensive set of interdependent values. Nor is DIRECTV specific in its proposal other than to say that the baseline should assume four-degree spacing and receiving antennas compliant with ITU Recommendation BO.1213.[221] Accordingly, we find that DIRECTV has not adequately supported its proposal.

3. Minimum Antenna Diameter and Performance Standards

77. ***45 cm/ITU-R Recommendation BO.1213-1 Minimum Antenna Standards Adopted:*** The *NPRM* sought comment on what minimum diameter earth stations the Commission should seek to accommodate in formulating service rules for the 17/24 GHz BSS.[222] In addition, the *NPRM* also asked whether we should afford interference protection to 17/24 GHz BSS systems only to the extent that they meet certain receive-antenna performance characteristics.[223] The Commission also noted that it has typically chosen not to explicitly regulate receive-only antenna characteristics, but rather has opted to regulate other characteristics shaping the interference environment, thereby leaving the choice of antenna characteristics to the operator. However, the *NPRM* recognized that receiving earth station antenna off-axis discrimination performance will affect the interference experienced by BSS subscribers arising from other systems and we asked whether in this instance we should depart from our established policy.[224] In particular, the *NPRM* requested comment on what types of antenna performance regulation, if any, might be appropriate.[225]

78. Most commenters support accommodating a minimum antenna diameter of 45 cm[226] and Intelsat proposes that the Commission adopt a specific 45 cm minimum antenna size requirement.[227] EchoStar and SES Americom advocate less stringent approaches, urging the Commission to adopt rules and policies that would facilitate the deployment of receiving antennas as small as 45 cm[228] or afford

[218] *See* DIRECTV Reply Comments at 6.

[219] *Id.* at 7.

[220] *Id.*

[221] *Id.*

[222] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7448-49, paras. 46-47.

[223] *Id.*

[224] *Id.*

[225] *Id.*

[226] *See* EchoStar Comments at Technical Annex at 3, SES Americom Comments at 10.

[227] *See* Intelsat Comments at 10.

[228] *See* SES Americom Comments at 10.

interference protection only to receiving antennas no smaller than 45 cm.[229] DIRECTV expressed the view that 60 cm is the minimum antenna diameter that the Commission should accommodate when considering an orbital spacing policy.[230] DIRECTV notes that 60 cm dishes have become more prevalent in recent years and have long been the consumer standard in Europe and elsewhere.[231] DIRECTV states further that BSS operators needing to combine capacity from multiple orbital locations will likely require multi-feed receive antennas with an effective diameter greater than 60 cm.[232] Alternatively, SES Americom argues that limiting interference protection to 17/24 GHz BSS receiving antennas that are greater than 45 cm would preclude new BSS entrants from successfully competing with established DBS operators for a customer base.[233] SES Americom asserts that affording interference protection to receiving antennas as small as those commonly used for DBS today (45 cm) is critical to ensuring the usefulness of the band for new competition.[234]

79. As a general matter, commenters also favor adoption of reference antenna performance characteristics that will ensure sufficient interference protection for subscriber antennas and to establish a baseline for protection in licensing of 17/24 GHz BSS systems.[235] Although advocating different minimum antenna diameters, SES Americom, DIRECTV, and Intelsat all propose that the reference antenna pattern given in ITU-R Recommendation BO.1213-1 be used as an appropriate standard for the protection of receiving antennas in the 17/24 GHz BSS.[236] DIRECTV cautions that while protection should be granted only to the extent that receiving antennas conform to the ITU-R standard, the Commission should continue its policy of letting operators retain the discretion to determine the characteristics of their equipment. As such, DIRECTV believes operators should remain free to deploy non-conforming antennas, but with the understanding that they must accept any resulting increase in interference levels.[237] Bermuda, in contrast, argues that the Commission should not regulate 17/24 GHz BSS receiving antenna performance characteristics, but rather that they should be determined by the requirements of the system in which they are deployed.[238]

80. Although the Commission has historically chosen not to regulate the antenna performance characteristics of non-transmitting earth stations, we recognize that the 17/24 GHz BSS confronts an operating environment different from the one in which most other GSO satellite services, must operate. In particular, the reverse-band sharing situation that exists between BSS receiving antennas and transmitting DBS feeder link earth stations in the 17 GHz band creates significant potential for interference from sources other than neighboring co-frequency space stations. Such an interference environment may not be as satisfactorily managed by the Commission's more traditional approach to regulating the downlink interference environment by establishing an orbital separation scheme and

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[229] *See* EchoStar Reply Comments at 10.

[230] *See* DIRECTV Comments at 8.

[231] *Id.*

[232] *Id.*

[233] *Id.*

[234] *See* SES Americom Comments at 6.

[235] *See* DIRECTV Comments at 8 -9, SES Americom Reply Comments at 14, Intelsat Reply Comments at 8.

[236] *See* DIRECTV Comments at 9, SES Americom Comments at 13, SES Americom Reply Comments at 14, and Intelsat Reply Comments at 8. *See* also ITU-R Recommendation BO.1213-1 which provides formulae defining reference co-polar and cross-polar antenna patterns.

[237] *See* DIRECTV Comments at 9.

[238] *See* Bermuda Comments at 8.

accompanying pfd limits, particularly given the widespread deployment of such small-diameter receiving antennas in a four-degree spacing environment. We agree with DIRECTV that establishing performance standards for receiving antennas could help to create a more stable and predictable interference environment. Moreover, we note that the majority of commenters concur as evidenced by their support for inclusion of the ITU antenna performance standards of Rec. BO.1213-1 in the Commission's rules. Accordingly, we adopt a rule that 17/24 GHz BSS receiving earth stations 45 cm or greater in diameter may claim protection from interference, but only to the extent that they meet the antenna performance characteristics given in ITU-R Recommendation BO.1213-1.[239] This rule does not apply to 17/24 GHz BSS telemetry earth stations that are subject to the antenna performance requirements of Section 25.209.

81. In adopting this rule, we recognize that we have already bounded the downlink interference environment by establishing a minimum orbital separation requirement in combination with the downlink pfd limits addressed in Section III. E. Thus, by specifying a minimum antenna diameter and reference antenna pattern for interference protection, we are departing from past practice in our treatment of receive-only earth stations and adding an additional interference mitigation requirement. However, as discussed above, we concur with commenters' concerns regarding the need to establish a predictable environment, particularly in light of the unique reverse-band frequency operations in the 17 GHz band. In addition we support DIRECTV's request to preserve operator discretion with regard to choice of antenna characteristics. We note that this new antenna performance standard does not preclude operators from deploying receiving earth stations smaller than 45 cm, or antennas that do not conform to the reference patterns in the ITU-R Recommendation. However, the operator must accept the additional levels of interference that results from its use of the non-conforming antenna.

E. Technical Requirements for Intra-Service Operations

1. Uplink Power Levels

82. ***Standards For Routine/Non-Routine Licensing of Feeder Link Antennas Adopted:*** In the *NPRM*, the Commission stated that successful implementation of any orbital spacing scheme in the 17/24 GHz BSS will likely require adoption of uplink power density and antenna off-axis performance standards similar to those established for the FSS.[240] However, we also recognized that space stations in the 17/24 GHz BSS are likely to operate at orbital separations greater than those existing in the FSS, and that feeder uplink earth stations typically operate with larger diameter antennas that exhibit good off-axis rejection properties.[241] Both of these factors will tend to mitigate the problem of off-axis interference into neighboring space stations. Consequently, we sought comment on the need to establish uplink off-axis power limits for this service.[242] Additionally, the Commission's rules currently provide for routine licensing of FSS earth stations when specific antenna performance standards and uplink power levels are met.[243] The *NPRM* sought comment on whether analogous criteria might be developed to expedite

[239] The amount of interference from adjacent satellites that a receiving antenna can reject is a function not only of the antenna size and performance standards, but also of the pointing accuracy of the antenna. Operators of 17/24 GHz BSS networks should take this parameter into account when designing and deploying their networks. Operators of 17/24 GHz BSS networks should assume the minimum allowed orbital separation between adjacent 17/24 GHz BSS satellites on both sides, and the maximum allowed pfd level. The Commission will not favorably consider complaints from 17/24 GHz BSS network operators that are based on the mispointing of their own BSS receiving antennas.

