Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Technical Standards for Determining	)	
Eligibility For Satellite-Delivered Signals	)	**ET Docket No. 00-90**
Pursuant to the Satellite Home Viewer	)	
Improvement Act	)	
	)	

To the Commission:

COMMENTS OF ECHOSTAR SATELLITE CORPORATION

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SUMMARY

EchoStar Satellite Corporation ("EchoStar") hereby submits its initial comments to the Notice of Inquiry ("NOI") in the above-captioned proceeding where the Commission has opened an inquiry, at the direction of Congress, to obtain information for evaluating whether the Grade B signal intensity standard used to determine the eligibility of satellite television subscribers to receive retransmitted distant signals of network stations should be modified or replaced. In addition, the Commission is to make recommendations relating to an appropriate standard for digital television signals.

EchoStar strongly urges the Commission to recommend several necessary modifications to the Grade B intensity standard. The current standard is hopelessly out of date because it is based upon consumer tests of picture quality that are almost a half century old and do not reflect the expectations of today's consumers in this digital era. Moreover, it relies upon planning factors that are no longer (assuming they ever were) accurate. The Commission's recommendations must, consistent with Congress' mandate, include clutter loss factors and other contributors to signal degradation, such as terrain, building structures, and other land cover variations. They must also include a mechanism for assessing and applying the effects of "ghosting" in the determination of eligibility of satellite television subscribers to receive retransmitted distant signals of network stations.

Consumers across the country should know that the Grade B intensity standard as currently implemented is of virtually no use in answering the question whether one can, or is willing, to use an off-air antenna to receive network channels. First, it was based on the subjective quality expectations of 1950s television viewers, rather than on the much more demanding expectations of consumers in today's digital era. The Commission must therefore

recommend to Congress that new tests be conducted based on statistically significant samplings of modern viewers to take account of this change in expectations. Second, it is now apparent that the assumptions underlying the planning factors used by the Commission to develop the Grade B definition do not reflect today's technological reality. Indeed, EchoStar's analysis to date reveals that the planning factors are severely outdated and no longer can be viewed as a rational basis for assessing eligibility for satellite-delivered network signals under the Satellite Home Viewer Improvement Act ("SHVIA").

The time has come for the rhetoric to stop and a standard appropriate for the digital age to be implemented. In these comments, EchoStar presents its analysis of the relevant factors that should be taken into account in developing a modern signal intensity standard, including revised assumptions for many of the Grade B planning factors and the quantification for a new "ghosting" factor. In the meantime, it is clear that the effect of ghosting can be quantified and used in determining whether an adequate network signal is available for viewing.

In sum, EchoStar strongly urges the Commission to recommend in its report to Congress modifications to the Grade B planning factors – to bring the Commission's Grade B intensity standard into the 21st century and to reflect the viewing habits of millions of Americans who have vastly greater expectations for television reception than they did in the 1950s when the current planning factors were developed.

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To the Commission:

COMMENTS OF ECHOSTAR SATELLITE CORPORATION

EchoStar Satellite Corporation ("EchoStar") hereby submits its initial comments to the Notice of Inquiry ("NOI") in the above-captioned proceeding,[1] where the Commission has opened an inquiry to obtain information for evaluating whether the signal intensity standard used to determine the eligibility of satellite television subscribers to receive retransmitted distant signals of network stations should be modified or replaced. More specifically, the Commission seeks "information and comment . . . on all technical parameters that scientifically could be considered to affect the quality of over-the-air reception of television pictures."[2]

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[1] *In the Matter of Technical Standards for Determining Eligibility For Satellite-Delivered Signals Pursuant to the Satellite Home Viewer Improvement Act*, ET Docket No. 00-90, Notice of Inquiry, FCC 00-184 (rel. May 26, 2000) ("*NOI*").

[2] *NOI* at ¶ 1.

This proceeding is being instituted at the direction of Congress, which has instructed the Commission to conduct an inquiry to evaluate all possible standards and factors for determining eligibility for retransmission of network station signals and, if appropriate, to recommend modification, or alternative standard or factors, to the Grade B intensity standard for analog television signals set forth in the Commission's Rules.[3] These findings and recommendations are to be submitted by the Commission to Congress within one year of adoption of SHVIA. In addition, the Commission is to make further recommendations relating to an appropriate standard for digital television signals.

EchoStar strongly urges the Commission to recommend to Congress several necessary modifications to the Grade B signal intensity standard. This standard was based upon the expectations of 1950s consumers for picture quality, a far cry from what consumers now expect to receive over their television receivers. In addition to taking into account consumer expectations for signal quality today in this digital era, the revised criteria must, consistent with Congress' mandate, include clutter loss factors and other contributors to signal degradation, such as terrain, building structures, and other land cover variations.[4] These criteria must also include

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[3] *See* 47 C.F.R. § 73.683(a). The Commission has initiated this proceeding in response to the requirements of the Satellite Home Viewer Improvement Act of 1999 ("SHVIA"). *See Title 1 of the Intellectual Property and Communications Omnibus Reform Act of 1999*, P.L. 106-113, 113 Stat. 1501, Appendix I (1999) (relating to copyright licensing and carriage of broadcast signals by satellite carriers). Section 1008(a) of SHVIA added, *inter alia*, new Section 339 ("Carriage of Distant Television Stations by Satellite Carriers") to the Commission's statutory charter, the Communications Act of 1934, 47 U.S.C. § 151 *et seq*.

