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ASSOCIATION OF FEDERAL COMMUNICATIONS CONSULTING ENGINEERS

WASHINGTON, D. C.

December 19, 1997

Ms. Magalie Roman Salas, Secretary
Federal Communications Commission
Mass Media Services
1919 M Street N.W.
Room 222
Washington, DC 20554

Dear Ms. Salas:

Transmitted on behalf of the Association of Federal Communications Consulting Engineers ("AFCCE") is a corrected original and 14 copies of a Response to Ex-Parte filings of the Association of Maximum Service Telecasters and the Association of Local Television Stations in MM Docket 87-268.

After the submission of AFCCE's response on December 17, 1997, several typographic errors were noticed. It is requested that the herein enclosed corrected statement be substituted.

If any questions should arise concerning this matter, please communicate with the undersigned.

Sincerely,

Cynthia M. Jacobson
Secretary

Enclosures

No. of Copies rec'd 0+14
List ABCDE

ASSOCIATION OF
FEDERAL COMMUNICATIONS CONSULTING ENGINEERS
WASHINGTON, D. C.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Advanced Television Systems	)	
and Their Impact Upon the	)	MM Docket No. 87-268
Existing Television Broadcast	)	
Service	)	

RESPONSE TO EX-PARTE FILINGS

The Association of Federal Communications Consulting Engineers (AFCCE) hereby submits comments regarding the ex-parte filings of the Association of Maximum Service Telecasters (MSTV) and the Association of Local Television Stations (ALTV) regarding various technical issues concerning the implementation of the Digital Television Broadcast service (DTV). AFCCE is a professional organization whose members are professional engineers practicing as consultants to broadcasters and other segments of the communications industry, communications company engineering executives, representatives of equipment manufacturers and others working in the communications arena. AFCCE has a long history of participation in FCC rule making proceedings dating back to its founding nearly fifty years ago and welcomes this opportunity to submit its Comments to the Commission.

AFCCE has previously filed comments in these proceedings and reference to those filings will be made in the instant filing. AFCCE's concern is that the Commission adopt scientifically sound technical standards for DTV which will permit practical implementation and will provide a high-quality, reliable service to the public.

P.O. Box 19333, 20th Street Station, Washington, D.C. 20036-0333

AFCCE compliments the Commission and the various parties which have participated in the decade-long process of establishing the system standards adopted one year ago and the subsequent activities related to quantifying the transmission standards and allotment table. However, AFCCE remains concerned about certain technical issues including those referenced in the above ex-parte filings.

MSTV FILING

MSTV has presented a new DTV allotment table which purports to resolve many of the issues raised by broadcasters and other parties regarding the Commission's Table of Allotments adopted in April, 1997. While AFCCE declines to offer comments regarding specific allotments, it supports the MSTV filing with regard to adjacent channel interference issues and the use of the channel 60-69 spectrum. AFCCE, in fact, made similar comments in its' earlier filings.[1/]

Adjacent Channel Interference

The DTV planning factors recommended to the FCC by the Advisory Committee for Advanced Television Service (ACATS) for DTV-into-DTV and DTV-into-NTSC interference were based upon measurements which were made on a highly linear laboratory RF test bed that generated minimal third order intermodulation products. These measurements were carried out by the Advanced Television Test Center[2/] (ATTC) in Alexandria, Virginia in strict accordance with the test plan drafted and approved by ACATS System Subcommittee Working Party 2 (SS/WP2). The test plan adopted by SS/WP-2 utilized a highly linear RF system test bed that was explicitly designed to avoid the introduction of interference components that were not a result of the then competitive systems under test for which were under test for recommendation by ACATS as the winner of the competitive process to determine the next United States terrestrial broadcast TV system standard. With the adoption of the DTV RF mask into the Rules by the FCC in its Sixth Report and Order on Digital Television Systems, additional laboratory measurements were carried out at the ATTC for adjacent channel DTV-into-DTV and DTV-into-NTSC interference to

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1/ Comments of AFCCE, Sixth Further Notice of Proposed Rulemaking.