[240] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7449, para.48.

[241] *Id.*

[242] *Id.*

[243] *See* 47 C.F.R. §§ 25.211(d), 25.212 (c)-(d).

licensing of 17/24 GHz BSS feeder link stations, and if so, what criteria might be appropriate.[244]

83. Because, by definition, feeder links operate in the FSS, the *NPRM* stated that the antenna performance standards of Section 25.209[245] could be applied to 17/24 GHz BSS feeder link earth stations. The Commission proposed to apply these off-axis performance standards in combination with the highest uplink Equivalent Isotropically Radiated Power (EIRP) density proposed by an applicant, *i.e.*, 5.6 dBW/Hz.[246] We sought comment on this proposal, recognizing that absent a clearly defined orbital separation scheme at that time, the resulting contribution to adjacent satellite interference would be difficult to determine.[247] We also asked what form any uplink off-axis power density requirement should take, and whether it would be most appropriate to specify separate off-axis antenna performance standards and uplink power density requirements, or a single composite off-axis EIRP density curve.[248]

84. Commenters in general acknowledge the need to apply uplink off-axis uplink EIRP limits to 17/24 GHz BSS feeder link stations, recognizing that such limits would help to address off-axis interference concerns as well as facilitate coordination with other services.[249] Intelsat initially stated that such requirements were unnecessary,[250] but, in its reply comments, provides off-axis EIRP density limits that it believes would be adequate.[251]

85. Commenters addressing this issue support applying the Ka-band FSS uplink off-axis power density requirements contained in Section 25.138(a)(1) – (4)[252] of our rules to feeder link earth stations in the 17/24 GHz BSS.[253] Commenters assert that this rule has been effective in the Ka-band,[254] sets limits that are consistent with levels proposed in applications already before the Commission,[255] and will successfully address adjacent satellite interference concerns.[256] Commenters also agree that in the case of the 17/24 GHz BSS, these values should be scaled to a 1 MHz reference bandwidth rather than the 40 kHz resolution specified in our current rule.[257] In addition, commenters suggest expressing the requirement as a limit on the off-axis EIRP density (rather than as separate off-axis antenna requirements and uplink power density limits) such that the operators must meet this EIRP density value regardless of

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[244] *Id.*

[245] *See* 47 C.F.R. § 25.209.

[246] *See 17/24 GHz BSS NPRM* at 7450, para. 49.

[247] *See 17/24 GHz BSS NPRM* at 7451, para. 50.

[248] *Id.*

[249] *See* DIRECTV Comments at 14-15, EchoStar Comments at A.4.2, SES Americom Comments at 16.

[250] *See* Intelsat Comments at 11.

[251] *See* Intelsat Reply Comments at 12-13.

[252] *See* 47 C.F.R. § 25.138(a)(1)-(4).

[253] *See* DIRECTV Comments at 14-15, EchoStar Reply Comments at 15 and Exhibit 1, 8-11, SES Americom Reply Comments at 20, Intelsat Reply Comments at 12-13.

[254] *See* SES Americom Reply Comments at 20.

[255] *See* Intelsat Reply Comments at 13.

[256] *See* EchoStar Reply Comments at Table A.4.2-1 of the Technical Annex that calculates the resulting typical ΔT/T from 1 12m feeder link antenna into adjacent satellites at 4° separation to be only 2.2% for spot beams and 0.2% for CONUS beams.

[257] *Id.*

on-axis absolute EIRP or actual antenna performance.[258]

86. Although the off-axis EIRP density limits favored by commenters are approximately 3 dB greater than those tentatively proposed by the Commission,[259] we agree with the commenters that the higher level has proven effective in the Ka-band FSS two-degree spacing environment and will effectively mitigate adjacent satellite interference in the 17/24 GHz BSS four-degree spacing environment. Accordingly, for routine processing of feeder link antennas transmitting to GSO satellites in the 24.75- 25.25 GHz band, we adopt the off-axis antenna performance requirements of Section 25.138(a) scaled to a 1 MHz reference bandwidth as follows:

(1) 17/24 GHz BSS earth station antenna off-axis EIRP spectral density for co-polarized signals shall not exceed the following values, within ±3° of the GSO arc, under clear sky conditions:

$32.5 - 25\log(\theta)$	dBW/MHz	for $2° \leq \theta \leq 7°$
11.4	dBW/MHz	for $7° \leq \theta \leq 9.2°$
$35.5 - 25\log(\theta)$	dBW/MHz	for $9.2° \leq \theta \leq 48°$
3.5	dBW/MHz	for $48° \leq \theta \leq 180°$

Where θ is the angle in degrees from the axis of the main lobe.

(2) 17/24 GHz BSS earth station antenna off-axis EIRP spectral density for co-polarized signals shall not exceed the following values, for all directions other than within ±3° of the GSO arc, under clear sky conditions:

$35.5 - 25\log(\theta)$	dBW/MHz	for $2° \leq \theta \leq 7°$
14.4	dBW/MHz	for $7° \leq \theta \leq 9.2°$
$38.5 - 25\log(\theta)$	dBW/MHz	for $9.2° \leq \theta \leq 48°$
6.5	dBW/MHz	for $48° \leq \theta \leq 180°$

Where θ is the angle in degrees from the axis of the main lobe.

(3) The values given in paragraphs (a) (1) and (2) of this section may be exceeded by 3 dB, for values of $\theta > 10°$, provided that the total angular range over which this occurs does not exceed 20° when measured along both sides of the GSO arc.

(4) 17/24 GHz BSS earth station antenna off-axis EIRP spectral density for cross-polarized signals shall not exceed the following values, in all directions other relative to the GSO arc, under clear sky conditions:

$22.5 - 25\log(\theta)$	dBW/MHz	for $2° \leq \theta \leq 7°$
1.4	dBW/MHz	for $7° \leq \theta \leq 9.2°$

Where θ is the angle in degrees from the axis of the main lobe.

87. The off-axis EIRP density curves given in Section 25.138(a)(1) – (4)[260] of our rules

[258] *See* DIRECTV Comments at 15, EchoStar Comments at Technical Annex at 19.

[259] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7450, para. 49. The Commission tentatively proposed to accommodate 5.6 dBW/Hz of EIRP Assuming a 65.1 dBi gain antenna this translates to an off-axis EIRP density at angle θ of no greater than $-30 - 25*\log_{10}(\theta)$ dBW/Hz. Scaled to a 1 MHz reference bandwidth this becomes $29.5 - 25*\log_{10}(\theta)$ dBW/MHz.

