recommendations for the correct signal threshold values necessary for DBS operation.[115] Using all of these measurements, along with a propagation and rain attenuation model, MITRE made predictions regarding the additional DBS outage time that may occur within an MVDDS service area.[116]

58. MITRE considered ten different locations for their simulations: stating that they were geographically diverse and thus representative of the entire U.S. in terms of rain characteristics and DBS signal availability. In addition, MITRE ran simulations varying parameters such as satellite power, MVDDS antenna height and elevation tilt angles, and frequency offset.[117] Based on their work, MITRE concluded that MVDDS sharing could occur if suitable mitigation techniques are applied to reduce the potential of interference to DBS customers.[118] They stated that these mitigation techniques could include adjustment of MVDDS operational parameters,[119] MVDDS system design changes,[120] and corrective measures at DBS receiver locations.[121] Finally, MITRE enumerated policy issues (along with recommendations) on which the Commission would have to decide.

59. Commenters had different approaches on the appropriate technical criteria for MVDDS to ensure adequate interference protection of DBS systems. The major disagreements among commenters are the criterion to use as a basis for establishing an interference limit, the method used to calculate that limit, and the specific requirement that should be placed in our rules.

60. DBS proponents argue that MVDDS is a secondary service and thus should be held to strict non-interference criteria.[122] DirecTV, for example, argues that the impact of MVDDS on BSS must be imperceptible, so that the quality of service is essentiality unchanged and DBS operators will not have to design around this new interference source.[123] The DBS proponents generally support an approach that would limit the amount of increased BSS unavailability due to the presence of MVDDS over a baseline level of BSS unavailability. Although this approach is similar to that adopted for NGSO FSS/BSS sharing and the proposals in the *Further Notice*, some of the DBS proponents' proposals are significantly different in certain respects. For example, DirecTV and EchoStar argue that the Commission's rules should specify an interference criterion for MVDDS that would limit the increase in DBS unavailability

[115] In general, a threshold is the minimum value of a signal that can be detected by the system under consideration.

[116] *See* MITRE Report at Section 5.

[117] For example, MITRE predicted that a DBS customer viewing the satellite at 101° W longitude would experience additional outages of less than 18 minutes per year over the entire MVDDS service area. For the satellite at 110° W longitude, an additional outage of 18 minutes per year would be experienced in a small zone approximately 1 km x 0.2 km in front of the MVDDS transmitting antenna; additional outages would be less than 18 minutes over the rest of the MVDDS service area. For the satellite at 119° W longitude, a DBS customer would experience additional outages of 3 hours per year in a zone approximately 1 km x 0.2 km; of 1 hour per year in a zone approximately 1.75 km x 0.4 km; and of 18 minutes per year in a zone approximately 6.2 km x 1 km. Variations occur due to differences in satellite power levels and the elevation angle of the DBS receive dish. *See* MITRE Report at Section 5 and Appendix B for all simulation results.

[118] *See* MITRE Report at 6-1.

[119] These include using low power, using a 7 megahertz frequency offset from the satellite carrier frequencies, increasing the MVDDS antenna height, and adjusting the MVDDS antenna elevation tilt angle. *See* MITRE Report at 6-2.

[120] These include using real time power control, using multiple MVDDS transmitting antenna beams, using circularly polarized transmitting antennas, and using larger receive antennas. *See* MITRE Report at 6-3.

[121] These include relocation of the DBS receive antenna, use of clip on shielding on the DBS receive antenna, replacement of the DBS receive antenna, and replacement of older DBS set-top boxes. *See* MITRE Report at 6-4.

[122] DirecTV Comments at 6-7; EchoStar at 18.

[123] DirecTV Reply Comments at Appendix C.

to 2.86% over the baseline at every DBS subscriber site,[124] rather than specify EPFD limits as was done for NGSO FSS operations.[125] Further, these parties argue that BSS should be subjected to no more than ten percent increased unavailability from all new interference sources, *i.e.*, both NGSO FSS and MVDDS. Thus, the 2.86% allowance for MVDDS would be only a portion of the ten percent allowance that, the parties argue, is the recommended ITU protection level for BSS systems from all interfering sources.[126] EchoStar contends that increased unavailability in excess of ten percent would violate the ITU's findings regarding DBS system performance and spectrum sharing expectations.[127] Consequently, these parties argue, the Commission would have to adjust the number of potential NGSO FSS systems authorized in this band because the EPFD limits adopted for those systems were based on applying the ten percent allowance only to those systems.[128]

61. DirecTV and EchoStar also propose that compliance with the 2.86% criterion would be measured by requiring that, at each MVDDS transmitting site, an EPFD limit be calculated for all DBS satellite links in view of the MVDDS transmitting antenna, including those orbital slots that are not now used for providing DBS service in the U.S.[129] Thus, the EPFD limit at each MVDDS transmitting antenna site will be the "worst case" at that location. DirecTV argues that MVDDS should protect all potential BSS orbital locations capable of United States coverage, including those, which are not now used to provide service in the United States.[130] The EPFD values would be derived by using a prescribed methodology to protect a database of identified DBS links and link budgets, current and future, which show satellite EIRP values. The EPFD value necessary to protect the weakest satellite link to the 2.86% criteria would have to be met at all DBS subscriber locations in that area. Finally, DirecTV argues that MVDDS initial deployment should be limited to one city pending further evaluation of interference to BSS and NGSO FSS.[131]

62. In contrast to DirecTV and EchoStar, Pegasus, a reseller of DBS service that also is interested in providing MVDDS, generally supports the Commission's proposal to set an interference threshold for MVDDS that is separate from the allowances provided for NGSO FSS systems. Pegasus would limit the amount of increased unavailability on a DBS subscriber to 2.86% from a single MVDDS system and to no more than ten percent from all MVDDS providers.[132] Pegasus states that, under this approach, if the

[124] Specifically, DirecTV proposes that MVDDS systems be limited to 2.86% of the time allowance for unavailability of the carrier-to-noise (C/N) value specified for operational performance objectives of the BSS network, where N is the total noise level in the noise bandwidth associated with the wanted carrier including all other non-time varying sources of interference. DirecTV also proposes that there be no loss of video picture continuity under clear sky conditions, and that the criteria be met over all habitable land. DirecTV Comments at 20-21.

[125] DirecTV Reply Comments at 20.

[126] DirecTV Comments at 7, citing Recommendation ITU-R BO.1444; EchoStar Comments at 10. All NGSO FSS systems in this band are not to cause more than a ten percent increase in unavailability to BSS networks. Single entry (per system) limits were derived based on a factor of 3.5 systems, *i.e.*, each NGSO FSS system should not contribute more than a 2.86% increase in unavailability. *See* Recommendation ITU-R BO.1444.

[127] EchoStar Comments at 15.

[128] DirecTV Comments at 20-21.

[129] *Id.* DirecTV notes that EPFD is an interference limit that can be measured in the field, and is an acceptable means to determine if the 2.86% criteria are met. *Id.* at 18-19.

[130] *Id.* at 17.

[131] *Id.* at 26-27, citing the RLSBA and the deployment of Local Multipoint Distribution Service (LMDS) as precedents.

[132] Pegasus Comments at 4-7; Pegasus Reply Comments at 5.

66. In its report, MITRE states that using a relative or percentage increase in unavailability as a measure of degradation is "attractive."[154] MITRE recognizes that although the "baseline unavailability varies dramatically depending on which satellite is used," this approach has the benefit of "reduc[ing] some of the variability that exist for other measures of interference outage time and thus the relative increase in unavailability is more attractive as a measure of degradation."[155] Further, they note, such an approach recognizes that the increase in unavailability that is noticeable to the consumer depends on the amount of outage the consumer currently experiences.[156] MITRE recommends that the MVDDS interference criterion be a ten percent relative increase in DBS unavailability rather than 2.86% because "[a]n increase of 2.86% seems very small and there is precedent for a ten percent increase ..."[157] MITRE recommends that the criterion be implemented by having the MVDDS provider calculate the C/I consistent with a ten percent increase in relative unavailability for each service area and for the DBS satellite at each longitude that has the largest baseline unavailability (limited to those with 100 hours/year unavailability or less).[158]

67. Discussion. To place this matter in perspective, it is important to bear in mind that DBS is, on the whole, extremely reliable with typical service availabilities on the order of 99.8 to 99.9 percent.[159] Thus, when availability changes even slightly (*e.g.*, from 99.9 percent to 99.8 percent), the correspondingly small change in unavailability (from 0.1 percent to 0.2 percent), can be expressed as a percentage change that appears deceivingly large (*i.e.*; a 100 percent change in unavailability). Unavailability fluctuations of this degree (and higher) are commonplace, result in higher DBS unavailability rates in some locations in the country than others, and are well tolerated by DBS subscribers in light of the overall dependability of the service.[160] The variability inherent in the DBS

[154] MITRE Report at 5 to 34.

[155] *Id.*

[156] *Id.* at 6-5 to 6-6.

[157] *Id* at 6-6.

[158] *Id.* at 6-5 to 6-7.

[159] *See* Satellite Outage Analysis Results in Appendix G, which show in all our calculations baseline service availability exceeding 99.5% from the CONUS satellites. For the thirty-two cities analyzed, the data show the following:

Satellite Location (Degrees West Longitude)	Availability		
	Mean (%)	Standard Deviation (%)	Median (%)
101	99.90	0.08	99.92
110	99.79	0.10	99.79
119	99.83	0.11	99.83

[160] This tolerance is reflected by the fact that the subscriber rates in areas experiencing the highest rates of unavailability are comparable to those in areas with the lowest such rates. *See* Comments of SBCA in CS Docket No. 01-129 (In the Matter of Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming). In Appendix A of their comments, SBCA provides state-by-state penetration rates for DBS. This data show penetration rates of 41.27% for Vermont to 1.80% for Hawaii; half of the States have penetration rates between 20 and 30 percent. From the data, it appears that the penetration rate for DBS is not sensitive to the amount of baseline outage for a particular location. Examples are provided below:

(continued....)

156.7 dBW/m^2/40 kHz in the southeastern U.S.;[143] –158.7 dBW/m^2/40 kHz in the southern U.S.;[144] – 160.5 dBW/m^2/40 kHz in the northeastern U.S.;[145] and –163.0 dBW/m^2/40 kHz in the western U.S.[146]

64. Northpoint criticizes the DBS proponents' approach of requiring compliance with a limitation on increased BSS unavailability as unrealistic because of the wide variability in DBS reliability across the country due to natural propagation characteristics and DBS system changes.[147] They contend that because there is not a database of baseline availability at each customer location and rain rates (the major contributor to DBS outages) may vary by up to thirty percent from year to year, there is no way to calculate compliance with a percentage based criterion.[148] Furthermore, they state that under the proposed percentage based criterion, outages due to terrestrial operations would be essentially undetectable and cannot be measured with the degree of accuracy needed to enforce the regulations.