2/ Now the Advanced Television Technology Center, Alexandria, Virginia, an independent non-profit laboratory composed of membership from the broadcast and electronics manufacturing industry for the purpose of providing test and development support for advanced television systems.

determine the impact of the adopted RF mask on adjacent channel interference. The new adjacent channel measurements incorporated controlled non-linear amplification of the RF source of the test bed. The characteristic of the non-linear amplification replicated the spectrum characteristics of the proposed RF mask later adopted in the Sixth Report and Order. The resulting measurements indicated a substantial deviation from the Desired-to-Undesired ratios originally recommended as the planning factors for adjacent channel interference upon which the proper allotment of DTV channels so critically depends.

Ex Parte Filings by the ATTC on Adjacent Channel Interference

In two ex parte filings, the Advanced Television Technology Center submitted reports documenting the impact of interference from DTV signals that have adjacent channel spectrum products that comply with the FCC DTV RF mask. The first report documented the effects of DTV-into-NTSC interference when the interfering source had spectrum characteristics that matched that of the FCC DTV RF mask. The second report documented the effects of the DTV-into-DTV interference when the interfering source had the spectrum characteristics that matched those of the FCC DTV RF mask.

The ATTC undertook these additional new measurements of adjacent channel interference at the request of its member organizations in order to gauge the effects of adjacent channel sideband splatter when the RF source (or DTV transmitter) conforms to emissions as specified by the FCC DTV RF mask.

Sideband Splatter into an NTSC Signal on Adjacent Channels

In the first of these two reports[3/] the ATTC separately examined the effects of upper and lower adjacent channel interference from DTV-into-NTSC. The RF source in the ATTC test bed used controlled levels of non-linear amplification to match as closely as possible the spectrum characteristics of the RF mask adopted by the FCC in its Rules. Measurements were conducted to determine the D/U ratios for the threshold-of-visibility (TOV) of upper and lower adjacent channel interference from DTV-into-NTSC. The

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[3/] An Evaluation of the FCC Proposed RF Mask for the Protection of Adjacent Channel NTSC Signals," Advanced Television Technology Center, Inc. Alexandria, Virginia, Document Number 96-02, October 22, 1996.

measurements conducted during the ACATS process with the important exception that the adjacent channel sideband splatter allowed by the DTV RF mask was included.

Sideband Splatter was Found to be the Limiting Factor for DTV-into-NTSC

The report revealed that the median D/U ratio for lower adjacent channel DTV-into-NTSC interference was 11.33 dB and the median D/U ratio from upper adjacent DTV into NTSC interference was 7.33 dB.

The planning factors submitted to the FCC by the Advisory Committee of ACATS, and adopted in the Sixth Report and Order, specify lower adjacent channel DTV-into-NTSC interference at a D/U ratio of −17.43 dB and upper adjacent channel DTV-into-NTSC interference at a D/U ratio of −11.95 dB. These planning factors for adjacent channel DTV-into-NTSC interference were based upon CCIR Grade 3 picture impairments and not the threshold-of-visibility for interference. The measurements made at the ATTC which took into account the DTV spectrum mask were not made at CCIR Grade 3, but were made at the threshold-of-visibility for DTV-into-NTSC interference.

In addition to the corrected D/U ratios, the threshold CNR for coverage and service calculations should be raised in those markets where one or more adjacent channels are allocated. That is because the sideband splatter comes in as incoherent noise that must be added to the thermal noise. Therefore the threshold CNR=15 dB for coverage must be raised by X dB.

For example, Canada has proposed C/(N+I)=19.5 dB of which 1.2 dB is multipath margin as a planning factor. Therefore, X $\approx$ 3 dB. It is not made clear in the Canadian document if the 19.5 dB is for a single adjacent channel nor how it was derived, however.

Current Planning Factors for DTV-into-NTSC Underestimate NTSC Interference

Charles W. Rhodes, formerly the Chief Scientist at the ATTC, and now an independent consultant to the Broadcast Industry, analyzed the additional measurements with regard to the threshold of visibility and the CCIR Grade 3 used as the planning factors. His analysis estimates that the planning factors used by the FCC in generating the table of allotments in the Sixth Report and Order will underestimate

interference from DTV-into-NTSC by at least 16 dB for low adjacent channel DTV allotments and 6.3 dB for upper adjacent channel DTV allotments.

