Comparison of proposed EPFD with other metrics

As fully described in the attached Annex C, Table 1, the proposed EPFD limit is equivalent to a 20 dB carrier-to interference ratio (C/I ratio). Others have proposed different metrics for estimating impact of Northpoint on DBS, such as: percentage increase in outage; increase in outage minutes per year; or increase in outage minutes per worst month. Table 2 shows the impact of Northpoint's proposal for EPFD at the edge of the mitigation zone, in terms of these various metrics. This information is presented not to advocate for adoption of any of these other metrics, but to show how Northpoint proposal would translate into a generalized case within the mitigation zone, based on reference DBS parameters. These reference parameters and the supporting analysis are given in Annex C, Table 1.

Table 2: Estimates of Potential Impact of Northpoint's Proposed EPFD Limits Within the Mitigation Zone*

		DirecTV			**Echostar** [18]	
Metric	*Min*	*Max*	*Average*	*Min*	*Max*	*Average*
Percent increase in potential outage	5%	14%	9.3%	11.8%	15.7%	13.3%
Minutes in average month of potential increased outage	0.9	2.6	1.7	0.4	5.8	3.2
Minutes in worst month of potential increased outage	3.5	9.6	6.1	1.9	19.2	11.2

*The mitigation zone is confined to the area immediately around the transmitter, typically less than 0.5% of the total Northpoint service area, and contains few households.[19]

The table shows the potential worst-case effect on a DBS subscriber at the edge of the mitigation contour. When reviewing this table, it is important to bear in mind that the Northpoint signal falls off rapidly as one moves away from the Northpoint transmitter, so that the effect of Northpoint on 99.9% of

[18] One might wonder why the range of data for Echostar varies more than that for DirecTV. This is because the links that Echostar provided to the ITU showed a wider variance than those provided by DirecTV, and Echostar claims its system requires greater margin to operate. The validity of these claims is unknown.

[19] *See* Annex B for additional information.

DBS subscribers will be negligible. We believe that these levels of increased outage are also negligible, and that DBS consumers would not be able to discern changes of such small magnitude.

To the end of putting the potential increases in outage minutes in Table 2 into perspective, consider the fact that the average household has the television turned on for about seven hours in a day.[20] In other words, the television is on less than 30 percent of the time. Therefore, the actual number of minutes of outage in Table 2 should be reduced to 30% to determine the estimated increase in potential outage, as in Table 3.

Table 3: Estimates of Potential Impact Within the Mitigation Zone* After Accounting for 30% Television "On" Time

		DirecTV			**Echostar**	
Metric	*Min*	*Max*	*Average*	*Min*	*Max*	*Average*
Minutes in average month of potential increased outage	0.3	0.8	0.5	0.1	1.7	1.0
Minutes in worst month of potential increased outage	1.1	2.9	1.8	0.6	5.8	3.4

*The mitigation zone is confined to the area immediately around the transmitter, typically less than 0.5% of the total Northpoint service area, and contains few households.[21]

Models for Calculating Potential Increases in Outages or Availability Have a High Margin of Error and Must Be Understood As Imprecise Estimates, Not as Fact

It is essential for the Commission to recognize that estimates of potential "increased outages" or potential "increased unavailability" are not precise and do not present an accurate picture of any real world conditions. These estimates are only models, based on reference parameters.

Northpoint urges caution in using these models because they create a false sense of accuracy, displaying results to many decimal places, when, in fact,

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[20] *See* Television Bureau of Advertising, Inc., *Trends in Television: Time Spent Viewing, available at* http://www.tvb.org/tvfacts/trends/tv/timespent.html.

[21] *See* Annex B for additional information.

the margin for error in the underlying assumptions is vast. This section demonstrates that the uncertainty and inaccuracies in the models of DBS availability mean that there is a large margin for error in any correlation of C/I ratio and an "increase in outage." While examinations of the relationship of a specific C/I to a specific model of increased outage may have some value, it is essential that the Commission recognize the limitations in such analysis and not fall into the trap of believing these models represent reality. In the following section, four separate sources of uncertainty are examined: Satellite EIRP inaccuracy, rain model uncertainty, antenna gain uncertainty and antenna pointing error.

Satellite EIRP–A great uncertainty exists for the satellite EIRP. The following table compares the EIRP as given by ITU, by the FCC, and most recently by DirecTV and Echostar themselves.

Table 4: Range of DBS EIRP Across the United States

		EIRP Estimate Across the United States (dBW/carrier)		
System	**Code Rate**	**ITU Recommended Assumption for EIRP[22]**	**FCC Estimate of EIRP[23]**	**DBS Stated EIRP[24]**
DirecTV	*2/3 Code Rate*	48.0 - 53.9	48.4 – 54.4	49.3 – 54.5
DirecTV	*6/7 Code Rate*	51.0 – 56.9	-	52.2 – 57.4
Echostar	*3/4 Code Rate*	47.4 – 53.5	47.6 – 53.6	48.5 – 57.6

According to DirecTV and Echostar, the EIRP in both the ITU recommendation and the FCC analysis is low by about 1 dB. This 1 dB error would translate into an "increase in unavailability" of about 60%.[25]

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22 Values from ITU Recommendation BO.1444 Annex 1 for US 45 cm antenna links.

23 *FCC Staff Analysis of DBS Outage Statistics for Top 32 Television Markets (corrected)*, ET Docket No. 98-206 (Feb. 13, 2001), *available at* http://www.fcc.gov/oet/dockets/et98-206/staff_analysis/staff_analysis_of_dbs_outagev2.doc ("*Staff Analysis of DBS Outage Statistics*").

24 *See DBS Response* at 3.

25 *See* example in Annex C, Table 2.

Rain Model Uncertainty–As stated earlier, even the best estimate of precipitation has an annual variability of at least (plus or minus) 30%. This is true when using either the Crane model or the ITU model. A 30% change in precipitation has the effect of changing the outage by about 30-50%.[26] Thus, even in the best case, the link budgets do not allow for planning of the availability to better than 50% accuracy. Thus, the expected level of outage would vary on an annual basis by over 50%, and this is far higher than any proposed criterion.

