Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	IB Docket No. 00-248
	)	
2000 Biennial Regulatory Review--	)	
Streamlining and Other Revisions of Part 25 of	)	
the Commission's Rules Governing the Licensing	)	
of, and Spectrum Usage by, Satellite Network	)	
Earth Stations and Space Stations	)	

JOINT COMMENTS OF HUGHES NETWORK SYSTEMS, HUGHES COMMUNICATIONS, INC. AND HUGHES COMMUNICATIONS GALAXY, INC.

Gary M. Epstein
John P. Janka
Dori K. Bailey
LATHAM & WATKINS
555 Eleventh Street, N.W.
Suite 1000
Washington, D.C. 20004-1304
(202) 637-2200

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Hughes Network Systems, Hughes Communications, Inc. and Hughes Communications Galaxy, Inc. (together "*Hughes*") hereby comment on the Commission's Notice of Proposed Rule Making[1] in this proceeding. Hughes is interested in this proceeding for a number of reasons. Hughes Network Systems is a leading manufacturer of C and Ku band earth station equipment and the operator of the two-way DirecPC Ku band high-speed satellite broadband service. Hughes also has significant interests in the Ka band. Hughes Communications Galaxy, Inc. is the licensee of the SPACEWAY satellite system and Hughes Communications, Inc. is the applicant for the SpacewayEXP and Spaceway NGSO Ka band satellite systems.

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1 *In the Matter of 2000 Biennial Regulatory Review – Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by,*

In addition, Hughes Communications, Inc. is the applicant for two Ku band NGSO FSS satellite systems---HughesLINK and HughesNET. (Application of Hughes Communications, Inc. for the HughesLINK Satellite System, FCC File No. SAT-LOA-19990108-00002 (filed January 8, 1999); Application of Hughes Communications, Inc. for the HughesNET Satellite System, FCC File No. SAT-LOA-19990108-00003 (filed January 8, 1999)).

I. INTRODUCTION AND SUMMARY

Hughes generally supports the Commission's proposals to streamline the processing of earth station applications. The proposed changes to the Commission's regulatory process appropriately respond to advances in technology, wider use of very small aperture terminals ("*VSATs*"), digitization of satellite services, and the increased use of satellite services by households and businesses. As the pioneer of the development and use of VSAT satellite networks, and the leading provider and manufacturer of those networks today in the U.S. and internationally, Hughes can attest to the rapid changes in VSAT technology and VSAT deployment.

VSAT satellite networks are ubiquitous throughout the U.S. and are a critical element in the telecommunications infrastructure that supports economic growth in this country. These networks provide rapid, reliable satellite transmission of data, voice, and video to geographically dispersed sites and are used by a wide range of industries to provide cost-effective business services. As the Commission well knows, VSAT networks historically have been used for linking internal business data networks, point-of-service credit verification, multimedia image transfer, and broadcast data and video communications. In the past few years,

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Satellite Network Earth Stations and Space Stations, FCC 00-435 (released Dec. 14, 2000) ("*NPRM*").

advances in technology have allowed VSATs also to be used to provide broadband service directly to consumers and small businesses.

As the operator of the DirecPC Ku band satellite broadband service, Hughes today offers two-way broadband services throughout the U.S., to businesses and households in urban areas as well as to parts of the U.S. that will be unserved or underserved by terrestrial technologies. Many of these users simply would not have the capability to access broadband capacity were it not for the technological advances achieved by the satellite industry.

As the Commission notes in the NPRM, advances in transmitter and receiver technology have permitted the use of smaller aperture VSAT earth station antennas while still maintaining service performance. These smaller antennas are less expensive, can be installed in a much wider range of locations, and are more attractive to the end user than ever before.[2] It is these very technological advances that have paved the way for the provision by satellite of broadband service to consumers who would not otherwise be able to receive those services.

Not surprisingly, because the Commission's rules are based on antenna technology that is over a decade old, these technological advances have resulted in an increase in the number of applications for earth stations defined as "non-routine." In response, the Commission has been employing an *ad hoc* licensing approach that allows these applications to be granted and this new technology to be deployed. Hughes commends the Commission for issuing this NPRM in an effort to further streamline the processing of these types of applications.[3] Hughes believes, however, that a number of these proposals do not go far enough to accommodate these advances in VSAT technology, or to allow service providers to translate these technological advances into consumer benefits in the form of better service at lower prices.

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[2] *See generally* NPRM ¶ 12.

In order to facilitate the provision of these benefits to consumers, Hughes is proposing a supplement to the proposals outlined in the NPRM. As an addition to the Commission's proposals to streamline the processing of non-routine earth station applications, Hughes proposes to modify the current rules to include some of these smaller (less than 1.2 meter) VSAT antennas in the category of "routine" Ku band earth station applications. This change would represent an important advancement of the Commission's rules based on the technological evolution of earth station and satellite technology, and would provide a concomitant benefit to consumers and the public interest.

II. OVERVIEW OF HUGHES' PROPOSED SUPPLEMENT TO THE COMMISSION'S PROPOSALS

Almost twenty years ago, the Commission instituted a two-degree orbital spacing policy to maximize the number of satellites in orbit.[4] Within this two-degree framework, and as a means of minimizing the potential for interference to adjacent satellite systems, the Commission established technical rules with respect to the power of the earth station transmissions and the size of the earth station antenna.[5] Earth station applicants that meet these technical requirements are "routinely" licensed by the Commission. All other earth station applicants are considered "non-routine" and require processing on a case-by-case basis.[6] "Non-

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3 *See* NPRM, § III.

4 NPRM ¶ 7 (citing *Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations*, Report and Order, CC Docket No. 81-704, FCC 83-184, 54 Rad. Reg. 2d 577 (released Aug. 16, 1983); *Licensing Space Stations in the Domestic Fixed-Satellite Service*, 48 F.R. 40233 (Sept. 6, 1983)).

5 *See generally* 47 C.F.R. Part 25.

6 NPRM ¶ 7.

routine" terminals currently include antennas that are less than 1.2 meters in the Ku band and less than 4.5 meters in the C band.[7]

In the NPRM, the Commission makes several proposals to streamline the processing of non-routine earth station applications. Although these proposals are an important step in streamlining the processing of earth stations, Hughes believes that a more fundamental change to the rules in Part 25 is now appropriate. Thus, Hughes proposes to supplement the Commission's proposals by expanding the category of "routinely" processed earth stations to incorporate not only the advances in technology that have already taken place in the satellite industry since the time when the rules were first developed, but also the continuing improvements in technology.

When the Commission first instituted the Part 25 rules, the prospect of deploying a 66 or 74 centimeter antenna in the Ku band was simply not envisioned. At present, the industry has deployed tens of thousands of 74 and 66 centimeter VSAT antennas, and the trend toward smaller, more efficient terminals has gained momentum. In order to address this rapidly changing technological environment, Hughes proposes that the definition of "routine" earth station applications for operation in the Ku band be expanded to include those VSAT earth stations that conform to the following requirements: (i) in the receive direction, meet a modified form of the antenna gain pattern rules currently codified in Section 25.209(a)(1), and (ii) in the transmit direction, meet an off-axis equivalent isotropically radiated power ("EIRP") density mask, similar to the Ka band rules in Section 25.138 of the Commission's Rules.[8]

Specifically, Hughes proposes to modify the antenna gain pattern rules for the Ku band by beginning the off-axis angle at 1.8 degrees rather than 1 degree. This change is

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[7] NPRM ¶ 11.

appropriate because advances in technology have permitted smaller earth stations to comply with a side lobe envelope beginning at 1.8 degrees off-axis. As the Commission recognized almost ten years ago with respect to the 1.2 meter antenna, "[a]lthough an antenna 1.2 meters in diameter does not fit within the envelope established in Section 25.209(a)(1) between 1 degree and 1.25 degrees off-axis, . . . this slight failure to meet the Commission's antenna gain standards does not generally cause unacceptable interference."[9] Therefore, the Commission revised the side lobe envelope for a 1.2 meter antenna operating in the Ku band to begin at 1.25 degrees off-axis instead of 1 degree off-axis.[10]

Hughes' proposal is a logical next step to the action taken almost ten years ago for 1.2 meter antennas in the Ku band. Advances in earth station and satellite technology over the past ten years have resulted in antennas smaller than 1.2 meters that can meet a side lobe envelope beginning at 1.8 degrees off-axis. Antennas that conform to an antenna gain pattern beginning at 1.8 degrees off-axis, by definition, are fully consistent with the Commission's two degree spacing requirement and, therefore, will not cause harmful interference to adjacent satellite systems. Thus, antennas less than 1.2 meters in diameter in the Ku band that comply with a side lobe envelope beginning at 1.8 degrees off-axis should be considered "routine" and should not require additional review by the Commission.

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8 *See infra* §III.

9 NPRM ¶ 11 n.19 (citing 47 C.F.R. § 25.209(g); *Amendment of Part 25 of the Commission's Rules and regulations to Reduce Alien Carrier Interference Between Fixed-Satellites at Reduced Orbital Spacings and to Revise Application Procedures for Satellite Communication Services*, Second Report and Order and Further Notice of Proposed Rulemaking, CC Docket No. 86-496, 8 FCC Rcd 1316, 1322, ¶¶ 38-39 (1993)).

10 *Id.*

III. THE COMMISSION'S PROPOSALS FOR STREAMLINING THE PROCESSING OF "NON-ROUTINE" EARTH STATION APPLICATIONS SHOULD BE SUPPLEMENTED BY THE HUGHES PROPOSAL

A. The Current Section 25.209 Antenna Gain Pattern Rules Should Be Revised to Include Smaller Antennas

The Commission proposes that an earth station applicant with a non-routine antenna gain pattern may receive streamlined processing by (1) reducing its power to a level that would be produced if the maximum allowable power were transmitted by an antenna that complies with the two-degree spacing standards, and/or (2) submitting affidavits from space station operators.[11] These affidavits would indicate that the space station operators have coordinated the earth station's proposed non-routine operations with all other affected satellite systems and that they will continue to reflect those non-routine operations in future coordination discussions.[12] In addition, the Commission proposes that a non-routine earth station applicant wishing to obtain interference protection would be required to submit affidavits from the applicable satellite systems.[13]

This streamlined approach would replace the current system of requiring applicants with antenna gain patterns that do not conform to the current Section 25.209(a)(1) to submit technical studies in the form of an analysis using the Adjacent Satellite Interference Analysis ("*ASIA*") program.[14] As noted by the Commission, the ASIA requirement is a burdensome process that is both time consuming and difficult to perform. The data required to perform the analysis must be obtained from various sources, the results of an ASIA study can be subject to varying interpretations, and the findings of the study also must be coordinated with

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11 NPRM ¶ 8.

12 NPRM ¶ 14.

13 NPRM ¶ 8.

adjacent satellite operators. As a result, in Hughes' experience, the ASIA requirement often delays the introduction of technological advances and new services to the public.[15]

To implement the first option of the streamlining proposals, the Commission proposes creating a new Section 25.220 for non-routine earth stations that requires an EIRP density vs. off-axis angle criterion beginning at 1 degree off-axis. According to the Commission, this criterion will permit the off-axis EIRP density of a non-routine earth station to be maintained at a level equivalent to that provided by routine earth stations at 2 degrees and beyond.[16] The Commission notes that very small antennas at these low power levels might be practical for satellite-delivered Internet services.[17]

It is Hughes' experience that reducing power levels to the low level required to comply with the 1 or 1.25 degree off-axis requirements would not encompass the two way DirecPC satellite broadband service. Thus, Hughes proposes that the Commission revise its antenna mask for the Ku band so that it starts at 1.8 degrees. This change would accommodate the use of VSAT antennas as small as 66 cm or 74 cm that are well-suited for satellite delivery of Internet services to consumers and businesses and would not increase the interference environment for adjacent satellite systems.

Hughes generally supports the desire of the Commission to streamline the processing of non-routine earth station applications. However, to spread the development of satellite broadband services to consumers and small businesses, Hughes proposes to supplement the Commission's proposals by expanding the definition of routine earth stations for the Ku band

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14 NPRM ¶¶ 8, 13.