[4] *See* Section 339(c)(3), 47 U.S.C. § 339(c)(3), which states that "[I]n prescribing such model, the Commission shall rely on the Individual Location Longley-Rice model set forth by the Federal Communications Commission in Docket No. 98-201 and ensure that such model takes into account terrain, building structures, and other land cover variations." [Emphasis added]

a mechanism for assessing and applying the effects of "ghosting" in the determination of eligibility of satellite television subscribers to receive retransmitted distant signals of network stations. EchoStar proposes such a mechanism in these comments.

It is also critically important that the Commission acknowledge in its report to Congress that the planning factors used to develop the Grade B signal intensity standard are no longer even remotely accurate representations of the current off-air television reception environment. Consumers across the country know that the Grade B intensity standard as currently implemented is of virtually no use answering the question as to whether a consumer can, or is willing, to use an off-air antenna to receive network channels.

The Commission must recommend to Congress that the Grade B intensity standard be revised using current viewer expectations and technical criteria that are appropriate for today's marketplace. The time has come for the rhetoric to stop and a standard appropriate for the digital age to be implemented

I. THE GRADE B DEFINITION MUST BE UPDATED TO REFLECT CHANGES IN TECHNOLOGY AND CONSUMER DEMAND SINCE ITS INCEPTION HALF A CENTURY AGO

It is critically important that the Commission recognize that both the planning factors used in the Grade B intensity definition and the consumer perceptions of quality reflected in this definition are severely outdated and no longer can be used as a rational basis for assessing eligibility for satellite-delivered network signals under the SHVIA.

Pursuant to the Satellite Home Viewer Act ("SHVA"),[5] Congress linked the definition of "unserved households" (for purposes of permitting satellite broadcasters to deliver broadcast network programming to subscribers) to the Commission's definition of "Grade B" intensity.[6] SHVA amended 47 U.S.C. § 119 to require statutory copyright licensing of certain secondary transmissions made by satellite carriers of television network programming. Specifically, Section 119(a)(2)(B) limits such licensing to persons who reside in "unserved households." In turn, Section 119(d) defines an unserved household as one "that cannot receive, through the use of a conventional outdoor rooftop receiving antenna, an over-the-air signal of Grade B intensity (as defined by the Federal Communications Commission) of a primary network station affiliated with that network…."[7]

The Commission's "Grade B" definition, however, was not developed to determine whether a given household is unserved under SHVA; rather, it was "developed in the early days of television as a key component of the Commission's channel allotment protocol,"[8] and has become badly outdated in at least two key respects. First, it is based on the ultimately subjective quality expectations of the 1950s television viewer, rather than on the much more

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[5] 17 U.S.C. §119.

[6] 47 C.F.R. § 73.683. The Commission has defined various grades of television service, each based on the probability that a viewer using a specified quality of receiving system will receive a picture of a certain quality from a given station. In particular, "Grade B" refers to a set of standards by which the extent of rural television coverage from a given station may be estimated.

[7] The Commission codified this carriage requirement and the reference to unserved households in 47 CFR § 76.64.

demanding requirements of consumers today in the digital era. The Commission must recommend to Congress new factors based on statistically significant samples of modern viewers to take account of their changing expectations. Second, it is now apparent that the assumptions underlying the planning factors used by the Commission to develop the Grade B definition do not reflect today's technological reality. Accordingly, EchoStar includes in the following sections its recommendations for updating the assumptions underlying the Grade B planning factors.

A. The Assumptions Underlying the Planning Factors of the Grade B Definition Must be Updated to Reflect Developments in the Marketplace

Many of the planning factors used by the Commission in the 1950s to describe the environment of a typical television rural viewer can vary with time, state of the technical art, population density, convention, and other factors. Clearly, they are based upon assumptions about a viewer's receiving installation. While these assumptions may have been reasonable in the 1950s, when the planning factors were first developed, they are not appropriate today. In addition to the need for new picture quality tests to capture the rising expectations of the digital era consumer, the Commission must recommend changes to the planning factors in the context of changes in television technology and viewership that have occurred in the last half century. Indeed, there can be no question that the typical television viewer today expects a vastly better television picture than did his or her grandfather or grandmother when the current planning factors were developed. Some of the planning factors most in need of updating are set forth below, along with proposed alternatives that the Commission should recommend to Congress.

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[8] *NOI* at ¶ 3.

1. Thermal Noise In Receiver Feedlines Is Different Today

One of the planning factors that requires updating is thermal noise, which is affected in proportion to a system's impedance. At the time of the TASO report,[9] substantially all television receiving systems operated at an impedance of 300 ohms. As the number of VCRs and "cable ready" televisions in consumer households has increased, the number of 300-ohm receiving systems has decreased. Today, at least 82.2% of households having at least one television also have a VCR, and at least 65.4% of all households having at least one television also subscribe to cable television.[10] An informal survey of two manufacturers of television receiving antennas indicates that substantially all new antennas, whether indoor or outdoor, are connected to 75-ohm receiving systems using 75-ohm cables.[11]

The amount of thermal noise present in the receiving system depends upon the system impedance. For a properly terminated system (the television receiver is assumed to be the termination), the noise voltage is expressed as

$$N = 20 \log \cdot \overline{(kTRB)}$$

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[9] *See, e.g., In the Matter of Fostering Expanded Use of UHF Television Channels*, 41 F.C.C. 1041 (1963).