Antenna Gain–Many current DBS customers use the 18-inch offset feed antenna, which has a nominal gain of 34 dB. However, this situation is rapidly changing. Echostar is currently selling only the 20-inch "Dish500" multi-satellite antenna. This antenna should have a 1 dB higher gain, as well as improved sidelobe characteristics, over the 45 cm antenna. DirecTV is also selling its 18 x 24-inch oval multi-satellite antenna, and should also provide better gain along with additional sidelobe protection. For customers with these antennas, not only would they offer improved signal strength of at least 1 dB, but also the impact of terrestrial interference would be even less.

Pointing Error–As the FCC has stated, the DBS link budget has a factor of 0.5 dB for antenna pointing error.[27] Simply pointing the user's dish properly can eliminate this error, and increase the DBS signal strength by 0.5 dB. This error is responsible for an uncertainty of approximately 26% in the change in unavailability.[28]

The following table shows the relationship among these variables. While uncertainties in the link are additive, uncertainties in unavailability are multiplicative, leading to a total uncertainty of over 350%, or over 100 times greater than one proposed criterion.

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[26] *See* example in Annex C, Table 2.

[27] Appendix I of *First Report and Order and FNPRM*, "MIS= 0.5 dB (DBS antenna mispointing loss)."

[28] *See* example in Annex C, Table 2.

Table 5: Uncertainties in Model of DBS Satellite Link Availability for Echostar 119° Service to Seattle

Uncertainty	*Magnitude of Uncertainty in Link*	*Magnitude of Uncertainty (Change in Unavailability)*
Satellite EIRP	1.0 dB	57.4%
Rain model yearly variance	-	51%
Receiving antenna gain	1.0 dB	57.4%
Pointing error	0.5 dB	26.1%
TOTAL	**2.5 dB**	**360%**

This exercise establishes that estimating an "increase in unavailability" from the model of the DBS satellite link budget is an inexact science. Any one of the above errors would cause an uncertainty of 26-61%. This clearly supports the Northpoint proposal for an EPFD limit as the criterion.

The following table compares the total uncertainty with the Northpoint proposal for interference criterion. Clearly, the uncertainty and errors in the model, in aggregate, or even singly, are far higher than this proposed criterion.

Table 6: Comparison of Northpoint EPFD with Uncertainties in Model of Satellite Unavailability for Echostar 119 Service to Seattle

	Effect on C/N	*Relative Change in Unavailability*
Total Uncertainty in Model of DBS Availability	2.5 dB	360%
Impact of Northpoint EPFD	0.2 dB	10%

Based upon the large uncertainties associated with availability, Northpoint has considerable skepticism that its emissions will cause measurable increase. As was demonstrated during Northpoint's Washington testing during Hurricane Floyd, both the Northpoint system and DBS service were able to operate without failure despite the fact that the rain rate exceeded the 0.1% rain rate.[29] As more fully described in Northpoint's experimental

[29] Progress Report WA2XMY, Northpoint – DBS Compatibility Testing, October, 1999, at 20.

report of the Washington testing, the DBS availability was actually higher and Northpoint's impact lower than what would have been the case based on the DBS claims of availability and Northpoint impact.

Therefore, we propose that the Commission adopt the EPFD associated with a 20 dB C/I contour as described in Table 1. Most importantly, the EPFD is easily measurable in the field, by the parties and the FCC, and therefore avoids the pitfalls of the "increase in outage" criterion. Second, from the comparisons in Tables 2 and 3, the EPFD based on a 20 dB C/I is far from harmful. Third, the EPFD would only apply to a universe of potential DBS subscribers that is smaller than 0.01% of all DBS subscribers.[30] Thus, 99.99% of DBS customers would have a C/I that is better than 20 dB. As another point of reference, a C/I of 20 dB is approximately the level of interference accepted by each DBS system from other DBS systems. As a different point of reference, on the average, a C/I of 20 dB would cause less than about 0.3 dB of link margin degradation, which can be deemed insignificant, especially in light of the uncertainties in the DBS link budget.

[30] Only 8 out of 1.3 million customers would need mitigation in the Washington, D.C. study, *see* Annex B, page 14.