15 NPRM ¶13.

16 NPRM ¶ 15.

17 NPRM ¶ 18.

to include those VSAT earth stations that comply with the following requirements: (i) in the receive direction, meet a modified form of the antenna gain pattern rules currently codified in Section 25.209(a)(1) and (ii) in the transmit direction, meet an off-axis EIRP density mask, similar to the Ka band rules in Section 25.138 of the Commission's Rules.

The current Ku band rules were promulgated at a time when VSAT satellite technology was still in its early stages. As a result of the dramatic technological advances achieved over the ensuing years, earth station antennas once considered non-routine no longer present interference issues. Thus, there is no need for time-consuming and burdensome consequences resulting from a case-by-case review of applications for these antennas. Instead, smaller earth stations should be able to be processed "routinely" as long as the parameters are consistent with the Commission's two-degree spacing criteria. To this end, Hughes recommends that the relevant off-axis angle criteria begin at 1.8 degrees rather than 1 or 1.25 degrees as currently provided.

Specifically, Hughes proposes that the antenna patterns in Section 25.209(a)(1) be modified as follows with respect to the Ku band:[18]

(a) The gain of any antenna to be employed by an earth station in the geostationary satellite orbit fixed-satellite service shall lie below the envelope defined below:

(1)(i) In the case of bands other than the 12/14 GHz band, in the plane of the geostationary orbit as it appears at the particular earth station location:

$29 - 25 \log_{10}(\theta)$	dBi	for	$1° \leq \theta \leq 7°$
+ 8	dBi	for	$7° < \theta \leq 9.2°$
$32 - 25 \log_{10}(\theta)$	dBi	for	$9.2° < \theta \leq 48°$
-10	dBi	for	$48° < \theta \leq 180°$

where θ is the angle in degrees from the axis of the main lobe, and dBi refers to dB relative to an isotropic radiator. For the purposes of this section, the peak gain

18 Appendix B contains a complete version of Section 25.209 reflecting these and certain other changes that are consistent with these Comments.

of an individual sidelobe may not exceed the envelope defined above for θ between 1.0 and 7.0 degrees. For θ greater than 7.0 degrees, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the gain envelope given above by more than 3 dB.

(ii) In the case of the 12/14 GHz band, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

$29 - 25 \log_{10}(\theta)$	dBi	for	$1.8° \leq \theta \leq 7°$
$+8$	dBi	for	$7° < \theta \leq 9.2°$
$32 - 25 \log_{10}(\theta)$	dBi	for	$9.2° < \theta \leq 48°$
0	dBi	for	$48° < \theta \leq 180°$

where θ is the angle in degrees from the axis of the main lobe, and dBi refers to dB relative to an isotropic radiator. For the purposes of this section, the peak gain of an individual sidelobe may not exceed the envelope defined above for θ between 1.8 and 7.0 degrees. For θ greater than 7.0 degrees, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the gain envelope given above by more than 3 dB.

The equation in clause (1)(ii) above contains two changes proposed by Hughes. First, the starting off-axis angle has been changed from 1 degree to 1.8 degrees because beginning the off-axis angle at 1 degree is unnecessarily restrictive. Currently, no satellites that serve the U.S. operate closer than 1.9 degrees. Therefore, beginning the off-axis angle at 1.8 degrees would alleviate any concerns regarding interference with respect to the adjacent satellites and also would be consistent with the Commission's two-degree spacing requirement.

In addition, the Commission currently permits 1.2 meter antennas in the Ku band to comply with a side lobe antenna gain pattern beginning at 1.25 degrees rather than 1 degree because the Commission found that this relaxed standard would not cause unacceptable interference to adjacent satellite systems. In that decision, the Commission determined that "relaxing" the Section 25.209(a)(1) mask would facilitate the wide deployment of the then-new 1.2 meter antennas.[19] As we have noted above, technology is continuing to evolve. Therefore, a

[19] *See generally* NPRM ¶ 11 n.19.

further relaxation of the Section 25.209 mask, by beginning the off-axis angle at 1.8 degrees, is consistent with the Commission's policy of relaxing the antenna gain pattern standards in order to reflect advances in technology that permit smaller antennas to operate without resulting in increased unacceptable interference.

The second change proposed by Hughes in clause (1)(ii) above is to replace the -10 dBi value in the last equation with 0 dBi for off-axis angles greater than 48 degrees. This would provide relief to the rise in the side lobes resulting from the spill over effect in the offset fed antennas. The Ku band is not shared with terrestrial services; thus, this change would not result in an increase in interference with respect to terrestrial service operators. In addition, the interference environment with respect to adjacent satellites would not be affected because the magnitude of the gain is not significant at angles greater than 48 degrees.

Hughes proposes that terminals that comply with the antenna gain mask proposed above should be "routinely" licensed and afforded protection from interference from satellite downlinks from other space stations located not closer than 1.9 degrees in the orbital arc.

Hughes also proposes that Section 25.134 be modified as follows for VSAT applicants seeking to transmit in the Ku band:[20]

(a) All applications for VSAT services in the 12/14 GHz band that meet the following requirements will be routinely processed:

(1) If the GSO FSS earth station antenna off-axis EIRP spectral density for co-polarized signals does not exceed the following values, under clear sky conditions, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

$15 - 25\log(\theta) - 10\log(N)$	dBW/4kHz	for	$1.8° \le \theta \le 7°$
$-6 - 10\log(N)$	dBW/4kHz	for	$7° < \theta \le 9.2°$
$18 - 25\log(\theta) - 10\log(N)$	dBW/4kHz	for	$9.2° < \theta \le 48°$
$-14 - 10\log(N)$	dBW/4kHz	for	$48° < \theta \le 180°$

[20] Appendix B contains a complete version of Section 25.134 reflecting these and certain other changes that are consistent with these Comments.

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

(i) For a VSAT network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.

(ii) For a VSAT network using code division multiple access (CDMA) technique, N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.

(2) If the GSO FSS earth station antenna off-axis EIRP spectral density for cross polarized signals does not exceed the following values, under clear sky conditions, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

$5 - 25 \log(\theta) - 10 \log(N)$	dBW/4 kHz	for	$1.8° \leq \theta \leq 7°$
$-16 - 10 \log(N)$	dBW/4 kHz	for	$7° < \theta \leq 9.2°$

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

(i) For a VSAT network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.

(ii) For a VSAT network using code division multiple access (CDMA) technique, N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.

This proposal permits a VSAT earth station applicant to optimize its transmit power and antenna mask to meet the permitted off-axis EIRP spectral density. Similarly, an earth station applicant will only be constrained by the combination of power density and antenna gain, rather than needing to satisfy each constraint individually.. In this way, earth stations would have the flexibility to adjust their power density depending on the nature of their antenna masks. Hughes' proposal to permit earth stations the flexibility to achieve a certain balance between power density and antenna gain patterns is similar to the Commission's rules for the Ka band as codified in Section 25.138.[21]

21 *See* 47 C.F.R. § 25.138.

This proposal provides the same level of adjacent satellite interference protection to two degree spaced spacecraft as the current rules. Thus, Hughes proposes that VSAT earth stations meeting the requirements of this revised Section 25.134 (as set forth more fully in Appendix B to these Comments) be processed "routinely" and receive an ALSAT earth station license.

B. The Interference Potential of Ku band Antennas Smaller Than 1.2 Meters is Unaffected by the Station Keeping Tolerances of Current Satellite Systems

Hughes believes that an increase in the number of antennas that do not conform to the current off-axis requirements of Section 25.209(a)(1) (i.e., are smaller than 1.2m) would not unreasonably increase the likelihood of unacceptable interference taking into consideration the station-keeping tolerances of existing satellite systems. As noted in the NPRM, Section 25.210(j)(1) establishes station-keeping requirements for satellites.[22] Specifically, a space station must be capable of maintaining its orbit within 0.05 degrees of its assigned orbital longitude.[23] Therefore, as the Commission recognized, interference from drifting satellites will not be a serious concern in most cases.[24]

The Commission notes that the station-keeping abilities of some non-U.S.-licensed satellites may not meet the same standards as U.S.-licensed satellites. In addition, the Commission indicates that it may relax the station-keeping standards in particular cases.[25] In Hughes' experience, satellites that are unable to conform to the station-keeping requirements of 25.210(j)(1) are those reaching end of life or those that result from a launch failure. Relaxation of the station-keeping standards in these cases is almost always temporary. Therefore, Hughes

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22 NPRM ¶ 27.

23 NPRM ¶ 27 n.34.

24 NPRM ¶ 27.

believes that the increased deployment of smaller antennas should not be hindered by the possibility of what appears to be both an uncommon and short-term issue.

C. An Increase in the Number of Ku band Antennas Smaller Than 1.2 Meters Would Not Adversely Impact Existing Coordination Agreements of Satellites Interleaved at 1 Degree Apart

As the Commission notes in the NPRM, satellites licensed by other countries are sometimes interleaved at 1 degree between U.S. satellites that are spaced at 2 degrees. There is no realistic threat of interference between these interleaved satellite networks because of geographic isolation, i.e., the footprints of these satellites do not overlap.[26] Hughes believes that an increase in the number of antennas that do not comply with the current antenna gain pattern envelope of Section 25.209(a)(1), but that do comply with Hughes proposals, would not adversely impact existing coordination agreements with respect to these satellites interleaved at 1 degree apart. Specifically, satellites with receive antennas that provide 20dB or more isolation from CONUS would not be adversely affected by an increase in the number of antennas that meet Hughes' proposed side lobe antenna gain pattern beginning at 1.8 degrees off-axis. In the NPRM, the Commission provides antenna patterns showing that an 85 cm antenna provides 35dB gain at 1 degree. This is 15 dB above the 29-25 $\log_{10}(\theta)$ envelope at 2 degrees.[27] Therefore, a spacecraft receive antenna isolation of 20 dB more than compensates for the increased VSAT antenna gain of 15 dB.

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[25] *Id.*

[26] NPRM ¶ 29.

[27] NPRM, App. A.

IV. THE COMMISSION SHOULD INCREASE THE MAXIMUM DOWNLINK EIRP SPECTRAL DENSITY LIMIT FOR DIGITAL OUTBOUND CARRIERS

As recognized by the Commission, earth station antenna diameters have decreased over the years but the power spectral density requirements of the Commission's Rules have remained the same.[28] As noted in the NPRM, a decrease in the size of the antenna will decrease the mainbeam antenna gain. As a result, a higher downlink EIRP density may be needed to close the satellite communication link.[29] Thus, an increase in the downlink EIRP density limit in certain circumstances would be an appropriate progression of the Commission's Rules and would respond to the advances in technology that have permitted the manufacture and deployment of smaller antennas.

Therefore, Hughes proposes to increase the maximum GSO FSS satellite EIRP spectral density limit for outbound digital modulated emissions from 6 dBW/4kHz to 9 dBW/4kHz. The proposed increase would permit the use of QPSK or higher modulation carriers with existing and smaller VSAT antennas. Hughes proposes this limit to be applicable to all digital carriers (other than single-carrier full transponder transmissions and dual-carrier full transponder transmissions, to which a higher power limit would apply.) Hughes does not agree with the Commission's proposed definition of "wideband."[30] Rather, Hughes proposes to define as "wideband" any carriers with a bandwidth greater than 5 MHz. These proposals are set forth more fully in Appendix B to these Comments.

The proposed increase to 9dBW/4kHz, even if applied to all VSAT related outroute carriers (those carriers transmitted by a hub earth station and received by VSATs),

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[28] NPRM ¶ 39.

[29] NPRM ¶ 40.