[260] *See* 47 C.F.R. § 25.238(a)(1)-(4).

include the term N, which is defined as the likely maximum number of simultaneously transmitting co-frequency earth stations in the receive beam of the satellite. Commenters do not include this term in their proposed formulae and we have chosen not to include it in our rules. Section 25.138 addresses *blanket licensing* of FSS earth stations where a number of co-frequency earth stations may be transmitting simultaneously in cases where contention protocols or CDMA may be used. We do not anticipate multiple simultaneous co-frequency transmissions from 17/24 GHz BSS feeder link earth stations, and as a consequence, these access schemes likely will not be relevant. Commenters do not explicitly address EIRP density envelopes for directions other than within 3 degrees of the GSO arc. Neither do they specifically address envelopes for cross-polarized signals or allowable exceedences, as contained in other parts of Section 25.138. Rather, they make more general references to a rule modeled on the framework of Section 25.138. We include these requirements here on the strength of those comments, and also because they are consistent with the Commission's approach to off-axis EIRP density limits in general.[261]

88. The *NPRM* also recognized that in some instances applicants might seek to operate at higher EIRP density levels than those permitted under the above requirement.[262] Our current rules provide a mechanism for licensing such non-conforming systems operating in the FSS by placing the burden on the applicant to provide a technical showing to the Commission, and to coordinate its non-conforming operations with adjacent operators.[263] We proposed a similar approach to licensing non-conforming systems in the 17/24 GHz BSS and sought comment on whether our proposal was appropriate to adopt.[264] We also asked over what angular distance coordination should be required, recognizing that the orbital spacing in the 17/24 GHz service could very likely be greater than the two-degree separation typical of the FSS.[265]

89. Commenters consistently favor allowing a mechanism by which operators could be licensed for non-conforming systems seeking to operate at higher off-axis power levels than those permitted for routine licensing. All commenters favor the general approach employed for FSS systems whereby applicants for non-conforming earth stations must submit the necessary technical showing to the Commission and coordinate their non-conforming operations with adjacent space station operators.[266] At present, our rules require non-compliant FSS operators to coordinate with potentially affected neighboring operations over an angular arc of six degrees, corresponding to up to three adjacent positions on each side.[267] At an orbital separation of six degrees, off-axis power levels are decreased by nearly 12 dB relative to those at the nearest neighbor at two degrees, and at a separation of eight degrees, power levels relative to the two-degree neighbor are decreased by more than 13 dB.[268] These values are true for an antenna that complies with FSS antenna gain envelope rules of 29-25*log10 (θ).[269] Accordingly, we believe that an angular arc of ±8 degrees, which in a four-degree spacing environment corresponds to the two nearest possible neighboring co-frequency space stations, is sufficient.

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[261] *See* §§ 25.138(a)(3)-(4), 25.209(a), (b).

[262] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7451, para. 51.

[263] *See* 47 C.F.R. §§ 25.220, 25.138(b), (c).

[264] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7451, para. 51.

[265] *Id.*

[266] *See* EchoStar Comments at Technical Annex at 20, DIRECTV Comments at 16, SES Americom Comments at 17, and EchoStar Reply Comments at Technical Annex at 11.

[267] *See* § 25.220(d)(1)(ii), (e)(1)(ii) and § 25.138(b).

[268] These values are true for an antenna that complies with the 29-25*log10 (θ) antenna gain envelope.

[269] *See* 47 C.F.R. § 25.209.

90. Commenters differ somewhat on the precise angular separation over which operators should be required to coordinate their non-conforming operations. DIRECTV and SES Americom, both of whom favor a four-degree orbital spacing scheme, propose coordination arcs of ±8 degrees and ±9 degrees, respectively.[270] EchoStar proposes a slightly more complex coordination arc requirement whereby operators would be required to obtain the agreement only of the immediate neighboring satellites (spaced at approximately four degrees away) for exceedences up to 3 dB, with the additional agreement of the second adjacent operator for exceedences up to 6 dB; no exceedence greater than 6 dB would be permitted.[271] We find that EchoStar's proposal affords significant interference protection to adjacent co-frequency satellites, while reducing the coordination burden on both the conforming and non-conforming parties. However, we also recognize that space stations may not always be located along a perfectly spaced four-degree grid, but sometimes may be offset from the orbital locations specified in Appendix F. To accommodate such instances, we will extend the angular coordination distance proposed by EchoStar by two degrees.

91. Accordingly, we will adopt a requirement that each applicant for an earth station license that proposes off-axis EIRP density levels in excess of those defined above shall certify that all potentially affected parties acknowledge and do not object to the use of the applicant's higher power densities. For proposed power levels less than 3 dB in excess of the limits defined above, the affected parties shall be those co-frequency operators authorized to provide service to the U.S. at up to ±6 degrees away; for excesses of greater than 3 dB and up to 6 dB, affected parties shall be all those co-frequency U.S. licensed operators at up to ±10 degrees away. We will not permit exceedences greater than 6 dB above the limits defined above. Although we take a slightly more flexible approach with regard to coordination of downlink pfd excedeences,[272] we believe that the sharing situation with 24 GHz fixed service systems requires a somewhat more conservative approach.[273] In addition, we require non-compliant operators to coordinate with any future applicants or licenses over these same orbital separation distances. We also require a non-compliant licensee to reduce its power levels should a coordination agreement not be reached. In addition, non-conforming applicants will be required to submit link budget analyses of the operations proposed along with a detailed written explanation of how they have derived each uplink and each transmitted satellite carrier density figure. Applicants will also be required to submit a narrative summary that must indicate whether there are margin shortfalls in any other licensee's current baseline services as a result of the addition the applicant's higher power service, and if so, how the applicant intends to resolve those margin shortfalls.

92. The *NPRM* also sought comment on the need for uplink adaptive power control, particularly in presence of rain fade,[274] noting that Section 25.204(g)[275] of our rules requires all Ka-band FSS earth stations to employ adaptive power control or other methods of rain fade compensation.[276] Commenters recognize the need for uplink power control in the event of rain fade and cite the specification already contained in our rules[277] as appropriate for the 17/24 GHz BSS.[278] We realize that

[270] *See* DIRECTV Comments at 16, SES Americom Comments at 17.

[271] *See* EchoStar Comments at Technical Annex at 20.

[272] *See* paras. 97-104 below. In the case of downlink pfd limits, we do not limit power exceedances to 6 dB.

[273] The band 25.05 – 25.25 GHz is allocated to the Fixed Service (FS) on a co-primary basis in the United States. *See* Section III.G.1. of this Order for requirements for coordination with FS systems.

[274] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7451, para. 52.

[275] *See* 47 C.F.R. § 25.204(g).

[276] *See* 47 C.F.R. § 25.204(g).

[277] *See e.g.*, 47 C.F.R. § 25.138(a)(5).

systems operating in the 24 GHz band can suffer significant signal attenuation in the event of precipitation and concur that some provision for adaptive uplink power control is necessary. Accordingly, we amend our rules to require 17/24 GHz BSS earth stations to employ adaptive uplink power control or other methods of fade compensation. We also adopt a requirement for the 17/24 GHz BSS analogous to the Ka-band FSS requirement of Section 25.138(a)(5).[279] This rules provides that (1) the required clear-sky uplink off-axis power limits may be exceeded by up to 20 dB in the presence of uplink fading due to precipitation; (2) that the amount of this increase relative to the excess attenuation over the clear sky propagation conditions shall not exceed 1.5 dB or 15% of the of the actual amount, which ever is greater; and (3) that this should occur with a confidence level of 90% except for transient periods of no more that 0.5% during which the excess shall be no more than 4.0 dB.

93. Some commenters also object to requiring applicants to provide measured radiation patterns as specified in Section 25.138(d)[280] of our rules as a means of demonstrating compliance with off-axis EIRP limits.[281] Intelsat argues that the requirement to provide measured radiation patterns for antennas not yet built is often not practical and unduly burdens the applicant.[282] Intelsat asserts that, instead, the Commission's evaluation process for earth stations in the 17/24 GHz service should follow the approach for earth stations on vessels (ESVs) contained in Section 25.221.[283] That approach requires the applicant to submit a series of charts or tables calculated for a production earth station antenna, based on measurements taken on a calibrated antenna range.[284] DIRECTV agrees that it is impractical to submit measured data, and argues further that because these very large feeder link antennas are typically assembled on site, it is simply not necessary to test these antennas on a range.[285] Instead, DIRECTV proposes that 17/24 GHz BSS feeder link antennas be tested as they are built, using in-orbit satellite resources, with the earth station operator responsible for certifying after licensing that the tests were satisfactorily performed, as part of its notification to the Commission that construction has been completed.[286] DIRECTV's proposed approach is based on a proposal submitted by the Satellite Industry Association in the *Biennial Review* docket,[287] and are founded in part upon existing rules for large C- and Ku-band earth stations.[288]

94. At present, our rules extend different earth station licensing requirements to different satellite services. Typically, C- and Ku-band GSO FSS applicants are required to meet the antenna performance requirements of Section 25.209[289] and may not exceed specified uplink power density levels

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[278] *See* EchoStar Comments at Technical Annex at 20, SES Americom Comments at 16, DIRECTV Comments at 15, and Intelsat Comments at 11.