65. DirecTV disagrees with Northpoint's suggested method for deriving and for applying EPFD limits. DirecTV states that using an assumed 20 dB C/I as the basis for calculating EPFD limits is insufficient to protect DBS because it does not account for variations in satellite EIRP values and link parameters from subscriber to subscriber across the country for a given DBS operator. Further, DirecTV argues that Northpoint's suggested EPFD limits will not provide adequate protection to DBS because they are calculated over a limited set of DBS links and do not take into account variations in satellite EIRP across the Earth's surface, future DBS links, and different DBS customer antennas.[149] DirecTV also argues that, because Northpoint suggests using regional EPFD limits, the suggested EPFD values do not reflect the 20 dB C/I criteria[150] and DBS link unavailability would increase by more than 2.86%.[151] They also suggest that regional EPFD values would actually be more stringent for MVDDS because they would have to protect to the "worst case." Rather, DirecTV contends that EPFD limits should be calculated for each MVDDS site, and that this approach would allow MVDDS to take advantage of differences in satellite EIRP at different points on the Earth.[152] They argue that, contrary to Northpoint's assertion, the EPFD calculation for each site does not require a database of field availability measurements, does not require extreme precision, and is not unduly sensitive to changes in rain models. They contend that Northpoint ignores the record on the use of predictive modeling of DBS availability calculations in order to establish protection criteria.[153]

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[143] Northpoint defines the southeastern region to include Florida, Georgia, Alabama, Mississippi, and Louisiana. In satellite applications, measurements are generally referenced to a 4 kHz bandwidth, rather than the 40 kHz used by Northpoint. The equivalent EPFD for this region based on a 4 kHz bandwidth is -166.7 dBW/m^2/4 kHz.

[144] Northpoint defines the southern region to include New Mexico, Texas, Oklahoma, Arkansas, Tennessee, South Carolina, and North Carolina. The equivalent EPFD for this region based on a 4 kHz bandwidth is -168.7 dBW/m^2/4 kHz.

[145] Northpoint defines the northeastern region as bounded by and inclusive of North Dakota, Kansas, Virginia, and Maine. The equivalent EPFD for this region based on a 4 kHz bandwidth is –170.5 dBW/m^2/4 kHz.

[146] Northpoint defines the western region as bounded by and inclusive of California, Arizona, Colorado, Montana, and Washington. The equivalent EPFD for this region based on a 4 kHz bandwidth is –173.0 dBW/m^2/4 kHz.

[147] Northpoint Comments at 34.

[148] *Id.*

[149] DirecTV Reply Comments at 19.

[150] *Id.* at 12-13.

[151] DirecTV Comments at 27. DirecTV argues that the 20 dB C/I would result in a 37% increase in unavailability in Washington, DC and a 16.6% increase in Seattle, WA. DirecTV Reply Comments at 11.

[152] DirecTV Reply Comments at Appendix C.

[153] *Id.* at 10.

- We will require the MVDDS operator to ensure that the prescribed EPFD limits are not exceeded at any DBS customer of record location. If the EPFD limits are exceeded, the MVDDS operator would be required to discontinue service until such time that the limits can be met.

- We adopt an EPFD "safety valve" so that if, due to an anomalous situation, a DBS provider can demonstrate a tangible detrimental impact on DBS caused by MVDDS operations, we will consider adjustments to the EPFD limit for that specific location.

69. We conclude that specifying EPFD limits that define the impact of MVDDS on DBS subscribers is the most reasonable approach for several reasons. First, EPFD is a measure of the amount of signal power from a terrestrial transmitter that is detected by the DBS receiver and thus, capable of causing interference. As such, it directly measures the effect of the terrestrial station on the DBS receiver. Second, an EPFD limit can be measured and enforced. Third, calculating and measuring EPFD is simpler than other approaches, such as compliance with a C/I ratio, as the majority of the parties recognize. To calculate EPFD, one only needs to know the parameters of the terrestrial station (*e.g.*, power, antenna height, and antenna gain pattern) and its relative position to the DBS receive antenna in question; information regarding the satellite signal strength at each DBS receive antenna is not relevant to the calculation. Under a C/I approach, one also needs information regarding the specific satellite to which the DBS receive antenna is pointing (*e.g.*, power of the DBS signal in the direction of the DBS receive antenna).[164] Finally, we note that an EPFD limit is consistent with the approach used for limiting interference from NGSO FSS to DBS operations in this same frequency band.

70. We do not believe that it would be practical to require MVDDS operators to demonstrate compliance with a percentage criterion *per se*, as suggested by DirecTV and EchoStar. It would be very difficult to measure compliance of a percentage increase over a baseline with sufficient accuracy to enforce such a regulation.[165] Further, the DBS entities themselves recognize that an EPFD value is a reasonable metric to use for measurements in the field. Nonetheless, we find merit in using a percentage criterion as we develop appropriate EPFD limits. As MITRE noted, "the increase in unavailability that is noticeable to the consumer depends on what the consumer is used to."[166]

71. As a starting point, we applied the very conservative technical parameters and assumptions described below to derive EPFD values that would limit unavailability to a 10 percent increase for representative DBS receive antenna locations across the country and for several DBS satellites currently in service. More specifically, we began our analysis with 32 sample cities and for each of the DBS satellites at 101°, 110°, and 119°.[167] The EPFD values for each location were then averaged. The data show four distinct regions where the EPFD values had little variance. The EPFD values for locations within each region were then averaged, resulting in four regional EPFD limits. We determined that, consistent with sound engineering and effective regulatory practice, the four regional EPFD limits we adopt here will ensure that an MVDDS signal will only result in a small increase in the DBS service outages that occur during heavy precipitation, *e.g.*, the onset of a rain outage may begin sooner or a rain

[164] EPFD and C/I are directly related. For a given satellite link the C/I is the difference between the satellite PFD and MVDDS EPFD.

[165] The actual percentage increase in unavailability can only be determined after the specified time period elapses and then only if each outage can be attributed to either natural phenomena (*e.g.*, rain fade, solar outage) or the presence of an MVDDS signal. For example, if the criterion is that MVDDS can cause no more than an increase in outage of 2.86% per year, then outages must be monitored for an entire year and the cause of each determined. From that data, the baseline outage due to natural phenomena and the increase due to MVDDS can be determined.

[166] MITRE Report at 6-6.

[167] *See* Appendix G.

service is due to many factors, including satellite orbital location, satellite power, rain rate, and receiver location. Of these, the principal contributor to DBS service outages is rain.

68. The introduction of MVDDS will constitute another factor that will likely affect DBS availability to some degree. We have previously determined, however, that this factor can be controlled to a sufficient degree so that any interference with DBS service will be minimized to permissible levels. After careful consideration of the extensive record in this proceeding and our own analysis, we are adopting technical requirements that strike the appropriate balance between protecting DBS customers from interference, minimizing the impact on DBS operators' ability to make adjustments to their networks,[161] and not unduly constraining the deployment of MVDDS. We believe that these technical requirements will limit the overall impact of MVDDS on DBS operations and will ensure that the presence of an MVDDS signal would not be perceptible to the DBS customer in most cases.[162] Of primary importance, these technical requirements will ensure that any interference caused to DBS customers will not exceed a level that is considered permissible. We are taking the following steps to achieve these results:

- We used a prescribed methodology and a predictive model to calculate EPFD values, based on a criterion that would limit the amount of increased BSS unavailability to a negligible level over a baseline level of BSS unavailability due to the presence of MVDDS. The unavailability allowance ascribed to MVDDS is in addition to the unavailability allowance ascribed to NGSO FSS operations in the 12.2-12.7 GHz band.

- We are specifying an EPFD limit for each of four regions across the United States. The regions and corresponding EPFD limits are: East: -168.4 dBW/m^2/4kHz, Midwest: -169.8 dBW/m^2/4kHz, Southwest: -171.0 dBW/m^2/4kHz, and Northwest: -172.1 dBW/m^2/4kHz.

- The EPFD limits we adopt, in conjunction with a maximum MVDDS power limit of 14 dBm per 24 megahertz EIRP[163] will ensure that the DBS service is protected from harmful interference.

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State/City	State Penetration Rate (%)	Baseline Outage Per Satellite (Minutes/Year)		
		101° W.L.	110° W.L.	119° W.L.
Colorado	21.78			
Denver		148	156	71
Washington	17.12			
Seattle		741	689	828
Florida	17.85			
Miami		1720	1930	2614
Tampa		1427	1598	2142
Orlando		1480	1668	2255
Texas	24.88			
Houston		1040	2476	1380
Dallas		820	2016	1099

[161] *See* para. 76, *infra* for discussion regarding the impact on DBS networks.

[162] The presence of an MVDDS signal could be detected under some circumstances even under the relatively strict limits we are adopting. For example, in certain rain events, the DBS signal from the satellite could be faded significantly while the terrestrial MVDDS signal is not, which could cause a rain induced DBS outage to last slightly longer than it would have if MVDDS were not present.

[163] *See* para. 196, *infra*.

calculate outage results is inconsequential, so long as the methodology is correct.[173] The model used follows the methodology laid out in the relevant ITU recommendations, and our results are consistent with those of the parties.[174]

75. The parties' primary differences concern the various input assumptions used in the analytic models. These include the unavailability criterion, threshold value of DBS signal quality, rain model, and DBS orbital locations to be protected. These issues are discussed in detail below.

76. At the outset, we conclude that the appropriate criterion on which to base EPFD levels is increased DBS unavailability expressed as a percentage of the baseline unavailability, and that this increase in unavailability would be in addition to the unavailability allowance relied upon for developing NGSO FSS limits. We believe that using a percentage increase in baseline unavailability as the criterion in developing EPFD limits has several advantages over a criterion based on a fixed C/I, as suggested by Northpoint. It allows entry of MVDDS while minimizing the impact to current DBS operations. DBS licensees currently apportion the satellite's resources to different customer locations based on a variety of factors such as DBS receive antenna elevation angles, average yearly rain rates in different regions of the country, and the amount of programming being made available to different markets. The results of these decisions can be seen when examining the link budgets for various cities. For example, the satellite transmit power or EIRP towards Washington, DC from DirecTV's satellite located at 101° W longitude is 55.8 dBW, but only 51.8 dBW towards Seattle, WA.[175] By adjusting these link budgets, DBS providers can adjust the amount of outage customers experience due to rain. A percentage based criterion generally preserves the current relationship between different areas with regard to their relative DBS service levels, *i.e.*, the outages in any given area will increase by different amounts, but the increase will be less in areas that currently experience less outage than in areas that currently experience more outage.[176] If a constant C/I criterion were used, the relationship between the relative level of outage between locations would not be preserved. Thus, DBS licensees would have to modify their current link budgets to maintain the current relationship of relative outage times between areas. Further, as new entrants, MVDDS providers can vary their system design and deployment (*e.g.*, antenna type, tower height) to "design around" the characteristics of already deployed satellites. Therefore, we adopt a percentage based approach because it provides maximum protection to incumbent DBS licensees by allowing them to maintain their current business practices while still providing for new MVDDS service.

77. We also conclude that our decision to adopt a percentage increase in unavailability as a criteria for developing EPFD limits for MVDDS, in addition to the unavailability allowance relied upon for developing NGSO FSS limits, strikes an appropriate balance among the three services that will share this frequency band. Initially, as discussed in the *MO&O* portion of this document, we reject DirecTV's and EchoStar's argument that the ITU findings in ITU-R Rec. BO.1444, which set forth sharing

[173] For example, Northpoint and DirecTV use a spreadsheet for their computations. However, inputs to that spreadsheet come from the computational methods of ITU-R Recommendation P.618. *See, e.g.*, DirecTV Comments at Appendix I, Table A, Lines 42 and 47. Under that approach, separate calculations would be needed to determine the necessary inputs. The Commission's Mathcad model combines all the calculations into one self-contained module, which incorporates the same methodology as DirecTV and Northpoint, but also incorporates the computations of the ITU Recommendation. A description of the Commission's model is provided in Appendix J.

[174] *See* Appendix G for analysis results.

[175] DirecTV Comments at Appendix I.

[176] For example, a DBS customer in Denver, CO viewing the satellite at 101° W longitude currently experiences an average outage of 148.6 minutes per year and a DBS customer in Washington, DC viewing the same satellite currently experiences an average yearly outage of 220.0 minutes per year. With an increase in unavailability due to MVDDS of approximately ten percent, these customers would experience average outage increases of 14.9 and 22.0 minutes per year for Denver and Washington, respectively.

outage may last somewhat longer. These outage increases are significantly less than the seasonal or yearly variability in DBS outages customers currently experience due to the variability in actual rainfall rates. We believe the increased unavailability will not be perceptible to DBS customers in most cases and, in any event, do not rise to the level of harmful interference.

