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To:	Robert Eckert	Date:	November 22, 1995
Fax #:	202-887-5637	Pages:	6, including this cover sheet.
From:	Jules Cohen		
Subject:	Bendov Letter and Response		

COMMENTS:

Bob, Oded Bendov sent the accompanying letter to Bob Hopkins with copies to a number of people. With help from Victor Tawil and Ed Williams, I prepared a response. Victor and I think you may be interested in both the letter and response.

O. BENDOV**DIELECTRIC COMMUNICATIONS**

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November 16, 1995

Dr. Robert Hopkins
Executive Director
Advanced Television Systems Committee
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Dear Bob:

The October 30 draft of the Final Technical Report to be submitted to the FCC by ACATS contains a statement which is factually and technically wrong. The statement, "An objective measurement (my emphasis) that should permit reliable prediction of satisfactory HDTV service at UHF is field strength", appears on page 27. I suspect that this statement was borrowed from the October 16 final report on the field tests. To my knowledge, the draft of that report was never circulated to, nor discussed with, the members of the field test task force.

In fact,

- HDTV field strength is not measurable and was never measured.
- The conversion process, from the measured total signal power in 6 Mhz to incident field strength at the receive antenna, used by the authors of the field test report (but not documented in the report), is not applicable to HDTV.
- Neither the measured total signal power in 6 MHz, nor the unmeasurable field strength can serve as reliable predictors of satisfactory HDTV service.

Let me explain these points in more detail and then suggest the proper recommendation to the FCC with respect to the measurement and service prediction of HDTV.

The 6 Mhz spectrum of HDTV shows no carrier. RF field strength is defined only at a single frequency and is measurable, for narrow-band transmission, provided it is constant during measurement. Both conditions apply to NTSC. Neither condition applies to HDTV.

During the Grand Alliance field tests, the field strength of the NTSC signal was measured using the Potomac Instruments' FIM-72 field strength meter. This measurement failed when applied to the HDTV signal.

So how did the final field test report come up with the unexplained field strength data even though it could not be measured? It started with the measured total signal power in 6 Mhz. That power is represented by the area under the power spectrum curve as seen on the

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analyzer. So far so good. The authors of the field test report then used Ohm's law and the NTSC formula that relates the measurable received voltage to the incident field strength--the so-called "dipole factor" to come up with "field strength". The implicit assumption made was that all of the HDTV energy is concentrated at the carrier frequency rather than spread across the channel.

Even if this wrong, and if eventually this misleading assumption is overlooked, the incorrect measured power was used in the conversion process to "field strength." To be used as service predictor, the correct power at the output of the receive antenna is the net useable power defined as:

Net Useable Power = Total Signal Power - Lost Effective Power (due to equalization)

Both terms on the right side of the equation are measurable.

The importance of the net useable power as the predictor can best be explained by considering the realistic nature of the incident channel's spectrum at the receiver. The HDTV spectrum is rarely flat over 6 Mhz and a deep notch, either from multipath, impulse noise, or cochannel interference may be present. Under these realistic conditions the total signal power (and the unmeasurable "field strength") will remain unaffected by the notch since the area under the power spectrum curve would hardly change with or without the notches. Consequently, the unmeasurable "field strength" predictor proposed by ACATS would predict HDTV service where, in fact, none would be available. Therefore, the suggestion that the total signal power can serve as a predictor is based on the wrong assumption that the HDTV power at the receiver is evenly distributed across 6 Mhz, and that deep notches from interference can be ignored. Aside from being wrong, this assumption contradicts the other assumption already made--that all the power is concentrated at a single frequency.

In short, the suggestion that there is a measurable field strength for HDTV transmission and that this field strength can serve as a service predictor borders on voodoo engineering.

~~The proper treatment of a service predictor is simple and straightforward. The FCC should be asked to convert their propagation curves (using the appropriate formula) as follows:~~

from $\frac{\text{Field Strength (dBu)}}{1 \text{ kW ERP}}$ to $\frac{\text{Net Received Power (dbm)}}{1 \text{ kW AERP}}$

where, AERP is the average effective radiated power, and the Net Received Power was defined above. Thus, the FCC curves will assume no distortion in the passband and the correction will be made by the proper measurement of the useable power, as defined above, at the receiver.