[10] U.S. Bureau of the Census, *Statistical Abstract of the United States: 1998*, (Washington, DC, 1998), Table 915.

[11] Terk Technologies, Commack, NY (http://www.terk.com) produces 13 antenna models, all of which are sold as "75-ohm." Also, Channel Master LLC, Smithfield, NC (http://www.channelmaster.com) produces 42 models, all of which are either sold as "75-ohm" devices, or are sold with a balun [balanced-to-unbalanced feedline converter] for use with a 75-ohm coaxial feedline.

where k is Boltzmann's constant, T is the ambient temperature, R is the system resistive equivalent of the system impedance, and B is the bandwidth of interest. The noise voltage generated is thus proportional to the square root of the system impedance, thereby reducing somewhat the thermal noise for a typical receive system today.[12]

2. Receiver Noise Figures For VHF Receivers Have Worsened

Another planning factor that must be re-examined and updated is the television receiver noise figures. At the time of the TASO Report,[13] the average television receiver noise factors were reported to be 6.5-8.5 dB (mean figure of 7.5 dB) for VHF channels and 12.8-13.8 dB (mean figure of 13.3 dB) for UHF channels, with extremes of 4.6-12.2 dB for VHF and 9.5-19.0 dB for UHF.[14] All of these values are for a nominal system impedance of 300 ohms. While it might be expected that improvement in the state-of-the-art would tend to drive TV receiver noise figures down, recent measurements indicate otherwise, suggesting that television receiver noise figures are in most cases worse today than in the 1950s.

Measurements taken in the late 1970s of 32 television receivers, and reported to the Commission as part of the UHF Comparability Task Force, show that the average VHF noise

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[12] O'Connor, *supra.*

[13] TASO Report, *supra, at* 120-121.

[14] While "noise figure" and "noise factor" are similar, they are not identical. *See IEEE Standard Dictionary of Electrical and Electronics Term* (ANSI/IEEE Standard 100, ed. 1984). For purposes here, however, they may be used interchangeably.

figure jumped to 9.2-14.6 dB (mean 11.9 dB), with extremes of 7.5-17.3 dB.[15] These values are also based on a nominal system impedance of 300 ohms. They suggest that the typical VHF television receiver noise figures actually degraded by over 4 dB in about 20 years. A possible explanation for this is the increased penetration of cable television and VCRs in the residential environment. The relatively high signal levels used by these devices tends to reduce the need for improved noise figure performance. Additionally, the high spectral density of signals in cable television systems requires improvements in other aspects of television receiver performance (*e.g.*, intermodulation distortion performance), which is sometimes "traded off" for reduced noise figure performance.[16]

3. A Peak Visual Carrier-to-RMS Noise Ratio Of 30 dB Is Too Low For Defining A "Passable" Picture Quality

Consumers today demand a much higher quality picture than they did fifty years ago. In large measure, this phenomenon is due to the increased penetration of cable television,

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[15] O'Neal Jr., J.B., "Television Receiver Noise Figure Study," March 1980, Figures A-1 and A-2 (data taken 1976 and 1978, respectively).

[16] While the Commission's own measurements of UHF noise figures in the 1970s revealed virtually no change from when the TASO report was prepared, there has been no regulatory incentive for improving the noise figure performance of UHF TV receivers. Indeed, Section 15.117(g) of the Commission's Rules, 47 C.F.R. § 15.117(g), currently requires that the noise figure for UHF television receivers not exceed 14 dB. This requirement is relaxed by 4 dB (to a figure of 18 dB) for certain types of VCR-based tuners and for receivers having multiple tuners (*e.g.*, picture-in-picture receivers). Prior to 1978, the Commission's noise figure requirement for UHF receivers was also 18 dB. *See* Middlekamp, Lawrence C., Hector Davis, and Carl R. Weber, "Relationship Between Noise Figures and Other Performance Characteristics of UHF TV Receivers," FCC/OET Project No. 22489, April 1978.

Direct Broadcast Satellite, VCRs, video game systems, etc., all of which produce substantially noise- and interference-free pictures.

In the late 1950s, TASO presented a report detailing its tests on television reception. In this report, a six-grade picture quality evaluation scale was presented.[17] The Commission later published a report which presented each picture quality grade as a function of signal-to-noise ratio ("SNR").[18] The SNR range corresponding to a TASO Grade 3 (passable) picture was 28-33 dB, so the choice of 30 dB for the planning factor seemed to be a reasonable one.[19] Both monochrome and color receivers were included in the TASO studies. EchoStar submits that consumers in the current television reception environment would view a much higher ratio of peak visual carrier to noise as "passable."

4. Transmission Line Losses Are Higher Today

The Commission must also change its outdated transmission line loss assumption underlying the Grade B planning factors. All available data indicate substantially higher average losses of current 75 ohm cable as compared to the figures used for 300 ohm cable in the 1950s.

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[17] TASO Report, *supra,* at 453-454.

[18] Fine, Harry, "A Further Analysis of TASO Panel 6 Data on Signal to Interference Ratios and Their Application to the Description of Television Service," FCC/OCE Report T.R.R. 5.1.2, April 1, 1960.