2.3.2 Residual Allowance to NGSO FSS Can Be Used for Northpoint

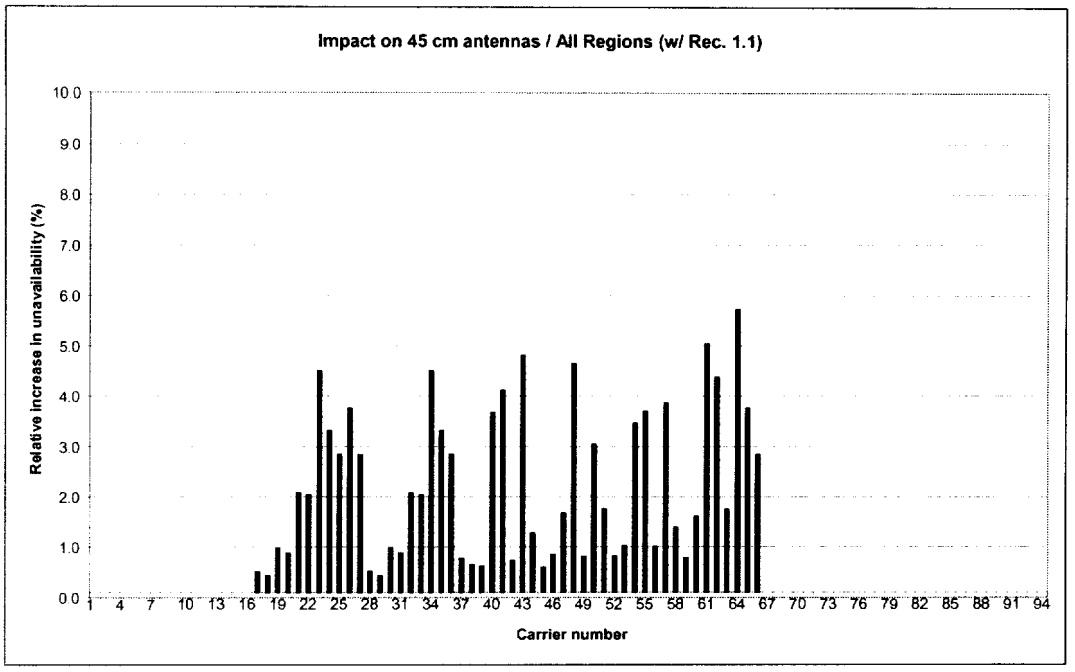

Figure 1: Impact of NGSO FSS on U.S. BSS carriers (numbered 17-66).[31]

Figure 1 shows the aggregate impact of all NGSO FSS systems on the U.S. Broadcast Satellite Service (BSS) carriers (using a 45 cm antenna), numbered 17 through 66. According to the data provided by the ITU, the average increase for these carriers caused by the aggregate of all NGSO FSS systems is a 2% increase. Thus, DBS accepted a 10% increase, but all NGSO FSS systems together would cause only an average of 2% increase in unavailability, leaving a residual of approximately 8%. This average residual of 8% outage can and should be allocated to Northpoint.

2.3.3 Summary

Northpoint's proposed EPFD limits would prevent harmful interference into DBS. The level of degradation is very small, and affects few people. It is insignificant and thus, it is not harmful to this service (DBS). Thus we urge the Commission to adopt this proposal.

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[31] *See* Annex 11 to 10-11S/209-E, Chairman's Report, Annex 1 to Annex 11: Recommended $EPFD_{down}$ Masks, at 90 (1999).

2.4 Methodologies for Determining Interference and Mitigation Contours

In this section we provide comments on the engineering methodologies and input assumptions used to predict the sharing environment between Northpoint and DBS. In the *First Report and Order and FNPRM*, the Commission proposes to use two separate methodologies, one to determine the equivalent C/I when given a 'percent increase in unavailability,' the other to define a mitigation contour near a terrestrial transmitter given a C/I ratio.

2.4.1 Definition of EPFD

The equivalent power flux density (EPFD) is defined by:

$$EPFD = 10 \cdot \log_{10}\left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4.\pi d_i^2} \cdot \frac{G_r(\phi_i)}{G_{r,\max}}\right]$$

where:

- N_a is the number of transmit stations in the terrestrial system that are visible from the DBS receiver on the Earth's surface;
- i is the index of the transmit station considered in the terrestrial system;
- P_i is the RF power at the input of the antenna of the terrestrial transmit station, in dBW in the reference bandwidth;
- θ_i is the off-axis angle between the boresight of the transmit station considered in the terrestrial system and the direction of the GSO receive station;
- $G_t(\theta_i)$ is the transmit antenna gain (as a ratio) of the station considered in the terrestrial system in the direction of the GSO receive station;
- d_i is the distance in meters between the terrestrial transmit station and the DBS receive station;

ϕ_i is the off-axis angle between the boresight of the antenna of the GSO receive station and the direction of the ith terrestrial transmit station;

$G_r(\phi_i)$ is the receive antenna gain (as a ratio) of the GSO receive station in the direction of the ith transmit station considered in the terrestrial system;

$G_{r,max}$ is the maximum gain (as a ratio) of the antenna of the GSO receive station;

EPFD is the computed equivalent power flux-density in dB(W/m^2) in the reference bandwidth.

Where there is only one terrestrial interferer in view, this equation simplifies to:

$$\textit{Equation 1: } EPFD = P + Gt(\theta) - 20\log(4\pi d) + (Gr(\phi) - Grmax)$$

Where:

P is the terrestrial transmit power in the reference bandwidth (b);

$Gt(\theta)$ is the terrestrial transmit gain in direction of receiver;

d is the distance in meters from the transmitter to the DBS receiver

$Gr(\phi)$ is the DBS receive gain in direction of transmitter;

Grmax is the DBS maximum receive gain.

Equation 1 can be used to estimate the EPFD for any DBS receiver near a Northpoint transmitter.

2.4.2 Conversion of C/I Ratio to EPFD Level

The relationship between the interference power (I) and the EPFD is given by the following equation:

$$\textit{Equation 2: } EPFD = I - (Grmax + (10\log(\lambda^2/(4\pi))) + 10\log(B/b))$$

where:

I	is the interference power at the input to the LNB as measured in the LNB noise bandwidth B;
$Grmax$	is the DBS maximum receive gain;
λ	is the wavelength of the radio wave;
B	is the noise bandwidth of the DBS receiver;
b	is the reference bandwidth.

Thus, the C/I can be converted to an EPFD by the following procedure.

1. Determine the wanted system carrier power (C).
2. Subtract the desired isolation ratio (nominally C/I of 20 dB) to obtain the required interference power (I).
3. Substitute the required interference power (I) into Equation 2 to obtain the appropriate EPFD.

2.4.3 Methodology for Estimating the Relationship Between C/I and a Percent Increase in Outage

From the discussion in Section 2.3.1, any calculation of a "percent increase in outage" is only an estimate, subject to a high degree of uncertainty. In contrast, a C/I is a quantity that can be determined through actual measurement. Therefore, the relationship between the two is only as good as the model and assumptions used to relate them. This point cannot be stressed enough, and is the reason why "percent increase in outage" is unsuitable as a metric.

This is not to say that no analysis should be conducted of model systems, however, if a model is to be used to estimate a percent increase in outage, it should be the best available model. Northpoint respectfully states that the model currently being used by the Commission is flawed and unreliable, as documented below. In place of the Commission's current model, we suggest a spreadsheet based on the ITU implementation. We attach this implementation as Annex A. We also believe the Commission has erred in several of the input assumptions used with its outage model. We propose alternatives to those in the Order and provide information on the erroneous assumptions and parameters currently employed; these are detailed in Section 2.4.4.