72. In adopting these EPFD limits, we find that an increase of ten percent over current DBS unavailability is the appropriate starting point for our analysis but need not be a strict limit. The ten percent benchmark represents an insubstantial amount of increased unavailability and does not approach a level that could be considered harmful interference. Our EPFD limits result in increased unavailability of approximately ten percent -- in some instances it is greater than ten percent of current unavailability, while in others it is less than ten percent. Taking into account the overly conservative assumptions used in our modeling, the reality that DBS outage rates vary widely around the country and from season to season, and the fact that outages occur at all times of the day – *i.e.*, not just when subscribers are watching DBS, we find that the additional service outage that may result here over and above the 10 percent starting point falls within the permissible level. As noted above, we believe that our MVDDS technical requirements create an appropriate balance – protecting DBS customers from harmful interference, minimizing the impact on DBS operators' ability to make future adjustments to their network, and not unduly constraining the deployment of MVDDS.

73. In response to the comments, we note as an initial matter that the parties suggest two different approaches for implementing the MVDDS interference criteria. The DBS entities suggest that the MVDDS operator calculate the EPFD limits for each DBS link within view of the area served at each terrestrial transmitting location, while Northpoint argues that specific EPFD limits should be applied to any MVDDS transmitter within defined regions. To understand the implications of these approaches, we conducted our own analysis of EPFD levels using the top 32 television markets. These particular cities were chosen because they represent population, geographic and climatic diversity across the United States. We used two analytical models to evaluate EPFD limits: one model calculates the baseline unavailability of a DBS system for a given location and the increased outage due to the presence of an MVDDS system; the other model calculates the contour within which the specified EPFD may potentially be exceeded.[168] This methodology is generally the same as those used by DirecTV,[169] MITRE, and the Commission in its *Further Notice*.[170]

74. As a threshold matter, we note that Northpoint objects to the Commission's use of a Mathcad program for the analytical model to calculate DBS outage time, claiming that the program itself produces inaccurate results.[171] In addition, DirecTV and Northpoint observe that MITRE, which used a MATLAB program for its analytic model, did not make the program available; thus, no party has been able to check whether the system measurements were used correctly in the model.[172] Because MITRE did not make its program available, we continued to develop and use our own model for analysis and to confirm the modeling results of the parties. Contrary to Northpoint's assertion, we believe that the software used to

[168] *See* Appendices E and J, respectively.

[169] *See* DirecTV Comments at Appendix I.

[170] *See Further Notice*, 16 FCC Rcd at Appendix H and MITRE Report at Section 2. MITRE's model differed from the Commission's in that it added a value for cross polarization isolation and a reference DBS antenna horizontal gain pattern. Those patterns are accounted for in the model used for this analysis. *See* Appendix J for detailed information on the model.

[171] Northpoint Comments at Appendix 2, pp. 17-24.

[172] DirecTV Reply Comments on the MITRE Report at 19; Northpoint Reply Comments on MITRE Report at Technical Appendix, p. 4 (argues that because the program code was not made available publicly, the Commission cannot rely on the MITRE estimates of unavailability or impact).

additional unavailability that may be attributed to MVDDS is only a marginal increase over the variability that already exists within this satellite service. In making this determination, we also take into account the very conservative parameters and assumptions used in our modeling. For example, as discussed below, we use a conservative performance threshold value of DBS signal performance to calculate the EPFD. In addition, we do not believe that the effect of NGSO FSS and MVDDS operations on DBS unavailability will be directly cumulative (*i.e.*, the total DBS unavailability will actually be less than the sum of the individual increases in unavailability caused by the NGSO FSS systems and an MVDDS system). We base this finding on our analysis, which (for computational simplicity) evaluated the effects of NGSO FSS and MVDDS independently. However, in some cases, the interference events caused by MVDDS and NGSO FSS signals will coincide. Thus, our assumption of independence overstates the actual outage to DBS, *i.e.*, our analysis calculated outage time due to MVDDS and NGSO FSS separately, but did not compute the amount of time the outages would occur simultaneously. Finally, our analysis assumed worst case operating conditions – a rain faded DBS signal and a full strength MVDDS signal. In practice rain will generally affect both the MVDDS and the DBS signals in an area. Because, in many cases, a faded MVDDS signal would be received by the DBS system, the total increase in DBS unavailability due to MVDDS will be less than the amount calculated in our analysis. We believe that in this band, under these circumstances, using an increase of ten percent in DBS unavailability is the correct starting point from which to calculate EPFD limits for MVDDS. On a going forward basis, the DBS operators should take this into account in designing future satellites.

80. Another point of contention among the parties was the correct threshold value of DBS signal performance to use as an input assumption in the predictive model. Essentially, the threshold value is a measure of the audio and video signal quality.[180] DirecTV argues that it is proper to use the operating threshold[181] of the system, while Northpoint states that the freeze-frame[182] threshold is the correct value to

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Table 1

	Rain (inches/month)			
	Reno, NV		Allentown, PA	
Year	January	August	January	August
2001	0.18	0.00	2.37	2.50
2000	2.14	0.79	1.99	5.22
1999	0.76	0.82	5.44	3.81
1998	1.10	0.00	3.42	3.12
1997	3.32	0.00	3.38	5.12
1996	1.33	0.16	7.32	0.91
1995	3.31	0.00	3.49	0.76
1994	0.06	0.00	5.69	6.18
1993	2.42	0.00	1.98	5.39
1992	0.13	0.28	1.73	4.08
1991	0.01	0.24	2.77	2.54
1990	0.62	0.21	4.57	6.47

Table 2

	Elevation (km)	Rain Rate* (mm/hr)	Baseline Outage** (min)
Denver	1.58	30.29	50.0
San Francisco	0.03	33.63	225.3
Miami	0.00	95.76	550.4

* Rain rate exceeded 0.01% of time in an average year.

** For the satellite at 101o W longitude.

[180] *See* MITRE Report at 3-12 to 3-13.

[181] The minimum signal level for GSO satellite to maintain communications is defined by an operational threshold in terms of a given carrier-to-noise ratio (C/N). The operating threshold defines the minimum C/N required for the link to achieve desired communications.

[182] When the bit error rate of the demodulated MPEG video bit stream is sufficiently high to cause the associated video MPEG decoder to cease to provide one or more pictures, the video decoder initiates error concealment techniques, such as the presentation of the last available MPEG picture (freeze frame).

parameters for DBS and NGSO FSS, limits increases in DBS unavailability from any source to ten percent and thus controls our decision in this proceeding. Furthermore, adopting this approach here would delay and unduly constrain the deployment of new NGSO FSS systems. In order to apportion some of the NGSO FSS unavailability allowance to MVDDS, we would have to revise the EPFD limits for NGSO FSS or limit the number of NGSO FSS systems in the band to less than the 3.5 factor used in developing these technical limits. These limits also have been adopted internationally because the NGSO FSS systems that plan to use this frequency band are global satellite systems, and thus, these limits also would have to be revised internationally. The EPFD limits for NGSO FSS were the result of a multi-year negotiation process among various countries, and we are not persuaded that the interests of the United States would be well served by revisiting these agreements at this time.

78. In the *Further Notice* the Commission sought comment on the different criteria that could be used to develop MVDDS technical limits, including a percentage increase in DBS unavailability, such as 2.86%, ten percent or any other percentage, or a fixed amount of minutes increase in DBS unavailability.[177] This percentage of time criteria must be considered in conjunction with all other operating parameters of the DBS and MVDDS systems (*e.g.*, DBS performance threshold,[178] satellite location and EIRP, MVDDS power, transmit and receive antennas, etc.) to calculate the EPFD necessary to protect DBS subscribers against impermissible interference. The DBS proponents wanted the increase in unavailability to be limited to 2.86% because the 2.86% allowance for MVDDS would be only a portion of the ten percent allowance that, the parties argue, is the recommended ITU protection level for BSS systems from all interfering sources. We now conclude, based on further analysis of these issues by Commission staff and the independent analysis performed by MITRE, that calculating MVDDS EPFD limits that allow additional increased unavailability in the range of ten percent ensures DBS of protection from harmful interference while creating an opportunity to deploy MVDDS.

79. Based on our analysis, we conclude that the EPFD limits we adopt here result in relatively modest increases in outage times that should not be readily perceptible to DBS customers. We observe that the increase in unavailability due to this potential interference is much less than the seasonal, yearly, and city-to-city variability that already exists in the unavailability within the DBS service.[179] Thus, the

[177] *See Further Notice,* 16 FCC Rcd at 4196-97 ¶¶ 268-270.

[178] The performance threshold is used to define when an outage occurs, as discussed in para. 79, *infra*.

[179] Although DBS licensees attempt to equalize service levels across various areas of the country, differences in geography and climactic conditions limit the ability to achieve this goal. Variations exist on a city-to-city basis due to a combination of these factors. In addition, variations exist within cities due to seasonal and yearly variations in the amount of rain. This is shown in the following tables. The first table shows the variation in the amount of rain for January and August for Reno, NV and Allentown, PA over a 12 year period (1990-2001) (Source: National Climatic Data Center http://lwf.ncdc.noaa.gov/oa/climate/research/cag3/city.html). The second table shows the variation in baseline outage time due to differences in geography (elevation above mean sea level) and rain rate. Note: some of the variation of the second table can also be attributed to differences in the elevation angle of the DBS receive antenna.

(continued....)

acceptable picture to a DBS customer.[195] Finally, we agree with commenters who argue that the freeze-frame threshold is not an appropriate measure because when the signal level is reduced to this level, picture and audio performance are already degraded to levels where DBS customers will notice the degradation. Consequently, neither the VQ6 nor the freeze frame thresholds satisfy our objective to identify a level of interference that would be imperceptible to a DBS customer.

81. As stated earlier, the primary cause of degradation to DBS signals is due to heavy rain. Thus, any analysis is dependent on the method used to model rain effects in different geographic locations. To assist administrations, the ITU has developed a series of recommendations to model long-term rain statistics, ITU-R Rec. P.618.[196] Since the original recommendation, more data has been collected and modeling methods have improved. Taking advantage of this, the ITU has adopted several revisions, with the current version referenced as ITU-R Rec. P.618-7. We note that for the DBS/NGSO FSS sharing studies, DirecTV submitted representative links which specified ITU-R Rec. P.618-5 as the relevant rain model; there is no similar indication of which rain model EchoStar recommended. DirecTV provides examples using the same version of the rain model, ITU-R Rec. P.618-5, for their analysis of the effects of MVDDS on DBS service.[197] However, they state that ITU-R Rec. P.618-6 could also be used.[198] Northpoint argues that the more recent ITU-R Rec. P.618-6 should be used. We agree. The change from version 5 to 6 was a major revision of the model. In version 5, the earth was divided into rain regions with a value for rain rate attributed to each region. Version 6, in contrast, relies on more data and incorporates a multi-dimensional interpolation to calculate a rain rate for any geographical location. As a result of the additional data and increased sophistication of the version 6 model, we believe that it provides more accurate results than previous versions. Thus, we have used it in our analysis. Finally, we note in February 2001, the ITU adopted an update to the rain model, ITU-R Rec. P.618-7. We believe that the changes in the newer version are minor in nature and would not affect the outcome of our analysis.[199]

82. Another parameter central to the analysis of MVDDS/DBS sharing is the inclusion or exclusion of the various satellites in use. Currently, the United States has eight orbital slots for DBS service. Nominally, these are 61.5°, 101°, 110°, 119°, 148°, 157°, 166°, and 175° west longitude.[200] Of

[195] *See* MITRE Report at A-9.