[19] It is interesting to note, as did O'Connor, that the results of these studies showed considerable disagreement between viewers as to what SNR was required to achieve a passable picture. For example, while one decile (10%) of viewers felt that an SNR of only 23 dB was required to achieve passable quality, another decile felt that an SNR of 34 dB was necessary. *See* TASO Report, *supra,* at 533, Attachment C.

As discussed above, most modern television receivers have an input impedance of 75 ohms, and most antenna transmission cables match this impedance. The losses associated with the older, 300-ohm "twinlead" cable are different from the newer, 75-ohm coaxial cable. For the standard length of cable (50 feet, or 15.2 meters) assumed in the development of the Grade B planning factors, a sampling of 300-ohm twinlead cables showed average losses of 0.9 dB at VHF-low band, 1.5 dB at VHF-high band, and 2.3 dB at UHF.[20] The same report, however, showed typical 1/4" (RG-59 type) 75-ohm cable having average losses of 1.5, 2.4, and 4.6 dB, at VHF-low band, VHF-high band, and UHF, respectively.

Some six years later, comparable results were reported in Commission-sponsored research.[21] The research, which included 17 types of transmission lines, found that typical twinlead cables had losses (again, based on 50-foot lengths) averaging 0.8, 1.5, and 3.1 dB at VHF-low band, VHF-high band, and UHF, respectively. These data were also similar to the results of testing of new lines.[22] The 300-ohm twinlead cable had average reported losses of 1.0, 1.8 and 3.2 dB, respectively, whereas RG-59 cable had reported losses of 1.2, 2.3, and 4.5 dB at VHF-low band, VHF-high band, and UHF, respectively.

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[20] Rubin, Philip A., W.J. Kessler and M.J. Wilhelm, "A Quantitative Comparison of the Relative Performance of VHF and UHF Broadcast Systems," CPB Technical Monograph No. 1, June 1974, at 27.

[21] *See, e.g.*, Free, W.R., J.A. Woody, and J.K. Daher, "Program to Improve UHF Television Reception," Prepared for the UHF Comparability Task Force by Georgia Institute of Technology, Project No. A-2475, September 1980, at 4-16 (reporting only data for TV channels up to 69).

[22] FitzGerrel, R.G., R.D. Jennings, and J.R. Juroshek, "Television Receiving Antenna System Component Measurements," NTIA Report 79-22, June 1979, at 33, 36.

Moreover, all of these data sources reported that aged, wet, and or improperly installed cables (*i.e.*, kinked or wrapped around a mast, conductors stapled, etc.) may have greater losses than do new, dry ones. While the effects of aging and moisture can be significant for 300-ohm twinlead (an input terminal voltage reduction of 3.7 dB was reported by TASO at UHF), the effects are less apparent for coaxial cable-based systems.[23] Greater losses due to improper installation are believed to be similar, but can be minimized by careful consumer- or professional-installation. Based upon measured data, contemporary receive antenna feedlines would be expected to have additional losses, particularly at UHF, when compared with the planning factors.

5. Receiving Antenna Gain Figures Have Decreased Over Time

The antenna gain assumptions on which the Grade B planning factors were based are outdated and must also be adjusted by as much as 6 dBd. One reason for this phenomenon is the trend away from separate VHF and UHF antennas.

The receiving antenna gain data reported by TASO are based primarily on separate VHF-only and UHF-only antennas.[24] Only 9 of the 64 antennas included in the TASO data (14%) were combination VHF/UHF designs, which are believed to be most common today. Data from a more recent NTIA report suggest that combination VHF/UHF designs now dominate the market by about 2 to 1 (34 of 51, or 67%, of the residences visited had combination

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[23] TASO Report, *supra*, at 123.

[24] *Id.*, at 137-141.

VHF/UHF designs).[25] An informal survey of two TV receive antenna vendors also suggests that the majority of available consumer antennas (both indoor and outdoor) are combination VHF/UHF designs.[26] All of Terk Technologies' 13 TV antenna products, and 27 out of 42 (64%) of Channel Master's TV antenna products are combination VHF/UHF designs.

Moreover, viewers using stationary, i.e., non-rotating, antennas typically will lose the benefit of gain that would otherwise be available toward a given transmitter site using a directional antenna, so that on average such antennas require a stronger signal input to achieve an equivalent signal strength. This situation is prevalent in areas where the various television transmit sites are geographically separated.

TASO reported average power gains of 3.7, 6.8, and 7.7 dBd for the three television bands for all antennas considered. Interestingly, the VHF-low band and UHF average gain values reported by TASO are both less than those assumed in the Grade B planning factors. More recent data on television receive antenna gains are available from several sources, and all show that average receive antenna gains somewhat lower than those contained in the planning factors. Commission-sponsored research shows average gains at a representative VHF-low band channel of 4.5 dBd (extremes 1.2-8.1 dBd), average gains at a representative VHF-high band channel of 7.2 dBd (extremes 4.7-10.6 dBd), and average gains near the geometric mean frequency of the UHF band of 6.9 dBd (extremes 0.5-12.8 dBd).[27] Available NTIA data for

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[25] Jennings, R.D., "Television Field Strength and Home Receiving System Gain Measurements in Northern Illinois," NTIA Report No. 81-68, March 1981.