Current Planning Factors for DTV-into-DTV Underestimate DTV Interference

In the second report[4] on adjacent channel interference, the ATTC documented the effects the adjacent channel interference from DTV-into-DTV signals. Again, controlled non-linear amplification was used in the RF source of the test bed to replicate the spectrum characteristics of the FCC DTV RF mask. The D/U ratio for lower channel DTV-into-DTV was measured at –23 dB and the D/U ratio for the upper channel DTV-into-DTV was measured at –21 dB. These values are more than 20 dB worse than the values used by the FCC for DTV allotments.

It should be noted that in the cases of DTV-into-NTSC interference and DTV-into-DTV interference cited above, the laboratory measurements did not take into account the variation in D/U ratios due to propagation effects (antennas not having common apertures or elevation patterns and differences in frequency), which can easily cause nominal D/U variations of 7 to 10 dB in practice.

Discussions with Transmitter Manufacturers on Intermodulation Products

Based upon discussions with DTV transmitter manufacturers, the current state of the art in high power transmitter design will approach the emission limits specified in the FCC DTV mask. Should the FCC tighten the technical parameters of the mask, the practical implementation issues for broadcasters and transmitter manufacturers should be carefully weighed. The practical application and economic impact of methods designed to reduce adjacent channel emissions and maintain good in channel DTV performance are currently under investigation by manufacturers. However, the solutions are still uncertain for the near future and have yet to be demonstrated in production quantities, thus making the use of proper planning factors extremely important when generating a table of allotments.

4/ "An Evaluation of the FCC RF Mask for the Protection of DTV signals from Adjacent Channel DTV Interference", Advanced Television Technology Center, Alexandria, Virginia, Document Number 97-06, July 17, 1997.

Substantive Studies Presented by MSTV in Ex-Parte Filing

On November 20, 1997, MSTV filed with the Commission an ex-parte submission[5/] that highlights the issues of adjacent channel DTV-into-DTV and DTV-into-NTSC interference when the impact of sideband splatter is considered. Its analysis took into account the measurements that were made at the ATTC which included the sideband splatter levels allowed by the FCC DTV RF mask.

In its analysis, MSTV cited numerous cases in which existing NTSC stations and proposed DTV allotments in the allotment table from the FCC's Sixth Report and Order would suffer from substantial and unexpected adjacent channel interference when the effects of sideband splatter come into play.

Impact on Planning

It is vitally important that the new adjacent channel D/U ratios be incorporated into any analysis that is designed to allot and assign DTV stations across the nation. Failure to do so will result in a substantial loss of service to existing NTSC stations due to interference which is not accounted-for when using the original ACATS planning factors for adjacent channel DTV-into-NTSC operation. The actual interference will be underestimated in excess of 20 dB for DTV-into-DTV interference; by 16 dB for lower adjacent DTV-into-NTSC interference, and by 6.3 dB for upper adjacent DTV-into-NTSC interference. Any analysis tools that are used to estimate the impact of interference by DTV station allotments which do not take into account the measured data based upon the transmitter non-linearity, will fail to correctly estimate interference levels and corresponding loss of service to NTSC and DTV stations.

Expanded DTV Spectrum

The MSTV allotment table makes extensive use of the channel 60-69 spectrum to alleviate many of the adjacent channel problems discussed above. Many of these problems are very serious and, in fact,

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5/ "Ex-Parte Submission Based on New Technical Discoveries to Help the Commission Improve the DTV Table of Allotments/Assignments Submitted by the Association for Maximum Service Television, Inc. and Other Broadcasters", Filed by MSTV on November 20, 1997.

are clearly unworkable in the Commission's allotment scheme. It is evident that more, not less, spectrum is needed to implement the DTV service while maintaining the NTSC service to which the pubic has become accustomed. If the adjacent channel problems are truly as serious as described above—and AFCCE believes this to be the case—formulating an acceptable allotment table will continue to be a formidable task.

ALTV PROPOSAL

ALTV has proposed the use of "tilt beam" technology to permit DTV stations which received relatively low power UHF allotments (e.g., 50 kW) to increase their maximum effective radiated power to a maximum of 1,000 kW. AFCCE has previously commented on the power disparity at the extremes of the allotment parameters and the fact that it believes that this will lead to myriad technical problems and competitive issues in the market-place. Indoor reception and available margins (so important for a reliable DTV service) are just two of the obvious issues.