[279] *See* 47 C.F.R. § 25.138(a)(5).

[280] *See* 47 C.F.R. §§ 25.138(d), 25.115(e).

[281] *See* Intelsat Comments at 11, DIRECTV Reply Comments at 22.

[282] *See* Intelsat Comments at 11.

[283] *Id.*

[284] *See* 47 C.F.R. § 25.221(b).

[285] *See* DIRECTV Reply Comments at 22.

[286] *See* DIRECTV Reply Comments at 22.

[287] *See* Satellite Industry Association Comments at 12-13, IB Docket No. 06-154.

[288] *See* 47 C.F.R. § 25.132(c)-(d).

[289] *See* 47 C.F.R. § 25.209.

and minimum antenna diameters.[290] Those C- and Ku-band applicants who do not meet these requirements may still be licensed via the rules outlined in Section 25.220.[291] In contrast, Ka-band earth station applicants must meet the off-axis EIRP density requirements of Sections 25.138(a)(1)-(4)[292] and demonstrate such by providing the antenna radiation pattern measurements specified in Section 25.138(d).[293] The earth station licensing requirement to submit with its application a series of measured test values over a range of frequencies is applied to any FSS earth station other than ESVs not meeting the antenna performance requirements of Section 25.209, as well as to all earth stations operating in the 20/30 GHz service. We find that it will be generally unnecessary to constrain feeder link earth stations applicants in the 24 GHz band in this manner, particularly since such large-diameter earth stations generally comply easily with existing antenna performance requirements. Moreover, we agree with commenters that such a requirement could be both impractical and burdensome for very large diameter antennas typically used for feeder link operations. Accordingly, we do not restrict 17/24 GHz BSS earth station applicants to the approach of Section 25.138(d). However, we will retain the option to allow non-compliant applicants to submit measured data.

95. We will require applicants for feeder link earth station licenses operating in the 24.75 – 25.25 GHz band to provide the particulars of operation identified on Form 312 and associated Schedule B, which may include an affirmative response that the earth station antenna conforms to the gain pattern criteria of Section 25.209(a) and (b) and that combined with the input power density entered in schedule B, demonstrates that the off-axis EIRP spectral density envelope set forth above will be met.[294] Alternately, an applicant that does not meet the antenna performance requirements of Section 25.209(a) and (b) may demonstrate that it meets the required off-axis EIRP spectral density requirements by providing: (i) a copy of the manufacturer's range test plots of the antenna gain patterns as specified in Section 25.132(b)(3) as revised in this Order; and (ii) a series of EIRP density charts or tables similar to the current requirements for ESVs as set forth in Section 25.222(b)(1).[295] Finally, an applicant that meets the antenna performance requirements of Section 25.209(a) and (b), but does not provide an input power density value in schedule B that will satisfy the off-axis EIRP spectral density envelope set forth above, may also demonstrate its compliance by providing a series of EIRP density charts or tables. Applicants seeking to operate with off-axis power density values in excess of the specified envelope are subject to the coordination process discussed above.

96. In addition, Section 25.132 of our rules sets forth the process for verification of earth station performance requirements. This rule is applicable to earth stations operating in the 24 GHz uplink band.[296] Paragraph (a)(1) of this rule requires applicants to submit manufacturer certification of measurements demonstrating that the antenna is compliant with the requirements of Section 25.209, and stipulates that the applicant be prepared to demonstrate these measurements to the Commission upon

[290] *See* 47 C.F.R. §§ 25.134, 25.211, 25.212.

[291] *See* 47 C.F.R. § 25.220. We note however that the Commission is currently considering off-axis EIRP envelopes for fixed earth stations in the C-band and Ku-band. *See Part 25 Earth Station Third Report and Order*, 20 FCC Rcd 5593.

[292] *See* 47 C.F.R. §§ 25.138(a)(1)-(4).

[293] *See* 47 C.F.R. § 25.138(d).

[294] These requirements assume antenna performance characteristics consistent with § 25.209 and a maximum input power density of 3.5 dBW/MHz (-56.5 dBW/Hz). By allowing applicants to submit separate power level and antenna performance data in their applications, we give them the option of complying with requirements substantially similar to those currently in effect for C-band and Ku-band FSS earth stations.

[295] *See* 47 C.F.R. § 25.222(b)(1).

[296] *See* 47 C.F.R. § 25.132.

request. For non-compliant antennas, as discussed above, the requirements of Section 25.132(b)(3), as revised in Appendix B of this Order, will apply.[297] Finally, Paragraphs (c) and (d) of this section recognize that while testing is typically performed at the manufacturer's facility, very large earth stations that are assembled on-site may require on-site measurements.[298] Paragraph (d) specifies the on-site verification measurements that must be performed for each new or modified transmitting antenna over three meters in diameter. Thus, for large-diameter 17/24 GHz BSS feeder link antennas, applicants must submit on-site verification measurements to the Commission as part of the notification of completion of the construction process as required in Section 25.133.[299]

2. Downlink Power Limits

97. ***Geographical Downlink PFD Limits Adopted:*** The downlink power levels transmitted by adjacent co-frequency satellites, when combined with the off-axis performance characteristics of the receiving antenna will determine the carrier-to-interference (C/I) value resulting from adjacent satellite interference.[300] The *NPRM* sought comment on whether we should adopt pfd or other downlink power limits in the 17.3 – 17.7 GHz band to ensure that receiving antennas are not subject to unforeseen levels of adjacent satellite interference, particularly as newer-generation, higher-powered satellites are brought into use.[301] The *NPRM* asked, in particular, whether the ITU Radio Regulations' pfd limit applicable to FSS systems in the 17.7 – 19.7 GHz band would be appropriate for BSS transmissions in the 17.3 – 17.7 GHz band.[302]

98. Commenters favor adopting pfd limits in the 17.3 – 17.7 GHz band to protect against unforeseen levels of adjacent satellite interference and to obviate the need for time-consuming coordination among co-frequency networks.[303] Intelsat favors adopting the ITU FSS pfd limits and maintains that these limits would satisfy the operational requirements in the band, provided that they are no more restrictive than the FSS pfd limits of Article 21 of the ITU Radio Regulations.[304] All other commenters advocate adopting a system of graduated pfd limits.[305] Under this approach, pfd limits would vary over different geographic regions of the United States, primarily to allow for the resulting signal attenuation arising from the variation in rainfall in different regions of the country.[306] In formulating this approach, commenters considered the planned deployment of both wide-area beams, and more localized, high-power spot beams by 17/24 GHz BSS operators. Due to the expected higher antenna gain for spot beams, in a given geographic area, EIRP imbalances of 10 dB or more may be anticipated between adjacent satellite transmissions. Potentially, the resulting interference could significantly affect quality of

[297] We will amend Section 25.132(b)(3) by adding a reference to the new off-axis antenna requirements adopted for 17/24 GHz BSS systems in Section 25.223.

[298] *See* 47 C.F.R. § 25.132(c)-(d).

[299] *See* 47 C.F.R. § 25.133.

[300] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7452, para. 53.

[301] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7453, para. 55.

[302] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7453, para. 55. These pfd limits are contained in Article 21-4 of the ITU Radio Regulations.