Conclusion

Field strength measurement at the carrier frequency of NTSC using standard instruments is possible and is based on sound engineering principles. Moreover, the measured field strength of

NTSC serves as a service predictor because of the narrow-band nature of NTSC transmission. That is, unless the notches fall very near the carrier, a rare probability, picture or sound may not be lost.

Field strength measurement at the carrier frequency of HDTV using standard instruments is not possible. Moreover, the measured total power in 6 Mhz of HDTV cannot serve as a service predictor because of the broad-band nature of HDTV transmission. That is, regardless of where the notches fall within the channel, not a rare probability, picture or sound will be lost. Service prediction require that both the total HDTV signal power and the shape of the channel's spectrum are combined to produce the net useful power.

Best regards,



O. Bendov
Vice President Antenna Engineering & Advanced Technologies

cc:

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November 22, 1995

VIA TELECOPIER

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Dr. Oded Bendov
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Dear Oded:

With reference to your letter of November 16 to Bob Hopkins, I cannot agree with your analysis. The conclusion you draw is contrary to what we have learned in field testing.

The derived field strength of the ATV signal was not based on "measured total signal power in 6 MHz." The calculation was based on the average signal power over the 6 MHz band. That is a substantial difference. The average power was then corrected by gains and losses of the field truck's RF distribution system, transmission line loss and antenna gain to convert to signal strength in decibels above a microvolt per meter.

FCC published propagation data are based, primarily, on empirically derived, narrow-band measurements on broadcast and land mobile transmissions. An important aspect of the field testing was a determination of whether such narrow-band data could have applicability to the wide-band case. The assumption, which field testing supports as being reasonable, is that the antenna characteristics remain constant over the entire 6-MHz band and instantaneous signal levels do not depart materially from the average. Of course, that last assumption does not apply in all instances, but experience shows that the correlation may be as high as 90 percent. For the FCC to undertake the project of converting its propagation curves to wide-band equivalents would be a useless exercise. The direct relationship can be applied as needed.

One of the parameters measured during both phases of the field testing was the 8VSB pilot level. As part of the analysis being undertaken in the preparation of a report of the Phase 2 work, the correlation between pilot level and average level over the 6-MHz band is being studied. Preliminary analysis suggests a high degree of correlation introducing the possibility that use of relatively narrow-band field strength meters may be as appropriate for HDTV as for NTSC. More field data would be desirable in this area.

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Dr. Oded Bendov

November 22, 1995

As illustrated in the data provided by Victor Tawil in Table 8 of the report distributed to the Field Testing Task Force (*Results of the Terrestrial Broadcast Transmission of the Grand Alliance HDTV System*) and in the plot of signal margin versus field strength included in the paper by Zou, Wu and Guillet, delivered at the '95 Broadcast Symposium, field strength derived by the method described above, based on average power over 6 MHz delivered to the receiver, provides a good prediction of whether or not HDTV service is to be expected.

Of course the system is not perfect any more than measurement of NTSC video carrier level is a perfect indicator of whether or not satisfactory NTSC service is available. My classic case for NTSC signal strength not being a reliable predictor of service goes back to when WCBS-TV moved from the Empire State Building to the World Trade Tower. At William Paley's town house on Fifth Avenue, a line of sight was available to the WCBS-TV antenna, and the signal strength was predictably very high, but the picture was unusable because of the multipath produced by the signal bouncing back and forth off the buildings lining Fifth Avenue

Nevertheless, despite some locations where interference or severe multipath will affect reception adversely, signal strength for both NTSC and HDTV is a good indicator of the likelihood of satisfactory reception. Your dire forecast and charge of "voodoo engineering" (which I cannot help but resent as not appropriate in what should be a dispassionate analysis) do not jibe with the empirical results derived from actual field experience.

Sincerely yours,



Jules Cohen, P.E.

cc: Robert S. Hopkins, Jr.
John F.X. Browne
Thomas E. Hankinson
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