The Commission suggests a Mathcad program be used to estimate the C/I ratio estimated to cause a percent increase in unavailability. A summary analysis of input and output to this program is presented in Appendix J of the FNPRM. We attempted to follow the procedures provided by the Commission in the Order, and could not duplicate their results. The Commission then placed in the record its software code, issuing a correction and a disclaimer as to its accuracy and precision at the same time.[32] Unfortunately, the Mathcad program is still flawed.

Northpoint ran the corrected Mathcad program for selected cities provided in the staff analysis, and compared the results with the spreadsheet implementation of the same methodology suggested in the FNPRM. The comparison shows that the two implementations differ such that the margin of difference is greater than any suggested criterion, demonstrating the inadequacy of the Mathcad program.

For example, with respect to DirecTV service in Seattle, the Mathcad program predicts a link availability of 99.928% per year, while the spreadsheet estimates the availability to be 99.943%.[33] The difference is a change in unavailability of 26%, which is an error about ten times greater than one suggested criterion of 2.86%.

One source of the difference in the availability was found to be the determination of the variable α_h and α_v in the specific attenuation. The calculation of these variables by Mathcad differed from that of the implementation used by the ITU. This difference is at least one source of error in the Mathcad calculation of availability.

In place of the Mathcad implementation, we propose to use a spreadsheet in Microsoft Excel, which follows the methodologies proffered by the Commission. This is the method suggested by the ITU in CR 116. Both Northpoint and DirecTV have used this method to develop their estimates of DBS link availability, and the relationship between C/I and increase in outage.[34] Therefore, the FCC should adopt this method. We also provide detailed procedures on the execution of these procedures, and we place our working code in the public record, provided in Annex A.

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[32] *See generally Staff Analysis of DBS Outage Statistics.*

[33] Both availabilities calculated using the same input values presented as "US-GSO 1(a)" in Annex C.

[34] *See* Technical Annex to Comments of DirecTV, Inc. at 6-8 (filed Mar. 1999).

2.4.4 Assumptions Regarding Availability Computations

The Commission requests comment on the input assumptions for availability calculations. We comment on three assumptions to be used in the methodology: the rain model, the pointing error, and the outage condition.

Rain Model–Northpoint agrees that the latest ITU rain model contained in Recommendation 618-6 should be used for availability calculations. This model has been subject to extensive peer review. It is worth noting that by updating the rain model, the 'unavailability' of the average DBS system was reduced by an average of 28%.[35]

Pointing Error–The Commission should take note that professional satellite installers install most DBS antennas, and thus 0.5 dB 'pointing error' is extremely conservative. At least one DBS provider recommends using only 0.4 dB of pointing error, and this also is conservative. However, we have used 0.5 dB in our calculations.

DBS System Availability Should be Estimated from the Freeze Frame Outage Condition

Northpoint is concerned that the use of the "operational threshold" in calculating availability leads to flawed analysis and over protection of the DBS system.[36] We propose to use the "freeze frame" outage condition for availability calculations.

The Commission recognizes that the point at which the DBS picture becomes unavailable is the "loss of demodulator lock."[37] Our suggested criterion for outage is also the loss of demodulator lock. This can be bounded by the criterion for loss of full picture, as described in ITU-R Recommendation BO.1444, Annex 1. This recommendation references two different performance objectives. The most relevant one for DBS system performance is the C/N value at which actual loss of picture occurs, the

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35 *See* Annex C, table 4.

36 *See* First Report and Order and FNPRM, App. G: "Required C/(N+I) for operating threshold."

37 "A picture demodulated by a digital receiver retains its quality until the desired to undesired signal ratio decreases to a level too low for the receiver demodulator to decode, at which point the picture is completely lost." *First Report and Order and FNPRM* ¶ 205.

"freeze frame" C/N performance point.[38] As BO.1444 states, the freeze frame point is the point where the MPEG decoder ceases to provide full pictures. If the customer is viewing a full picture, then it is clearly not an outage condition.

For example, for DirecTV 6/7 rate Viterbi coded signal, the actual loss of picture (freeze frame) occurs at 6.1 dB C/N, according to DirecTV.[39] The user cannot even perceive picture degradation unless the C/N is very close to, or at the "freeze frame" point. This certainly is below the other performance point, the so-called "operational threshold." The 'operational threshold' is typically set at 1.5 dB higher than the loss of picture, and thus it serves only to hide system margin and availability.

Further, both DirecTV and Echostar state that the values chosen for the operational threshold are set for "worst-case transponder characteristics and worst case demodulator performance. Performance through randomly selected off-the-shelf receivers and through an average satellite transponder may be better."[40] In other words, DBS is relying on extremely conservative assumptions that might never be found in the real world to support their proposed "operational threshold."

When considering that any impact from the Northpoint signal will not even be measurable at more than 99.5% of DBS customer locations, it becomes clear that such extreme worst case assumptions cannot be appropriately applied to such a small population; more realistic assumptions are appropriate.

In summary, Northpoint asserts that the "loss of lock" point is the DBS outage condition. The "loss of lock" point is bounded by the "freeze frame" point, therefore maintaining a cushion for the DBS operator. Because the DBS subscriber views a full picture at the freeze frame point, and because this point is well defined, Northpoint proposes the "freeze frame" point be used for availability calculations.

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38 *See* ITU-R Recommendation BO.1444, Annex 1: BSS System Characteristics, n.2 (stating that the freeze frame point is the point where "the high frequency of data errors causes the MPEG decoder to cease providing full pictures").

39 *See DBS Response* at 4.

40 *Id.* at 5.

2.4.5 Methodology for Determining C/I Contours Near a Northpoint Transmitter

A method is needed to draw C/I or EPFD contours near the Northpoint transmitter. There are several such tools available: commercial software packages such as MSITE spreadsheet tools. The Commission also proposes a Mathcad tool, but this is flawed. We propose to use a spreadsheet method that has been extensively validated against commercial contour software.