[26] *See* Terk, *supra; see also* Channel Master, *supra.*

[27] Free, *et al*., *supra,* at 22-23.

combination VHF/UHF outdoor antennas show that the average gains are 2.2, 6.3, and 4.9 dBd, respectively, in the three television bands.[29] Somewhat higher gains were reported for separate VHF and UHF antennas, but, as noted above, such antennas appear now to be relatively uncommon. A Commission Report also compiled antenna gain data from a variety of sources and revealed average power gain values of 2.2, 6.4, and 7.0 dBd at the three television bands for combination VHF/UHF outdoor antennas.[30]

6. The Dipole Factors Must Be Changed

To account for the change in system impedance from 300 ohms to 75 ohms, and to reflect the removal of UHF channels 70-83, the dipole factors must also be adjusted upward. The dipole factor is the ratio of the voltage at the matched transmission line terminals of the dipole antenna to the uniform field strength of the field in which the dipole is located.[31]

These value are based simply on the "effective length" of the antenna and are equal to 20 log (47.7/f), where f is the geometric mean frequency in MHz of the band in question. The geometric mean frequencies are 69 MHz for Channels 2-6 and 194 MHz for Channels 7-13; these values are unchanged from the present Grade B planning factors. However, with the removal of TV Channels 70-83 from the broadcast television service, the

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[29] FitzGerrel, *et al*., *supra*, at 8-23.

[30] Gieseler, Philip B, *et al*., "Comparability for UHF Television - A preliminary Analysis," FCC Staff Report, September 1979.

[31] The Grade B planning factors includes an impedance transformation term, which should be removed inasmuch as the intrinsic impedance of a dipole is approximately the 75-ohm impedance of the modern receiving system.

geometric mean frequency for all UHF channels has changed to 615 MHz. These frequencies yield dipole factor values of 3, 12, and 22 dB, respectively, compared to the Grade B planning factor values of 3, 6, and 16 dB, respectively.

7. Demographic Changes Require an Increase in the Urban Noise Factor

The Commission must recognize the vast changes in the level of urban noise that has occurred n the half century since the planning factors were developed and update them to reflect today's environment.

In addition to the noise that electronic components make within a television, disturbances that occur outside both transmitter and receiver can contribute significantly to degradation of the displayed picture. This extraneous noise is classified as either man-made or natural noise. Naturally-occurring noise, apart from lightning, which is usually sporadic, is not generally believed to be a significant factor in television broadcasting, but man-made noise often is a nearly continuous ambient factor that degrades the displayed picture.

Demographic patterns have changed significantly since the TASO report was published. These changes affect TV broadcasting patterns and man-made noise factors. Beginning in the 1950s, a trend toward "suburbanization" began in the U.S., leading to a decrease in the density of the inner cities and development of myriad suburban towns and settlements. Work locations remained in many cases in the downtown areas, requiring workers to commute longer distances between home and job. One way of quantifying this trend is to examine over time the average home-to-work commute mileage. From 1969 until 1990, the

average vehicle trip length from home to work increased by 17%.[32] One of the effects of such suburbanization is to create the well-known "sprawl" that surrounds many of the larger cities in the United States, and this trend is not abating. For example, it has been reported that the communities surrounding the City of Atlanta appropriate nearly 500 new acres per week.[33]

From the standpoint of television coverage, many of the locations in so-called Grade B reception areas, which were rural in character 40 years ago, are now suburban. In addition to the minimum values of required field intensity to serve these expanded areas, further signal intensity is necessary to overcome the accumulation of effects of various man-made noise sources such as auto ignition, discharge lighting, electric hair dryers, etc. Such noise sources become increasingly important in direct proportion to population density. Thus, while the planning factor "to overcome urban noise" was set to 0 in the 1950s, the "suburbanization" over the past 40 years – and the increased density of noise-producing devices – requires that some "man-made" noise factor now be included in the Grade B planning factors. Indeed, some 23 years ago the Commission noted that ". . . large population shifts from cities to suburban areas . . . cause the Grade B contours in these areas to no longer lie in 'rural' areas. The assumption of 0 dB to overcome rural noise in these 'rural areas' is probably no longer valid. . . ."[34]

The "urban noise" planning factors date from before the time of the "3rd TV Notice."[35] The factors are 14 dB, 7 dB, and 0 dB, respectively, for the three television bands.

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[32] *Statistical Abstract of the U.S., supra.*, Table 1039.

[33] *See* http://www.policy.com/issuewk/1999/0426_70/Intro70.html.

[34] Gary Kalagian, "A Review of the Technical Planning Factors for the VHF Television Service," FCC/OCE Report RS 77-01, March 1, 1997 at 11.

More recently, Rubinstein collected environmental noise data at 162 MHz, which is slightly below the bottom edge of the TV VHF-high band channels (7-13).[36] His data suggest that the difference in ambient noise between forest land (categories 41 and 43, Northwest Washington state) and some urbanized areas of Southern California (category 17) is about 5 dB. This value is close to the long-standing value of 7 dB for the VHF-high band channels. Thus, available data seem to support the continued use of the long-standing "urban noise" planning factors. To account for the effects of increased population density in areas that were rural 40 years ago, it is appropriate and necessary to apply the urban noise factors currently used for establishing the Grade A required field strengths. These values are 14, 7, and 0 dB, for the VHF-low, VHF-high, and UHF bands, respectively.