[303] *See* Intelsat Comments at 10, EchoStar Comments at Technical Annex, 15-17, SES Americom Comments at 18, and DIRECTV Comments at 10.

[304] *See* Intelsat Comments at 10, and Intelsat Reply Comments at 10.

[305] *See* DIRECTV Comments at 10-14, EchoStar Reply Comments, Technical Annex at 6-7, and SES Americom Reply Comments at 19.

[306] *Id.*

service to those consumers receiving lower-power, wide-area beam signals. The various proposals' utilization of graduated pfd levels in differing regions seeks to balance the competing goals of permitting sufficient flexibility to spot beam operations while simultaneously protecting wide-area beams from unacceptable interference levels. This approach also considers the need to allow higher-power downlink transmissions in regions of the country where they are most needed in order to overcome rain fade effects. As a result, all proposals to adopt graduated power levels for downlink transmissions in the 17/24 GHz BSS recognize the need for the highest power limits in the Southeastern region of the United States, with lower levels in the Northeast and the lowest levels in the West.[307]

99. Although the various proposals to adopt graduated pfd limits are similar in their general approach, they differ in certain respects. EchoStar's proposal advocates four geographic regions with the highest pfd level in the Southeast of -113 dBW/m^2/MHz; -114.5 dBW/m^2/MHz in the Northeast; -116 dBW/m^2/MHz in the Upper Midwest; and -118 dBW/m^2/MHz in the West. The westernmost region is defined by the 103° West Longitude line; the northern regions are above the 40° North Latitude line; and the 85° West Longitude line divides the Northeast Region from the Upper Midwest Region.[308] For areas outside of the Contiguous United States (CONUS) including Alaska, Hawaii and Puerto Rico, the pfd limit would be -113 dBW/m^2/MHz.[309] EchoStar notes that its proposal does not differ significantly from that of DIRECTV, discussed further below, and maintains that the somewhat lower power limits proposed by DIRECTV result from its plan to offer service using 60 cm diameter antennas contrasted with the 45 cm antennas planned by EchoStar, SES Americom and Intelsat.[310] Accordingly, EchoStar urges the Commission to accommodate the requirements of all operators and to permit pfd levels on the higher side.[311] SES Americom supports EchoStar's proposal.[312]

100. DIRECTV proposes adopting three geographic regions, with the highest power level in the Southeast of -115 dBW/m^2/MHz; -118 dBW/m^2/MHz in the Northeast; and -121 dBW/m^2/MHz in the West. In DIRECTV's proposal the far western region is defined by the 100° West Longitude line and the Northeast and Southeast Regions are divided by the 38° North Latitude line.[313] DIRECTV argues that its somewhat lower pfd levels are more appropriate because CONUS beams cannot match the higher power levels of -113 dBW/m^2/MHz proposed by EchoStar and SES Americom, and should the Commission adopt pfd values this high, the result would only be to codify the power disparity between wide-area and spot beams.[314] Later, in an *ex parte* statement, DIRECTV, EchoStar, and Intelsat proposed a jointly-agreed scheme, which proposed geographic regions and pfd levels in a four-degree spacing environment consistent with the values proposed in DIRECTV's original proposal as discussed above. This new scheme also proposes a formula by which pfd levels could be allowed to vary as a function of orbital separation.[315]

101. We agree that there is merit in considering graduated pfd limits in differing regions of the

[307] *See* DIRECTV Reply Comments at 13, EchoStar Reply Comments at Technical Annex at 7, SES Americom Reply Comments at 19.

[308] *See* EchoStar Reply Comments at Technical Annex at 6-7.

[309] *Id.*

[310] *See* EchoStar Reply Comments at Technical Annex at 7.

[311] *Id.*

[312] *See* SES Americom Reply Comments at 19.

[313] *See* DIRECTV Reply Comments at 13.

[314] *See* DIRECTV Reply Comments at 15

[315] *See March 15 Joint Ex Parte Statement.*

country. We recognize the need to employ both wide-area and spot beams in the 17/24 GHz BSS and appreciate the inherent difficulties encountered in attempting to balance the requirements of both applications. While we wish to protect the more vulnerable wide-area beam receivers from adjacent satellite downlink interference, we also want to permit licensees the flexibility to achieve the power and spectral efficiencies attainable with spot beam transmissions, particularly when broadcasting local programming to restricted geographic areas. We concur with DIRECTV, EchoStar and SES Americom that the use of regional pfd values best balances these competing goals. Although it presents a somewhat more complex regulatory mechanism than does a uniform pfd limit, this approach has been applied to other services, notably MVDDS.[316] Thus, after carefully considering the various regional pfd schemes, and recognizing the agreement among many of the commenting parties with regard to the regional boundaries and pfd levels, we believe that the proposal originally put forward by DIRECTV most successfully balances our goals of accommodating both beam technologies while best meeting the needs of all operators. Accordingly, we adopt the three-region graduated pfd plan presented by DIRECTV. We note that a key difference between DIRECTV's proposal and the approach contained in the *Joint Ex Parte Statement*, is the proposed use of formulae to determine the variation in pfd levels that would be permitted as a function of orbital separation.[317] We decline to adopt this approach. Rather, we will adopt pfd levels consistent with a four-degree spacing environment, but will permit licensees to operate at higher levels subject to coordination, as discussed below.

102. In most cases, commenters propose pfd limits for the entire 17.3 – 17.8 GHz band and do not separate the question of pfd limits in the 17.7 – 17.8 GHz band from the issue of pfd limits for BSS downlink transmissions in the 17.3 – 17.7 GHz band. In adopting the graduated pfd scheme discussed above, the Commission seeks to facilitate intra-service operations by establishing a relatively homogeneous transmitting environment that will accommodate both wide-area and spot beam operations. Because U.S. domestic service is not allocated in the 17.7 – 17.8 GHz band, we do not believe these intra-service sharing challenges will be present to the same extent. In contrast, pfd limits in the 17.7-17.8 GHz band are intended to facilitate inter-service sharing by protecting terrestrial service receivers from satellite transmissions serving other Region 2 countries, but that may illuminate portions of the United States. We believe that the pfd limits that are adopted in Section III.C. of this Order, that vary as a function of elevation angle, will best accomplish that goal.[318] Accordingly, we clarify here that the graduated pfd limits adopted above will apply only to the 17.3 – 17.7 GHz band, and that the elevation-angle-based pfd limits adopted in Section III.C. will apply in the 17.7-17.8 GHz BSS GHz band.

103. Commenters also advocate applying the pfd levels in the 17.3 – 17.7 GHz band in a manner similar to the Ka-band FSS requirement in Section 25.138(a)(6).[319] Under this approach an applicant seeking to operate outside the required pfd levels must submit a technical showing to the Commission that includes detailed link budgets and a narrative summary indicating whether there are margin shortfalls resulting from the applicant's higher powers, and if so, an explanation of how these

[316] *See* 47 C.F.R. § 101.105.

[317] *See March 15 Joint Ex Parte Statement* at 6-7.

[318] These limits do not vary as a function of geographic area. The are as follows:

-115 dBW/m^2/MHz	for $0° \leq \delta \leq 5°$
-115 + 0.5(δ-5) dBW/m^2/MHz	for $5° \leq \delta \leq 25°$
-105 dBW/m^2/MHz	for $25° \leq \delta \leq 90°$

where δ is the angle of arrival above the horizontal plane.