A threshold problem with the FCC's Mathcad tool is that it does not draw a contour, so it cannot be used for this purpose; however, the Mathcad program also is flawed at calculating point specific information.
The FCC's Mathcad program does attempt make an estimate of C/I ratio along a given azimuth, but it does not do so correctly, for at least three reasons. First, the FCC states that the use of the pattern in the 1994 DirecTV report[41] is mandatory[42]; yet its Mathcad program does not use this pattern. The pattern used by the Mathcad program is compared to the 1994 pattern in the figure below, and they are clearly different in the region 0 to 30 degrees off boresight.

Second, the 1994 report shows that for constant azimuth towards the Northpoint transmitter, the gain does not change, and this is true for satellite elevation angles of 20 – 50 degrees. However, the FCC program varies the DBS gain along a given azimuth, which is incorrect. Third, the method proposed by the Commission requires the user to select the desired contour, and then solve inversely for the distance from the transmitter to this contour for each azimuth. Implicit in this assumption is that C/I is a monotonic function for each azimuth. However, C/I is not a monotonic function of azimuth and multiple contours may exist due to the interference geometry. Thus, the method proposed by the Commission is flawed.

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41 DirecTV, Inc., Report, *Terrestrial Interference in the DBS Downlink Band* (1994) ("*DirecTV 1994 Report*").

42 *See* First Report and Order and FNPRM, App. I (table) (setting parameters for "DBS earth station antenna pattern [$G_{dbs}(\Phi)$]" based on "DIRECTV, April 11, 1994").

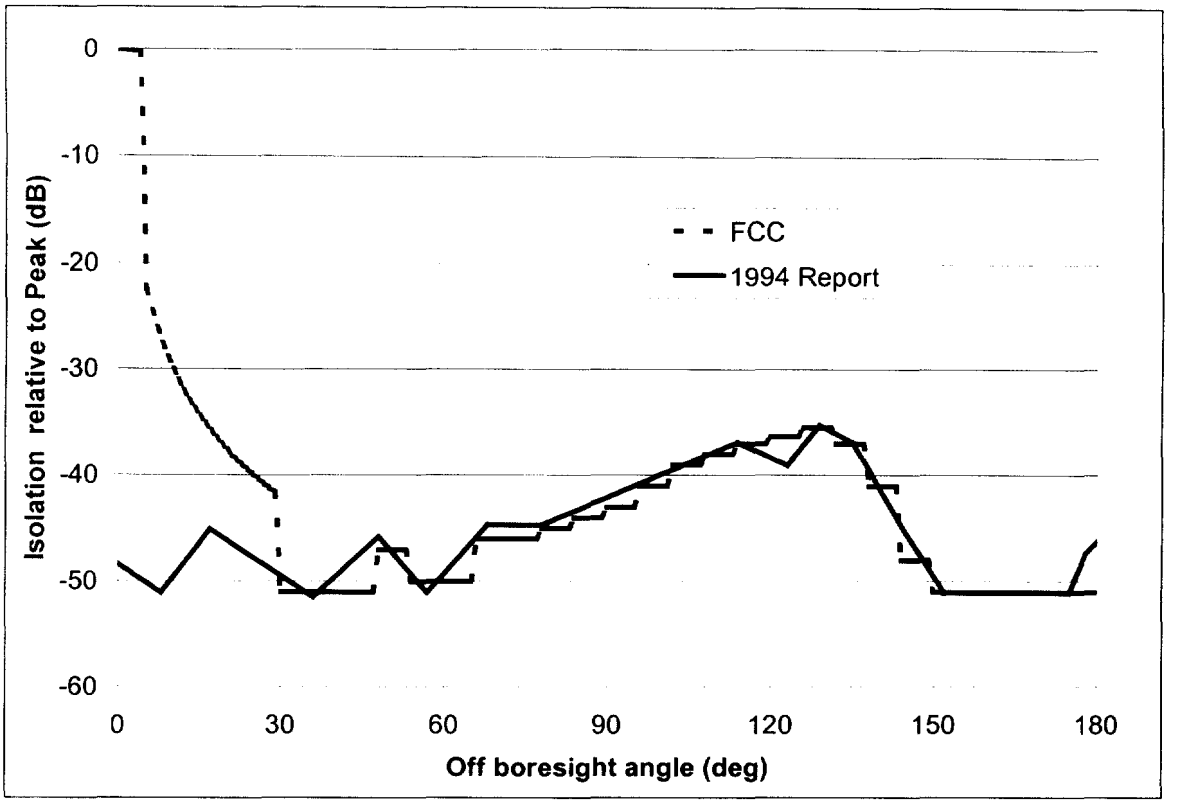

Figure 2: Comparison of FCC antenna pattern with DirecTV 1994 report.

Therefore, we are making available to any interested party the method and software code for estimating C/I contours.[43] The code is an implementation of the methodology for free-space propagation geometry described in Annex B. The idea forming the basis of the spreadsheet is to define a grid and then calculate the C/I ratio at each point in the grid. This is the same method used by commercial software programs such as MSITE™. Northpoint has compared the output of its program with that of the MSITE™ software suite.[44] Precision is guaranteed to the precision and accuracy of the user inputs and the fidelity of the grid. Figure 3 of this document was produced with this code. Compare the sample contour provided by the Commission in its Appendix I (Figure I-1) with that given in Figure 3 below. Both figures use the same input assumptions. This comparison reveals the two results differ significantly.

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43 Interested parties may request code through Antoinette C. Bush, Northpoint Technology, 400 N. Capitol Street, N.W., Washington DC 20001.

44 MSITE™ is a windows product for wireless design, produced by EDX in Eugene, Oregon. It can accurately predict C/I ratios under a variety of different assumptions.

