Reply Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained by EchoStar Satellite L.L.C. to provide expert technical analysis of issues raised in comments filed by others to the Notice of Proposed Rulemaking ("NPRM") released by the FCC on April 28, 2006, in ET Docket No. 06-94, "Measurement Standards for Digital Television Signals Pursuant To the Satellite Home Viewer Extension and Reauthorization Act of 2004."

I. Adjusting for 90% Time Probability

The engineering statement submitted with the Comments of the National Association of Broadcasters, The ABC, CBS, and NBC Affiliate Associations, and the Association for Maximum Service Television ("NAB Statement")[1] correctly notes that the "cluster measurement" protocol described in Section 73.686(d) of the Commission's Rules provides a practical means of deriving a median field strength value for a given location. However, the DTV service criteria set forth by the FCC are not based upon median field strength values. Section 73.622(e)(1) specifies that that "the service area of a DTV station is the geographic area within the station's noise-limited F(50,90) contour where its signal strength is predicted to exceed the noise-limited service level." Similarly, OET Bulletin No. 69 (February 6, 2004) explains that, "noise-limited DTV coverage [is] defined as the presence of the field strengths identified … at 50% of locations and 90% of the time."[2] The Bulletin goes on to state that, "to predict DTV service … the FCC sets the location variability at 50% and the time variability at 90%."[3] This is the "F(50,90)" DTV service requirement definition.

For *calculated* projections of DTV service, determining the F(50,90) value does not present a problem, but in order to conduct *measurements* of actual conditions, which are intended by the proposed measurement protocols to be median, F(50,50) values, either the F(50,90) service definition levels would need to be adjusted upward to an equivalent F(50,50) value, or the measured F(50,50) values would need to be adjusted downward to an equivalent F(50,90) value. As noted in OET-69, "the (50,90) value is lower than F(50,50) by the same amount that F(50,10) exceeds F(50,50)."[4] OET-69 goes on to describe how to derive F(50,90) propagation curves using the difference between the Commission's published F(50,50) and F(50,10) propagation curves. This difference is not zero. Indeed, this difference is the very adjustment that we recommended in our August 7, 2006, Engineering Statement.[5]

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1 ¶13, August 7, 2006.
2 OET-69, p. 5.
3 *Ibid* p. 6.
4 *Ibid* p. 2
5 Engineering Statement of Hammett & Edison, Inc., Consulting Engineers, a part of the Comments of EchoStar L.L.C. to ET Docket No. 06-94.

II. Antenna Selection for Measurements

The NAB Statement argues that use of a "gain antenna" (as opposed to a dipole antenna)[6] for measurements allows flexibility for the tester.[7] To the contrary, it should be obvious that allowing the tester the freedom to choose a suitable antenna allows *greater* flexibility. While it is possible that the "use of a dipole antenna could limit the sensitivity of certain measurement instruments to a signal level greater than 41 dBu [at UHF],"[8] our experience has been that the gain of a dipole antenna is adequate for field strength measurements at that level. H&E has conducted numerous DTV field strength surveys in various markets, using both dipole and gain antennas with equal success, at UHF channels. These measurements were conducted with a variety of instruments, including spectrum analyzers and calibrated receivers. Indeed, our experience has been that the main measurement system limitation is at VHF-Low band (Channels 2–6), where the service field strength of 28 dBu can be difficult or impossible to detect, particularly when man-made noise is present.

NAB claims speciously that the cost of a dipole antenna is much greater than a "gain antenna." In fact, the comparison offered by NAB is invalid, since the dipole antenna has NIST-traceable calibration, while its "gain antenna" does not. The addition of NIST-traceable calibration adds significantly to the retail cost of an antenna. When compared on an equal basis, the dipole antenna is in fact *less* expensive than the "gain antenna." For example, A.H. Systems, a leading U.S. manufacturer of NIST-traceable antennas, offers its TV-2 UHF dipole for $860, while the SAS-510-2, log-periodic (a "gain antenna") costs $1,720, fully twice the cost of the dipole. If NAB is proposing the use of uncalibrated antennas, then it should be noted that dipole antennas can easily be constructed according to standard designs[9] at very low cost.