B. Proposed Grade B Planning Factors for SHVIA Compliance Purposes

Based upon the above analysis, the following revised Grade B planning factors are recommended as more realistic indicators of coverage than those currently embodied in the Commission's Grade B signal intensity rules.

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[35] The earliest reference to the "urban noise" factors that could be located was "Notice of Issuance of Report of *ad hoc* Committee, Docket 9175," FCC Public Notice 49-773, June 7, 1949.

[36] Rubinstein, Thomas N., "Clutter Losses and Environmental Noise Characteristics Associated with Various LULC Categories," *IEEE Trans. Broadcasting*, Vol. 44, No. 3, September 1998, at 286-293.

Factors	Units	**New** Channels 2-6	7-13	14-69	**Old** Channels 2-6	7-13	14-69
1. Thermal Noise @ 75 ohms	dB• V	1	1	1	7	7	7
2. Receiver Noise Figure	dB	8	13	15	12	12	15
3. Peak Visual Car RMS Noise	dB	30	30	30	30	30	30
4. Transmission Line Loss	dB	1	2	6	1	2	5
5. Receiving Ant. Gain	dBd	3	7	6	6	6	13
6. Dipole Factor	dB•	3	12	22	3	6	16
7. Local Field	dB(• V/m)	46	65	80	41	51	60
8. Terrain Factor (50%)	dB	0	0	0	0	0	0
9. Time Fading Factor (90%)	dB•	6	5	4	6	5	4
10. Median Field F (50, 50)	dB (• V/m)	52	70	84	47	56	64
11. To Overcome Urban Noise	dB	14	7	0	0	0	0
12. Required Median Field	dB (• V/m)	66	77	84	47	56	64

As demonstrated in the discussion above, these factors reflect today's television reception environment in a far more realistic fashion than do the 1950s Grade B planning factors. If these new planning factors were adopted by the Commission, the Grade B coverage for purposes of determining eligibility to receive distant network signals would decrease significantly.

C. The Commission Should Recommend A Measurement Methodology Change To Account For The Fact That Consumers Do Not Generally Have Rotary Antennas

In its 1998 Report and Order, the Commission determined that, under the current statutory standard, measurement of the strength of each network signal required orienting the

measurement antenna to the transmitter in question.[37] If the statutory Grade B standard can indeed be read to require such a rule, then a clarification of the standard is eminently in the consumer's interest

The Commission should recommend a clarification of its measurement methodology whereby intensity for all local stations would be measured with the consumer's antenna oriented towards the network station most frequently watched by that consumer. Only in this way could the signal intensity actually received by the consumer be reflected in the measurements as opposed to the theoretical case of a consumer using an expensive rotary antenna to constantly adjust his or her picture. Such a change would also be consistent with the SHVIA, which has added the specification of a "stationary" antenna.[38]

II. THE COMMISSION MUST TAKE GHOSTING INTO ACCOUNT IN DEVELOPING ELIGIBILITY STANDARDS

The Commission asks for comment on whether the eligibility standards for satellite television subscribers to receive retransmitted distant signals of network stations should account for ghosting and, if so, what methods and values should be used.[39] It further asks whether there are scientifically accepted models for predicting ghosting that should be used in determining eligibility standards.[40] EchoStar strongly believes that consideration of ghosting

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[37] *Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act*, CS Docket No. 98-201, Report and Order, 14 FCC Rcd. 2654 at ¶ 59. (1999).

[38] SHVIA, Section 1005(a)(10)(A).

[39] *NOI* at ¶ 27.

[40] *Id.*

must be included in the Commission's eligibility standard, and it offers an objective mechanism for evaluating ghosting for purposes of determining such eligibility.

A. Evaluating Television Signal Impairment Due To Ghosting

When an NTSC television signal is reflected by natural or man-made objects, the viewer receives both the original (direct or main) signal and the reflected signal, which is displaced in time. Because the reflected image looks to the viewer like it is a ghost of the main image, the phenomenon is referred to as "ghosting." The subjective effect of ghosting depends on many factors, which are physiologically and psychologically based. Viewer tests have been conducted to derive limits for the amplitude of the reflected signals that can be tolerated for any particular time displacement of the ghost. If the amplitude or displacement is small, the disruption to the picture might be negligible, but it is often noticeable and/or objectionable. Various curves have been derived to define the conditions under which ghosting would be perceptible. The most commonly used one is the so-called Mertz curve.[41] ITU-R Recommendation BT-654 suggests that the impairment characteristics shown in the top graph of Attachment A (which is Figure 7 from the ITU-R Recommendation, corresponding to the case of a ghost that is delayed by 1 μsec from the main signal) should be used for assessment purposes.[42]

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[41] Pierre Mertz, "Influence of Echoes on Television Transmission," *SMPTE Journal*, May 1953.

[42] Impairment (imp) ratings are shown on the left-hand Y-axis of the top graph of Attachment A as a function of the impairment factor D. This was formerly CCIR Recommendation 654, "Subjective Quality of Television Pictures in Relation to the Main Impairments of the Analogue Composite Television Signal," *Recommendations and Reports of the CCIR*, 1986, vol. XI, Part 1 (Dubrovnik), at 223–230.