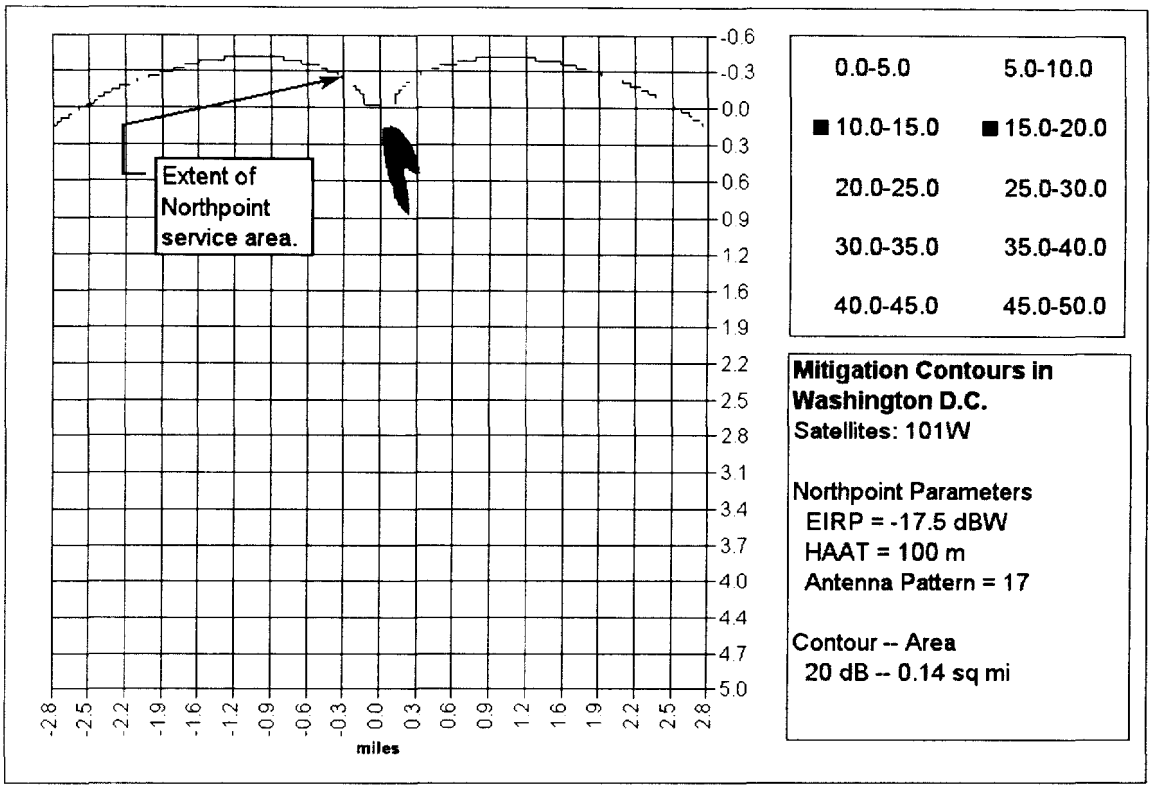

Figure 3: Mitigation contour in Washington, D.C. for DBS at 101.

In summary, we urge the Commission to use a spreadsheet implementation for estimating C/I contours, or a commercial software program such as MSITE.

2.4.6 Assumptions to Be Used for Estimating C/I Ratios Near a Northpoint Transmitter

Three dB of isolation should be accounted for from linear to circular

The isolation from linear to circular polarization is one-half power, or three dB of isolation[45], and is true for all angles of reception. Circularly polarized (CP) antennas typically use quarter-wave dipoles oriented at right angles to receive the CP signal, rotating at a given rate (ω). A linearly polarized wave can excite one or the other of these dipoles, or at most, excite them equally at one-half of the power. In this fashion, one-half of the power available

[45] *See Electronics Engineer's Handbook*, at 22.10-12 (Donald Christiansen et al. eds., McGraw-Hill, 4th ed. 1997).

from a linear polarized (LP) wave is lost when received by a CP antenna.[46] The existence of this three dB isolation was recognized by DirecTV in its 1994 report to the Commission on terrestrial interference.[47]

A linear polarized wave can be converted to circular polarization if it passes through a circular polarizing filter, such as a grid of quarter-wave plates.[48] By inspection, the DBS antenna does not consist of a polarizing filter. A linearly polarized wave can also be rotated by atmospheric phenomenon, (Faraday rotation), but this is limited to a few degrees at frequencies above a few GHz.[49] Therefore, a three dB isolation from linear into circular polarization should continue to be taken into account in the interference budget.

2.5 Other Regulatory Issues

Mitigation of interference–Northpoint supports most of the methods for potential interference mitigation cited by the Commission in paragraph 216. Our first solution for solving interference issues would be to properly point a DBS subscriber's dish. As shown in Table 5, this can provide about a 30% decrease in outage, or more. However, the Commission suggests that reducing the Northpoint power during periods of rain may be used to mitigate interference into DBS. Northpoint opposes the use of automatic level control during rain for its system, and believes that the Northpoint EPFD, in conjunction with other mitigation techniques, is adequate to protect DBS.

Rain and snow are the primary causes of DBS outages; therefore, Northpoint would never be the primary reason that a DBS system would experience an outage. As has been discussed elsewhere in this filing, interference from Northpoint into DBS would be limited in time and space to periods of very heavy rain in the small area immediately surrounding the Northpoint transmitter. The frequency of these rain events has been estimated to be 0.01% of the time, and the area of potential impact averages 0.1% of the

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46 *See Antenna Theory and Design*, Chapter 9, Section 9.1, (Warren L. Stutzman & Gary A. Thiele, eds., John Wiley and Sons, 2d. ed., 1998).

47 *See DirecTV 1994 Report*" at 6-15.

48 *See* L.V. Blake, *Antennas*, at 329 (Artech House, 1984).

49 *See* 2 *Antenna Handbook* § 12-10 (Y. T. Lo, ed., Van Nostrand Reihold, 1998).