[30] NPRM, App. B, §25.201.

would not cause unacceptable levels of harmful interference to existing systems operating under the 6 dBW/4kHz limit. A typical VSAT link budget for the outroute transmission, BPSK modulated, rate ½ Forward Error Correcting (FEC) coding, would be designed for 99.7 % propagation availability.[31] For a typical site in Crane Rain Region D2, this implies about 2.0 dB of clear-sky link margin, including the effect of added sky noise during rain. Under clear-sky conditions, the total noise contribution from the four adjacent satellite systems[32] accounts for about 11% of the total noise budget, assuming that the wanted carrier and the carriers operating on the adjacent satellites are all transmitting at 6dBW/4kHz downlink EIRP density. This also assumes that the receiving antenna just exactly meets the requisite sidelobe envelope. Increasing the adjacent carriers to 9 dBW/4kHz while leaving the wanted carrier unchanged would degrade the clear sky C/N[33] by 0.4 dB, and the faded C/N by 0.3 dB. This is a small increase that could be accommodated by most systems and which results from the worst-case scenario of all adjacent carriers at the 9dBW/4kHz level.

Current GSO FSS satellites exhibit peak EIRPs in the range of 49 to 52 dBW and have transponder bandwidths of 27 to 54 MHz, with 36 MHz being most common. The operation of 36 MHz transponders at an EIRP spectral density of 6 dBW/4kHz results in substantial underutilization of the available power. Although operation with many carriers requires transponder output backoff in the 3 to 4 dB range, the use of 2 to 3 carriers makes it feasible to operate closer to saturation. If the transponder is operated in a single carrier saturation mode, then a 27 MHz wide transponder carrier with a peak EIRP of 52 dBW will

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31 Separate margin allowances would be included for antenna pointing errors and various other static degradations. These are not included in this discussion.

32 Those satellite systems that are 2 degrees and 4 degrees to either side.

33 C/N refers to the carrier to noise ratio.

produce a maximum EIRP density of 13.7 dBW/4kHz. Using 36 MHz wide transponder bandwidth with the same peak EIRP will result in a maximum EIRP density of 12.5 dBW/4kHz. Hughes proposes that the FCC adopt a maximum EIRP density of 13.0 dBW/4kHz for single-carrier full-transponder and dual-carrier full-transponder digital transmissions that would be eligible for routine licensing. This change is covered in Hughes' proposed modifications to Section 25.211 of the Commission's Rules, as described in Appendix B to these Comments.

Based on the above analysis, the Commission should increase the maximum GSO FSS satellite EIRP spectral density limit for digital modulated emissions from 6 dBW/4kHz to 9 dBW/4kHz for digital outbound carriers in general. For digital signals operated in a single-carrier, full-transponder mode, or a dual-carrier, full-transponder mode, the maximum GSO FSS satellite EIRP spectral density limit should be increased to 13.0 dBW/4kHz.

V. THE COMMISSION SHOULD EXTEND THE TERM OF EARTH STATION LICENSES TO 15 YEARS

The Commission proposes to extend the license term for all earth stations from 10 years to 15 years, and similarly to extend the term for receive-only registrations to 15 years.[34] Hughes supports these proposals to extend both the license term for earth stations and the registration term for receive-only terminals to 15 years.

However, the Commission currently has a rule that requires registrants of receive-only earth stations in bands that are shared with terrestrial users to notify the Commission when a station has not been used during any 6-month period.[35] Hughes believes that this rule is unwarranted and burdensome and should be deleted. Hughes is not aware of any evidence to

[34] NPRM ¶¶ 44-45.

[35] 47 C.F.R. §25.131(i).

indicate that registered receive-only terminals are typically unused for periods of 6 months or longer.

In a market in which earth station operators and terrestrial operators are sometimes competing to deliver communications services, the Commission's rule provides an unfair advantage to the terrestrial users. The delivery of communications services is a highly competitive environment, and any imbalance in the regulatory burdens toward one particular industry could significantly impact the marketplace.

This notification rule for registrants of receive-only terminals in bands shared with terrestrial services is a burdensome requirement and is not necessary in any event. Therefore, the rule should be deleted as part of the Commission's regulatory streamlining effort.

Receive-only terminals in the Ku band are not covered by this rule because the Ku band is not shared with terrestrial users, and receive-only terminals are not registered in this band. With regard to streamlined licensing of Ka band terminals in those portions of the Ka band shared with terrestrial services, the Commission has opened a separate proceeding addressing this issue.[36]

VI. THE COMMISSION'S PROPOSAL TO REDUCE THE POWER FOR RANDOM ACCESS VSAT NETWORKS IS UNNECESSARY AND OVERLY BURDENSOME.

The Commission proposes to revise Sections 25.134(a) and 24.212(d) of its rules to include the following language: "The maximum transmitter power spectral density of a digital modulated carrier into an GSO FSS earth station antenna shall not exceed –14.0 - 10 log(N) dB(W/4kHz)." In addition, Section 25.134(a) would specify different values of "N" for systems

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36 *In the Matter of FWCC Request for Declaratory Ruling on Partial-Band Licensing of Earth Stations in the Fixed-Satellite Service That Share Terrestrial Spectrum*, FCC 00-369 (released Oct. 24, 2000).

using TDMA, FDMA, CDMA or Aloha multiple access techniques.[37] The Commission proposes to require a reduction in the power spectral density emitted by earth stations using Aloha random access techniques by as much as 3 dB from the existing limits.[38]

The proposed limits on Aloha access in a TDMA or FDMA environment are unnecessary from a technical viewpoint.[39] A more detailed discussion of why the proposed limits on Aloha access are unnecessary is provided in Appendix A to these Comments. The main points of that analysis are summarized as follows: A typical VSAT link budget for the inroute transmission (transmitted from the VSAT) would be designed for 99.7% propagation availability.[40] For a typical site in Crane Rain Region D2, this implies about 1.7 dB of clear-sky link margin. The predominant modulation/coding schemes in use are PSK or MSK with rate ½ FEC coding. Under clear-sky conditions, the total noise contribution into this system from the four adjacent satellite systems[41] would account for about 12% of the total noise budget. This assumes that the VSATs operating on the adjacent satellites were all transmitting at -14dBW/4kHz input power density, and that the antennas just exactly meet the $29 - 25 \log_{10}(\theta)$ sidelobe envelope.

Hughes examines the case in which three of the four adjacent carriers have a 100% duty cycle, the fourth carrier is using the Aloha random access technique, and the Aloha carrier experiences a collision (all other combinations of Aloha and continuous carriers have a

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37 NPRM ¶ 55.

38 NRPM ¶ 56.

39 Hughes acknowledges that CDMA and CDMA/Aloha techniques may present unique issues, but these concerns simply do not apply in a TDMA mode.

40 Separate margin allowances also would be included for antenna pointing errors and various other static degradations. These are not relevant to this discussion.

41 Those satellite systems at 2 degrees and 4 degrees spacing on either side.

significantly lower probability of resulting in five simultaneous transmissions across four carriers).[42] The increased interference from the collision would degrade the link by 0.2 dB for the duration of the collision. This is well below the available clear-sky link margin and would be expected to cause negligible degradation in the bit error rate, unless the wanted carrier was already in a faded condition.

Clear-sky or minimally faded (fading less than 50% of the available margin) conditions can be expected to prevail for at least 90% of the time. Therefore, a carrier is *vulnerable to a collision* only 10% of the time. The *probability of a collision* occurring when two earth stations[43] are transmitting simultaneously is 4.9%.[44] Therefore, the *probability that an Aloha collision would cause harmful interference* to an adjacent satellite system is 0.49% or less than 1%. As noted in the NPRM, the Commission has already determined that a smaller than 1% probability of carrier collision would be acceptable.[45] Therefore, when the additional relevant factor of "vulnerability to a collision occurring" is taken into account, the probability that an Aloha collision would cause harmful interference is reduced to the point of negligibility.

Furthermore, the assumption of 100% duty cycle for the other adjacent carriers is overly conservative. Even for non-Aloha TDMA techniques (which are predominantly used in

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42 For instance, if an analysis was performed assuming all four carriers were using Aloha, the probability of five simultaneous transmissions would be lower because Aloha carriers have less than a 100% duty cycle. *See Appendix A hereto*.

43 The probability of a larger number of earth stations transmitting simultaneously is less than 1%, and therefore is not relevant to this analysis.

44 *In the Matter of Petition of Spacenet, Inc. for a Declaratory Ruling that Section 25.134 of the Commission's Rules Permits VSAT Remote Stations in the Fixed Satellite Service to Use Network Access Schemes that Allow Statistically Infrequent Overlapping Transmissions of Short Duration, or, in the Alternative, For Rulemaking to Amend that Section,* DA 00-2664, RM-9864 (released Dec 7, 2000), app. A, § II.

the Hughes VSAT products), the duty cycle is at most about 80% in practice and lower still in many actual networks. This lower duty cycle is a result of the traffic characteristics and the desire of customers for relatively short transmission delay. (The heavier a transmission channel is loaded, the longer the transmission delay. Furthermore, if traffic characteristics are random, it is difficult to load a TDMA transmission channel to 100% unless a significant backlog or queue is allowed to form. In real TDMA networks, 100% duty cycles are impractical.)

Therefore, this more realistic assumption regarding the duty cycle implies that three adjacent carriers assumed to be non-Aloha TDMA would be transmitting simultaneously only about 52% of the time, thereby reducing even more the fraction of time during which increased interference would be experienced. It is logical and consistent to consider this duty cycle, even though it is specific to TDMA access, because the treatment of Aloha in the proposed rule revision is also specific to this access technique. Hughes believes that continuous (i.e. - pure FDMA) carriers are rare in the VSAT environment and will continue to be so.

Any increase in the deployment of earth stations as a result of the Commission's streamlining proposals would not impact the above analysis. VSAT systems must be designed so that the collision rate is reasonably low or the service performance will be poor. Loading is determined by the ratio of the number of transmissions per second and the number of opportunities to transmit per second. The loading will remain constant regardless of the number of terminals. Therefore, if more terminals are deployed, then each terminal would have fewer transmissions per second.

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[45] *See* NPRM app. E, § III(E). "[U]nder the conditions proposed by the Spacenet (Poisson distribution with 38% channel load), we determine that a smaller than 1% probability of carrier collision would be acceptable as a good tradeoff."

In addition to the above technical analysis, Hughes can affirm from its own practical experience that the Commission's proposal to reduce the power for Aloha systems is unnecessary. Hughes currently operates over 100,000 VSAT terminals, and is not aware of any interference issues that are attributable to Aloha collisions. The Commission's proposal would be a radical change to the existing rules and appears to be a solution to a problem that does not exist.

The proposed limitation on Aloha systems would impose an unnecessarily stringent limit on the operation of VSAT networks, in effect limiting the overall link performance or introducing significant additional inefficiency into the system. The Hughes VSAT products have an inherent reliance on the Aloha technique. Although the extent of this reliance differs depending on the configuration of the network, the Aloha technique is regarded as indispensable to the current architecture.

Even if the existing system architecture were modified to incorporate dynamic power reduction when Aloha is used, adequate link performance still would need to be provided under the proposed reduced power condition. The Commission tentatively finds that a 3dB reduction in power still "would provide a technically viable service."[46] The Commission provides no evidence to support its contention of technical viability. To the contrary, Hughes can attest that this 3dB of excess link margin is not available for these purposes. VSAT networks do not have 3dB, or in many cases even 1dB, of *excess* link margin to be sacrificed for these purposes. Instead, if this power reduction were imposed, antenna sizes would need to be increased, or the systems would be limited to relatively bandwidth-inefficient modulation/coding schemes. In either case, the Commission's proposal to reduce the power for Aloha systems

[46] NPRM ¶ 56.

would result in an overly burdensome increase in system cost. In many cases, it would require an expensive and time consuming "retooling" of systems that have operated for years in reliance on existing Commission rules that do not preclude Aloha access.

Furthermore, the trend of the market is in the direction of smaller antennas and lower costs. These factors are extremely important to the continued growth of the industry. In addition, developments in satellite technology permit greater efficiencies when higher powers are used. For instance, newer spacecraft incorporate total North American coverage, which reduces satellite receive performance (compared with previous CONUS coverages). These newer satellites also use higher power transponders. Therefore, the bandwidth inefficiency that would result from the proposed reduction in power (e.g., by using more FEC coding to compensate) becomes even more problematic with newer spacecraft because poor use would be made of the available higher power.