[196] The ITU Recommendation P.618 is titled, "Propagation Data and Prediction Methods Required for the Design of Earth-Space Telecommunication Systems."

[197] DirecTV Comments at Appendix I, page 2.

[198] *Id.*

[199] These changes include the removal of a step-by-step procedure for calculating gaseous attenuation and a removal of some information included with the section on estimating total attenuation due to multiple sources of simultaneously occurring atmospheric attenuation. In both instances, the updated recommendation references the methods of ITU Rec. P.676.

[200] Actual transponder usage at each orbital location is shown in the table below:

(continued....)

use.[183] As an alternative, MITRE established a 9-level video/audio criterion to measure signal quality.[184] Based on their analysis, MITRE recommends basing the threshold value at signal level 6 (or video quality 6 (VQ6), less than one error per 15 seconds, but more than one error per minute).[185] EchoStar disagrees with MITRE's approach, claiming that this factor is arbitrary and much less severe than the level of performance they guarantee their customers. Instead of VQ6, they argue that the threshold should be set to a level equivalent to quasi-error free (QEF) performance (1 uncorrectable error per hour). They state that this is the level of performance they guarantee to their customers.[186] Northpoint, in contrast, argues that the VQ6 standard is too strict. They state that a certain amount of pixelation of the video image will occur due to incompatibility between the video compression rate and the channel bandwidth.[187] Therefore, they argue, the DBS link is available even below these levels and a less stringent threshold can be used.[188] After consideration of this matter, we conclude that the operational or QEF threshold is the appropriate value to use as an input assumption in the predictive model.[189] The QEF value represents an audio/video signal that appears essentially error-free to the DBS customer; errors that occur in transmission can be corrected using forward error correction[190] at the DBS customer's decoder. Because one of our primary objectives here is to identify a level of interference from MVDDS that would be essentially imperceptible to a DBS customer, using the highest threshold value in the predictive model is closer to calculating the worst case impact on DBS signal quality. We note however, that the QEF threshold values used in our analysis are, in general, stricter than the threshold values that the DBS entities submitted to the ITU for use in developing EPFD limits for DBS/NGSO FSS sharing. For that analysis, EchoStar assumed an operating threshold of 6.1 dB for all links and DirecTV assumed threshold values of 5 dB or 7.6 dB.[191] In addition, in their comments, DirecTV suggests using threshold values of 5.5 dB and 7.6 dB.[192] Although these values closely correlate with the VQ6 value used by MITRE,[193] we do not believe that the VQ6 value is appropriate to use in our analysis. MITRE devised its own scale to meet specific objectives of its testing environment[194] and stated that the VQ6 level may not represent an

[183] *See* DirecTV Comments at 20-21 and Appendix I; Northpoint Comments at Technical Appendix, Page 19.

[184] *See* MITRE Report at 3-13.

[185] *Id.* at 3-12 to 3-13 and 6-5.

[186] *See* EchoStar Comments to MITRE Report at 11.

[187] *See* Northpoint Comments to MITRE Report at Technical Appendix, Page 8.

[188] *Id.* at 10-11.

[189] QEF threshold values of 8.1 dB and 8.4 dB are used for EchoStar and DirecTV's systems, respectively. *See* MITRE Report at 3-18.

[190] Forward error correction (FEC) is a technique used for data transmission wherein the receiving device has the capability to detect and correct any character or code block that contains fewer than a predetermined number of symbols in error. FEC is accomplished by adding bits to each transmitted character or code block, using a predetermined algorithm.

[191] *See* ITU-R Recommendation BO.1444, Annex 1. The database of representative links is available on the ITU's website at http://www.itu.int//itudoc/itu-r/sg11/docs/sg11/1998-00/contrib/138e2.html. With respect to the threshold values used by DirecTV, we note that 5 dB is used for weaker transponders and 7.6 is used for stronger transponders. Also, in two cases DirecTV assumed a threshold value of 11 dB.

[192] These are the threshold values used in their example calculations for Washington, DC and Seattle, WA. *See* DirecTV Comments at Appendix I.

[193] For DirecTV, MITRE uses a VQ6 threshold of 7.3 dB which is approximately the same as DirecTV's 7.6 dB threshold and more stringent than their 5.5 dB threshold.

[194] MITRE chose the VQ6 threshold because it was mid-range in the span over which signal degradation could actually be observed repeatedly and reduced the amount of time in test execution. *See* MITRE Report at A-8.

83. Using the parameters and assumptions described above, we analyzed the top 32 television markets to determine the EPFD value for each market. As described in Appendix G, because these markets provide population, geographic, and climatic diversity, we believe they are representative of the U.S. as a whole. The results of our analysis revealed the presence of four distinct regions where calculated EPFD levels do not vary substantially and thus, the application of regional EPFD values to specific locations within each region result in acceptable variations in unavailability. These regions can be roughly described as the East, Midwest, Southwest, and Northwest and are shown in Figure 2 in Appendix G. Because of the consistent EPFD levels within each of these regions, we believe that it is appropriate to average the individual EPFDs for each market and adopt that average EPFD within each region. Specifically, we adopt the following EPFD limits for MVDDS to meet at any DBS subscriber location and for all U.S. satellites in view:[204] -168.4 dBW/m^2/4kHz in the East;[205] -169.8 dBW/m^2/4kHz in the Midwest[206]; -171.0 dBW/m^2/4kHz in the Southwest[207]; and -172.1 dBW/m^2/4kHz in the Northwest.[208] Because anomalous situations may arise at specific locations within such large regions—*e.g.*, rainfall at a location may deviate significantly from the rain model—we will consider requests by DBS providers to adjust the EPFD limit for a specific location within a region where they can demonstrate a tangible detrimental impact on DBS caused by MVDDS operations. This EPFD "safety valve" should ensure that DBS operations are fully protected throughout a region.

84. Although an approach based on averaging affects each market and satellite combination differently (*i.e.*, the effect on better performing satellites in a market is minimized, while the effect on poorer performing satellites is increased), these effects are relatively minor.[209] Using the average EPFD values for each region, the data show that the median increase in unavailability was 10.5% and the mean value was 11.9% for the total 32-city sample.[210] We find these results to be well within the range of ten

[204] The EPFD limits are incorporated into the rules in 47 C.F.R. § 101.105.

[205] The Eastern region consists of the following states: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Florida.

[206] The Midwestern region consists of the following states: Ohio, Michigan, Indiana, Wisconsin, Illinois, Minnesota, Iowa, Missouri, Arkansas, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

[207] The Southwestern region consists of the following states: Wyoming, Colorado, New Mexico, Utah, Arizona, Nevada, and California (south of 37° North Latitude).

[208] The Northwestern region consists of the following states: Washington, Oregon, California (north of 37° North Latitude), Idaho, Montana, North Dakota, Alaska, and Hawaii.

[209] The calculated outage from an average EPFD will vary from ten percent. The amount of variance depends on the satellite EIRP, average rainfall in a specific location, and elevation angle of the DBS receive antenna. *See* Appendix G.

[210] *See* Appendix G. As a consequence of using an average EPFD value, many of the "difference in outage" values for the 32-city sample are above the starting basis of a 10% increase in unavailability. In many instances, this is only by a small nominal amount of a few percentages. In others, however, the differences are larger. For example, in a few instances, the increase in unavailability was on the order of 20-30%. However, the corresponding decrease in DBS service availability for these instances was only on the order of 0.05-0.08%. There are factors within DBS providers' control that affect the link budget and could result in similar increases in unavailability. These include the way available satellite power is apportioned among transponders and the amount of forward error correction being used. Less power allocated to a given transponder and less forward error correction results in a decrease in the margin and an increase in unavailability. Other factors such as actual seasonal and yearly precipitation conditions will cause much greater variations in the DBS service availability. Therefore, engineering judgment suggests that these differences are not significant and represent an acceptable range. Further, the instances where unavailability was on the order of 20-30% occurred only in the case of the satellite at 110°. This DBS satellite is scheduled to be replaced with a newer higher-powered satellite well in advance of MVDDS deployment. A higher-powered satellite will reduce service unavailability due to MVDDS. *See, e.g.*, footnote 211, *infra*. While these values are taken into account in the averaging to determine the regional EPFDs, as noted above, we conclude that they should not

(continued....)

these, only three provide full continental United States (CONUS) coverage - 101°, 110°, and 119° west longitude.[201] Taking advantage of the coverage afforded by the satellite at 101° west longitude, DirecTV uses it to provide service (core programming and local channels) to the majority of its customers. EchoStar has implemented its system differently. It generally provides core programming via its satellite at 119° west longitude and local channels via its satellite at 110° west longitude.[202] The remaining orbital locations are used for specialized programming or are not currently used at all. In considering orbital locations as part of our interference analysis, we developed as an initial step protection criterion that focused on the three CONUS slots because the vast majority of DBS programming originates from the three orbital slots and because we believed that our results would translate comparably to the other satellites. After deriving EPFD levels based on our analysis of the three satellites providing full CONUS coverage, we then applied these levels to satellites using other orbital slots and found that these EPFD levels provide a level of protection consistent with that specified for the CONUS slots. In particular, we modeled the satellites at 61.5° and 148° west longitude to ensure that the effect of our EPFD limits on outage time is generally consistent with the protection criterion from which we started. This modeling effort showed that these satellites will receive sufficient protection from MVDDS under our adopted EPFD limits.[203] Such protection is essential because Dominion operates solely from the satellite located at 61.5° west longitude and the other DBS licensees could shift programming to make heavier use of the satellites at the non-CONUS orbital locations in the future.

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Orbital Location (west longitude)	DirecTV (transponders)	EchoStar (transponders)	Dominion (transponders)	General Usage*
61.5°		30**	2***	International / Special/ Religious
101.0°	32			Basic / Premium / Sports / Local (29)
109.8°	3			Local (2)
110.0°		29		Local (34)
118.8°	11			Spanish / Local (10)
119.0°		21		Basic / Premium / Sports / National network feeds (4)
148.0°		24		International / Special
157.0°				
166.0°				
175.0°				

* This column only indicates general usage. In many cases additional types of programming are present.
** EchoStar uses 13 channels on a temporary basis pursuant to Special Temporary Authority only.
*** Dominion leases 8 transponders on the EchoStar's EchoStar III satellite and subleases 6 transponders back to EchoStar.
(x) x indicates the number of markets served. There are several channels (ABC, NBC, CBS, FOX, WB, UPN, etc.) per market.

Source:
Transponders – Satellite Broadcasting and Communications Association training materials.
Usage information – www.lyngsat.com

[201] The satellite at 61.5° has very low look angles in the northwestern U.S. and the satellites at 148°-175° are below the horizon in the eastern U.S.

[202] Under the various implementations, DirecTV subscribers can receive all programming from a single feed receive antenna while EchoStar subscribers require a dual feed receive antenna or a second single feed receive antenna to receive both core programming and local channels. *See* http://faq.dishnetwork.com/questions/85.asp?sc=%2F&cboSubCategory=0&cboCategory=0&txtSearch=local+broadcast&pg=1.