Northpoint service area. By any standard, this should be considered *de minimus* and no further mitigation steps should be required.

However, there is a larger issue with the use of an automatic level control. The Northpoint system is a network of cells. With this architecture, turning off a single cell would have a ripple effect throughout the system creating unnecessary outages in areas where it is not raining. Northpoint will be typically carrying local news and information content, in contrast to DBS's typical entertainment programming, it would seem to be a poor public policy to require local services to be turned off just at the critical moment when they are needed most.

Therefore, Northpoint believes its impact on the DBS service is negligible in all weather conditions, a conclusion supported by Lucent Technologies[50]and thus, the use of a automatic level control is unnecessary and against the public interest.

Coordination between Northpoint and NGSO FSS– Northpoint will make available a database of transmit locations to operating NGSO FSS operators upon request, but it would be overly burdensome to require Northpoint to provide this information to companies whose satellites are not in operation.

Adjacent Northpoint license holders– Northpoint agrees with the proposal to allow adjacent licensees to develop their own sharing and protection criteria.

Technical requirements for Northpoint receive antennas–Northpoint disagrees with the proposal that its receive antennas have a minimum unidirectional gain of 34 dBi. Such a rule serves no purpose and reduces the flexibility and future innovation of Northpoint system operators.

Technical requirements for Northpoint transmit antennas–The Commission suggests that Northpoint transmit antennas generally point south. This requirement is an unnecessary restraint on Northpoint system deployment and would actually in some cases provide less protection to DBS.[51] A far

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[50] *See* Lucent Technologies, Bell Labs Report on Northpoint Technologies Field Trial in Washington DC Sept-Oct 1999, attached to October 25, 1999 Ex Parte filed by Diversified Communications Engineering and Northpoint Technologies in ET Docket No. 98-206

[51] Northpoint's patented technology calls for transmitting terrestrial signals on a different path than that which is taken by the co-channel satellite service. For geographic areas on both coasts, optimal

better approach is to use the EPFD limit advocated by Northpoint, as this limit would provide the needed protection to all DBS receivers regardless of their location.

3. Northpoint Sharing with NGSO FSS

In comments to the first NPRM in this docket, Northpoint proposed that the FCC adopt certain PFD limits to protect Northpoint from NGSO FSS operations. The Commission proposes to adopt these PFD limits, and we agree with this decision.

To protect NGSO FSS, the Commission proposes to limit Northpoint to 12.5 dBm EIRP in urban areas, with a few exceptions. The choice of 12.5 dBm is not an appropriate standard. Limiting Northpoint to 12.5 dBm is unnecessary and would disserve the public; it will lead to a 50% increase in the number of Northpoint transmitters in urban areas, without benefit to any system.[52] This increased number of transmitters will actually disadvantage future NGSO FSS systems as each Northpoint transmit location will require additional steps on the part of NGSO FSS when installing customers at this site. Thus, fewer Northpoint transmit locations are preferable to both NGSO FSS and Northpoint.

This EIRP limit rule unnecessarily restricts the Northpoint system. As noted in paragraph 234, the Commission considered and rejected suggestions that would unnecessarily constrain the design of NGSO systems, because they did not provide any benefit, as the EPFD limit completely defined the protection requirements for DBS. This is the same issue, because the terrestrial EPFD can completely define the protection requirements.

To establish a rule limiting the EIRP of terrestrial systems to 12.5 dBm would preclude improvements in antenna or other technology that would allow terrestrial systems to increase their reliability and coverage with no disadvantage to DBS systems or NGSO FSS. As another example, the Commission states: "We believe that reducing PFD limits for satellites that

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transmit paths might be other than southerly, as demonstrated in Northpoint's Washington testing where non-interfering transmissions were made along an easterly and westerly direction.

[52] For example, in the Washington DC conceptual deployment enclosed, 12 out of 25 transmitters have EIRP of greater than 12.5 dBm, some as high as 9.5 dBm.

may transmit at low-earth angles is preferable to establishing a minimum elevation angle for downlinks in the 12.2-12.7 GHz band because those limits would allow low-earth-orbit (LEO) systems to operate at a greater range of angles to the earth."[53] In another example, the Commission considered and rejected similar constraints on NGSO FSS for sharing with DBS ("we find that imposing an additional GSO arc avoidance requirement would be an unnecessary constraint on the design of NGSO FSS systems").[54] In the case of NGSO FSS sharing with DBS, no such criteria were adopted. Instead, single-entry EPFD limits were adopted.

We believe the Northpoint EPFD limits to protect DBS will also provide sufficient protection to NGSO FSS. The EPFD and the PFD are related by the following equation:

$$EPFD = PFD + (Gr(\phi) - Grmax).$$

In words, the EPFD is equal to the PFD, plus the isolation in the antenna towards the interferer. In the case of DBS, the isolation ranges between 34 and 50 dB. Hence, the Northpoint EPFD can be equated to the PFD values that may only be exceeded in a tiny fraction of the populated portion of the Northpoint service area. The PFD levels are consistent with analysis presented by Northpoint in ET Docket 98-206.[55]

Table 7: PFD Values Associated with Northpoint EPFD

Location in U.S.	PFD (dBW/m^2 – 40 kHz)
Southeastern U.S. (FL, GA, AL, MS, LA)	-122.7 to -106.7
Southern U.S. (NM, TX, OK, AR, TN, SC, NC)	-123.7 to -108.7
Northeastern U.S. (ND-KS-VA-ME)	-126.5 to -110.5
Western U.S. (CA-AZ-CO-MT-WA)	-129.0 to -113.0

[53] *First Report and Order and FNPRM* ¶ 279.

[54] *Id.* ¶ 234.

[55] *See generally* Technical Annex to Comments of Northpoint Technology (filed Mar. 2, 1999).

These PFD levels would be exceeded in far less than 0.5% of the Northpoint service area, in an urban environment. Thus, the EPFD is a practical limit on the interference power into NGSO FSS.