NAB claims[10] that measurements at each channel require precise adjustment of the length of the antenna elements. This is true for half-wave dipoles, but broadband dipoles, such as the A.H. Systems Model SAS-530, are available that cover a large frequency range without the need for retuning or other adjustment. NAB also claims that a "gain antenna" is more physically robust than a dipole.[11] To the contrary, H&E has found that log-periodic, Yagi, and other "gain antennas" are much more susceptible to breakage than the dipole antenna, particularly during rigging, storage, and shipment. This is because calibrated "gain antennas" are often not designed for repeated rigging in field use, are unwieldy, and utilize fixed elements, which are easily damaged or distorted during rigging and transport. In contrast,

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6 A misnomer, since a dipole antenna has 2.14 dB gain above an isotropic radiator.
7 NAB Statement, ¶7
8 *Ibid*
9 FCC Project 3235-33, "Construction of general purpose receiving antenna dipole sets and balun assemblies," (1980)
10 NAB Statement, ¶11
11 *Ibid* ¶12.

dipole antennas typically have removable, and/or collapsible elements, which enables them to be stored and shipped conveniently, and allows for simple and inexpensive replacement of damaged elements. Further, replacement or repair of "gain antennas" typically involves return of the antenna to its manufacturer for both repair and recalibration. In fact, in our experience, the cost of repair and subsequent performance verification (recalibration) is comparable to the cost of purchasing a new unit. Finally, as mentioned in our earlier statement, H&E is aware of no calibrated "gain antenna" having gains and front-to-back ratios consistent with the Commission's DTV planning assumptions that can be used at all TV channels.

III. Measurement Procedures: Antenna Orientation

The NAB statement recommends[12] that the receive antenna be oriented for maximum signal strength. In the case of cluster measurements at five points, this technique could require re-orientation of the antenna five times for each station measured, and so could be burdensome. The software employed by the Commission for DTV planning assumes, instead, that the receiving antenna is always pointed toward the station being measured. For consistency, we recommend that the main lobe of the measurement antenna also be oriented toward the transmitter, as envisioned by the planning factors.

Re-orienting the measurement antenna at each point in the cluster also creates an atypical situation, which is contrary to the statistical assumptions upon which DTV coverage is based. Although the Commission commonly refers to DTV reception at 50% of the locations 90% of the time, *i.e.*, a two-dimensional statistical probability, there is another dimension called confidence (or situation),[13] which is typically ignored, since it is assumed to take on the typical (median) value. OET Bulletin No. 69 specifies that the confidence value be set to 50% when DTV coverage is to be projected.[14] By re-orienting the antenna at each measurement point, the tester is creating an *a*typical situation. In effect, the tester is improperly increasing the median value, which effectively biases the results. In a treatise about the Longley-Rice model, upon which OET-69 is based, NTIA describes[15] a "situation" as "a particular deployment" and cautions that this should "… include only paths with a common set of system parameters…." Varying the receive antenna orientation obviously changes the gain parameter along the transmitter-receiver propagation path, and always selecting the orientation having maximum signal level creates a bias toward higher signal levels.

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12 NAB Statement, ¶25
13 George A. Hufford, "The ITS Irregular Terrain Model," version 1.2.2 – The Algorithm," p. 4.
14 OET-69, page 6, "The percent confidence is set at 50% indicating that we are interested in median situations."
15 NTIA Report 82-100, "Use of the ITS Irregular Terrain Model in the Area Prediction Mode." p. 27.

The cluster measurement protocol is intended as a convenient substitute, to facilitate rapidity of measurement, for the more reliable but time-consuming, mobile-run procedure.[16] Certainly, no one would propose to re-orient the receiving antenna on-the-fly for maximum signal during a mobile-run, and it is also inappropriate to do so when taking cluster measurements. Because selective re-orientation of the receiving antenna can create an atypical situation, inflating the local median signal level, we recommend that the receiving antenna always be oriented toward the transmitter being measured.

IV. NAB's Appendix C Needs Clarification

One of the formulas offered in Appendix C to the NAB statement needs clarification. Specifically, at page 19, the so-called Dipole Factor (in logarithmic form), which converts from voltage to field strength, is missing its frequency term. NAB derives a fixed value, valid only at 615 MHz. The formula should read as follows:

$$K_{EV} = 20*\log[c/(2\pi F)] = 20*\log[300/2\pi F] = 33.6 - 20\log F$$

Thus, its frequency-dependent nature is preserved.

/s/ *Robert D. Weller*
Robert D. Weller, P.E.

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[16] FCC rules specify that mobile runs are continuous measurements made over a horizontal distance of at least 30.5 meters (100 feet), §73.686(b)(2).