[203] *See* Appendix G.

b. DBS Mitigation

86. Background. In the *Further Notice*, the Commission proposed to hold the MVDDS operator responsible for ensuring that DBS subscribers within the mitigation zone do not suffer an impermissible level of interference due to MVDDS operations.[212] Toward that end, the Commission proposed to require MVDDS licensees to correct any impermissible interference within the mitigation zone and proposed a general plan to accomplish the correction.[213] The Commission also requested comment on alternative procedures that could be used to expeditiously resolve interference disputes between the MVDDS and DBS licensees.[214]

87. Discussion. After careful consideration of the record, we reach the following conclusions. First, we disagree with the assertions of DBS entities' that MVDDS is a secondary service.[215] As we affirm in the *MO&O* portion of this document, the BSS and Fixed services have co-primary status in the 12.2-12.7 GHz band, but the Fixed Service is required by a footnote to the Table of Frequency Allocations not to cause harmful interference to DBS.[216] Co-primary services have an obligation to ensure that interference is not caused to existing operations. This obligation includes steps that go beyond antenna siting and design and thus we do not limit this obligation solely to MVDDS licensees.[217] Second, we agree with the MITRE Report findings that techniques exist, both for the MVDDS transmitting antenna and the DBS receive antenna locations that could be used when installing new DBS receive antennas to reduce the interference impact on DBS.[218] While the parties disagree on the effectiveness of some of these techniques under certain conditions,[219] we find that a wide variety of techniques are available. In many cases, DBS receive antennas can be installed such that they will be protected by "natural" shielding from, for example, buildings or topographical features. The MITRE Report discussed several techniques, such as proper siting of the DBS receive antenna to take advantage of natural shielding, using modest additional shielding on the DBS receive antenna (*e.g.*, clip on shields), and using

[212] *See Further Notice*, 16 FCC Rcd at 4198-99 ¶¶ 272-274.

[213] *Id.* at 4199 ¶ 273.

[214] *Id.* at 4199 ¶ 276.

[215] *See* DirecTV Comments at 14; EchoStar Comments at 20; DirecTV Reply Comments at 18. EchoStar and DirecTV argue that MVDDS operations have a secondary allocation status in the frequency band, and thus MVDDS has the burden of avoiding harmful interference to the primary DBS service. They also argue that mitigation at a DBS subscriber premise should not be allowed because it would effectively render DBS a secondary service in the band.

[216] *See* 47 C.F.R. § 2.105(c) (in the Table of Frequency Allocations, the names of primary services are listed in all capitals, whereas a mix of upper and lower case characters are used for secondary services). The Fixed Service in the 12.2-12.7 GHz band is listed in all capitals. Footnote S5.490 specifically states: "In Region 2, in the band 12.2-12.7 GHz, existing and future terrestrial radiocommunication services shall not cause harmful interference to space services operating in conformity with the broadcasting-satellite Plan for Region 2 contained in Appendix S30." Although the fixed and satellite services are co-primary in the Table of Allocations, the fixed services must not cause harmful interference to the DBS assignments that have been implemented in accordance with Appendix S30 as opposed to any DBS operations that are not consistent with the Plan. We note that, in general, the DBS satellites have characteristics that require modification to the Plan assignments. These assignment modifications have to be coordinated through the Appendix S30 process with other affected assignments and accepted into the Plan before they can be protected from the existing and future fixed services. Hence, it is more efficient to implement sharing and protection guidelines between the fixed service and these modified DBS assignments as outlined herein rather than wait for the outcome of the ITU coordination process, which is not guaranteed.

[217] *See* para. 92, *infra* which discusses the obligations of both MVDDS and DBS licensees.

[218] *See* MITRE Report at 6-3 to 6-4.

[219] *See, e.g.* EchoStar MITRE Report Comments at 4.

percent, and we conclude that they constitute permissible interference. We find further that many benefits are inherent in a regional approach that outweigh the drawbacks of separately calculating an EPFD for each market. By specifying an EPFD level in our rules, a separate calculation is not needed for each transmitting location, which provides a simple regulatory framework for our licensees. Thus, all parties know *apriori* the sharing environment that exists in each market. Further, by specifying EPFD levels in the rules, DBS licensees reap all the benefits of upgrading their system. For example, because the EPFD levels we are adopting are based on the current state of the DBS system, the performance of newer, more powerful satellites will decrease the potential outages to DBS customers. However, if a separate calculation were required for each transmitting antenna, the EPFD levels calculated in regions served by more powerful satellites would be higher than those we are specifying and allow MVDDS to operate with higher powers. Under our approach, therefore, the potential DBS outage minutes for each market would decrease as newer, higher powered satellites are implemented.[211] Finally, we note that this approach is similar to the approach adopted for NGSO FSS/DBS sharing which set specific EPFD levels that must be met.

85. In sum, we believe that the approach to technical sharing of MVDDS with DBS as outlined above strikes a reasonable balance between protecting incumbent licensees and their subscribers and providing sufficient flexibility for new service providers to deploy. These new services will provide opportunities for licensees to enhance the video and data services enjoyed by the public. Finally, in making these new services available, our analysis shows that under the parameters we specify, additional outages to DBS customers will be limited to levels which we believe will be imperceptible to the consumer in most cases, and in any event, at permissible levels. Nonetheless, as described above, if due to an anomalous situation, a DBS provider can demonstrate a tangible detrimental impact on DBS caused by MVDDS operations, we will consider adjustments to the EPFD limit for that specific location.

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predominate in the determination of the EPFDs given the scheduled satellite upgrade and the fact that even a 20-30% increase in predicted unavailability (under our conservative model) should be considered permissible.

[211] For example, we calculated a baseline outage of 1331.7 minutes per year in Atlanta when viewing the satellite at 119° west longitude. On February 21, 2002, EchoStar launched a new satellite, EchoStar 7, to this orbital location. This satellite is more powerful than the previous satellite at 119° west longitude and will also use spot beams to many markets. In Atlanta, this translates to a reduction in baseline outage to 645.9 minutes per year for the general DBS signal and to 156.5 minutes per year for those channels that are transmitted using the spot beam. *See* Application of EchoStar Satellite Corporation for Minor Modification of DBS Authorization, Launch and Operating Authority for EchoStar 7, File Nos. SAT-MOD-20010810-00071 & SAT-A/O-20010810-00073, (August 10, 2001). As shown in the table below, a corresponding decrease in the outages caused by MVDDS would also be seen:

Atlanta, GA								
Satellite	Baseline Outage	Baseline Outage plus 10% Increase	EPFD For 10% Increase	FCC Adopted EPFD	Outage With FCC EPFD	Outage Increase		Difference Between Calculated And FCC EPFDs
	(minutes)	(minutes)	(dBW/m^2/4 kHz)		(minutes)	%	(minutes)	DB
Previous	1331.7	1464.87	-169.4	-168.4	1510	13.4	178.3	0.96
Echo7 (General)	645.9	710.49	-166.5	-168.4	686.4	6.3	40.5	-1.9
Echo 7 (Spot)	156.5	172.15	-160.3	-168.4	158.7	1.4	2.2	-8.1

the EPFD contour model developed by the Commission.[223] For example, the model can be used to develop a family of contours based on the planned height of the transmit antenna, a variety of DBS receive antenna models and heights, and each satellite in view at that location.[224] Using those contours along with knowledge of local terrain and building characteristics and the survey results, an MVDDS licensee could make a determination of whether its signal levels will exceed the EPFD limit at a specific DBS customer site.[225] For example, if a DBS receive antenna is within the zone predicted by the model where the EPFD level might be exceeded, but that antenna is mounted on the back of a structure facing away from the MVDDS transmitting antenna site such that the MVDDS signal would be blocked from the DBS antenna, the MVDDS licensee could make a determination that its signal level at that antenna would comply with the rules. If the MVDDS licensee determines that its signal level will exceed the EPFD limit at any existing DBS customer site, the licensee must take whatever steps are necessary, up to and including finding a new transmitting site, to ensure that the EPFD limit would not be exceeded at any existing DBS customer location.

92. We will require the MVDDS operator to provide to the DBS licensees at least 90 days prior to the planned date of commencement of operations of each transmitting antenna, the proposed location (including coordinates), maximum EIRP of each transmitting antenna system, antenna height above ground, antenna type along with main beam azimuth and altitude orientation and description of the antenna radiation pattern, and the survey results, including a description of how compliance with the appropriate EPFD level was determined at DBS customer of record locations. No later than forty-five days after receipt of the MVDDS system information, the DBS licensee(s) will provide the MVDDS licensee with a list of any new DBS customer locations that have been installed in the 30-day period following the MVDDS site notification. In addition, the DBS licensee(s) could indicate agreement with the MVDDS licensee's technical assessment, or identify DBS customer locations that the MVDDS licensee failed to consider or DBS customer locations where they believe the MVDDS licensee erred in its analysis and could exceed the prescribed EPFD limit. We believe that this 90-day period will provide sufficient time for the DBS licensees to adjust their installation guidelines for future DBS customers to account for the presence of the MVDDS transmitting antenna. After the DBS licensees are informed of a potential MVDDS site, the DBS licensee will have the responsibility of ensuring that all DBS receive antennas installed more than 30 days after such notification are located in such a way as to avoid interference from MVDDS. As noted above, the power limit we adopt here allows for the introduction of new DBS customers in close proximity to MVDDS transmitters. We believe that DBS licensees can take modest measures, *e.g.*, siting and shielding steps or use of a larger antenna, to account for the presence of an MVDDS signal. Because such steps are simple, effective, and consistent with existing DBS installation practices, we believe it is reasonable to expect DBS licensees to incorporate the presence of an MVDDS signal into their installation guidelines.[226] We conclude, therefore, that MVDDS licensees

[223] *See* Appendix J for a detailed model description.

[224] We note that the determination of MVDDS EPFD at a DBS subscriber location is dependent on many factors, including the location of the MVDDS transmitter, transmit and receive antenna gain patterns, MVDDS EIRP, and the relative height between the MVDDS transmitting antenna and the DBS receive antenna.

[225] While conducting its survey of the local area around a proposed transmit site, the MVDDS licensee may determine that its signal level would comply with the EPFD limit at all existing DBS customer locations; or it may determine that the EPFD limit would be exceeded at certain DBS customer locations.

[226] The Commission elsewhere requires primary users to incorporate protective measures, up to and including antenna replacement, to avoid receiving harmful interference. *See, e.g.*, 47 C.F.R. § 74.937(a) ("Should interference occur and it can be demonstrated that the existing [primary ITFS] receiving antenna is inadequate, a more suitable antenna should be installed. In such cases, installation of the new receiving antenna will be the responsibility of the [ITFS] system operator serving the receive site."); 47 C.F.R. § 101.115(d) ("The Commission shall require the replacement of any [primary Fixed microwave directional] antenna ... that does not meet performance Standard A ... at the expense of the licensee operating such antenna, upon a showing that said antenna [is likely to] receive interference from ... any other authorized antenna or applied for station whereas a higher performance antenna is not

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larger or better performing DBS receive antennas as reasonable measures to consider.[220] The acceptability of any given technique can be determined, by the installer, on a case-by-case basis.

88. When an MVDDS operator enters a market where there are existing DBS customers, the MVDDS operator must satisfy certain requirements that will provide protection to these customers. First, the MVDDS operator must site and design its transmitting system to avoid causing harmful interference to existing DBS subscribers. In this context, the MVDDS operator must site and design its transmitting system to ensure that an MVDDS signal does not seriously degrade, obstruct, or repeatedly interrupt the DBS signal under clear sky conditions. If harmful interference to an existing DBS subscriber occurs, the MVDDS operator must immediately take corrective action or cease operation until it corrects the problem. Second, the MVDDS transmitting system power must not exceed 14 dBm per 24 MHz EIRP. We believe that this power limit reduces the likelihood that MVDDS operations would significantly degrade DBS service to both existing and new DBS customers. We also believe that this power limit will not inhibit the introduction of new DBS customers in close proximity to the MVDDS transmitting system, *i.e.*, later-installed DBS receive antennas can be properly sited and shielded from the MVDDS signal.