If the Commission chooses to adopt the proposed rule revision, notwithstanding the above analysis, the Commission should grandfather the use of random access techniques for existing VSAT networks. These existing networks have been built out based on the current rules, which do not even address the use of Aloha. As noted above, the proposed rule revision will require Hughes to modify its existing system architecture. Even then, antenna sizes would need to be increased, or the systems would be limited to relatively bandwidth-inefficient modulation/coding schemes. Based on these required changes, the Commission's proposal to reduce the power for multiple access systems would result in a significant increase in the cost of operating existing VSAT networks. In accordance with the Commission's general policy[47] of

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[47] *See, e.g., Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz*

grandfathering existing licensees that have reasonably and justifiably relied on the Commission's rules in making substantial financial investments in their businesses, the Commission should grandfather these existing systems.

Hughes also believes that the Commission's proposal should not be adopted for the Ka band systems preparing for operations in the next year or two.[48] Hughes believes that it is premature to adopt restrictive rule revisions prior to the satellites being launched and an industry practice having developed in the Ka band.

VII. THE COMMISSION SHOULD ADOPT A STREAMLINED VERSION OF FORM 312 FOR ROUTINE EARTH STATION APPLICATIONS

Hughes generally supports the Commission's proposal to adopt a new streamlined version of Form 312 for routine earth station applications in the C band and the Ku band.[49] However, in order to receive routine processing and be eligible for the "auto-grant" process, the applicant must affirmatively respond to whether the proposed antenna complies with the antenna gain standard in Section 25.209(a) and (b).[50] As discussed above, Hughes is proposing a modification to the current antenna gain pattern rules of Section 25.209 and also to Section 25.134. Therefore, Hughes proposes that the new form be modified to incorporate its proposed changes to the antenna gain pattern.

Hughes believes that the current Form 312 should be phased out after a period of one year for routine applications, and supports retaining the existing Form 312 for non-routine

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Frequency Bands for Broadcast Satellite-Service Use, IB Docket No. 98-172, FCC 00-212, ¶63 (released June 22, 2000).

48 *See* NPRM ¶ 57.

49 *See* NPRM ¶ 68.

50 *See generally* NPRM ¶ 69; *see also* NPRM app. D, No. 03.

applications.[51] Hughes also supports permitting applicants to use the new form to request licenses to use bands other than the conventional C and Ku bands, such as the Ka band.[52]

VIII. THE COMMISSION SHOULD NOT REQUIRE MANDATORY ELECTRONIC FILING

The Commission proposes to accept only electronically filed applications for routine C band and routine Ku band applications after June 1, 2002 and to require the electronic filing of applications for assignments and transfers.[53] In addition, the Commission proposes to create an Internet filing form that would be used to accept electronically filed comments or petitions to deny.[54]

Although the Commission's desire to create a more comprehensive database and process applications more quickly is commendable and necessary, the Commission's current electronic filing system is still in the early stages and has been too unreliable to be the sole means of filing, particularly for petitions to deny that must be filed within a prescribed time period to be entitled to certain procedural rights and for applications that have to be filed by the close of a processing round. Indeed, an increase in the number of applicants using the system may cause further pressure on the electronic system and its capacity. Rather than making electronic filing the only means of filing, the Commission should continue to accept paper filings and perhaps require an electronic filing of the document within thirty days. In this way, the applicant is assured of a timely filing, and the Commission's goals could be satisfied as well. The Commission could review the maturity of the electronic filing system during the next Biennial Review.

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[51] *See* NPRM ¶ 69.

[52] *See* NPRM ¶ 70.

[53] NPRM ¶ 76

At this time, however, Hughes opposes the Commission's proposal to require mandatory electronic filing, especially as the only means of filing.

IX. ANY EXTENSION OF THE POWER LIMITS OF SECTIONS 25.211 AND 25.212 TO OTHER FSS BANDS MUST BE APPROPRIATE TO THE TYPE OF SERVICE

The Commission proposes to amend Sections 25.211 and 25.212 to state explicitly that the Commission may apply the power limits in these sections to other FSS bands to the extent power limits for these other bands have not been established.[55] While Hughes is sympathetic to the Commission's concern that appropriate power limits may need to be applied in the extended C band and expansion Ku band, Hughes is concerned that the Commission's proposal is vague and needs to be specifically tailored to identify the frequency bands to which it may apply. Otherwise, it is not possible to comment meaningfully on how or whether such an extension of these limits could have an adverse effect on certain services. For example, power limits imposed in a band to support the deployment of VSAT services should not automatically be extended to a band such as 13.75-14.0 GHz where VSATs currently are not permitted due to limitations in the Table of Frequency Allocations. Thus, Hughes recommends that the Commission either delete proposed Rule Sections 25.211(g) and 25.212(f), or else proposes that the application of Sections 25.211 and 25.212 be to specific additional parts of the C or Ku bands.

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[54] NPRM ¶77.

[55] NPRM ¶ 86. Presumably, this would exclude the Ka band where an earth station licensing proceeding just recently ended.

X. OTHER MATTERS

The NPRM and 46 C.F.R. § 25.134(a),(b) refer to a hub EIRP limit of 78.3 dBW without further description. Hughes believes that the rule should be clarified to indicate that the EIRP limit of 78.3 dBW relates to each carrier transmitted by the earth station.

As the Commission is aware, many antennas used today are elliptical in shape. That is, their equivalent diameter along the major axis (aligned with the GSO arc) is larger than it is along the minor axis. These antennas are attractive to service providers and end users because they provide the better sidelobe performance of a technically equivalent circular antenna without the larger physical size. Certain rules proposed by the Commission contemplate their application to elliptical antennas as they refer to "an antenna equivalent diameter [x] meters or greater."[56] In addition, the NPRM proposes a definition for computing the equivalent diameter of a circular aperture antenna when a non-circular, e.g., elliptical antenna, is used.[57] Appendix A of the NPRM discusses the impact of the Commission's proposals on certain sizes of antennas, based on the theoretical circular antenna patterns depicted there. To avoid any ambiguity in the future, Hughes requests that the Commission confirm that Appendix A to the NPRM is exemplary in nature, and nothing therein is intended to limit the size or shape of the antenna based on the circular aperture.[58]

Section 25.134(c) of the Commission's Rules currently provides that, *licensees* authorized pursuant to the Commission's proposed Section 25.220 "shall *bear the burden* of coordinating with any future applicants or licensees whose proposed compliant VSAT operations

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[56] *See, e.g.*, NPRM, app. B, §25.211(d).

[57] NPRM, app. B, §25.201.

[58] *See generally* NPRM, App. A.

. . . is potentially or actually affected by the operation of the non-compliant licensee."[59] Hughes recommends deleting Section 25.134(c) because it is inconsistent with the Commission's proposed Section 25.220, which provides that the satellite operators will coordinate with any future applicant or licensee.[60]

The Commission proposes in Section 25.134(d) that a VSAT licensee must follow the procedures proposed in Section 25.121(e)(3) in renewing its license.[61] In Section 25.121(e)(3), the Commission proposes that if a VSAT licensee does not bring all its licensed VSAT units into operation by the time of renewal, subsequent modification applications to add VSAT units will require prior authorization by the Commission.[62] This is a burdensome, unnecessary, and overly-regulatory requirement. Therefore, the Commission should not adopt this proposal.

In addition to the changes to Sections 25.134 and 25.209 described in detail above, Hughes recommends that the Commission make certain other changes to those rules, as well as certain changes to Section 25.201, 25.211, 25.212, and 25.220. These changes are all fully set forth in the proposed revisions attached as Appendix B to these Comments. Many of those changes are required to conform the existing rules, or the Commission's pending proposals, to the Hughes recommendations in these Comments.

XI. CONCLUSION

For the foregoing reasons, the Commission should grant the Hughes proposals to modify the existing antenna gain pattern rules to accommodate smaller antennas and to increase

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[59] NPRM, app. B §25.134(c); *See also* 47 C.F.R. § 25.134(c) (emphasis added).

[60] NPRM, app. B, §25.220.

[61] NPRM, app B, §25.134(d).

[62] NPRM, app. B, §25.121(e)(3).

the maximum downlink EIRP spectral density limit for digital outbound carriers. In addition, the Commission should adopt Hughes' proposed definition for "wideband" and those other changes to Part 25 described in Appendix B to these Comments.

The Commission should not adopt its proposal to require VSAT earth stations using Aloha random access and TDMA techniques to reduce their power. In addition, the Commission should not adopt its proposed notification requirement for registrants of receive-only terminals. The Commission also should not adopt its mandatory electronic filing proposal at this time.

Respectfully submitted,

HUGHES NETWORK SYSTEMS
HUGHES COMMUNICATIONS, INC.
HUGHES COMMUNICATIONS GALAXY, INC.

By: /s/ Dori K. Bailey
Gary M. Epstein
John P. Janka
Dori K. Bailey
LATHAM & WATKINS
555 Eleventh Street, N.W.
Suite 1000
Washington, D.C. 20004
(202) 637-1006

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Appendix A

Technical Analysis

I. DOWNLINK INTERFERENCE CALCULATIONS

In this section we present calculations for the case of a VSAT receiving a BPSK modulated carrier with rate ½ FEC coding, operating at a maximum downlink EIRP density of 6dBW/4kHz. We believe that this is typical of the vast majority of existing systems using small antennas, including two-way data VSAT networks and receive-only networks for music and data distribution. The design includes sufficient link margin to provide an availability of 99.7% or more. Interference noise, uplink and downlink receiver noise, and satellite intermodulation noise are all considered continuous sources and are accounted for specifically in the link noise budget. Excess attenuation and sky noise arising from rainfall are time-varying and are accounted for using an accepted propagation model such as the Crane (Global) Model[63] or CCIR Model[64].

Table 1 shows the results of some link budget calculations for VSAT receive stations in the four major climate zones covering the CONUS.[65] Signal parameters are as described above, and the design minimum carrier-to-noise ratio (C/N) is 3.5 dB, corresponding to a bit error rate (BER) after error correction of $1x10^{-7}$. The link has been adjusted in each case

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63 Crane, R.K. and D.W. Blood (1979) "Handbook for the Estimation of Microwave Propagation Effects - Link Calculations for Earth-Space Paths," Environmental Research and Technology Report No.1

64 CCIR (1986) Reports 563-3 and 564-3

65 The climate zones in the mountain and Pacific west and southwest are represented by D1. Using the actual model zones for these very dry areas yields unrealistically small link margins (i.e. less than 1dB); it would be impractical to implement systems using such low margins.

so that the link margin just exactly accommodates the 99.7% rain attenuation calculated by the model. This is of course the limiting case for each antenna size.

The second through fifth columns in Table 1 show the breakdown of noise components for the baseline case, where all adjacent satellite signals are operating at a maximum downlink EIRP density of 6dBW/4kHz, as is the wanted signal. The last two columns show the reduction in link margin for the wanted signal if all adjacent satellite signals are increased to a maximum downlink EIRP density of 9dBW/4kHz. Although there is some degradation with respect to the baseline, we believe that these minimal increases in noise could be accommodated by existing networks, especially considering that this is a worst-case with all adjacent signals at the higher level. Many operators would wish to take advantage of the increased limits to provide higher availability with their existing antennas. In many cases with the newer spacecraft, a maximum downlink EIRP density of 6dBW/4kHz results in using more transponder bandwidth than power on a percentage basis, so network operators could increase power utilization at no cost.