When this disparity reaches or approaches the ultimate i.e., 50 kW and 1000 kW stations in the same market, perhaps broadcasting from the same tower/site, these problems will be significant. The Commission is reminded that the maximum power levels for the existing NTSC service (100 kW low band VHF, 316 kW high band VHF and 5,000 kW UHF band) were established in an attempt to equalize the services provided by stations in all bands; the effect of the Commission's replication process is to create a situation which yields seemingly opposite results for DTV. Therefore, AFCCE supports any technically sound solution of this dilemma. However, it is concerned that the ALTV proposal will not be practical for achieving the ultimate (13 dB) improvement. Also, ALTV mentions the use of "other technologies" but these are not further described in its filing.

Typical Beam Tilt Scenarios

ALTV proposes that stations with assigned ERP of 50 kW be allowed to increase their ERP to the 1 MW maximum and then use excessive beam tilt, on the order of -3° or more, to focus the peak ERP inside their Grade-A contour instead of toward the radio horizon. The exact beam tilt will be fixed such

that the total **calculated** power in the 6 MHz channel toward the horizon does not exceed the assigned 50 kW.

Enclosed is a calculated pattern of an end-fed DTV antenna for channel 38. The pattern was calculated over 5.38 MHz channel starting at the pilot frequency of 614.31 MHz..

The ERP is 1 MW at a tilt of 2.2° as the frequency is swept across the channel from 614.31 MHz to 619.69 MHz. The 50 kW (average) level is at an average relative voltage of 0.224 which can be maintained approximately within ±0.25° if the radio horizon is at 0.5°. The ±0.25° tolerance is not enough margin to counter the effects of windsway and other effects as discussed below.

As noted below, the Commission should appoint an engineering advisory committee that will examine, market-by-market, the parity issue between the U-to-U and the V-to-U around the center of population and recommend the right mix of power/tilt/antenna that would resolve the problem within a predetermined level of minimum interference. The tilt could be mechanical, electrical or both. Perhaps an increase of power from 50 kW to 250 kW combined with approximately 1° tilt would provide acceptable coverage for the U-to-U stations without introducing undue interference beyond the radio horizon.

Possible Sources of Variability

There will be a need for margins to ensure interference protection under all adverse conditions, such that the beam tilt is maintained in order that the energy at (or above) the radio horizon does not exceed the desire level (equivalent to allotment power). Some of these issues were discussed above. Additional issues include:

- Variation of signal levels due to tower movement (sway)
- Bending of antennas due to wind loads and differential heating by the sun
- Variations in actual antenna performance vis a vis design criteria

While complete data is not available on the magnitude of these factors, it is evident that a margin of an additional one degree might be required to assure compliance. This may require beam tilts in excess of 3° using medium gain antennas. It is a known fact that, as these excessively large electrical beam tilts are introduced by varying the amplitude and phase relationships among the antenna elements, the upper lobes (above the horizontal) begin to increase dramatically and could reach relative field values approaching 0.50 or just 6 dB below the energy in the main lobe. This, of course, would place significant energy at or above the horizon, an effect opposite to that desired.

Other Related Issues

AFCCE is also concerned about propagation issues which have not been addressed in the ALTV proposal. Theoretical analyses and, perhaps, actual field testing should be conducted to determine whether there are over-the-horizon propagation modes under varying atmospheric conditions (e.g., varying refractive index) which might support higher levels of interfering signals.

AFCCE does not believe that the interference resolution program proposed by ALTS would be acceptable in real-world conditions. The variability of measurements, differences in methodologies, defining "additional incremental visible interference" and the need for long term measurement data do not bode well for this kind of an approach. Interference protection must be afforded in the traditional manner using an acceptable model and established propagation curves to determine whether appropriate D/U ratios are being maintained.

Also, in a scenario where the beam tilt is 3° or more from an antenna mounted on a 1,000 ft. tower, the main energy will be directed only 3.5 miles or less from the transmitter. The high level fields thus created will approach or exceed "blanketing" levels and receiver overload and intermodulation distortion issues may become quite significant. (The fields may also be 8-10 dB higher at this distance than those created by a 1,000 kW allotment station employing normal beam tilt.)