A ghost impairment factor, D, is related to the ratio of the echo amplitude to that of the main signal, and is defined as

$$D = 20 \log \frac{S}{E}$$

where S is the main signal amplitude and E is the echo amplitude.

The impairment factor for ghosts delayed by time periods other than 1 µsec can be obtained by subtracting a correction factor obtained from the bottom graph of Attachment A.

B. A Mechanism for Evaluating Ghosting

The mechanism for evaluating ghosting depends, in the first instance, on an "equivalence" rule between ghosting-related impairment and signal strength loss (which is related, in turn, on the correspondence of both ghosting and signal strength to a measurable level of picture quality degradation). During the course of their work in the mid-1960s on behalf of the British Post Office, Allnatt and Prosser developed such a rule, making it possible to find the magnitude of the picture impairment resulting from combined effects on a desired signal arising from the presence of a number of unrelated, simultaneous subjective impairments.[43] This method has been summarized by Weaver.[44] For r different subjective impairments, the overall impairment can be expressed as follows

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[43] Allnatt, J.W. and J.D. Prosser, "Subjective Quality of Television Pictures Impaired by Long Delayed Echoes," *Proc. IEEE*, 112, No. 3, March 1965, at 487–492.

[44] Weaver, L.E., "The Quality Rating of Color Television Pictures," J. SMPTE, Vol. 77, June 1968, at 610–612.

$$I = \sum_{r=1}^{n} I_r$$

where the variable I is given the name "Impairment units," or, more commonly, "imps." The values of I_r can be determined from the normalized observer opinion scores p_r, as follows

$$I_r = \frac{1}{p_r} - 1$$

The term p_r represents the normalized observer opinion scores, which can be determined from either of the two picture grading systems (TASO or CCIR) by assigning a score of 1.0 to the top-quality grade, 0.0 to the bottom-quality grade, and linearly interpolating the other grades between 0 and 1. The TASO interference scale consists of six grades, ranging from 1 (not perceptible) to 6 (not usable). The CCIR scale consists of five grades, ranging from 5 (imperceptible) to 1 (very annoying). Since the two scales consist of a different number of grades and move in opposite directions, the above means of assigning a common numerical value (opinion score) puts both scales on the same footing. The TASO and CCIR grades thus become:

TASO Grade	Adjective	Normalized Opinion Score		Adjective	CCIR Grade
1	not perceptible	1.0	1.0	Imperceptible	5
2	just perceptible	0.8	0.75	Perceptible	4
3	not objectionable	0.6	0.5	Slightly annoying	3
4	somewhat objectionable	0.4	0.25	Annoying	2
5	definitely objectionable	0.2	0.0	Very Annoying	1
6	not usable	0.0			

For example, a TASO Grade of 3 gives a normalized opinion score of 0.6, which is equivalent to 0.667 imps, *i.e.*, using the formula for I_r above. The imp scale ranges from 0 for

a “perfect” picture to • for an “unwatchable” one. Convenient reference points may be placed on the imp scale, such as at 0.125, 0.25, 0.5 and 1.0 imps.[45] An impairment of 0.125 imps represents approximately the threshold of visibility under controlled conditions. An impairment of 0.25 imps may be taken as a practical design objective for a high-quality distribution system. And an impairment of 0.5 imps may be taken as a reasonable design objective for each major impairment in a complex system involving transmission over a chain of long-distance international links.[46] By extension, an impairment of 1.0 imps lies beyond what might be considered acceptable for purposes of Grade B viewing.

The probability models typically used to represent the distribution of opinions for each grade are the normal distribution for the TASO scale,[47] and the binomial distribution for the CCIR scale.[48] For a large number of observers, the binomial distribution can be approximated by the normal distribution.[49] Hence, to a good degree of approximation, the two distributions would be expected to give equivalent results. The method that Allnatt and Prosser developed can

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[45] CCIR Report 405-5, Annex II, “Analysis and Presentation of the Results of Television Subjective Tests,” *Recommendations and Reports of the CCIR*, 1986, vol. XI, Part 1 (Dubrovnik), at 178–183.

[46] *Id*.

[47] TASO Report, *supra*, at 460.

[48] CCIR Report 405-5, “Analysis and Presentation of the Results of Television Subjective Tests,” *Recommendations and Reports of the CCIR*, 1986, vol. XI, Part 1 (Dubrovnik), at 178-183.

[49] Bowker, Albert H and Gerald J. Lieberman, *Engineering Statistics*, (Englewood Cliffs, NJ, Prentice-Hall, 1959), at 90.

thus be used to combine the impairments due to low signal-to-noise ratio (low field strength) with those due to ghosting.

C. Application to the Commission's Grade B Definition

The planning factors used to establish the Grade B median field strength include the signal-to-noise ratio required for Grade B service. Specifically, the received video carrier must be stronger than the system noise by some margin in order to provide a "passable" (TASO Grade 3) quality picture. By combining the impairment due to the signal-to-noise ratio of 30 dB associated with a "passable" quality picture with the impairment due to ghosting, it is possible to compare the unimpaired picture quality rating with the rating resulting when ghosting is present.[50] As discussed earlier, a TASO Grade 3 picture has an impairment rating of 0.667 imps. This is the impairment rating that can be assumed to exist at the Grade B signal strength level. Strictly speaking, any additional impairment (due to ghosting or some other factor) would cause the viewed image to fall below the Grade 3 criterion. However, some additional impairment might be allowed so that the total impairment does not exceed 1.0 imps. The reason for this is that in the Grade B definition the mid-Grade scores are not allowed in the TASO grading system. Therefore, a TASO Grade of 3 may actually consist of mean grades ranging from 2.5 to 3.5. Thus, as a worst case, a TASO Grade of 3.5, which is equivalent to 1.0 imps, would still be considered Grade 3.