Because these power levels are consistent with other analysis presented, it is functionally equivalent to the 12.5 dBm limit suggested by the Commission. However, the Northpoint EPFD will allow Northpoint EIRP greater than 12.5 dBm, without increasing interference into NGSO FSS systems. This could occur under the following conditions:

- Near a large unpopulated area;
- Transmitters located at heights above average terrain (HAAT) greater than 300 feet; or
- Improvements in transmit antenna technology.

Thus the Commission should not adopt an urban EIRP limit for Northpoint, because the EPFD limit will provide sufficient protection to NGSO FSS systems.

CERTIFICATION

I, Robert A. Combs, am Director, System Development for Broadwave USA, Inc. I have a Masters in Communication Systems Engineering from the University of Virginia, and a BS in Aerospace Engineering from the University of Texas (Austin). I am familiar with the technical and operational characteristics of the Northpoint system.

I certify that I am the technically qualified person responsible for the preparation of the technical material in this filing. The contents are complete and accurate to the best of my knowledge.

R Combs

Robert A. Combs
Director, System Development
Broadwave USA, Inc.

Dated: March 12, 2001

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US OFFICE PRODUCTS

Annex A: Methodology for estimating C/I ratio given an allowable increase in outage.

This methodology uses a spreadsheet to estimate a C/I ratio based upon an allowable increase in outage. There are three steps in the methodology:

1. Enter the input assumptions in column C of the spreadsheet.
2. Calculate the DBS system availability in cell C5 by using the "Goal Seek" function of Excel. Set cell C71 ("C/N+I margin above outage condition for availability percentage of the time") equal to zero by changing cell C5. This maximizes the availability of the DBS system.
3. In cell B7 or B8, enter the increase in outage hours, or percent increase in unavailability desired. Column D calculates the estimated C/I to cause the percent increase.

The following tables provide a sample calculation, as well as the formulae required. A soft version of this program, including functions "Distance" and "Rec_618_6" are available by request, send requests to Antoinette Cook Bush, Northpoint Technology, 400 N. Capitol St. N.W. Washington, DC 20001.

Example Calculations:

	A	B	C	D
1			**Availability Calculation**	**C/I Estimation**
2	BSS Assignment characteristics	**Units**	**US-GSO 1(a)**	**US-GSO 1(a)**
3	System Characteristics		Seattle	Seattle
4	Frequency	GHz	12.450	12.450
5	Availability objective	%	99.9427	99.9427
6	Outage Hours per Year	hrs	5.03	5.03
7	Increase in outage hours	0.00		0.421
8	Percentage increase in unavailability	8.38%		8.38%
9	New Availability Objective			99.9379
10				
11				
12	Receiver noise Bandwidth	MHz	24	24
13	Modulation type		QPSK	QPSK
14	C/I due to other GSO BSS networks	dB	20.7	20.7
15	C(faded)/I(unfaded) due to Northpoint for Percentage increase in unavailability	dB	96.7	17.8
16	Clear sky C/I due to Northpoint required for Percentage increase in unavailability	dB	99.0	20.0
17	Clear sky feeder link C/N+I	dB	24.2	24.2
18				
19	C/N+I required at the outage condition	dB	3.5	3.5
20	Clear sky C/N+I margin above outage condition	dB	5.0	4.6
21				
22				
23				
24				
25				
26				
27	Space station characteristics			
28	Longitude	°	101W	101W
29	Satellite e.i.r.p. in the direction of the earth station	dBW	48.0	48.0
30	Earth station characteristics			

ANNEX A

31	Receive antenna diameter	cm	45	45
32	Receive antenna efficiency	%	70	70
33	On-axis antenna gain at receiver input	dBi	33.8	33.8
34	On-axis antenna gain at antenna output			
35				
36	Clear sky receive system noise temperature at receiver input	K	125	125
37	Clear sky receive system noise temperature at antenna output	K		
38	Clear sky G/T	dB/K	12.9	12.9
39	Total pointing loss	dB	0.5	0.5
40	Rain Rate	mm/hr	35.9	35.9
41	Latitude	°	47.6	47.6
42	Longitude	°	122.3W	122.3W
43	Altitude	km	0.0	0.0
44				
45	Elevation angle	°	31.5	31.5
46	Propagation characteristics		Seattle	Seattle
47	Slant path	km	38479	38479
48	Free space loss	dB	206.0	206.0
49	Atmospheric absorption	dB	0.20	0.20
50	Rain attenuation for 99.7% of the time		0.000	0.873
51	Noise increase due to rain for 99.7 % of the time		0.000	1.531
52				
53	Rain attenuation for availability percentage of time	dB	2.344	2.243
54	Noise increase due to rain for availability percentage of time	dB	2.939	2.869
55	Downlink budget clear sky			
56	C/N thermal clear sky downlink	dB	8.9	8.9
57	C/N+I clear sky downlink	dB	8.6	8.1
58	C/N+I clear sky total link	dB	8.5	8.0
59	Clear sky C/N downlink margin above outage condition		5.4	5.4
60	Clear sky C/N+I downlink margin above outage condition		5.1	4.6
61	Clear sky C/N+I total margin above outage condition	dB	5.0	4.5
62	Downlink budget 99.7% of the time			
63	C/N thermal for 99.7% of the time, downlink		8.90	6.50
64	C/N+I for 99.7% of the time, downlink		8.63	6.04
65	C/N margin above outage condition for 99.7% of the time, downlink		5.40	3.00
66	C/N+I margin above outage condition threshold for 99.7% of the time, downlink		5.13	2.54
67	Link budget for availability percentage of time			
68	C/N thermal for availability percentage of time, downlink	dB	3.62	3.79
69	C/N+I for availability percentage of time	dB	3.5	3.5
70	C/N margin above outage condition for availability percentage of the time, downlink	dB	0.1	0.3
71	C/N+I margin above outage condition for availability percentage of the time	dB	0.0	0.0
72	Decrease in link margin due to Northpoint	dB	-	0.17