Conclusion

AFCCE believes that the ALTV proposal, while well intentioned, should not be adopted as proposed. Considerable further study will be required to determine the efficacy of the proposal; such study may prove that the technique is appropriate for moderate power increases.

OTHER TECHNICAL MATTERS

AFCCE members have been preparing applications for DTV construction permits and have identified a number of technical issues which the Commission needs to address. Perhaps the most significant of these is the directional DTV Antenna pattern assigned to every station and the treatment of practical antenna patterns—including omnidirectional versions—as they relate to the Commissions "zero tolerance" interference standards.

DTV Antenna Patterns

As stated in OET Bulletin No. 69, "...the azimuthal ERP pattern which replicates in UHF the Grade B contour of an omnidirectional VHF operation will be somewhat distorted because terrain has a different effect on propagation in the two bands. In addition, the 90% time variability allowance for DTV has an effect on the DTV pattern. Thus the procedure described above effectively derives a new directional antenna pattern wherever necessary for a precise match according to FCC curves."

Although AFCCE understands that DTV replication of NTSC service is the desired goal of the FCC, it also believes that the quest for a perfect match is an elusive and impossible goal. A more practical approach, taking into consideration the variability's of predicting acceptable coverage, should be employed. In adopting a "perfect" match approach, the FCC actually makes it an impossible task, as it is not possible to replicate antenna patterns determined by the Commission's method, therefore coverage replication cannot be achieved.

The variables involved in the propagation process include directional antennas which do not in reality produce the exact predicted patterns, and omnidirectional patterns which are in fact slightly directional. For example, a side-mounted television antenna will exhibit some pattern ripple affecting the theoretical relative field by several decibels. Even top directional antennas on candelabra type structures will exhibit some small amount of ripple. Omnidirectional antennas have been traditionally accepted by the FCC even though pattern values vary 1.5 to 2 dB from an RMS value. So-called VHF "batwing" antennas typically exhibit minor directional characteristics. A perfect omnidirectional antenna is simply unachievable in today's world.

Another substantial variability in the prediction of coverage lies in the predicted field strength versus distance curves of 47 CFR 73.699, Figures 9, 9a, 10, 10a, 10B and 10c. These "average" curves result from use of measured field strength data, which are quite scattered as is typical for measurements in these frequency ranges. The accuracy of the curves is believed to be in the range of plus or minus 9 dB[6].

The Commission recognizes the inherent inaccuracy of the curves in 47 CFR 73.683 where it is stated "under actual conditions, the true coverage may vary greatly from these estimates because the terrain over any specific path is expected to be different from the average terrain on which the field strength charts were based." And "...the curves should be used with appreciation of their limitations in estimating levels of field strength."

If replication of service is desired, the transmitting antenna of the DTV station should be at the same location and height as the NTSC station. With this condition the propagation path to a receiver is identical except for the propagation difference resulting from use of different frequencies. The major factor in coverage replication then becomes the effective radiated power "ERP" along the pertinent radial. As a first approximation, use of the same antenna pattern for NTSC and DTV appears quite appropriate, and is a more realistic value to use than the Commission's proposal of DTV patterns with abrupt varying fields, associated with changes in azimuth.

[6/] FCC Report No. R-6602, "Development of VHF and UHF Propagation Curves for TV and FM Broadcasting", Jack Damelin, et. al., September 7, 1966.

The AFCCE believes use of the existing NTSC antenna pattern, whether omni or directional, makes infinitely more sense than a new unachievable DTV directional antenna. The use of the existing NTSC antenna pattern for DTV service will more closely replicate existing NTSC coverage than the method described in OET Bulletin No. 69.

In the search for accuracy, we believe the Commission has overlooked some of the inherent limitations associated with prediction of coverage. In our opinion, a more practical approach is called for, and that approach simply allows a DTV station to employ its existing antenna pattern, using the maximum ERP determined by the FCC, which either replicates service or achieves the maximum permitted value. The Association also believes that the transitional DTV operation needs only to provide a reasonable replication of existing service, not an exact duplication, with the latter requiring a complex and unachievable directional antenna, which must by definition, result in reduced replication.