89. Finally, with respect to the performance of mitigation, we decline to adopt rules that require an MVDDS licensee to perform mitigation at existing DBS locations within a mitigation zone. Instead, we adopt an approach in which MVDDS licensees must ensure that the adopted EPFD is not exceeded at any DBS customer of record[221] location. We believe that this approach offers a reasonable compromise between the positions of the parties and strikes a balance among several factors including the impact on DBS customers and the effect on DBS and MVDDS deployment. As detailed below, the procedures we adopt streamline the regulatory process and reduce the need for ongoing interactions between DBS and MVDDS providers.

90. We will require the MVDDS licensee to ensure that the EPFD at all existing DBS subscriber locations is at or below the values adopted herein or to turn off the transmitter(s) which are causing the excessive EPFD levels. MVDDS cannot resume until such time that the specified EPFD levels can be met. This approach addresses many of the concerns raised by DBS entities. First, it provides a strong incentive to the MVDDS licensee to site and design its system in such a way that existing DBS subscribers are not affected. Second, neither party would have a mandate under the rules to approach DBS customers to offer mitigation. However, we note that our rules do not preclude private parties (including MVDDS licensees and DBS subscribers) from entering into arrangements agreed to by both parties. Finally, because MVDDS licensees have total control of their system design (*e.g.*, through reduced power levels or re-siting of the MVDDS transmitting antenna) under this approach, they can predict system costs to meet the EPFD limits and factor such expenses into their bidding strategies during the auction process.

91. As mentioned above, MVDDS licensees will be required to ensure that the EPFD levels are met at all DBS customer of record locations.[222] Under the rules we adopt, MVDDS licensees must conduct a survey of the area around their proposed transmitting antenna site to determine the location of all DBS customers who may potentially be affected by the introduction of MVDDS service. The MVDDS licensee will assess whether the signal levels from its system, under its deployment plans, would exceed the adopted EPFD levels. To assist in making this determination, the MVDDS provider can use

[220] *See* MITRE Report at 6-4.

[221] DBS customers of record are those who had their DBS receive antennas installed prior to or within the 30 day period after notification to the DBS operator by the MVDDS licensee of the proposed MVDDS transmitting antenna site. *See* para. 92, *infra*. for a discussion of the notification requirement.

[222] We note that this is analogous to the approach we adopt for NGSO FSS/MVDDS sharing where we require that an MVDDS operator meet a PFD limit at all locations 3 km from its transmitting facility. *See* para. 112, *infra*.

The Commission also proposed to protect MVDDS receivers from NGSO FSS interference by reducing the PFD limit for NGSO FSS satellites that transmit at angles of 5 degrees or less above the horizon.[233] The Commission declined to propose specific PFD or EPFD limits on MVDDS operations or to propose coordination procedures between MVDDS and NGSO FSS operators because such requirements might be overly burdensome on both parties.[234] Instead, the Commission proposed to limit the transmitter power of MVDDS operations to minimize any area of potential interference and rely upon the ability of NGSO FSS user terminals to work around static sources of interference in any environment in which they might be placed.[235]

97. After careful review of all the comments and based upon further extensive technical analysis, we are persuaded that further refinement of MVDDS/NGSO FSS operating criteria is required. We believe that the criteria we adopt herein will provide a technically sound and equitable framework for MVDDS and NGSO FSS sharing that is responsive to the concerns expressed by the commenters in this proceeding.

98. The majority of commenters disagree with the merits of the initial technical criteria the Commission proposed in the *Further Notice* for MVDDS/NGSO sharing, while others suggest fairly comprehensive alternative criteria for sharing. For example, SkyBridge comments that the Commission's initial proposals for MVDDS and NGSO FSS sharing are too simplistic and place too much of the burden of resolving interference upon the NGSO FSS operators. SkyBridge also argues that the Commission's general treatment of MVDDS sharing with NGSO FSS is inconsistent with its approach to NGSO sharing with BSS/DBS. SkyBridge contends that simply setting a limit of 12.5 dBm on MVDDS transmitting system output power would create sizable exclusion zones and is subject to too many uncertainties and variability in the real world to afford adequate interference protection to NGSO FSS operations. SkyBridge argues instead that focusing upon the EPFD seen by an NGSO receiver will provide a more workable and accurate gauge of interference to NGSO FSS receivers than a simple output power limitation for MVDDS transmitting systems.

99. The SkyBridge proposal describes a complex scheme involving multiple in-band PFD contours and EPFD defined zones and out-of-band emission limitations.[236] The three in-band limits proposed by SkyBridge are described as 1.) A PFD limit of –120 dBw/m^2/MHz corresponding to an NGSO FSS frequency diversity zone that SkyBridge suggests should not be exceeded over ten percent of the MVDDS service area; 2.) An EPFD limit of –120 dBw/m^2/4kHz corresponding to a NGSO FSS receiver saturation buffer zone that should not be exceeded over 0.2% of the MVDDS service area, and 3.) An EPFD limit of –132 dBw/m^2/4kHz corresponding to a NGSO FSS receiver saturation threshold zone that would function as a limit that could not be exceeded into any operational NGSO FSS receiver.

100. SkyBridge argues that these multiple contours and zones are designed to avoid NGSO FSS receiver saturation and to prevent NGSO FSS receivers from making undue use, through frequency diversity techniques, of the lower 11.7-12.2 GHz band also authorized for NGSO FSS downlink operation.[237] In addition, SkyBridge suggests that low angle radiation limitations for NGSO FSS satellite

[233] *Id.* at 4200 ¶ 279. In particular, we proposed to require NGSO FSS downlinks in the 12.2-12.7 GHz band to meet a reduced PFD limit of –158 dB (W/m^2/4kHz) for angles of 0-2° above the horizon, and a reduced PFD limit of –158 + 3.33(δ-2) dB(W/m^2/4kHz) for angles of 2-5° above the horizon.

[234] *Id.* at 4201 ¶ 281.

[235] *Id.*

[236] *See* SkyBridge comments at 33-47. *See, also*, SkyBridge *ex parte* letter from Jeffrey H. Olson to Magalie Roman Salas, Secretary, FCC (filed Jul 10, 2000).

[237] In the *First R&O*, we authorized NGSO FSS downlink operations in both the 11.7-12.2 and 12.2-12.7 GHz bands for a total 1,000 megahertz of spectrum. *See First R&O*, 16 FCC Rcd at 4159 ¶¶ 161, 165.

will not cause harmful interference to new DBS receivers, consistent with the RLBSA.[227] MVDDS licensee will have to take into account the information provided by the DBS licensee. We encourage MVDDS operators to closely review the situation involving any DBS customers that the DBS licensee thinks may be in danger of receiving MVDDS signal levels in excess of the limit. However, we will not require the MVDDS licensee to take any specific action, provided its analysis shows the absence of a problem. The MVDDS licensee will be responsible once it commences service for ensuring that its signal level is not above the adopted limit at any DBS customer location. If the MVDDS licensee determines that it cannot meet the EPFD limit for DBS customers of record from its proposed site and finds a new site, a new 90 day coordination period will begin prior to the commencement of service. Finally, we will require that in the event of either an increase in the EPFD contour in any direction or a major modification to an MVDDS station, these procedures would apply anew. This does not include applications for renewal, assignment or transfer of control which are considered to be major filings.[228]

93. If a DBS provider or customer of record lodges a complaint regarding service within one year after MVDDS commences operation, the MVDDS licensees must correct interference to that customer or cease operation if it is demonstrated that the customer is receiving harmful interference from the MVDDS system or that the MVDDS signal exceeds the permitted EPFD level at the customer location. We believe that this procedure will minimize the potential for false claim reporting against the MVDDS licensee.

94. These procedures balance the positions of the various parties in this proceeding and will result in the ability of MVDDS to offer service in a timely fashion after licensing is completed. In addition, our adopted approach provides certainty to all parties involved and will allow them to develop their business plans accordingly.

2. MVDDS/NGSO FSS Sharing

95. Background. In the *Further Notice*, the Commission proposed basic technical operating standards to enable MVDDS and NGSO FSS sharing in the 12.2-12.7 GHz band.[229] At the same time, the Commission sought comment on whether different power limits would be appropriate for MVDDS transmitting systems and whether a database of MVDDS transmitting sites and NGSO FSS earth stations sites should be established so that licensees could determine problem areas prior to deployment of facilities.[230] The Commission also requested comment on whether various forms of coordination or information database sharing procedures should be established between NGSO FSS earth stations and MVDDS transmitting sites rather than specifying particular EPFD limits.[231]

96. The Commission proposed to limit the interference that MVDDS transmitting systems would cause to NGSO FSS receivers by restricting MVDDS transmitter power to 12.5 dBm in most areas.[232]

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likely to involve such interference."); 47 C.F.R. § 90.361 (finding that primary multilateration LMS systems cannot claim harmful interference from parts 15 and 97 operations that operate under certain conditions).] Given the conservative MVDDS transmitting power level and the availability of simple protective measures, we find that DBS licensees can introduce new DBS receiver antennas without experiencing harmful interference from the MVDDS signal.

[227] *See* RLBSA, § 2002(B)(2).

[228] *See* 47 C.F.R. § 1.929.

[229] *See, generally, Further Notice,* 16 FCC Rcd at 4200-01 ¶¶ 277-281.

[230] *Id.* at 4201 ¶¶ 280, 281.

[231] *Id.*.

[232] *Id.*.

emission standards to ensure that NGSO FSS receivers can utilize the lower frequency bands below 12.2 GHz. Boeing also suggests that coordination rules and mitigation procedures must be put in place to facilitate NGSO FSS and MVDDS band sharing.

105. Virtual Geosatellite, LLC (Virtual Geo) generally agrees that sharing between MVDDS and NGSO FSS is feasible.[246] Virtual Geo also agrees, in part, with the low angle EPFD limitations the Commission proposed. However, they argue that requiring compliance with the low angle EPFD limits might unduly constrain the operating power of some NGSO FSS satellites under certain circumstances at higher angles. Virtual Geo urges that such a result could be avoided by allowing NGSO FSS operators to specify, in lieu of complying with the EPFD limits, that their satellites will not transmit at or below angles of 5 degrees.[247] In the latter situation, the NGSO licenses would be conditioned to prohibit transmission below 5 degrees, but would not have the low angle EPFD limits.[248] Virtual Geo argues that this would permit licensees of NGSO FSS systems to retain the maximum flexibility, while still providing MVDDS systems with the desired protection from NGSO FSS downlink emissions.[249] Pegasus generally supports sharing between NGSO FSS and MVDDS in the 12 GHz band and takes the position that the MVDDS limits to protect DBS that were proposed in the *Further Notice* are sufficient to offer protection to NGSO FSS.

106. In response to the Commission's requests for comment regarding coordination procedures, Boeing, among others, indicates that the Commission should adopt coordination rules and policies for NGSO FSS/MVDDS sharing.[250] Boeing also argues that MVDDS operators should be required to pay the entire cost of mitigating interference to NGSO FSS receivers. Boeing proposes a sliding scale approach whereby an MVDDS operator would be responsible for paying either all, half or one-quarter the mitigation expense depending upon various criteria within five and ten year time periods. Virtual Geo urges that a predicate to successful co-existence and coordination between NGSO FSS and MVDDS should include a well-maintained data base of MVDDS transmitter locations that is readily accessible to NFSO FSS operators. Virtual Geo also opines that MVDDS transmitting towers should be reasonably limited in number and power so as not to hinder the ability of NGSO FSS installers/operators from ascertaining the location of potentially interfering transmitters.[251] Pegasus supports coordination procedures that would require MVDDS operators to alert NGSO FSS operators of the commencement of MVDDS service so that mitigation procedures could begin.

