Comments of
Hammett & Edison, Inc.
Consulting Engineers

CS Docket 98-201

Revised Method for
Calculating Grade B
TV Signal Coverage

December 11, 1998

HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
SAN FRANCISCO

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

In the Matter of:	
Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act	CS Docket No. 98-201

To: The Commission

Comments of Hammett & Edison, Inc.

The firm of Hammett & Edison, Inc., Consulting Engineers, respectfully submits these comments in the above-captioned proceeding relating to prediction of Grade B television service for Satellite Home Viewer Act ("SHVA") purposes. Hammett & Edison, Inc. is a professional service organization that provides consultation to commercial and governmental clients on communications, radio, television, and related engineering matters.

I. Qualifications of Hammett & Edison, Inc.

1. Hammett & Edison, Inc. ("H&E") is well qualified to make comments on this matter, its professional staff having been involved for over 45 years with the design of individual TV broadcast stations, their applications for FCC authorization, and various assessments of station performance. H&E has participated over the years in many rule makings involving the television broadcast service. When the Sixth Report and Order to MM Docket 87-268 was issued in April of 1997, H&E analyzed in great detail the software relied upon by the FCC for the development of its DTV allotment table, implemented that software on its own computer system, and has written proprietary software that applies the FCC's "OET-69 method" to modified and/or new NTSC and DTV transmitting facilities.

II. SHVA Language is Flawed

2. In pertinent part, Section 119(a)(2)(B) grants statutory copyright licensing for transmission to persons who reside in unserved households. Subsection (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 ...." The operative word in this definition is receive. If one cannot receive a usable picture, the presence or absence of Grade B field strength in the area is immaterial. We are aware of no computer models that predict the presence of picture impairment, including, for

example, multipath (ghost) images. Any television viewer who has experienced severe ghosting would agree that the presence of such condition does not provide a picture that is usable.

3. On its face, the SHVA combines two concepts, "conventional outdoor rooftop receiving antenna" and "Grade B service," that are incompatible, since Grade B service is defined independently of the receiving antenna. Moreover, TV field strength measurements, as defined in the FCC Rules under §73.686 for other purposes, call for measurements at 30 feet above ground, while this height is, in many cases, beyond a reasonable definition of "conventional." Roof-mounted antennas are commonly attached to chimneys or to a guyed pole, limiting their height for reasons of mechanical stability to about 10 feet above the roof. In areas where lightning is frequent, many homes do not mount their antennas outside at all; instead, antennas designed for outdoor use are installed in the attic. Therefore, a single-story, ranch home might have a "conventional outdoor antenna" that is installed at a height of only 15–25 feet above ground. Until this flawed language is revised or interpreted officially, there will continue to be varying opinions as to its intended meaning.

4. Congress' intent presumably was to allow households where the local network affiliate does not produce a picture of acceptable quality, using receiving equipment typical in that community, to receive network programming by alternate means (such as satellite). Since the word "conventional" is used in the statute, Herculean efforts should not be required to receive TV signals of marginal quality. For instance, in developing its regulations to implement the Cable Television Consumer Protection and Competition Act of 1992, the Commission stated "that a cable operator should not be required to incur ... equipment improvement expenses [such as improved antennas, increased tower height, microwave relay equipment, and amplification equipment] when it is mandated to re-transmit a particular television signal on its cable system." Since the FCC does not require cable television headends, which are relatively few in number, to take extreme measures to receive a given TV station, it seems reasonable that such measures should not be required of individual viewers, either.

III. Testing for Signal Intensity Must be Simple, Fast, and Conclusive

5. The Commission recognizes that no computer model can account for all of the terrain and other subtleties present in a real receiving situation, noting at Paragraph 30 that "... no Commission-endorsed model will preclude a party from using actual measurements at individual households."

6. The question of whether an individual household can receive such a signal through the use of a conventional antenna requires at a minimum that the specific over-the-air signal is present at that antenna. Extensive field measurements of the kind specified in Section §73.683(a) generally are not appropriate to determine signal strength at a viewer's location.