FCC Filing: Omnidirectional or Directional Pattern

In the NTSC world, stations filing omnidirectional patterns radiate the assigned ERP at the RMS value of the filed azimuthal pattern. Typical VHF and UHF azimuthal pattern scalloping could easily reach ±3 dB from RMS. Therefore, in some directions the actual ERP may be twice that assigned without any consideration of potential interference in those directions.

There are no similar and specific rules with respect to omnidirectional DTV antennas. The FCC has issued a directional pattern with a maximum ERP for each DTV channel. One approach would be to permit omnidirectional stations filing for omnidirectional DTV service to file for an azimuthal pattern with its RMS value not to exceed the RMS value of the FCC's assigned DTV pattern.

For example, the FCC assigned KUSA a maximum ERP of 1,000 kW. But the directional pattern assigned by the FCC shows that KUSA will have to operate at the minimum ERP of 290 kW (-5.37 dB) if it elects to continue its omnidirectional service (i.e. with an omnidirectional antenna). As the attached pattern shows, the RMS voltage for the FCC pattern is ≈ 0.88 (by inspection). Therefore, if KUSA files for omnidirectional DTV service, it should not have to reduce its DTV power by more than 10 $\text{Log}[(.88/.7)^2]$ or 2 dB, rather than 5.37 dB.

The choice of any station to file for omnidirectional or directional service will ultimately depend on which approach provides for maximum service. This suggestion, if adopted by the FCC, will help those broadcasters who presently provide omnidirectional service in mountainous or hilly terrain.

FCC Filing: Side-Mounted Omnidirectional Antennas

Omnidirectional antennas, when side-mounted on a tower or on another metallic support structure, will have a substantially modified azimuthal pattern. The modified pattern may present variations of 10 dB or greater in some directions, relative to the intended pattern. The consequence of such variations could be increased interference in those directions or a reduction in signal over the city of license below the minimum required by the FCC. Allowing stations to file on the free-space omnidirectional pattern and then side-mount the antenna is wholly inconsistent with the FCC's policy of mandating directional antennas with precisely defined patterns for each DTV station.

FCC Filing Tolerances

The Commission used the present NTSC radiation center height for each station's DTV allotment. For most stations this is an unusable height because the aperture is occupied by the existing NTSC antenna. The solutions for most stations lie in the vertical stacking (preferred) or lower side-mounting of the DTV antenna (undesirable). In the case where stacking is feasible, AFCCE suggests that the station be permitted to exceed the allotment radiation center height by 25 meters without the necessity for making additional interference showings.

Furthermore, AFCCE notes that the Commission has provided a 5 km "window" for moving the DTV allotment (from the allotment reference coordinates) without the need for an interference showing. AFCCE recommends that stations submitting applications to "maximize" their facilities be permitted to use the theoretical interference which would have been created if the DTV facility had been sited 5 km closer to the "victim" station (using the allotment power and height, as modified above) as the baseline for judging a non-interference condition from the "maximized" facility.

to the "victim" station (using the allotment power and height, as modified above) as the baseline for judging a non-interference condition from the "maximized" facility.

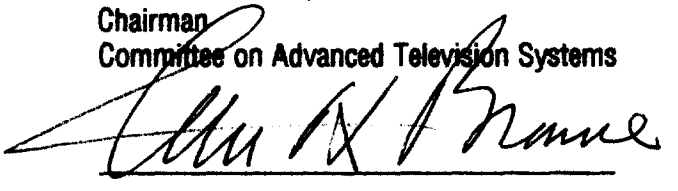
Television Allocations Standard Organization

In previous filings, AFCCE has noted the excellent work performed by TASO in the early days of NTSC television service. AFCCE urged the Commission to re-establish such a body—which AFCCE referred to as TASO II—to deal with the myriad matters related to finalizing technically sound allotment criteria and implementation standards. AFCCE is more convinced than ever that there is an urgent need for such a body to resolve these problems; the adjacent channel interference standards and other issues discussed herein make this abundantly clear.