107. Discussion. The rules the Commission adopted in the *First R&O* limit MVDDS operations to 500 megahertz in the 12.2-12.7 GHz band. In contrast, NGSO FSS service downlinks are authorized to use 1,000 megahertz of spectrum in both the 12.2-12.7 GHz band and the adjacent 11.7-12.2 GHz bands. As a result, NGSO FSS is authorized access to twice the available spectrum for downlinks as compared to MVDDS. We find that NGSO FSS receivers operating in the 12.2-12.7 GHz band could be designed with "frequency diversity" capability that enables dynamic switching to the lower 11.7-12.2 GHz band for downlink service to avoid potential MVDDS interference in the 12.2-12.7 GHz band. NGSO FSS operators could enhance the frequency diversity capabilities of subscriber receivers by using narrower bandwidth designs and through other refinements that would provide greater discrimination against undesired signals.

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[246] *See, generally,* Virtual Geo Comments at 1-4.

[247] *Id.*

[248] *Id.*

[249] *Id.*

[250] Boeing Comments at 30.

[251] *See, generally,* Virtual Geo Comments at 1-4.

downlinks would be appropriate in order to afford protection into the boresight of MVDDS user terminals.

101. Northpoint argues from the contrary perspective that the proposed 12.5 dBm limit on MVDDS transmitter power is an inappropriate standard because it is too restrictive on MVDDS; that it would lead to a fifty percent increase in the number of MVDDS transmitters; that it would preclude improvements in antenna or other technology with no advantage to DBS or NGSO FSS; and that the increased number of MVDDS transmitters would result in excessive transmitter density that would actually disadvantage NGSO FSS.[238] Northpoint contends that a better approach would be to utilize the regional EPFD limits Northpoint suggests for DBS protection.[239] Northpoint claims that because these EFPD limits protect DBS operations they will lend inherent protection to NGSO FSS operations as well. Northpoint further argues that these EPFD levels would be exceeded in far less than 0.5% of the MVDDS service area in urban environments and that they are functionally equivalent to the 12.5 dBm limit proposed by the Commission. Thus, Northpoint concludes that these EPFD values are a practical limit on the interference power into NGSO FSS operations while affording MVDDS additional flexibility of using greater than 12.5 dBm power in certain circumstances.[240]

102. Northpoint also disagrees with SkyBridge's contention that multi-tiered, in-band PFD and EFPD limits are required to adequately protect NGSO FSS receivers from MVDDS interference. Northpoint maintains that NGSO FSS operators can avoid potential MVDDS interference because the NGSO's can easily use the lower 11.7-12.2 GHz band of frequencies allocated to the NGSO FSS for downlink operations. Northpoint also argues that SkyBridge is unable to cite any support in the record that NGSO FSS receivers might experience front-end saturation or be unable to utilize the lower 11.7-12.7 GHz band due to MVDDS operation. Any potential problem could be resolved, Northpoint argues, by NGSO FSS operators switching to LNB converters having a bandwidth of 500 MHz instead of 1000 MHz. Finally, Northpoint argues that the SkyBridge EPFD limit for ten percent of the MVDDS service area is arbitrary and unnecessary in light of the regional EPFD limits suggested by Northpoint.[241]

103. On the other hand, Northpoint concurs with SkyBridge and Boeing that some form of out-of-band limits are appropriate citing SkyBridge's letter of July 10, 2000.[242] However, Northpoint disagrees with the imposition of a 24 MHz bandwidth limit arguing that such a limit would have no benefit on NGSO FSS and might hamper future MVDDS operations.[243]

104. Boeing indicates that the specific EPFD limits offered by SkyBridge would not adequately protect many of Boeing's NGSO FSS receivers.[244] Nevertheless, Boeing agrees with SkyBridge that focusing on MVDDS EPFD limitations into NGSO FSS receivers would be far more useful than relying upon a single MVDDS transmitter power limit.[245] Boeing also argues for out-of-band

[238] Northpoint Comments at 26-28.

[239] *See, e.g.*, Northpoint Comments at 27. *See also*, para. 63, *supra* for a complete description of Northpoint's EPFD proposal.

[240] The exceptional conditions enumerated by Northpoint that would allow for an EIRP in excess of 12.5 dBm include, 1) locations near large unpopulated areas, 2) transmitters located at heights above average terrain (HAAT) greater than 300 feet, or 3) to accommodate improved transmit antenna technologies that might be developed in the future. *See* Northpoint Comments at 28.

[241] *See, generally*, Northpoint Comments at 12-21.

[242] Northpoint Reply Comments at 19.

[243] *Id.*

[244] Boeing Comments at 28.

[245] *Id.*

3 km also serves to place a worst-case cap on the extent of MVDDS interference that might be caused to NGSO FSS receivers. As noted above, we acknowledge that NGSO FSS receivers that might be installed in close proximity to MVDDS transmitting antennas using 14 dBm EIRP, particularly within 3 km, could be susceptible to interference from MVDDS when the NGSO FSS receivers are operating in the 12.2-12.7 GHz band. However, in this situation, NGSO FSS receivers could also be designed to switch to the lower 11.7-12.2 GHz band and could be designed with narrower bandwidths to avoid such interference.

113. We find that adopting a single PFD limit that may not be exceeded at a specified distance has significant advantages over other proposed approaches. First, we believe that this approach is relatively uncomplicated and will not be burdensome for compliance by licensees. Second, the PFD limit is technology neutral because it allows for the use of any antenna type, tower height and EIRP combination (up to the maximum 14 dBm) so long as the PFD limit is not exceeded at the specified distance. Third, by specifying a maximum PFD limit in terms of an absolute distance from the MVDDS transmitting site, we eliminate any dependence upon potentially equivocal determinations of percentages of MVDDS service area as suggested by SkyBridge. Finally, the approach we adopt fixes the worst-case maximum extent of possible NGSO FSS interference regardless of MVDDS transmitter or antenna design. As a result, we believe that both MVDDS and NGSO FSS licensees will benefit from the predictability of being able to anticipate and plan around the potential sharing and coordination issues that might arise.

114. In arriving at our decision to adopt the PFD limit of $-135 dBW/m^2/4kHz$ measured and/or calculated at the surface of the earth at 3 km, we believe that we have crafted an effective and reasonable compromise from among the available options. Boeing suggested the most stringent limits on MVDDS operation but indicated for its part that the SkyBridge proposal would be an acceptable compromise. We conclude, on balance, that the Boeing proposal is so restrictive that it could unduly undermine the ability to deploy MVDDS without a corresponding benefit to NGSO FSS operators. Therefore, our analysis focused on the merits of the multi-EPFD SkyBridge scheme as a possible solution. We also carefully considered Northpoint's proposal for higher permissible EIRPs and single-value EPFD limits.[255] To maintain uniformity for comparison purposes, we utilized a PFD value of $-150.7 dBw/m^2/4kHz$ that corresponds to the value specified by Northpoint as point of reference for defining the MVDDS service area.

115. A key benefit of the PFD limit-at-a-distance standard we adopt is that it does not depend upon determinations of percentages of MVDDS service area as proposed by SkyBridge. Nonetheless, we did compare the worst case results obtained by the standard we adopt in terms of the limits proposed by SkyBridge. In making this comparison, we found that unless restrictions are placed on permissible MVDDS transmission modes, discrepancies exist between the protection limits proposed by SkyBridge

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adopt will also serve to encourage the use and further development of alternative antenna forms that could provide improved service and protection characteristics.

[255]In an *ex parte* filing, Northpoint cautions that we should not determine MVDDS/NGSO FSS sharing criteria based upon NGSO FSS antennas that do not comply with the rules in 47 C.F.R. § 25.209 for GSO FSS antennas. *See* Northpoint *ex parte* filing of Feb. 6, 2002. However, as SkyBridge correctly points out in response, the Commission declined to adopt antenna standards for NGSO FSS user terminals in the *First R&O*. *See* SkyBridge *ex parte* filing of March 1, 2002. *See, also, First R&O,* 16 FCC Rcd at 4186 ¶ 240. In any event, notwithstanding Northpoint's concerns, we note that the PFD limits that we adopt herein do not depend upon the characteristics of the NGSO FSS receive antennas and instead are designed to limit the geographic extent of potential MVDDS interference to NGSO FSS regardless of the NGSO FSS antenna used.

108. Under the MVDDS/NGSO FSS sharing rules adopted herein, we believe that NGSO FSS receivers will not be precluded from operation in any significant area. First-in NGSO FSS receivers will be afforded full use of the entire 11.7-12.7 GHz band with significantly reduced need to rely upon frequency diversity as a result of the conservative spacing requirements we adopt between MVDDS transmitting antennas and pre-existing NGSO FSS receivers. NGSO FSS receivers that are later installed within an existing MVDDS service area, particularly those sited within 3 km of existing MVDDS transmitting antennas, may experience some degree of in-band interference that could encumber NGSO FSS operation in the 12.2-12.7 GHz band. However, NGSO FSS receivers would still have access to the remaining 500 megahertz of spectrum in the lower 11.7-12.2 GHz band for downlink service. As a result, later-in NGSO FSS receivers could utilize frequency diversity techniques so that they will not be precluded from operation even in areas where MVDDS operation has already been established.

109. We recognize that NGSO FSS receivers newly installed in close proximity to existing MVDDS transmitting antennas might be susceptible to receiver saturation from MVDDS signals in the 12.2-12.7 GHz band and might find it necessary to rely upon frequency diversity to make use of the lower 11.7- 12.2 GHz band. In these circumstances, each NGSO FSS operator can make its own business decision whether to employ receivers with sufficient signal discrimination characteristics and/or narrower bandwidth front-ends to enable operation in close proximity to pre-existing MVDDS transmitting antennas.

110. MVDDS transmitting antenna density limits (*i.e.*, limits on how closely multiple MVDDS transmitting antennas could be spaced and/or numerical limits within a given region) were suggested by some parties either in comments or in *ex parte* communications.[252] However, we find that insufficient information has been developed in the record for us to proceed any further with a quantitative analysis on this particular issue. Any possible limit that might be set would be entirely arbitrary and would have no means of evaluating the benefit to NGSO FSS. Therefore, we decline to adopt MVDDS transmitting antenna density limits.

111. Under our approach, first-in NGSO FSS receivers and first-in MVDDS transmitting systems will be afforded more and easier use of the shared 12.2-12.7 GHz portion of spectrum. We conclude that such a result is equitable and consistent with the co-primary status of NGSO FSS and MVDDS.

a. MVDDS Operating Requirements

112. In-band PFD limits. We adopt a requirement that the PFD of an MVDDS transmitting system not exceed –135 dBw/m^2/4kHz measured and/or calculated at the surface of the earth at distances greater than 3 km from the MVDDS transmitting site. The PFD of –135 dBw/m^2/4kHz corresponds to the limit proposed by SkyBridge for an NGSO FSS receiver saturation buffer zone. We recognize that the operating requirement we adopt is not as restrictive as that proposed by SkyBridge. However, we believe that setting the reference distance at 3 km for the specified PFD limit strikes a reasonable balance between limiting the potential for NGSO FSS receiver saturation or reliance on frequency diversity to relatively small and predictable areas while affording MVDDS operators benefit of the maximum 14 dBm EIRP adopted elsewhere herein[253] in most instances.[254] Limiting the distance to the specified PFD at

[252] *See, e.g.*, Boeing Comments at 14.

[253] *See* para. 198, *infra*.