TABLE 1. NOISE BUDGET COMPONENTS - VSAT RECEIVE

					Margin Loss (dB)	
Crane Rain Zone	Uplink Thermal Noise	Downlink Thermal Noise	Downlink Adjacent Satellite	Other Noise	Clear Sky	Faded
D1	11%	70%	9%	10%	0.4	0.3
D2	13%	64%	11%	12%	0.4	0.3
D3	16%	56%	13%	14%	0.5	0.3
E	21%	49%	11%	19%	0.5	0.2

II. CALCULATIONS RELATING TO ALOHA TDMA

A. Probability of Simultaneous Transmissions On Adjacent Satellites

We can calculate the probability of N simultaneous transmissions across the four adjacent satellites of interest (at +/- 2 degrees and +/- 4 degrees) as a function of the number of Aloha or continuous (pure FDMA) cofrequency signals. The minimum number is four, corresponding to the limiting case of four FDMA signals and no Aloha signals; this case is of no interest as it is by definition compliant with the existing and proposed regulations. We first note that the case of one Aloha signal and three FDMA signals has been treated in the petition of Spacenet[66], which is cited in several locations in the NPRM. We extend this calculation to multiple cofrequency Aloha signals by observing that the same equation can be used to compute the number of simultaneous transmissions "k" across a number of carriers "M" provided that the loading factor used is the sum of the loadings of all M carriers. Thus, using the proposed maximum loading factor of 38% proposed by Spacenet, the calculation would be:

$$P[k] = ((0.38*M)^k/k!)*e^{(-0.38*M)}$$

Where P[k] is the probability of k simultaneous transmissions. While the range of interest for the total number of simultaneous transmissions across all four adjacent signals will run from 5 through 8[67], the quantity k in the equation above will be a function of the balance between FDMA and Aloha signals; k will range from 2 through 8. Table 2 shows the results. In fact, the only case of interest is that with one Aloha and three FDMA signals across the four adjacent satellites. Note that this is a worst-case calculation, since it assumes that a collision on any of the four adjacent satellites is equally harmful. However, collisions on the 4 degree

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66 Spacenet Petition for a Declaratory Ruling, filed April 5, 2000

67 The probabilities will be quite low by the time we reach 8.

adjacent satellites will have much less effect, because at 4 degrees the sidelobe envelope is at least 7.5 dB below the value at 2 degrees.

TABLE 2. PROBABILITY OF SIMULTANEOUS TRANSMISSIONS

Total Simultaneous Transmissions N	Number of Aloha Signals			
	1	2	3	4
	Number of FDMA Signals			
	3	2	1	0
5	4.937%	3.422%	2.251%	1.479%
6	0.625%	0.650%	0.513%	0.375%
7	0.059%	0.099%	0.097%	0.081%
8	0.005%	0.013%	0.016%	0.015%

B. Uplink Interference Calculations

In this section we present calculations for the case of a VSAT transmitting a PSK or MSK modulated carrier with rate ½ FEC coding, operating at a maximum uplink input power density of -14dBW/4kHz. We believe that this is typical of the vast majority of existing systems using small antennas for two-way data VSAT networks. The design includes sufficient link margin to provide an availability of 99.7% or more. Interference noise, uplink and downlink receiver noise, and satellite intermodulation noise are all considered continuous sources and are accounted for specifically in the link noise budget. Excess attenuation and sky noise arising from rainfall are time-varying and are accounted for using an accepted propagation model such as the Crane Model or CCIR Model.

Table 3 shows the results of some link budget calculations for VSAT transmit stations in the four major climate zones covering the CONUS. Signal parameters are as described above, and the design minimum carrier-to-noise ratio (C/N) is 3.5 dB, corresponding to a bit error rate (BER) after error correction of $1x10^{-7}$. The link has been adjusted in each case so that the link margin just exactly accommodates the 99.7% rain attenuation calculated by the model. This is of course the limiting case for each combination of antenna size and transmitter power.

The second through fifth columns in Table 3 show the breakdown of noise components for the baseline case, where all adjacent satellite signals are operating at a maximum uplink input power density of -14dBW/4kHz, as is the wanted signal. The interfering carriers are assumed to be located at the same uplink contour (on the "wanted" satellite) as is the wanted signal. The last two columns show the reduction in link margin for the wanted signal if one of the adjacent satellite signals is increased 3dB (corresponding to an Aloha collision involving two stations). The degradation is always significantly less than the link margin available in clear sky conditions. Clear sky conditions prevail for at least 90% of the time, at least as regards excess attenuation on the propagation path; in fact, the accepted propagation models show no measurable attenuation for approximately 99% of the time in the climates that exist in the U.S.

TABLE 3. NOISE BUDGET COMPONENTS - VSAT TRANSMIT

					Margin Loss (dB)	
Crane Rain Zone	Uplink Thermal Noise	Downlink Thermal Noise	Uplink Adjacent Satellite	Other Noise	Clear Sky	Faded
D1	56%	7%	11%	26%	0.2	0.2
D2	57%	7%	11%	25%	0.2	0.2
D3	58%	7%	12%	23%	0.2	0.2
E	54%	7%	17%	22%	0.3	0.3

C. Conclusions as to the Probability of Harmful Interference

Based on the combination of the calculations shown in (A) and (B) above, we conclude that at worst the probability of harmful interference arising from adjacent satellite Aloha collisions is less than the 1% threshold put forth by the Commission[68]. We arrive at this

68 NPRM, app. E

conclusion by observing that harmful interference will only take place when the wanted link is already partially faded, a condition that occurs no more than 10% of the time, and further that the probability of occurrence of the increased interfering level itself is expected to be in the range of 5% or less. Therefore the conjunction of these two conditions will occur less than 0.5% of the time.

D. Detailed Link Budgets

Following are detailed link budgets for the Rain Zone D2 cases. Table 4 is an outroute link calculation with all adjacent satellites at 6dBW/4kHz. Table 5 shows the same calculation with all adjacent satellites at 9dBW/4kHz. Table 6 is an inroute link budget with no collisions on any adjacent satellites (i.e. - each adjacent satellite has a single continuous cofrequency transmission from a VSAT meeting the sidelobe envelope and transmitting at an input power density of -14dBW/4kHz). Table 7 shows the same inroute calculation, but with one instance of a random-access collision on one of the 2 degree spaced satellites.

Table 4. Outroute Link Budget with 6dBW/4kHz Interference

23-Mar-01	OUTROUTE LINK BUDGET		
08:22 PM	Satellite:	Galaxy XI Horiz	
	1.00	m PES Located in	D2 Typical

	BASELINE PARAMETERS	Value	Unit
CARRIER DATA	Carrier Info Rate	512	Kbps
	FEC Code Rate	0.500	
	Crr Xmission Rate	1024	Kbps
	Min Reqd Ebt/No	3.5	dB
	No of bits/symbol	1.0	Bits
SATELLITE DATA	Satellite	Galaxy XI Horiz	
	Location	91.1	WL
	EIRP Contour at PES	47.1	dBW
	Relative EIRP Contour	-2.4	dB
	G/T Contour at Hub	3.0	dB/K
	Attenuator Setting	8.0	dB
	Transponder Gain	184.8	dB
	SFD	-88.5	dBW/m2
	Transponder Bandwidth	36.0	MHz
	Agg Input BO	8.2	dB
	Agg Output BO	3.5	dB
	Uplink Frequency	14.250	GHz
	Dnlink Frequency	11.950	GHz
GROUND SEGMENT DATA	Tx Antenna Dia	5.6	meters
	HPA Max Output Pwr	350.0	Watts
	Tx Antenna Gain	56.4	dBi
	Tx Pointing Losses	0.7	dB
	Rx Antenna Dia	1.00	meters
	Rx Clr Sky G/T	17.3	dB/K
RAIN MARGINS	Uplink Rain Attn	8.0	dB
	Dnlink Rain Attn	1.2	dB
	Up Fade Pwr Cntrl	8.0	dB
SITE GEOGRAPHIC DATA	Tx E/S Location	Minneapolis	
	Tx E/S Latitude	45.0	N
	Tx E/S Longitude	93.2	W
	Tx E/S Elev Angle	38	deg
	Rx E/S Location	D2 Typical	
	Rx E/S Elev Angle	46	deg
XPOL ISOLATION DATA	S/C Isolation	33.0	dB
	Tx E/S Isolation	35.0	dB
	Rx E/S Isolation	25.0	dB

SUMMARY	Value	Unit
% Avail S/C Power Reqd/Crr	3.0	%
% Xponder Bandwidth Reqd/Crr	4.5	%
Clear Sky Link Margin	1.8	dB

	LINK PERFORMANCE	Cl Sky	Up Fade	Dn Fade	Unit
UPLINK BUDGET	Satellite SFD	-88.5	-88.5	-88.5	dBW/m2
	Agg Input B.O.	8.2	8.2	8.2	Db
	Input Backoff/Crr	24.2	24.2	24.2	dB
	Crr Flux Density	-112.7	-112.7	-112.7	dBW/m2
	Gain of a Sq meter	44.5	44.5	44.5	dBi
	Uplink Path Losses	207.4	215.4	207.4	dB
	Carrier Up EIRP	50.1	58.1	50.1	dBW
	Satellite G/T	3.0	3.0	3.0	dB/K
	C/N Uplink	14.2	14.2	14.2	dB
DOWNLINK BUDGET	EIRP Contour	47.1	47.1	47.1	dBW
	Agg Output B.O.	3.5	3.5	3.5	dB
	Output Backoff/Crr	19.5	19.5	19.5	dB
	Carrier Dn EIRP	27.6	27.6	27.6	dBW
	Dnlink Path Losses	205.6	205.6	206.8	dB
	Rx Pointing Losses	0.5	0.5	0.5	dB
	Cl Sky E/S G/T	17.3	17.3	17.3	dB/K
	Degradation in G/T	0.0	0.0	1.4	dB
	C/N Downlink	7.2	7.2	4.6	dB
COMPOSITE LINK	C/N Uplink	14.2	14.2	14.2	dB
	C/N Downlink	7.2	7.2	4.6	dB
	C/I Intermod (Spacecraft)	18.3	18.3	18.3	dB
	C/I Uplink Adj Sat	21.4	21.4	21.4	dB
	C/I Dnlink Adj Sat	15.2	15.2	15.2	dB
	C/I Dnlink Adj Transponder	24.3	24.3	24.3	dB
	C/I Xpol	21.1	21.1	21.1	dB
	C/I Intermod (Transmit E/S)	34.0	18.0	34.0	dB
	C/(Nu,d)	6.4	6.4	4.2	dB
	C/(Nu,d,ims/c)	6.1	6.1	4.0	dB
	C/(Nu,d,im,i)Total	5.3	5.1	3.5	dB
	LINK MARGIN	1.8	1.6	0.0	dB

MODEM	Minimum Reqd Ebi/No	6.5	dB
	Minimum Reqd Ebt/No	3.5	dB
	10*log(Rbt/Noise BW)	0.0	dB
	Minimum Reqd C/N	3.5	dB
MISC LOSSES	Uplnk Free Sp Loss	207.1	dB
	Dnlnk Free Sp Loss	205.4	dB
	Uplink Atmos Attn	0.3	dB
	Dnlink Atmos Attn	0.2	dB

Dnlink EIRP Dens @ Beam Peak (49.5 dBW)	6.0	dBW/4kHz
FCC Limit for VSAT Blanket License	6.0	dBW/4kHz

Table 5. Outroute Link Budget with 9dBW/4kHz Interference

23-Mar-01	OUTROUTE LINK BUDGET		
08:26 PM	Satellite:	Galaxy XI Horiz	
	1.00 m PES Located in	D2 Typical	

	BASELINE PARAMETERS	Value	Unit
	Carrier Info Rate	512	Kbps
	FEC Code Rate	0.500	
	Crr Xmission Rate	1024	Kbps
CARRIER	Min Reqd Ebt/No	3.5	dB
DATA	No of bits/symbol	1.0	Bits
	Satellite	Galaxy XI Horiz	
	Location	91.1	WL
	EIRP Contour at PES	47.1	dBW
	Relative EIRP Contour	-2.4	dB
	G/T Contour at Hub	3.0	dB/K
	Attenuator Setting	8.0	dB
	Transponder Gain	184.8	dB
SATELLITE	SFD	-88.5	dBW/m2
DATA	Transponder Bandwidth	36.0	MHz
	Agg Input BO	8.2	dB
	Agg Output BO	3.5	dB
	Uplink Frequency	14.250	GHz
	Dnlink Frequency	11.950	GHz
	Tx Antenna Dia	5.6	meters
	HPA Max Output Pwr	350.0	Watts
	Tx Antenna Gain	56.4	dBi
GROUND	Tx Pointing Losses	0.7	dB
SEGMENT	Rx Antenna Dia	1.00	meters
DATA	Rx Clr Sky G/T	17.3	dB/K
	Uplink Rain Attn	8.0	dB
RAIN	Dnlink Rain Attn	1.2	dB
MARGINS	Up Fade Pwr Cntrl	8.0	dB
	Tx E/S Location	Minneapolis	
	Tx E/S Latitude	45.0	N
	Tx E/S Longitude	93.2	W
SITE	Tx E/S Elev Angle	38	deg
GEOGRAPHIC			
DATA	Rx E/S Location	D2 Typical	
	Rx E/S Elev Angle	46	deg
XPOL	S/C Isolation	33.0	dB
ISOLATION	Tx E/S Isolation	35.0	dB
DATA	Rx E/S Isolation	25.0	dB