7. A more reasonable, well-defined, and conclusive approach would be to measure the field strength with a calibrated antenna elevated near the household in question at a height comparable to other antennas in the vicinity. Because it is reasonable to expect the viewer to have installed the household antenna at a relatively attractive location in terms of reception, measurements at several locations near the household could be made. We recommend that the Commission accept such signal strength measurements for SHVA purposes.

IV. Receive Carrier Level Required

8. Inasmuch as it is relatively cumbersome to measure independently the field strength at a household's outdoor receiving antenna, measurement of the signal as gathered by that antenna and carried by the antenna transmission line to the household receiver antenna terminals may be of interest. The voltage at the output of the antenna downlead cable is commonly referred to as the receive carrier level ("RCL"). Television receivers have a specified sensitivity, which varies from model to model, and which requires that a certain voltage be present at the set's antenna terminals in order for the picture to be of passable quality insofar as noise is concerned.

9. To account for variations in receiving systems, it is not unusual for a minimum RCL to be specified, rather than minimum field strength. For instance, for providing a good quality picture at a cable television headend, the Commission has specified[1] a minimum RCL sufficient to produce a high quality picture in most television receivers (assuming the absence of interference or ghosting). A higher quality signal is necessary at cable television headends, because the television signal is distributed to a large number of subscribers from the headend and there is some degradation resulting from the distribution process.

10. The planning factors[2] used to establish the Grade B median field strength may be used to define the implied RCL for Grade B service. Specifically, the receive carrier must equal a minimal level just to overcome ambient thermal noise and noise in the television set's

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1 47 CFR 76.55(d) defines a "good quality" signal as being -49 dBm for VHF signals, which is equivalent to 59.75 dBμV for a 75-ohm system. This same level was specified by Congress in the Cable Television Consumer Protection and Competition Act of 1992 (P.L. 102-385).

2 Gary Kalagian, "A Review of the Technical Planning Factors for VHF Television Service," FCC/OCE Report RS 77-01, March 1, 1977.

own circuitry. In addition, the receiver carrier must be stronger than this noise by some margin in order to provide a passable quality picture. While a 45 dB "carrier-to-noise ratio" or greater is considered necessary for an excellent picture, the FCC assumed that 30 dB would suffice for a passable picture for the median observer in the 1950s TASO tests in the absence of interference or other impairments; a greater carrier-to-noise ratio, such as 36 dB, is likely appropriate in today's consumer market. The required RCL would be the sum of these factors.[3]

11. We recommend that the Commission accept RCL measurements for SHVA purposes. RCL measurements could be made either using the household's own installed antenna and downlead or using a consumer-grade antenna mounted at a typical height for the area. We recommend that the Commission accept RCL exceeding the following levels (or some others that the Commission might deem more appropriate): -58 and -54 dBm for VHF and UHF channels, respectively.

V. Advantages of Existing F(50,50) Contour Methodology

12. While H&E applauds the Commission's desire to provide increased accuracy in the prediction of TV service, H&E also notes are advantages to the present methodology that warrant its continued use. Namely, use of the F(50,50) curves and the "average terrain" definition is familiar and well understood, and it gives the same results regardless of who is doing the calculations. These advantages would be lost by adoption of a new calculation methodology whose results can be heavily influenced by the computer operator.

VI. Problems with the Longley-Rice Algorithm

13. Nevertheless, if the Commission decides to require the Longley-Rice ("L-R") method for SHVA purposes, then several issues with that algorithm, which have come to be more widely recognized as a result of its use for DTV purposes, need to be addressed. Most importantly, all of the variable input parameters must be specified, so that the new

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[3] It is recognized that the presence of an adequate RCL is not sufficient of itself to guarantee a usable picture. This is because, apart from random noise, which is eliminated by the presence of sufficiently strong signal, there are other types of impairments to the video image. Among these are, most commonly, ghosting, interference, loss of color, and loss of sound. When present, these impairments can be as annoying to the viewer as a "snowy" picture. A useful guide in making picture quality assessments is the scale defined by the Television Allocations Study Organization to the Federal Communications Commission, commonly known as the TASO scale, among other methods available for assessing picture impairments. For contemporary viewers, the ability to read character generator-produced text (such as sports scores) and the ability to record the programming using a consumer video cassette recorder may be important, additional measures of adequate picture quality.

methodology becomes, like the traditional F(50,50) curves, a tool that will give the same results in anyone's hands.