[319] *See* EchoStar Comments at Technical Annex at 17, DIRECTV Reply Comments at 19-20, and SES Americom Reply Comments at 14-15.

shortfalls will be addressed. In addition, a non-conforming applicant must certify that its operations have been coordinated with all affected parties. EchoStar proposes that for non-conforming 17/24 GHz BSS operations, the angular separation over which coordination is required should be linked to the magnitude of the power excess.[320] Specifically, EchoStar proposes that given the wider orbital spacing in the 17/24 GHz BSS as compared to the Ka-band FSS, the agreement of the immediately adjacent operators should be sufficient for excesses of no greater than 3 dB, and that coordination with the second adjacent neighboring satellite should also be required for excesses between 3 dB and 6 dB. EchoStar also proposes prohibiting power levels greater than 6 dB.[321] DIRECTV and SES Americom support EchoStar's proposal, although DIRECTV argues that power exceedences of greater than 6 dB should be permitted if a coordination agreement can be reached, however unlikely that may be.[322]

104. The Commission has always sought to afford satellite operators the maximum flexibility to design and operate their systems while simultaneously protecting other licensees from unacceptable levels of interference. Thus, we concur with commenter's proposals to provide a mechanism for licensing and coordinating systems operating with non-compliant pfd levels. We also agree that there are advantages in linking the angular separation over which coordination is required to the degree of the power excess, as this approach may avoid placing an unnecessary coordination requirement on the parties. Accordingly, we adopt a requirement for non-compliant systems in the 17/24 GHz BSS similar to the Ka-band requirement of Section 25.138(b). However, to account for the different orbital spacing rules that we adopt for the 17/24 GHz BSS environment, as well as the possibility of offset from the locations specified in Appendix F, we will require applicants to coordinate with adjacent satellites within an angular separation of ±6 degrees for exceedences of up to 3 dB, and to coordinate with adjacent operators within an angular separation of ±10 degrees for exceedences of more than 3 dB. In addition, consistent with the Ka-band FSS requirement of Section 25.138(c), we require non-compliant operators to coordinate with any future applicants or licensees over these same orbital separation distances. We also require a non-compliant licensee to reduce its power levels should a coordination agreement not be reached.

F. Other Technical Requirements

105. The *NPRM* sought comment on several additional technical matters, including issues relating to Tracking Telemetry and Control (TT&C) frequencies, full frequency re-use, polarization requirements, cross-polarization isolation requirements, and channelization requirements.

1. Tracking, Telemetry and Command (TT&C) Frequencies

106. ***No Additional TT&C Rules Adopted:*** With regard to TT&C frequencies, the *NPRM* recognized the present lack of 17/24 GHz ground facilities to support launch, transfer and testing operations, and sought comment on how best to address the issue.[323] Commenters suggest that the Commission should take a flexible approach toward TT&C requirements, particularly recognizing the absence of the ground network necessary for support during critical launch and early operation phases.[324] DIRECTV also points out that because the 17/24 GHz bands are not allocated for use by BSS satellites outside of Region 2, it is unlikely that such facilities will be deployed in other parts of the world.[325]

[320] *See* EchoStar Comments at Technical Annex at 16-17.

[321] *Id.*

[322] *See* DIRECTV Reply Comments at 20, SES Americom Reply Comments at 14.

[323] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7464, para. 82.

[324] *See* EchoStar Comments at Technical Annex at 28, DIRECTV Comments at 36, SES Americom Comments at 20-21, and SES Americom Reply Comments at 15.

[325] *See* DIRECTV Comments at 36.

Commenters generally encourage the Commission to consider requests to use alternate TT&C frequencies on the merits of each individual application, but maintain that applicants should demonstrate their need for such non-standard uses and must coordinate their operations.[326] Accordingly, we make no changes to our existing rules, but will consider the merits and needs for 17/24 GHz BSS systems to use alternate TT&C frequencies on a case-by-case waiver basis. Applicants seeking alternative TT&C frequencies should include a request for waiver in their applications.

107. The *NPRM* also sought comment on the problem of reverse-band interference between receiving 17 GHz telemetry stations and DBS feeder uplink transmissions, and in particular on the ramifications to TT&C operations when such operations are co-located or located in close proximity to one another.[327] DIRECTV states that with careful planning it is possible to coordinate the operations of the two services, even to the point that the earth stations may be co-located.[328] Thus, DIRECTV requests that the Commission not limit operator flexibility by precluding such co-location, or by requiring a minimum separation distance.[329] Rather, DIRECTV supports the Commission's proposal to require that applicants submit a technical showing demonstrating its ability to maintain sufficient telemetry link margin in the presence of the interfering DBS signal.[330] Bermuda also supports this proposal, stating that the applicant could demonstrate compliance through a technical showing and urges the Commission not to preclude the possibility of co-locating DBS feeder link earth stations with 17/24 GHz BSS telemetry stations.[331] EchoStar also argues that interference can be avoided by careful frequency planning.[332]

108. At this time, we will not modify our rules to preclude co-location of DBS and 17/24 GHz BSS TT&C facilities, nor will we require a minimum separation distance between TT&C facilities for the two services. Although there was support for our proposal to require a technical showing on the part of applicants seeking to operate co-located earth stations, we are not prepared to adopt such a requirement at this time. Rather, we recognize that the question of interference into 17/24 GHz BSS telemetry receivers from DBS feeder link transmissions is not separate from the larger issue of reverse-band, ground path interference into 17/24 GHz BSS receiving antennas in general. For this reason, we will not adopt specific rules concerning the question of DBS ground path interference into 17/24 GHz BSS telemetry stations in this Order, but will address this issue in the further notice, within the larger context of ground path interference in the presence of reverse-band operations.[333] We believe that this approach will better permit us to develop the record more fully, treat the issue within its larger context, and ultimately adopt the most appropriate requirements.

2. Polarization and Full Frequency Re-Use Requirements

109. ***Full Frequency Re-Use Required:*** The *NPRM* sought comment on requirements relating to antenna polarization and full frequency re-use.[334] Most commenters agreed that the Commission should mandate full-frequency re-use for 17/24 GHz BSS systems, but that it should

[326] *See* EchoStar Comments at Technical Annex at 28, DIRECTV Comments at 36, SES Americom Comments at 20-21, and SES Americom Reply Comments at 15.

[327] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7464, para. 83.

[328] *See* DIRECTV Comments at 22.

[329] *Id.*

[330] *Id.*

[331] *See* Bermuda Comments at 9.

[332] *See* EchoStar Comments at Technical Annex at 23.

[333] *See* Section IV.A. below.

[334] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7465-66, paras. 87-90. 47 C.F.R. § 25.210.

maintain flexibility with regard to channelization and polarization, and therefore should not adopt any specific channelization or polarization requirements.[335] DIRECTV argues, however, that all transmissions from a given orbital location should be of the same type,[336] and SES Americom urges the Commission not to divide the spectrum at a given orbital location among multiple entrants as was done for the DBS service.[337] Only EchoStar proposes a standardized polarization and channelization scheme in which the co-frequency polarization senses are alternated among adjacent satellites across the geostationary arc.[338] EchoStar asserts that such a scheme would yield about 1 dB of reduction in adjacent-satellite interference through judicious placement of the guardbands of an interfering satellite within the transponder bandwidth of the victim satellite.[339] DIRECTV notes that applicants have all proposed to implement different channelization schemes, and argues that the cost to re-engineer their business plans cannot justify the modest 1 dB of interference reduction.[340] We concur with DIRECTV that the potential for 1 dB of interference reduction does not compensate for the accompanying loss of flexibility in system design that the Commission has historically sought to afford satellite operators. Accordingly, we will not mandate a polarization or channelization scheme for 17/24 GHz BSS systems. We will, however, mandate full frequency re-use, through either the use of orthogonal polarizations within the same beam and/or through the use of spatially independent beams.