SUMMARY		
% Avail S/C Power Reqd/Crr	3.0	%
% Xponder Bandwidth Reqd/Crr	4.5	%
Clear Sky Link Margin	1.4	dB

	LINK PERFORMANCE	Cl Sky	Up Fade	Dn Fade	Unit
	Satellite SFD	-88.5	-88.5	-88.5	dBW/m2
	Agg Input B.O.	8.2	8.2	8.2	dB
	Input Backoff/Crr	24.2	24.2	24.2	dB
	Crr Flux Density	-112.7	-112.7	-112.7	dBW/m2
UPLINK	Gain of a Sq meter	44.5	44.5	44.5	dBi
BUDGET	Uplink Path Losses	207.4	215.4	207.4	dB
	Carrier Up EIRP	50.1	58.1	50.1	dBW
	Satellite G/T	3.0	3.0	3.0	dB/K
	C/N Uplink	14.2	14.2	14.2	dB
	EIRP Contour	47.1	47.1	47.1	dBW
	Agg Output B.O.	3.5	3.5	3.5	dB
	Output Backoff/Crr	19.5	19.5	19.5	dB
	Carrier Dn EIRP	27.6	27.6	27.6	dBW
	Dnlink Path Losses	205.6	205.6	206.8	dB
DOWNLINK	Rx Pointing Losses	0.5	0.5	0.5	dB
BUDGET	Cl Sky E/S G/T	17.3	17.3	17.3	dB/K
	Degradation in G/T	0.0	0.0	1.4	dB
	C/N Downlink	7.2	7.2	4.6	dB
	C/N Uplink	14.2	14.2	14.2	dB
	C/N Downlink	7.2	7.2	4.6	dB
	C/I Intermod (Spacecraft)	18.3	18.3	18.3	dB
	C/I Uplink Adj Sat	21.4	21.4	21.4	dB
COMPOSITE	C/I Dnlink Adj Sat	12.2	12.2	12.2	dB
LINK	C/I Dnlink Adj Transponder	24.3	24.3	24.3	dB
	C/I Xpol	21.1	21.1	21.1	dB
	C/I Intermod (Transmit E/S)	34.0	18.0	34.0	dB
	C/(Nu,d)	6.4	6.4	4.2	dB
	C/(Nu,d,ims/c)	6.1	6.1	4.0	dB
	C/(Nu,d,im,i)Total	4.9	4.7	3.2	dB
	LINK MARGIN	1.4	1.2	-0.3	dB

	Minimum Reqd Ebi/No	6.5	dB
MODEM	Minimum Reqd Ebt/No	3.5	dB
	10*log(Rbt/Noise BW)	0.0	dB
	Minimum Reqd C/N	3.5	dB
	Uplnk Free Sp Loss	207.1	dB
MISC	Dnlnk Free Sp Loss	205.4	dB
LOSSES	Uplink Atmos Attn	0.3	dB
	Dnlink Atmos Attn	0.2	dB

Dnlink EIRP Dens @ Beam Peak (49.5 dBW)	6.0	dBW/4kHz
FCC Limit for VSAT Blanket License	6.0	dBW/4kHz

TABLE 6. INROUTE LINK BUDGET - NO ADJACENT COLLISIONS

23-Mar-01	128 kbps PES X000 INROUTE LINK BUDGET		Condition: No collision on adjacent satellites
08:22 PM	Satellite:Galaxy XI Horiz		
	1.00m PES in D2 Typical	5.6m hub in Minneapolis	

Section	BASELINE PARAMETERS	Value	Unit
CARRIER DATA	Carrier Info Rate	128	Kbps
	FEC Code Rate	0.500	
	Crr Xmission Rate	256	Kbps
	Min Reqd Ebt/No	3.5	dB
	No of bits/symbol	1.0	Bits
SATELLITE DATA	Satellite	Galaxy XI Horiz	
	Location	91.1	WL
	Hub EIRP Contour	47.0	dBW
	PES G/T Contour	-3.2	dB/K
	Attn Setting	8.0	dB
	Xponder Gain	178.6	dB
	SFD	-82.3	dBW/m2
	Xponder Bandwidth	36.0	MHz
	Agg Input BO	8.2	dB
	Agg Output BO	3.5	dB
	Uplink Frequency	14.2500	GHz
	Dnlink Frequency	11.9500	GHz
GROUND SEGMENT DATA	Tx Antenna Dia	1.00	meters
	HPA Max Output Pwr	3.0	Watts
	Tx Antenna Gain	39.9	dBi
	Tx Pointing Losses	0.5	dB
	Cl Sky Noise Temp	130	K
	Rx Clr Sky G/T	33.6	dB/K
RAIN MARGINS	Uplink Rain Attn	1.7	dB
	Dnlink Rain Attn	6.2	dB
	Target Link Availability	99.7	%
SITE GEOGRAPHIC DATA	Tx E/S Location	D2 Typical	
	Tx E/S Elev Angle	45.8	deg
	Rx E/S Location	Minneapolis	
	Rx E/S Latitude	45.0	N
	Rx E/S Longitude	93.2	W
	Rx E/S Elev Angle	38.2	deg
XPOL ISOLATION DATA	S/C Isolation	33.0	dB
	Tx E/S Isolation	25.0	dB
	Rx E/S Isolation	35.0	dB

S U M M A R Y	Value	Unit
% Avail S/C Power Reqd/Crr	0.16	%
% Xponder Bandwidth Reqd/Crr	1.12	%
Clear Sky Link Margin	2.4	dB

Section	LINK PERFORMANCE	Cl Sky	Up Fade	Dn Fade	Unit
UPLINK BUDGET	Satellite SFD	-82.3	-82.3	-82.3	dBW/m2
	Agg Input B.O.	8.2	8.2	8.2	dB
	Input Backoff/Crr	36.2	37.9	36.2	dB
	Crr Flux Density	-118.5	-120.2	-118.5	dBW/m2
	Gain of a Sq meter	44.5	44.5	44.5	dBi
	Uplink Path Losses	207.3	208.9	207.3	dB
	Carrier Up EIRP	44.2	44.2	44.2	dBW
	Satellite G/T	-3.2	-3.2	-3.2	dB/K
	C/N Uplink	8.3	6.6	8.3	dB
DOWNLINK BUDGET	Saturation EIRP	47.0	47.0	47.0	dBW
	Agg Output B.O.	3.5	3.5	3.5	dB
	Output Backoff/Crr	31.5	33.2	31.5	dB
	Carrier Dn EIRP	15.5	13.8	15.5	dBW
	Dnlink Path Losses	205.8	205.8	212.0	dB
	Rx Pointing Losses	0.5	0.5	0.5	dB
	Cl Sky E/S G/T	33.6	33.6	33.6	dB/K
	Degradation in G/T	0.0	0.0	4.3	dB
	C/N Downlink	17.3	15.7	6.8	dB
COMPOSITE LINK	C/N Uplink	8.3	6.6	8.3	dB
	C/N Downlink	17.3	15.7	6.8	dB
	C/I Intermod (S/C)	17.1	15.4	17.1	dB
	C/I Uplink Adj Sat	15.5	13.8	15.5	dB
	C/I Downlink Adj Sat	21.1	19.4	21.1	dB
	C/I Xpol	15.0	13.3	14.9	dB
	C/I Downlink Adj. Transponder	23.1	21.4	23.1	dB
	C/(Nu,d)	7.8	6.1	4.5	dB
	C/(Nu,d,ims/c)	7.3	5.6	4.2	dB
	C/(Nu,d,im,i)Total	5.9	4.2	3.5	dB
	LINK MARGIN	2.4	0.7	0.0	dB

Section	Parameter	Value	Unit
MODEM	Minimum BER	1.0E-07	
	Minimum Ebi/No	6.5	dB
	Minimum Reqd Ebt/No	3.5	dB
	10*log(Rbt/Noise BW)	0.0	dB
	Minimum Reqd C/N	3.5	dB
MISC LOSSES	Uplnk Free Sp Loss	207.0	dB
	Dnlnk Free Sp Loss	205.6	dB
	Uplink Atmos Attn	0.3	dB
	Dnlink Atmos Attn	0.2	dB
	Uplink Pwr Dens into Antenna	-14.1	dBW/4kHz
	FCC Limit	-14.0	dBW/4kHz

TABLE 7. INROUTE LINK BUDGET - SINGLE ADJACENT COLLISION

23-Mar-01 — 128 kbps PES X000 INROUTE LINK BUDGET — Condition: Single collision on adjacent satellites

08:26 PM — Galaxy XI — Satellite: Horiz — 1.00m PES in D2 Typical — 5.6m hub in Minneapolis

	BASELINE PARAMETERS	Value	Unit
CARRIER DATA	Carrier Info Rate	128	Kbps
	FEC Code Rate	0.500	
	Crr Xmission Rate	256	Kbps
	Min Reqd Ebt/No	3.5	dB
	No of bits/symbol	1.0	Bits
SATELLITE DATA	Satellite	Galaxy XI Horiz	
	Location	91.1	WL
	Hub EIRP Contour	47.0	dBW
	PES G/T Contour	-3.2	dB/K
	Attn Setting	8.0	dB
	Xponder Gain	178.6	dB
	SFD	-82.3	dBW/m2
	Xponder Bandwidth	36.0	MHz
	Agg Input BO	8.2	dB
	Agg Output BO	3.5	dB
	Uplink Frequency	14.2500	GHz
	Dnlink Frequency	11.9500	GHz
GROUND SEGMENT DATA	Tx Antenna Dia	1.00	meters
	HPA Max Output Pwr	3.0	Watts
	Tx Antenna Gain	39.9	dBi
	Tx Pointing Losses	0.5	dB
	Rx Clr Sky G/T	33.6	dB/K
RAIN MARGINS	Uplink Rain Attn	1.7	dB
	Dnlink Rain Attn	6.2	dB
	Target Link Availability	99.7	%
SITE GEOGRAPHIC DATA	Tx E/S Location	D2 Typical	
	Tx E/S Elev Angle	45.8	deg
	Rx E/S Location	Minneapolis	
	Rx E/S Latitude	45.0	N
	Rx E/S Longitude	93.2	W
	Rx E/S Elev Angle	38.2	deg
XPOL ISOLATION DATA	S/C Isolation	33.0	dB
	Tx E/S Isolation	25.0	dB
	Rx E/S Isolation	35.0	dB

SUMMARY	Value	Unit
% Avail S/C Power Reqd/Crr	0.16	%
% Xponder Bandwidth Reqd/Crr	1.12	%
Clear Sky Link Margin	2.2	dB