[254] Some types of MVDDS transmitting antennas, such as the large and small sector horns proposed by Northpoint, may be restricted to EIRP values somewhat less than 14 dBm at some lower heights by the PFD limit at 3 km. However, we also note that use of other types of known antenna configurations, such as the cosecant-squared type, would allow for essentially the full 14 dBm EIRP for most antenna heights. Therefore, we find that the limit we

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118. In light of these findings, we decline to adopt the SkyBridge scheme that is based primarily upon multiple PFD/EPFD limits associated with percentages of MVDDS service. We believe that such a scheme is too complex on its face and would be inordinately burdensome in practical application. In addition, we believe that such a multi-level scheme would be susceptible to litigious dispute and manipulation among competing licensees. We conclude that we can achieve as much benefit as would be realizable from the either the Northpoint or SkyBridge proposals, but in a much more direct, predictable and practical fashion by specifying a fixed distance to the -135 dBW/m^2/4kHz PFD. Finally, because we conclude that MVDDS transmissions should not be restricted to a particular polarization mode, we believe that the standard we adopt will provide a more accurate depiction of the potential worst-case interference concerns while affording both significant protection for NGSO FSS and maximum flexibility for MVDDS.

119. MVDDS out-of-band emission limits. Northpoint agrees with the SkyBridge proposal that MVDDS should be required to adhere to some form of out-of-band limits.[260] SkyBridge asserts that the function of out-of-band limitations can be accomplished by specifying a maximum bandwidth of 24 megahertz for the emissions mask contained in Section 101.111(a)(2). We agree. Accordingly, we adopt elsewhere herein a change in the value of B to 24 MHz in the equation for determining the emissions mask as set forth in Section 101.111(a)(2) of our rules.[261]

b. NGSO FSS Operating Requirements

120. We adopt the low angle PFD limits on NGSO FSS downlinks in the 12.2-12.7 GHz band that the Commission proposed in the *Further Notice*. For angles of 0-2 degrees above the horizon, NGSO FSS downlinks must meet a reduced PFD of -158 dBW/m^2/4kHz, and for angles of 2-5 degrees above the horizon, a reduced PFD of $-158 + 3.33\ (\delta - 2)$ dBW/m^2/4kHz.[262] We note that Northpoint and SkyBridge both agree that low angle NGSO FSS radiation should be limited. Some of the most restrictive limits proposed by each are the same and comport with the PFD values we adopt herein. However, Northpoint and SkyBridge disagree on the manner in which compliance with the limits should be demonstrated. Northpoint proposes that low angle NGSO FSS PFD limits that are tightened by 10 dB from the ITU Article S21 standards should be applied as hard limits that NGSO FSS must not exceed in any circumstances.[263] SkyBridge proposes that we should adopt the ITU Article S21 limits without the 10 dB tightening proposed by Northpoint. SkyBridge also proposes that those limits should be complied with in the same manner as the operational limits imposed on NGSO FSS systems for the protection of GSO FSS and BSS systems.[264]

121. For the same reasons described in the *First R&O*, we conclude that the method of demonstrating compliance with the PFD limits we are adopting should follow the same approach as the operational EPFD down limits that the Commission adopted to protect GSO BSS operations.[265] We further believe that consistent requirements for DBS and MVDDS protection will be less burdensome for compliance by licensees. We do not believe that making any of the PFD limits dependent upon complaints or demonstration by MVDDS operators of violation with the limits would provide adequate or uniform protection. Therefore, we will require an NGSO FSS applicant to demonstrate, prior to becoming operational, that it meets the PFD limits we adopt herein to protect MVDDS. Each NGSO FSS

[260] *See* Northpoint Reply Comment (Technical Appendix) at 13; SkyBridge Comments at 38.

[261] *See* Transmitting Equipment Section at para. 206, *supra*.

[262] Where δ is defined as the angle of arrival above the horizontal plane.

[263] *See* Northpoint Reply Comments at 20-21.

[264] *See* SkyBridge Comments at 44-45.

[265] *See First R&O*, 16 FCC Rcd at 4170 ¶ 195.

and the MVDDS service area percentages associated with those protection limits.[256] We conclude, however, that placing polarization limits on MVDDS would only serve to undermine operational flexibility of MVDDS licensees and hinder efficient sharing of the 12 GHz band in exchange for a marginal benefit to NGSO FSS.

116. SkyBridge proposed that the extent of their so-called frequency diversity limit should not exceed ten percent of the MVDDS service area. Without considering MVDDS polarization constraints, we found that SkyBridge's frequency diversity zone will occupy, in the worst case, twenty percent of the MVDDS service area regardless of the EIRP or tower height. As a second example, SkyBridge proposed to limit the –135 dBw/m^2/4kHz saturation buffer zone to 0.2% of the MVDDS service area. We found that the –135 dBw/m^2/4kHz limit will, in the worst case, generally occupy between 1.8% [with MVDDS EIRPs restricted to levels as low as 4-6 dBm] and 2.5% [with MVDDS EIRPs unrestricted at 14 dBm] of the MVDDS service area for any reasonable combination of EIRP and transmitting antenna height. As in the first example, we achieved these figures without considering MVDDS polarization constraints. These results were obtained by fixing the distance to the –135 dBw/m^2/4kHz PFD limit between 1 km and 3.5 km from the MVDDS transmitting site.[257]

117. As noted above, virtually any EIRP and tower height combination will result in the same percentage of affected MVDDS service area. SkyBridge's stated criterion for selecting their proposed ten percent limit was to avoid use of frequency diversity "... over a large proportion of the MVDDS service area."[258] To the extent that we attempt to accommodate the stated goals of SkyBridge's proposal, we find that a worst case "frequency diversity" zone of twenty percent will afford significant protection to NGSO FSS in a large proportion (*i.e.*, eighty percent) of the MVDDS service area. As to the "saturation zone" limit of –135 dBW/m^2/4kHz, we observe that drastic reductions in MVDDS EIRP from the maximum 14 dBm to as low as 4 dBm have relatively little impact when viewed as a percentage of MVDDS service area as proposed by SkyBridge. The difference amounts to 2.5% at 14 dBm compared with 1.8% at 4 to 6 dBm – an improvement of only 0.7 percentage points. SkyBridge's stated criterion for selecting its proposed 0.2% limit was to honor assurances by MVDDS proponents that the area of NGSO saturation would be "small."[259] To the extent that we attempt to further accommodate that goal of SkyBridge's proposal, we find that a worst-case "saturation zone" of 2.5% of the MVDDS service area is sufficiently "small" to afford significant protection for NGSO FSS in the worst case.

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[256] SkyBridge explains in an *ex parte* communication that the percentage figures they proposed are achievable when MVDDS is limited to a single linear polarization mode of transmission or whenever MVDDS utilizes a single polarization mode dissimilar to that used by NGSO FSS. SkyBridge asserts that, under those constraints, NGSO FSS receivers would benefit from a 3 dB reduction in interference due to polarization discrimination. *See* SkyBridge *ex parte*, Letter from Jeffrey H. Ohlson, Paul, Weiss, Rifkind, *et al.* to Magalie Roman Salas, Secretary, FCC (filed Nov. 15, 2001). In response, Northpoint reiterates its position that MVDDS operation is not feasible under the SkyBridge proposed limits. *See* Northpoint *ex parte* Letter from Robert Combs of Broadwave USA, to Magalie Roman Salas, Secretary, Federal Communications Commission (filed Jan. 14, 2002).

[257] The significance of the 1 km distance is that it equates very nearly to the 0.2% of the MVDDS service area specified by SkyBridge as an acceptable "saturation zone" threshold when referenced to an EIRP of 14 dBm. When viewed in that context, the SkyBridge proposal implicitly accepts a worst-case "saturation buffer" EPFD limit of –135 dBW/m^2/4kHz that extends at least 1 km from the MVDDS transmitter for a worst-case 19.5 km service area radius at 14 dBm. We find, however, that EIRP constraints on MVDDS would be so extreme with the PFD limit established at 1 km - as low as 4 to 6 dBm EIRP with some common antenna type and height combinations - that MVDDS service quality could be significantly impaired. At the other end of the scale, fixing the distance at 3 km for the –135 dBW/m^2/4kHz saturation limit would allow for an unrestricted EIRP of 14 dBm with any antenna type and height.

[258] SkyBridge Comments at 33-34.

[259] *Id.* at 36.

licensee will be issued a conditional authorization and must submit, ninety days prior to operation, technical information demonstrating compliance with the PFD limits adopted herein to protect MVDDS.

c. MVDDS and NGSO FSS Spacing and Coordination Requirements

122. The interference mechanisms we considered in evaluating MVDDS impact on NGSO FSS are somewhat different than those we considered herein for MVDDS protection of DBS. In the DBS scenario, interference may occur primarily during heavy rain events due to DBS signal fading. All the parties generally agree with the presumption that MVDDS/DBS interference will not result during clear weather. By comparison, the MVDDS potential interference to NGSO FSS is not primarily related to rain or other inclement weather. Instead, interference is likely to occur when an NGSO FSS receiving antenna momentarily points directly at an MVDDS transmitting antenna as the receiving antenna tracks the NGSO satellite. In addition, interference may be caused through the back lobes of an NGSO FSS receiving antenna when in very close proximity to an MVDDS transmitting antenna. These interference events may occur regardless of weather conditions. We also note that the co-frequency interference that occurs when the NGSO FSS antenna points directly at an MVDDS transmitting antenna generally cannot be readily mitigated. Under these conditions, the NGSO FSS receiver essentially "sees" both the desired NGSO and undesired MVDDS transmitting antennas as a single source at the same point in the sky. As a result, we believe that standard mitigation techniques such as shielding and repositioning of the NGSO FSS antenna may be of little benefit and require NGSO FSS to make greater use of frequency diversity to utilize the lower 11.7-12.2 GHz band.

123. Because mitigation efforts might not be sufficiently feasible to address potential MVDDS interference to NGSO FSS receivers, we conclude instead that spacing and notification requirements should be employed to achieve optimal sharing conditions. Therefore, we decide that an MVDDS transmitting antenna may not be installed within 10 km of any pre-existing NGSO FSS receiver unless the affected licensees agree to a closer separation.[266] On the other hand, we also conclude that later-in NGSO FSS receivers must accept any interference resulting from pre-existing MVDDS transmitting antennas.

124. We conclude that NGSO FSS operators must maintain and share a database of existing NGSO FSS receiver locations. In addition, MVDDS operators must maintain and share with NGSO FSS operators a database of existing and proposed MVDDS transmitting locations, EIRP, tower height and related technical information. For each new MVDDS transmitting antenna, the MVDDS licensee must notify all NGSO FSS operators within the general service area of the proposed transmitting location and also disclose the related technical operating parameters. Within ten days of this notification, each NGSO FSS licensee must in turn advise the MVDDS licensee of the location of any NGSO FSS receiver within 10 km of the proposed MVDDS transmitting antenna site. If a qualifying NGSO FSS receiver, as defined by the rules adopted herein, is located within 10 km of the proposed MVDDS transmitting antenna site, then the parties are free to negotiate an agreement by which the NGSO FSS licensee would accept the MVDDS transmitting antenna at the closer-spaced site. In the absence of such an agreement, the MVDDS licensee may not construct the new transmitting antennas at the proposed site and must seek an alternative location that complies with the 10 km spacing criterion.

125. We believe that this approach preserves the relative rights and duties of both co-primary licensees without unduly hampering the expansion plans of either. We also conclude that the alternative approach of employing the existing coordination procedures in Parts 25 and 101 of our rules is not well-suited to the sharing situation in this band and, in any event, would not achieve any better results than the requirements we adopt herein.

[266] Our choice of 10 km is based upon the distance to the −144 dBW/m^2/4kHz PFD contour – which we equate to the "frequency diversity" zone limit proposed by SkyBridge – that extends approximately 9 to 10 km from the MVDDS transmitting site in the worst-case with an EIRP of 14 dBm per 24 megahertz.