3. Cross-Polarization Isolation Requirements

110. ***25 dB Space Station Cross-Polarization Isolation Requirements Adopted:*** Commenters generally support some relaxation of the current FSS requirement for 30 dB cross-polarization isolation contained in Section 25.210(i) of the Commission's rules.[341] All commenters believe that this rule is too restrictive and should be relaxed for 17/24 GHz BSS systems, although they differ in the degree of relaxation that should be provided. SES Americom proposes a reduction of the cross-polarization isolation requirement from 30 dB to 25 dB, stating that this value will adequately protect adjacent operators and that licensees will be able to manage any accompanying intra-system interference (*i.e.*, "self-interference").[342] DIRECTV also proposes a less strict value of 27 dB, arguing that this value is more than sufficient to avoid excess levels of intra-system interference, particularly in light of recent advances in digital transmission technology that reduce system sensitivity to cross-polarization interference.[343] EchoStar argues that the Commission's existing FSS requirement is too stringent and notes that most antennas fail to meet this level in only a small part of their service area, usually by no more than a few dB.[344] Accordingly, EchoStar initially proposes a multipart scheme wherein operators would be required to meet the 30 dB level over 90% of the land within its service area, and a value of at

[335] *See* DIRECTV Comments at 37-38, Intelsat Comments at 12, SES Americom Comments at 21-22, DIRECTV Reply Comments at 30, SES Americom Reply Comments at 16. *See also* EchoStar Comments at 23 regarding full frequency re-use.

[336] DIRECTV Comments at 37.

[337] SES Americom Comments at 21.

[338] EchoStar Comments at Technical Annex at 22-23.

[339] *Id.*

[340] DIRECTV Reply Comments at 30-31.

[341] *See* 47 C.F.R. § 25.210(i).

[342] SES Americom Comments at 22, SES Americom Reply Comments at 17.

[343] DIRECTV Comments at 38.

[344] EchoStar Comments at Technical Annex at 28-29.

least 26 dB within the remaining 10%.[345] In its Reply Comments, EchoStar proposed a compromise to take into account the comments from other parties and amended its proposal to require 27 dB cross-polarization isolation over 90% of the land within its service area and at least 25 dB within the remaining 10%.[346] In its Reply Comments, DIRECTV offered support for EchoStar's original proposal.[347]

111. The Commission adopted its 30 dB FSS cross-polarization isolation requirement in an environment where satellites were predominantly using analog transmissions. Along with the C-band analog video frequency plan of Section 25.211(a)[348] and the polarization switchability requirement of Section 25.210(c),[349] the cross-polarization requirement serves to minimize the interference between adjacent satellites when both are carrying analog video signals that have highly varying (peaked) power density levels. In addition, the cross polarization requirement serves to limit the level of self-interference, thus assuring that operators do not allocate an inordinate proportion of the interference budget to themselves. In this context, it is worth noting that the cross polarization performance of the satellite receive antenna has negligible effect on the interference into other systems.

112. Moreover, in a four-degree spacing environment, the cross-polarization performance of the downlink satellite antenna has only a second-order effect on the interference into the neighboring system. The impact of the satellite downlink antenna's cross polarization transmission is to raise slightly the interference level into the downlink of the victim satellite's wanted polarization. Thus, the earth station receiving the signal from the neighboring victim satellite receives a co-polar interfering signal at a level defined by its own antenna co-polar sidelobe performance. In addition, in the same polarization, it also receives a much lower interfering signal whose level is defined by the interfering satellite's downlink cross-polarization performance. If the satellite antenna meets the 30 dB FSS requirement of Section 25.210(i) and if it transmits at the same level in both polarizations, this cross-polarization contribution will increase the co-polar interference level into the adjacent satellite's downlink signal by one part per thousand. This increase corresponds to a decrease in carrier-to-interference ratio (C/I) of 0.004 dB. For 17/24 GHz BSS satellites meeting a cross-polarization isolation requirement of 25 dB, the co-polar interference will increase by about 3 parts per thousand with a corresponding C/I decrease of 0.014 dB.[350] This level of increased interference resulting from the satellite downlink antenna's more relaxed performance remains negligible relative to the main interfering signal.

113. We anticipate that 17/24 GHz BSS system will operate almost exclusively with digital transmissions. We also accept that operators will be able to manage intra-system interference if a more relaxed requirement is adopted. In addition, we agree with the commenters that a more relaxed off-axis cross-polarization isolation requirement should yield only a negligible increase in interference to adjacent satellite systems. Thus, we agree that the 30 dB antenna cross-polarization isolation requirement originally designed for the analog transmission environment is unnecessarily stringent for 17/24 GHz BSS systems. Moreover, we recognize that the Commission has frequently waived the cross-polarization requirement of Section 25.210(i) for FSS applicants, allowing these systems to operate with isolation

[345] *Id.*

[346] EchoStar Reply Comments at 17.

[347] DIRECTV Reply Comments at 31.

[348] 47 C.F.R. § 25.211(a).

[349] 47 C.F.R. § 25.210(c).

[350] If the downlink antenna cross-polarization isolation requirement is relaxed to 27 dB as proposed by DIRECTV, the cross-polar interference contribution will increase to about two parts per thousand, which represents a C/I decrease of 0.009 dB.

levels less that 30 dB.[351] Consequently, we adopt the 25 dB antenna cross-polarization isolation requirement proposed by SES Americom.

4. Spectrum Allocation Issue

114. ***Footnote NG176 Unchanged:*** The *NPRM* also proposed to modify footnote NG167 of the Domestic Table of Frequency Allocations[352] in order to permit use of the 24.75 – 25.25 GHz FSS allocation (Earth-to-space) by feeder links operating with the BSS in frequency bands other than 17 GHz, *e.g.*, the 12 GHz DBS band.[353] Only Intelsat supports this proposal asserting that this increase in flexibility of spectrum use would help alleviate groundpath interference problems associated with reverse-band operations.[354] EchoStar disagrees strongly with the proposal, arguing that it would preclude co-location of 17/24 GHz BSS and DBS satellites, and would also be inconsistent with its planned uses of both multiple spot-beam technology, and the 17.7 – 17.8 GHz band.[355] Finally, DIRECTV responds that, although the flexibility to use this alternative uplink spectrum could be useful in avoiding ground-path interference problems associated with reverse-band operations in the DBS uplink band (17.3-17.8 GHz), users of this band already face the challenges of sharing spectrum with co-primary commercial and government systems.[356] DIRECTV also states that 17/24 GHz BSS operators will likely require more uplink locations than do traditional DBS systems due to the increased atmospheric attenuation at these higher frequencies, which will result in increased site-diversity requirements, further increasing the potential burdens on systems sharing the band.[357] Accordingly, DIRECTV cautions the Commission to weigh carefully the offsetting disadvantages of increased interference in the band.[358] Intelsat disagrees with DIRECTV's comments, which it believes overstate the difficulties associated with additional use of the 24 GHz band. Intelsat argues that, given the limited number of 17/24 GHz BSS feeder link sites anticipated overall, any increase in use of spectrum could still be easily accommodated.[359]

115. In light of the limited support in the record for this proposal, we decline to adopt the *NPRM* proposal to permit the additional use of the 24.75-25.25 GHz band by DBS feeder uplink earth stations. Specifically, only Intelsat offers any support for this proposal, and bases that support on a speculative assumption regarding growth of 17/24 GHz BSS feeder link sites. As a result, in this case, we find DIRECTV's and EchoStar's concerns regarding the potential complexities created by changing the spectrum allocation to be more persuasive.

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[351] *See, e.g.*, EchoStar Satellite Operating Corporation, Order and Authorization, File Nos. SAT-MOD-20060830-00092 and SAT-STA-20050608-00116, paras. 6-8, (adopted Dec. 22, 2006); Hughes Communications Inc., Grant Stamp, File No., SAT-MOD-20050523-00106, at condition 9, (granted June 30, 2006); DIRECTV Enterprises, LLC, Grant Stamp, File No. SAT-LOA-20041122-00210, at condition 3, (granted March 18, 2005); New Skies Satellites N.V., 17 FCC Rcd. 10369 (Int'l bur. 2002) at para. 19.