	LINK PERFORMANCE	Cl Sky	Up Fade	Dn Fade	Unit
UPLINK BUDGET	Satellite SFD	-82.3	-82.3	-82.3	dBW/m2
	Agg Input B.O.	8.2	8.2	8.2	dB
	Input Backoff/Crr	36.2	37.9	36.2	dB
	Crr Flux Density	-118.5	-120.2	-118.5	dBW/m2
	Gain of a Sq meter	44.5	44.5	44.5	dBi
	Uplink Path Losses	207.3	208.9	207.3	dB
	Carrier Up EIRP	44.2	44.2	44.2	dBW
	Satellite G/T	-3.2	-3.2	-3.2	dB/K
	C/N Uplink	8.3	6.6	8.3	dB
DOWNLINK BUDGET	Saturation EIRP	47.0	47.0	47.0	dBW
	Agg Output B.O.	3.5	3.5	3.5	dB
	Output Backoff/Crr	31.5	33.2	31.5	dB
	Carrier Dn EIRP	15.5	13.8	15.5	dBW
	Dnlink Path Losses	205.8	205.8	212.0	dB
	Rx Pointing Losses	0.5	0.5	0.5	dB
	Cl Sky E/S G/T	33.6	33.6	33.6	dB/K
	Degradation in G/T	0.0	0.0	4.3	dB
	C/N Downlink	17.3	15.7	6.8	dB
COMPOSITE LINK	C/N Uplink	8.3	6.6	8.3	dB
	C/N Downlink	17.3	15.7	6.8	dB
	C/I Intermod (S/C)	17.2	15.5	17.2	dB
	C/I Uplink Adj Sat	14.0	12.3	14.0	dB
	C/I Downlink Adj Sat	21.1	19.4	21.1	dB
	C/I Xpol	15.0	13.3	14.9	dB
	C/I Downlink Adj. Transponder	23.2	21.5	23.2	dB
	C/(Nu,d)	7.8	6.1	4.5	dB
	C/(Nu,d,ims/c)	7.3	5.6	4.3	dB
	C/(Nu,d,im,i)Total	5.7	4.0	3.4	dB
	LINK MARGIN	2.2	0.5	-0.1	dB

		Value	Unit
MODEM	Minimum BER	1.0E-07	
	Minimum Ebi/No	6.5	dB
	Minimum Reqd Ebt/No	3.5	dB
	10*log(Rbt/Noise BW)	0.0	dB
	Minimum Reqd C/N	3.5	dB
MISC LOSSES	Uplnk Free Sp Loss	207.0	dB
	Dnlnk Free Sp Loss	205.6	dB
	Uplink Atmos Attn	0.3	dB
	Dnlink Atmos Attn	0.2	dB
	Uplink Pwr Dens into Antenna	-14.1	dBW/4kHz
	FCC Limit	-14.0	dBW/4kHz

Appendix B

Hughes' Proposed Rule Revisions

The following rules contain the changes necessary to implement Hughes' proposals in its Comments in this proceeding. For the convenience of the reader, the text of the current Commission rule appears below in plain text.

Additional text proposed by the Commission in the NPRM appears in bold type, and text proposed by the Commission to be deleted in the NPRM appears with a single strikethrough.

Hughes' proposed additions appear in italics and Hughes' proposed deletions appear with a double strikethrough.

§25.134 Licensing provisions of very small aperture terminal (VSAT) networks.

~~(a) All applications for digital VSAT networks with a maximum outbound downlink EIRP density of +6.0 dBW/4 kHz per carrier and earth station antennas with maximum input power density of -14 dBW/4 kHz and maximum hub EIRP of 78.3 dBW will be processed routinely. All applications for analog VSAT networks with maximum outbound downlink power densities of +13.0 dBW/4 kHz per carrier and maximum antenna input power densities of -8.0 dBW/4 kHz shall be processed routinely in accordance with Declaratory Order in the Matter of Routine Licensing of Earth Stations in the 6 GHz and 14 GHz Bands Using Antennas Less Than 9 Meters and 5 Meters in Diameter, Respectively, for Both Full Transponder and Narrowband Transmissions, 2 FCC Rcd 2149 (1987) (Declaratory Order).~~

~~(b) Each applicant for digital and/or analog VSAT network authorization proposing to use transmitted satellite carrier EIRP densities in excess of +6.0 dBW/4 kHz and +13.0 dBW/4 kHz, respectively, and/or maximum antenna input power densities of -14.0 dBW/4 kHz and maximum hub EIRPs of 78.3 dBW and -8.0 dBW/ 4 kHz per carrier, respectively, shall conduct an engineering analysis using the Sharp, Adjacent Satellite Interference Analysis (ASIA) program. Applicants shall submit a complete description of those baseline parameters they use in conducting their analysis and tabular summaries of the ASIA program's output detailing potential interference shortfalls. Applicants shall also submit a narrative summary which must indicate whether there are margin shortfalls in any of the current baseline services as a result of the addition of the new applicant's high power service, and if so, how the applicant intends to resolve those margin shortfalls. Applicants shall submit link budget analyses of the operations proposed along with a detailed written explanation of how each uplink and each transmitted satellite carrier density figure is derived. Applicants shall provide proof by affidavit that all potentially affected parties acknowledge and do not object to the use of the applicant's higher power density.~~

(a) All applications for VSAT service in the 12/14 GHz band that meet the following requirements will be routinely processed:

~~**(1) The maximum transmitter power spectral density of a digital modulated carrier into any GSO FSS earth station antenna shall not exceed - 14.0 - 10log(N) dB(W/4 kHz).**~~

> ~~**(i) For a VSAT network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.**~~
> ~~**(ii) For a VSAT network using code division multiple access (CDMA) technique, N is the likely maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.**~~
> ~~**(iii) For a VSAT network using contention Aloha multiple access technique, N is equal to two.**~~
> ~~**(iv) For a VSAT network using contention CDMA/Aloha multiple access technique, N is twice the likely maximum number of co-frequency simultaneously transmitting earth stations in the same satellite-receiving beam without contention.**~~

(1) If the GSO FSS earth station antenna off-axis EIRP spectral density for co-polarized digital signals does not exceed the following values, under clear sky conditions, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

$15 - 25 \log(\theta) - 10 \log(N)$	dBW/4kHz	for	$1.8° \leq \theta \leq 7°$
$-6 - 10 \log(N)$	dBW/4kHz	for	$7° < \theta \leq 9.2°$
$18 - 25 \log(\theta) - 10 \log(N)$	dBW/4kHz	for	$9.2° < \theta \leq 48°$
$-14 - 10 \log(N)$	dBW/4kHz	for	$48° < \theta \leq 180°$

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

(i) For a VSAT network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.

(ii) For a VSAT network using code division multiple access (CDMA) technique, N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.

(2) If the GSO FSS earth station antenna off-axis EIRP spectral density for cross polarized digital signals does not exceed the following values, under clear sky conditions, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

$5 - 25 \log(\theta) - 10 \log(N)$	dBW/4 kHz	for	$1.8° \leq \theta \leq 7°$
$-16 - 10 \log(N)$	dBW/4 kHz	for	$7° < \theta \leq 9.2°$

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

(i) For a VSAT network using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.

(ii) For a VSAT network using code division multiple access (CDMA) technique, N is the maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.

(*3*) *If t***he maximum GSO FSS satellite EIRP spectral density of the digital modulated emission** *of any transmission (other than a single-carrier full-transponder transmission, or a dual-carrier full-transponder transmission)* ~~**shall**~~ *does* **not exceed** *9dB (W/4kHz)* ~~**6 dB (W/4kHz)**~~ **for all methods of modulation and accessing techniques.**

(4) If the maximum GSO FSS satellite EIRP spectral density of the digital modulated emission of a single-carrier full-transponder transmission, or a dual-carrier full-transponder transmission, does not exceed 13dB (W/4kHz) for all methods of modulation and accessing techniques.

(5) *If t***he maximum** ~~**hub earth station**~~ **EIRP** *of the hub earth station supporting the VSAT network* ~~**shall**~~ *does* **not exceed 78.3 dBW** *per carrier* **for all methods of multiple access techniques.** ~~**and supporting VSAT network identified in paragraph (a)(1) of this section.**~~

(6) *If t*he maximum transmitter power spectral density of an analog carrier into any GSO FSS earth station antenna shall not exceed – 8.0 dB(W/4kHz) and the maximum GSO FSS satellite EIRP spectral density shall not exceed + 13.0 dB(W/4kHz).

(7) *If the antenna meets the requirements of Section 25.209(a) and (b) for receive purposes.*

(b) Each applicant for digital and/or analog VSAT network authorization proposing to use transmitted satellite carrier EIRP densities, *maximum transmitter power* **and/or** *earth station antenna off-axis EIRP density (as applicable)*~~**maximum antenna input power**~~ **in excess of those specified in paragraph (a) of this Section must comply with the procedures set forth in § 25.220 of this Chapter.**

(c) ~~Licensees authorized pursuant to paragraph (b) of this section shall bear the burden of coordinating with any future applicants or licensees whose proposed compliant VSAT operations, as defined by paragraph (a) of this section, is potentially or actually adversely affected by the operation of the non-compliant licensee. If no good faith agreement can be reached, however, the non-compliant licensee shall reduce its power density levels to those compliant with *Section 25.212*.the VSAT Order or the Declaratory Order, whichever is applicable~~.

~~(d) An application for VSAT authorization shall be filed on FCC Form 312, Main Form and Schedule B. A VSAT licensee applying to renew its license must include on FCC Form 405, the number of constructed VSAT units in its network..~~

(d) An application for VSAT authorization shall be filed on FCC Form 312, Main Form and Schedule B. ~~A VSAT licensee applying to renew its license must follow the procedures provided in § 25.121(e)(3) of this part.~~

25.201 Definitions [Only changed provisions set forth]

(10) *Full transponder.* Radio emissions or transmissions that occupy, or nearly occupy, the entire satellite transponder. C band and Ku band satellite systems typically have transponder bandwidths on the order of 36 MHz or more. Single carrier *or dual-carrier* full transponder transmissions can include full motion analog video, thousands of multiplexed voice channels, or high date rates on the order of 50 Mb/s.

(41) *Wideband.* ~~See Full Transponder~~. *Radio emissions or transmissions with bandwidths greater than 5MHz.*

§25.209 Antenna performance standards.

(a) The gain of any antenna to be employed *by* ~~in transmission from~~ an earth station in the geostationary satellite orbit fixed-satellite service (GSO FSS) shall lie below the envelope defined as follows:

(1)*(i)* *In the case of bands other than the 12/14 GHz band, i*n the plane of the geostationary satellite orbit as it appears at the particular earth station location:

29 - 25 log10 (Theta) dBi 1° </= Theta </= 7°
+8 dBi 7° < Theta </= 9.2°
32 - 25 log10 (Theta) dBi 9.2° < Theta </= 48°
-10 dBi 48° < Theta </= 180°

where Theta is the angle in degrees from the axis of the main lobe. and dBi refers to dB relative to an isotropic radiator. For the purposes of this section, the peak gain of an individual sidelobe may not exceed the envelope defined above for Theta between 1.0 and 7.0 degrees. For Theta greater than 7.0 degrees, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the gain envelope given above by more than 3 dB.

(1)(ii) In the case of the 12/14 GHz band, in the plane of the geostationary satellite orbit as it appears at the particular earth station location:

29 – 25 log(θ)	*dBi*	*for*	$1.8° \leq \theta \leq 7°$
+ 8	*dBi*	*for*	$7° < \theta \leq 9.2°$
32 – 25 log(θ)	*dBi*	*for*	$9.2° < \theta \leq 48°$
0	*dBi*	*for*	$48° < \theta \leq 180°$

where θ is the angle in degrees from the axis of the main lobe, and dBi refers to dB relative to an isotropic radiator. For the purposes of this section, the peak gain of an individual sidelobe may not exceed the envelope defined above for θ between 1.8 and 7.0 degrees. For θ greater than 7.0 degrees, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the gain envelope given above by more than 3 dB.

(2) *In the case of bands which are shared with terrestrial services, i*n all other directions, or in the plane of the horizon including any out-of-plane potential terrestrial interference paths:

Outside the main beam, the gain of the antenna shall lie below the envelope defined by:
32 - 25 log10 (Theta) dBi 1° </= Theta </= 48°
-10 dBi 48° < Theta </= 180°

where Theta and dBi are defined above. For the purposes of this section, the envelope may be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.