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[50] Today, consumers would view a passable signal at higher than 30 dB, as discussed *supra*. This figure is used here for illustrative purposes only.

As discussed previously, there is an empirically-defined relationship between baseband SNR and TASO Grade.[51] Because the signal level input to the television receiver adds directly to the baseband SNR, there is a one-to-one equivalence between RF field strength and baseband SNR.[52] If the field strength required to produce a picture of TASO Grade 3 is taken to be a particular value (such as the present value of 41 dBμV/m for the VHF-low band channels), the dependence of field strength on picture quality is well defined. The field strength, relative to the Grade B or some other value required to produce a given SNR, and TASO Grade can therefore be related. These relationships are shown graphically in Attachment B for the case where the Grade B value of field strength is defined to be an SNR of 30 dB.

Using the method of Allnatt and Prosser, field strength values relative to a Grade B signal may be converted to equivalent impairment units. The relationship is shown in Attachment C. Additional impairments, such as ghosting, may now be combined with the impairment due to signal strength to obtain an overall impairment value. Because the overall impairment for a picture of Grade B quality must not exceed 1.0 imps, it becomes possible to relate field strength with the permissible ghost impairment factor, D. For example, when the field strength is 5 dB above the Grade B criterion, the equivalent impairment is 0.25 imps. Impairment due to ghosting of up to 0.75 imps would still result in a picture of Grade B quality.

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[51] Fine, *supra*.

[52] The relationship of RF "carrier to noise ratio" to baseband SNR depends upon the definitions of both signal and noise, and any noise-weighting function that might be employed. TASO relates the rms power of the video signal during a synchronizing pulse with the rms noise power in a 6 MHz band. Because these factors are constant, the addition of RF power at the receiver antenna terminals is equivalent to adding power in the video baseband.

This is equivalent to a ghost impairment factor, D, of 19.2 dB. Ghosting that exceeds the allowable value of D for a given field strength is, by definition, less than Grade B quality. The relationship between field strength (relative to Grade B) and the permissible ghost impairment factor, D, is shown in Attachment D.

Thus, for a given measured or calculated field strength level, the impairment factor resulting from measurement or calculation of the amplitude and time delay of a ghost image can be used to determine whether the picture is of Grade B quality or not.

D. In-Service Measurement Of Impairments Due To Ghosting

Objective test methods have been designed for use by the cable television industry to determine impairments caused by "echoes,"[53] and could be applied here. One practical method for in-service testing involves the use of the 2T pulse, which is transmitted by many NTSC television stations as part of the vertical interval test signals (VITS). These signals are routinely inserted into the video signal by television stations using test signal generators, and they are used for in-service testing of the studio and transmitter equipment. Such signals may also be used to measure the propagation path.[54] Any echoes will show up as "ringing," either before or after the 2T pulse, and the amount of ringing can be measured and related to the picture impairment that it will cause.

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[53] *E.g.*, IEC Standard 728-1, "Cabled Distribution Systems" (1986).

[54] Bernard Caron, "Video Channels Characterization for Advanced Television," *IEEE Trans. Consumer Electronics*, Vol. CE-35, at 178-183.

E. Data Collection Project Update

In support of the use of the 2T pulse as a measurement of ghost image severity, a program of field measurements is being undertaken by EchoStar. Available prior research suggests that the distribution of ghosts is continuous in both amplitude and time.[55] Additional research is underway, however, to determine whether any generalizations can be made concerning the impairments caused by ghosting in specific classes of receiving situations (*e.g.*, LU/LC types). Such a correlation, together with the previously described correspondence between ghosting and signal strength loss, would allow integration of predicted ghosting values (based upon measurements) into the ILLR predictive model. Thus far, several hundred measurements of 2T pulses have been made in a variety of receive environments, which may be meaningfully related to the USGS LU/LC categories and to other measures of clutter. Preliminary results suggest that objectionable ghosting is very common in both suburban and urban areas.

III. CONCLUSION

The Commission has initiated this proceeding in order to obtain information for evaluating whether the signal intensity standard used to determine the eligibility of satellite television subscribers to receive retransmitted distant signals of network stations should be modified or replaced. EchoStar has demonstrated that since the Grade B definition was developed, assumptions underlying the planning factors have changed markedly, reflecting

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[55] Hufford, G.A., *et al.*, "Characterization of the HDTV Channel in the Denver Area," NTIA Report 90-270 (1990).

evolutionary shifts in viewer expectations as well as technological and demographic changes. The Commission must therefore update these factors to produce a Grade B definition that more accurately and reliably reflects the signal intensity standard needed for determining retransmission eligibility.

With regard to ghosting, EchoStar has shown that the basis for an appropriate mechanism to account for ghosting is both feasible and practical to implement. Accordingly, consideration of ghosting must also be integrated into the signal intensity standard used to determine retransmission eligibility.

Respectfully submitted,

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