[352] *See* 47 C.F.R. § 2.106. Footnote NG 167 to the Domestic Table of Frequency Allocations limits use of the FSS allocation (Earth-to-space) in the 24.75 – 25.25 GHz band to use by feeder links for the BSS operating in the band 17.3 – 17.7 GHz, *i.e.*, the 17/24 GHz BSS service.

[353] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7459, para. 69.

[354] Intelsat Comments at 10 and Intelsat Reply Comments at 16-17.

[355] EchoStar Comments at Technical Annex at 26-27, EchoStar Reply Comments at Technical Annex at 22-23.

[356] DIRECTV Comments at 35.

[357] *Id.*

[358] *Id.*

[359] Intelsat Reply Comments at 16-17.

G. Technical Requirements for Inter-Service Operations

1. Sharing in the 24 GHz Band

a. Coordination Procedure

116. ***-114 dBW/m²/MHz PFD Coordination Threshold Adopted at Edge of FS License Area:*** Feeder uplinks for satellites operating in the 17/24 GHz BSS are allocated use of the 24.75-25.25 GHz band on a primary basis in both the U.S. Table of Allocations and the International Tables of Allocations.[360] Domestically, the upper portion of this band from 25.05 – 25.25 GHz is also allocated on a primary basis to the Fixed Service (FS).[361] Fixed service operations in the band include Digital Electronic Message Service (DEMS)[362] systems as well as a variety of other fixed services licensed throughout the United States by Economic Areas (EAs).[363] In the *18 GHz Report and Order,* the Commission amended the Table of Allocations to allocate spectrum in the 24.75 – 25.25 GHz band for use by BSS feeder links consistent with the international allocation made at the 1992 World Administrative Radiocommunication Conference.[364] The Commission adopted this shared allocation[365] in part based on the belief that co-frequency operation would be feasible given the limited number of anticipated feeder link earth stations. It noted, however, that the successful implementation of this allocation would require the development of sharing criteria in a future rulemaking.[366]

117. Recognizing the potential for 17/24 GHz BSS feeder link earth stations operating in this portion of the band to interfere with existing and future 24 GHz FS operations, the *NPRM* sought comment on rules we might adopt to facilitate co-frequency operations of these two services. Specifically we asked whether the antenna off-axis performance requirements of Section 25.209[367] in combination with earth station power limits in Section 25.204[368] would afford sufficient protection to 24 GHz FS systems, or whether changes to our rules are required.[369] The *NPRM* also recognized certain conditions

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[360] *See* 47 C.F.R. § 2.106 and note NG 167. *See also* ITU Radio Regulations, Article 5 and No. 5.535.

[361] *See* 47 C.F.R. § 2.106. Domestically, the radionavigation service is also allocated use of the 24.75 – 25.05 GHz band on a primary basis. However as the *NPRM* stated, at this time we are aware of no operational systems in this band.

[362] DEMS systems were relocated from the 18 GHz band to the 24 GHz band in 1997. *See* Amendment of the Commission's Rules to Reallocate the Digital Electronic Message Service from the 18 GHz Band to the 24 GHz Band and to Allocate the 24 GHz Band for Fixed Service, *Order*, ET Docket No. 97-99, 12 FCC Rcd 3471 (1997).

[363] *See* Amendments to Parts 1, 2, 87 and 101 of the Commission's Rules to License Fixed Services at 24 GHz, *Order*, 15 FCC Rcd 16934 (2000) ("*24 GHz Report and Order*").

[364] *See 18 GHz Report & Order*, 15 FCC Rcd at 13479-80, paras. 102-06. *See also* 47 C.F.R. §2.106 and the International Radio Regulations, Article 5.

[365] The allocation is shared on a co-primary basis with the fixed service only in the 25.05 – 25.25 GHz frequency band. The fixed service is not allocated use of the 24.75 – 25.05 GHz band.

[366] *See 18 GHz Report & Order*, 15 FCC Rcd at 13477, para. 98. *See also 24 GHz Report and Order*, 15 FCC Rcd at 16940-41, para. 10, where the Commission again opted to defer rules for terrestrial and satellite sharing to a future rulemaking.

[367] 47 C.F.R. § 25.209.

[368] 47 C.F.R. § 25.204. Paragraph (b) of this section establishes power limits for earth stations operating in frequency bands above 15 GHz shared co-equally with terrestrial radiocommunication services. These power limits extend to elevation angles up to 5 degrees above the horizon. In this Order the Commission also adopts off-axis EIRP density limits for 17/24 GHz BSS feeder link earth stations that are significantly more restrictive than those contained in § 25.204. *See* Section III.B.1. of this Order.

[369] *See 17/24 GHz BSS NPRM*, 21 FCC Rcd at 7467, para. 92.

unique to the 24 GHz band that may either facilitate or complicate inter-service sharing, including the relatively small number of anticipated BSS feeder uplink stations, their large diameters and accompanying good off-axis discrimination characteristics,[370] as well as the geographic area licensing of 24 GHz FS systems wherein licensees are not required to file site-specific data.[371]

118. Commenters' responses were similar among the terrestrial and satellite communities. Satellite commenters generally believe that co-frequency operation of 24 GHz FS systems and 17/24 GHz BSS feeder link earth stations should be feasible, given the Commission's well-established procedures for coordination between terrestrial operations and satellite earth stations, in combination with the large-diameter and relatively small number of feeder link antennas, and the large regions of the country where no FS systems are licensed to operate.[372] Terrestrial service commenters assert that the tests and analyses necessary to understand the inter-service sharing situation will be time-consuming and costly, and that the cost of complying with coordination procedures that are eventually developed will be substantial.[373]

119. FiberTower asserts that the technical data and assumptions before the Commission are outdated, and that Section 25.204(b) is overly permissive as it does not take into account present-day equipment evolution.[374] FiberTower maintains that reliable answers concerning band sharing criteria will only become available following the substantial expenditure of time and resources devoted to that end.[375] FiberTower details many questions that it believes need to be answered, and additional information it believes must be made available in the record, in order to begin the necessary sharing studies.[376] Consequently, FiberTower asserts that the best course of action is to require 17/24 GHz BSS feeder link earth stations to locate well beyond the boundaries of the FS licensed areas until such studies can be completed and non-interference to FS operations can be assured.[377] Specifically, FiberTower urges the Commission to require 17/24 GHz BSS earth stations to locate at least 100 miles from the edge of any FS licensed area.[378] In addition, FiberTower maintains that the Commission may also need to limit the number of BSS feeder links allowed to no more than five nationally until mutually acceptable analyses and supporting data are available to demonstrate that additional BSS feeder links are actually necessary, and that they can be operated without causing interference to 24 GHz FS systems in existing license areas.[379] The FWCC supports FiberTower's proposals, arguing that the characteristics of the BSS feeder links are not well known, and adding that FS operations are subject to recent developments in available equipment and architectures.[380]

120. DIRECTV and EchoStar take issue with FiberTower's argument that coordination between 24 GHz FS systems and 17/24 GHz BSS feeder link earth stations is unduly complicated. These

[370] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7467, para. 92.

[371] *See 17/24 GHz BSS NPRM,* 21 FCC Rcd at 7467, para. 91.

[372] *See* DIRECTV Comments at 28-31, SES Americom Comments at 22-23, SES Americom Reply Comments at 18-19, EchoStar Reply Comments at 28-31, and DIRECTV Reply Comments at 22-25.

[373] FiberTower Comments at 8.

[374] FiberTower Comments at 6 – 11.

[375] FiberTower Comments at 2.

[376] *Id.* at 4-7.

[377] FiberTower Reply Comments at 2.

[378] FiberTower Comments at 8.

[379] FiberTower Comments at 9-10.

[380] FWCC Reply Comments at 4-5.