14. The L-R methodology mandated by OET-69 included the following specified parameters, which it is presumed will be maintained in the implementation mandated by the instant Rule Making: percent time/location/confidence; minimum/maximum AGL heights; mode of variability; climate code; ground permittivity; ground conductivity; atmospheric refractivity; polarization; and radiation center elevation AMSL. What OET-69 failed to specify, or specified incorrectly, are:

a) Source and version of the 3-second terrain database. Different federal government agencies have provided this terrain data over the years, and the databases are not identical.

b) Distance constant for spherical earth bearing and distance calculations. The OET source code used 111.15 kilometers/degree,[4] rather than the 111.180 kilometers/degree that can be derived from Section 73.190(b) of the FCC Rules, the 111.230 kilometers/degree that can be derived from Section 73.684(c)(1) of the FCC Rules, or the 111.125 kilometers/degree that can be derived from the definition of a nautical mile.

c) Rounding or truncation method. Distances are truncated at various calculation points within the OET-69 source code instead of being rounded.

d) Antenna radiation at specific depression angles. Some TV antennas are omnidirectional in the azimuth plane, but all TV antennas are directional in the elevation plane, and the elevation patterns can vary considerably one antenna model to another. While VHF low-band stations might have only 3 or 4 antenna bays and a broad elevation pattern half-power beam width ("HPBW") of 10°–15°, such is no longer the case for VHF high band stations having 6 or more antenna bays and certainly not for a common 25- or 30-gain UHF pylon antenna, having a HPBW of 1.5°–2.0°. For such antennas, the actual radiation toward a particular field strength calculation point is greatly affected by elevation pattern shape, electrical beam tilt, and mechanical beam tilt. The OET-69 software makes use of arbitrary elevation patterns that vary considerably from the actual patterns in many if not most cases.

15. The first three parameters can each make up to a 5% impact on the calculation results, while the fourth can have an enormous 10–20 dB impact (3–10 *times*). For DTV purposes, these parameters could be divined only by examination of the OET source code used to derive

[4] A comment in the OET source code indicates that the 111.150 km/degree constant came from the "Rio Final Acts."

the DTV Table of Allotments. These parameters need to be publicly specified, so that all parties using the L-R algorithm will obtain the same results.

16. The treatment of error codes generated by L-R needs to be changed. In our June 16, 1997, Petition for Reconsideration to the Fifth and Sixth Report and Orders to MM Docket 87-268, we pointed out that

> " ... the Longley-Rice model ... used to analyze paths between the transmitter and assumed receiver locations ... is not always capable of determining, within certain confidence limits, whether a particular cell has service.[5] Specifically, in cases where the actual horizon from a given cell or transmitter location is less than 0.1 times or greater than 3 times the distance to the smooth earth horizon, the Longley-Rice algorithm will return an "Error Code 3" that, according to the program documentation, means internal program calculations show parameters out of range, and any reported results are dubious or unusable. Incredibly, the procedure used by the FCC when such a Longley-Rice error occurs, whether during determination of potential service or potential interference, is to mark that cell as enjoying "interference-free service."
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> "While this assumption appears not to introduce significant overall errors in areas of relatively flat terrain, it has been found that the error code is returned much more often for studies involving mountainous or even hilly terrain. ... The table below summarizes for a number of top markets the tremendous arbitrary designation of service occurring due to Longley-Rice errors:

			Longley-Rice Errors (*as % of Grade B*)			
	Market	Example Station	Area, sq. km		Population (1990)	
...						
#6	Boston, MA	WGBH(N02/D19)	6,697	*27.1%*	1,373,952	*19.7%*
#12	Seattle, WA	KTZZ(N22/D25)	7,360	*37.3%*	385,679	*13.0%*
#17	Phoenix, AZ	KPHO(N05/D17)	7,862	*16.5%*	40,830	*1.8%*
#18	Denver, CO	KCNC(N04/D35)	9,211	*22.0%*	204,553	*7.8%*
#19	Pittsburgh, PA	KDKA(N02/D25)	17,074	*50.5%*	2,041,954	*52.3%*
#24	Portland, OR	KOPB(N10/D27)	13,739	*35.8%*	121,680	*5.8%*
#29	Raleigh, NC	WLFL(N22/D57)	3,964	*12.6%*	239,358	*11.3%*

> "Thus, there are situations within the top 30 markets where Longley-Rice errors are the only justification for classifying over half of the area or over half of the population with "interference-free" service."

[5] This is one of the reasons that H&E uses TIREM (Terrain-Integrated Rough Earth Model), a more sophisticated propagation loss algorithm of which the Longley-Rice routine is only a part.

17. However, in response, the February 23, 1998, Fifth Recon Order to MM Docket 87-268 stated, at Paragraph 181, "While we recognize that the Longley-Rice model may have certain limitations, as do all propagation models, we continue to believe that it provides a sufficiently accurate measure of service and interference."

18. Present analysis of all the DTV allotments in the contiguous United States shows the following Error Code 3 ("EC3") prevalence:

Percentage of DTV Allotments	Percent of Population in Cells with Error Code 3
9.9%	<1%
16.0	1 – 5%
16.0	5 – 10
23.4	10 – 20
28.1	20 – 50
6.5	50 – 90
0.1	> 90

On the average, fully 18% of a DTV allotment's population falls into cells with EC3.

19. If the Commission does adopt L-R for re-calculation of a TV station's Grade B coverage for SHVA purposes, if the decision is nevertheless made to do so, then it is essential that the Commission decide how users should deal with terrain paths that return EC3. We recommend that the error message be ignored and that the field strength value returned by the L-R algorithm be used, anyway, as though the EC3 warning were a "false alarm."[6]

20. H&E has now had approximately 18 months of additional experience using the L-R model as implemented by OET-69 and has discussed certain technical problems with FCC Mass Media Bureau and OET staff on numerous occasions. This ongoing work has convinced us that the implementation of the L-R model is even more flawed than had been originally suspected. For example, it has come to light that the OET-69 software calculates the depression angle to a calculation point using the sources height above ground, not its height above sea level. This coding mistake by itself will introduce errors of perhaps 10–20 dB in the calculation results.

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6 This would be a different policy from that adopted by MMB for DTV allocation and interference study purposes. When it derived the DTV Table of Allotments, OET assumed that cells that returned Error Code 3 were a) above threshold and b) interference-free. In the Sixth Recon Order to MM Docket 87-268, MMB stated that parties using the Longley-Rice algorithm for DTV interference studies should continue to treat cells with Error Code 3 in this same manner; that is, presume the Desired signal is above its DTV threshold signal strength and/or ignore possible interference.

VII. Summary

21. The Commission should recognize the primacy of measurements for determining adequate service under the SHVA. The measurements that will be acceptable should include both field strength measurements and receive carrier level measurements. By adopting a new calculation methodology that may not be as well-defined, the Commission risks losing the advantages of its traditional methodology for determining a TV station's Grade B contour. If the Commission nevertheless decides to change to the Longley-Rice model for SHVA purposes, then the lessons to be learned from the DTV rule making regarding that model should be applied, and such calculation methodology should be adequately codified so that all parties submitting showings to the Commission on this basis may have reasonable expectation that their results will agree with those of other parties and with those of the Commission staff.

Respectfully submitted,

Hammett & Edison, Inc.
Consulting Engineers
San Francisco

/s/ William F. Hammett, P.E.
President

/s/ Dane E. Ericksen, P.E.
Senior Engineer

/s/ Stanley Salek, P.E.
Senior Engineer

/s/ Robert D. Weller, P.E.
Senior Engineer

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