(b) The off-axis cross-polarization gain of any antenna to be employed in transmission from an earth station to a space station in the domestic fixed-satellite service shall be defined by:

19 - 25 log10 (Theta) dBi 1.8° < Theta </= 7°
-2 dBi 7° < Theta </= 9.2°

(c) Earth station antennas licensed for reception of radio transmissions from a space station in the fixed-satellite service are protected from radio interference caused by other space stations only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in paragraphs (a) and (b) of this section, and protected from radio interference caused by terrestrial radio transmitters identified by the frequency coordination process only to the degree to which harmful interference would not be expected to be caused to an earth station conforming to the reference pattern defined in paragraph (a)(2) of this section.

(d) The patterns specified in paragraphs (a) and (b) of this section shall apply to all new earth station antennas initially authorized after February 15, 1985 and shall apply to all earth station antennas after March 11, 1994.

(e) The operations of any earth station with an antenna not conforming to the standards of paragraphs (a) and (b) of this section shall impose no limitations upon the operation, location or design of any terrestrial station, any other earth station, or any space station beyond those limitations that would be expected to be imposed by an earth station employing an antenna conforming to the reference patterns defined in paragraphs (a) and (b) of this section.

~~(f) An earth station with an antenna not conforming to the standards of paragraphs (a) and (b) of this section will be routinely authorized after February 15, 1985 upon a finding by the Commission that unacceptable levels of interference will not be caused under conditions of uniform 2° orbital spacings. An earth station antenna initially authorized on or before February 15, 1985 will be authorized by the Commission to continue to operate as long as such operations are found not to cause any unacceptable levels of adjacent satellite interference. In either case, the Commission will impose appropriate terms and conditions in its authorization of such facilities and operations.~~

(f) An earth station with an antenna not conforming to the standards of paragraphs (a) and (b) of this section will be authorized after February 15, 1985 upon finding by the Commission that unacceptable levels of interference will not be caused under conditions of uniform 2º orbital spacing. An earth station antenna initially authorized on or before February 15, 1985 will be authorized by the Commission to continue to operate as long as such operations are found not to cause unacceptable levels of adjacent satellite interference. In either case, the Commission will impose appropriate terms and conditions in its authorization of such facilities and operations. The applicant has the burden of demonstrating that its antenna not

conforming to the standards of paragraphs (a) and (b) of this section will not cause unacceptable interference. This demonstration must comply with the procedures set forth in § 25.220 of this Chapter. *This Section 25.209(f) shall not apply to an antenna that complies with the requirements of Section 25.134(a)(1)-(2).*

~~(g) The antenna performance standards of small antennas operating in the 12/14 GHz band with diameters as small as 1.2 meters starts at 1.25° instead of 1° as stipulated in paragraph (a) of this section.~~

(h)(1) The gain of any antennas to be employed in transmission from a gateway earth station antenna operating in the frequency bands 10.7-11.7 GHz, 12.75-13.15 GHz, 13.2125-13.25 GHz, 13.8-14.0 GHz, and 14.4-14.5 GHz and communicating with NGSO FSS satellites shall lie below the envelope defined as follows:

29 - 25log10 (è) dBi - 10 dBi
1º = è = 36º
36º = è = 180º

Where: è is the angle in degrees from the axis of the main lobe, and dBi refers to dB relative to an isotropic radiator.

(h)(2) For the purposes of this section, the peak gain of an individual sidelobe may not exceed the envelope defined in paragraph (h)(1) of this section.

§25.211 *Analog* Video, *Single-Carrier Full-Transponder, and Dual-Carrier Full-Transponder* transmissions in the Fixed-Satellite Service.

(a) Downlink analog video transmissions in the band 3700-4200 MHz shall be transmitted only on a center frequency of 3700 + 20N MHz, where N=1 to 24. The corresponding uplink frequency shall be 2225 MHz higher.

(b) All 4/6 GHz analog video transmissions shall contain an energy dispersal signal at all times with a minimum peak-to-peak bandwidth set at whatever value is necessary to meet the power flux density limits specified in §25.208(a) and successfully coordinated internationally and accepted by adjacent U.S. satellite operators based on the use of state of the art space and earth station facilities. Further, all transmissions operating in frequency bands described in §25.208(b) and (c) shall also contain an energy dispersal signal at all times with a minimum peak-to-peak bandwidth set at whatever value is necessary to meet the power flux density limits specified in §25.208(b) and (c) and successfully coordinated internationally and accepted by adjacent U.S. satellite operators based on the use of state of the art space and earth station facilities. The transmission of an unmodulated carrier at a power level sufficient to saturate a transponder is prohibited, except by the space station licensee to determine transponder performance characteristics. All 12/14 GHz video transmissions for TV/FM shall identify the particular carrier frequencies for necessary coordination with adjacent U.S. satellite systems and affected satellite systems of other administrations.

(c) All initial analog video transmissions shall be preceded by a video test transmission at an uplink e.i.r.p. at least 10 dB below the normal operating level. The earth station operator shall not increase power until receiving notification from the satellite network control center that the frequency and polarization alignment are satisfactory pursuant to the procedures specified in §25.272. The stationary earth station operator that has successfully transmitted an initial video test signal to a satellite pursuant to this paragraph is not required to make subsequent video test transmissions if subsequent transmissions are conducted using exactly the same parameters as the initial transmission.

~~(d) In the 6 GHz band, an earth station with an equivalent diameter of 9 meters or smaller may be routinely licensed for transmission of full transponder services if the maximum power into the antenna does not exceed 450 watts (26.5 dBW). In the 14 GHz band, an earth station with an equivalent diameter of 5 meters or smaller may be routinely licensed for transmission of full transponder services if the maximum power into the antenna does not exceed 500 watts (27 dBW).~~

(d) An earth station may be routinely licensed for transmission ~~to~~ ***of*** single-carrier **full -** *transponder or dual-carrier full*-**transponder services provided:**

(1) In the 6 GHz band, with an antenna equivalent diameter 4.5 meters or greater, the maximum power into the antenna does not exceed 26.5 dBW; or

(2) **In the 14 GHz band,** *for analog video transmissions* **with an antenna equivalent diameter 1.2 meters or greater the maximum power into the antenna does not exceed 27 dBW.**

(3) *In the 14 GHz band, for digital transmissions with an antenna equivalent diameter 1.2 meters or greater the EIRP of the earth station does not exceed 78.3 dBW per carrier.*

(4) *In the 12/14 GHz band, the maximum downlink EIRP density does not exceed 13dBW/4kHz.*

(5) *In either the 12 GHz or the 4 GHz band, as applicable, the antenna meets the requirements of Section 25.209(a) and (b).*

(e) Antennas with an equivalent diameter smaller than those specified in paragraph (d) of this section are subject to the provisions of Section 25.220 of this Chapter, which may include power reduction requirements. These antennas will not be routinely licensed for transmission of full transponder services.

(f) Each applicant for authorization for ~~video~~ *single-carrier full transponder or dual-carrier full-transponder transmissions* **in the fixed-satellite service proposing to use transmitted satellite carrier EIRP densities,** *earth station EIRPs,* **and/or maximum power into the antenna in excess of those specified in Section 25.211(d), must comply with the procedures set forth in § 25.220 of this Chapter.**

~~(g) The Commission has authority to apply the power level limits in this section to earth station applications for authority to operate in any other FSS frequency band to the extent it deems necessary to prevent unacceptable interference into adjacent satellite systems, to the extent that power limits have not been established elsewhere in this Part.~~

§25.212 Narrowband *Analog and Digital* ~~t~~ *T*ransmissions in the GSO Fixed-Satellite Service.

(a) Except as otherwise provided by these rules and regulations, criteria for unacceptable levels of interference caused by other satellite networks shall be established on the basis of nominal operating conditions and with the objective of minimizing orbital separations between satellites.

(b) Emissions with an occupied bandwidth of less than 2 MHz are not protected from interference from wider bandwidth transmissions if the r.f. carrier frequency of the narrowband signal is within ±1 MHz of one of the frequencies specified in §25.211(a).

(c) In the *12/*14 GHz band,

(i) an earth station *meeting the requirements of Section 25.209(a) and (b)* ~~with an equivalent diameter of 1.2 meters or greater~~ may be routinely licensed for ~~transmission of~~ narrowband analog services with bandwidths up to 200 kHz if the maximum input power density into the antenna does not exceed -8 dBW/4 kHz and the maximum transmitted satellite carrier EIRP density does not exceed 13 dBW/4 kHz, ~~and~~

(ii) an earth station meeting the requirements of Section 25.134(a)(1)-(2) for transmit purposes and Section 25.209(a) and (b) for receive purposes may be routinely licensed for digital services, if the maximum transmitted satellite carrier EIRP density does not exceed 9dBW/4kHz.

~~Antennas with an equivalent diameter smaller than 1.2 meters~~ *Earth stations* in the 14 GHz band *not meeting the applicable requirements of clause (i) or (ii)* are subject to the provisions of §25.220 of this chapter, which may include power reduction requirements.

(d)**(1)** In the 6 GHz band, an earth station with an equivalent diameter of 4.5 meters or greater may be routinely licensed for transmission of SCPC services if the maximum power densities into the antenna do not exceed +0.5 dBW/4 kHz for analog SCPC carriers with bandwidths up to 200 kHz, and do not exceed -2.7 dBW/4 kHz for narrow and/or wideband digital SCPC carriers. **Antennas with an equivalent diameter smaller than ~~1.2~~ *4.5* meters in the ~~14~~ *6* GHz band are subject to the provisions of §25.220 of this chapter, which may include power reduction requirements.**

(d)(2) In the 6 GHz band, an earth station with an equivalent diameter antenna of 4.5 meters or greater may be routinely licensed for transmission of SCPC services if the maximum power spectral densities into the antenna do not exceed + 0.5 dB(W/4kHz) for analog SCPC carriers with bandwidths up to 200 kHz and do not exceed –2.7 – 10log(N) dB (W/4kHz) for narrow and/or wideband digital SCPC carriers.

(i) For digital SCPC using frequency division multiple access (FDMA) or time division multiple access (TDMA) technique, N is equal to one.

(ii) For digital SCPC using code division multiple access (CDMA) technique, N is the likely maximum number of co-frequency simultaneously transmitting earth stations in the same satellite receiving beam.

(iii) For digital SCPC using contention Aloha multiple access technique, N is equal to two.

(iv) For digital SCPC using contention CDMA/Aloha multiple access technique, N is twice the likely maximum number of co-frequency simultaneously transmitting earth stations in the same satellite-receiving beam without contention.

(e) Each applicant for authorization for narrowband transmissions in the fixed-satellite service proposing to use transmitted satellite carrier EIRP densities, *earth station EIRPs,* **and/or maximum antenna input power densities in excess of those specified in paragraph (c) of this Section for Ku band service, or paragraph (d) of this Section for C band service, respectively, must comply with the procedures set forth in § 25.220 of this Chapter.**

(f) The Commission has authority to apply the power level limits in this section to earth station applications for authority to operate in any other FSS frequency band to the extent it deems necessary to prevent unacceptable interference into adjacent satellite systems, to the extent that power limits have not been established elsewhere in this Part.

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

(a)(1) This section applies to earth station applications in which:

(i) *in the case of an antenna proposed to operate other than at 14GHz*, the proposed antenna does not conform to the standards of §25.209(a) and (b) of this Chapter, ~~and/~~or ~~(ii)~~ the proposed power density levels are in excess of those specified in §25.134, §25.211, or §25.212 of this Chapter, or those derived by the procedure set forth in paragraph (c)(1) of this Section, whichever is applicable, *or*

(ii) in the case of an antenna proposed to transmit at 14 GHz, the proposed antenna conforms neither (i) to the standards of §25.209(a) and (b) of this Chapter nor (ii) to those specified in Section 25.134(a)(1)-(2) of this Chapter, or

(iii) in the case of an antenna proposed to transmit at 14 GHz, the proposed power density levels are in excess of those specified in §25.134, §25.211, or §25.212 of this Chapter, or those derived by the procedure set forth in paragraph (c)(1) of this Section, whichever is applicable, or

(iv). in the case of an antenna proposed to receive at 12 GHz, the proposed antenna does not comply with the standards of §25.209(a) and (b) of this Chapter.

[Remainder of rule is unchanged]