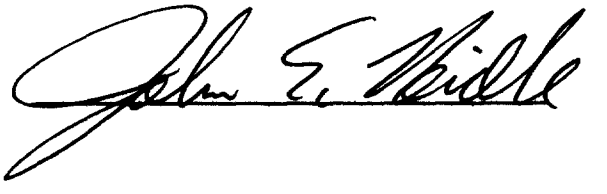
Respectfully submitted,

THE ASSOCIATION OF FEDERAL
COMMUNICATIONS CONSULTING ENGINEERS

John F.X. Browne, P.E.
Chairman
Committee on Advanced Television Systems



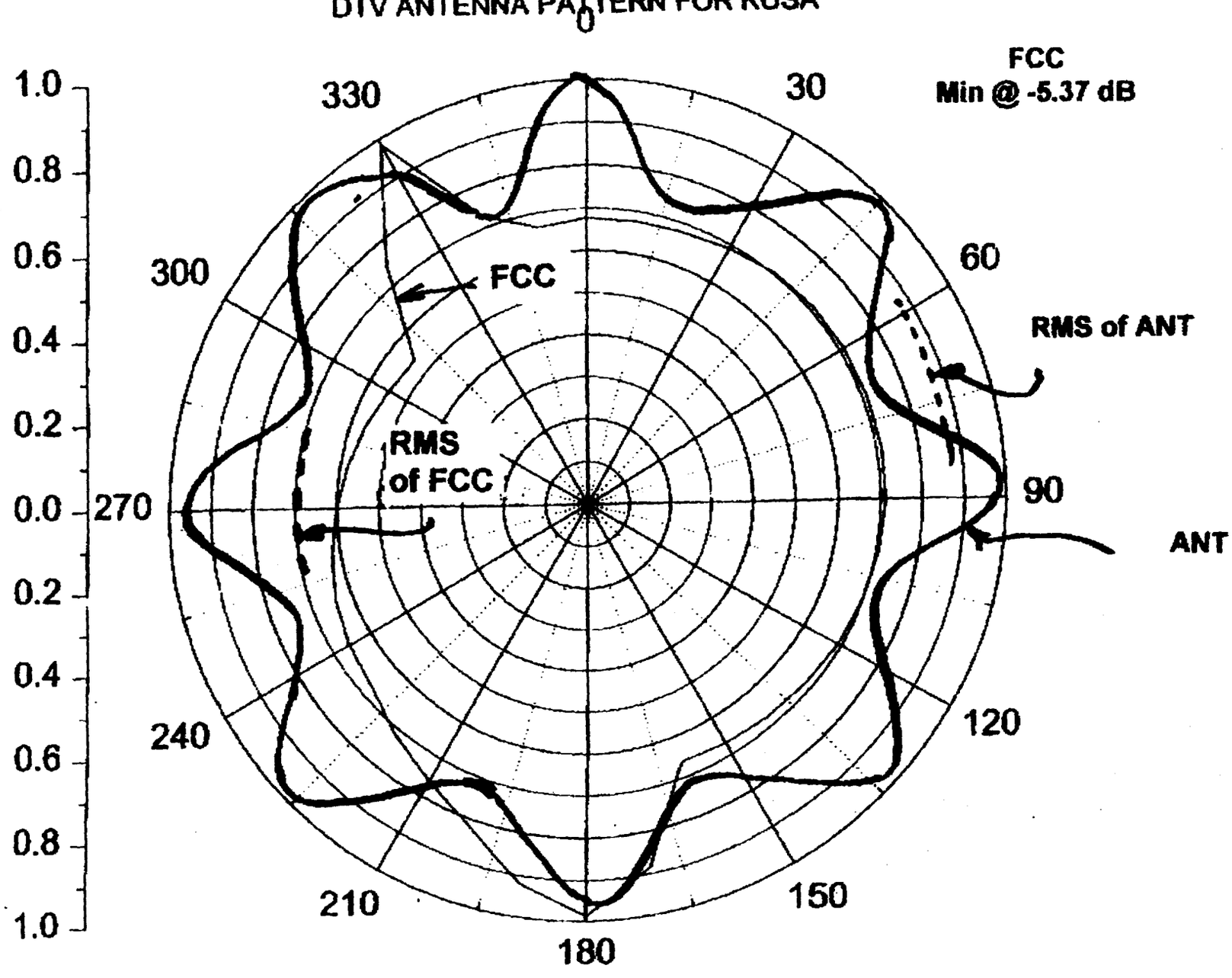
John Hidle, P.E.
President



December 17, 1997
Attachments

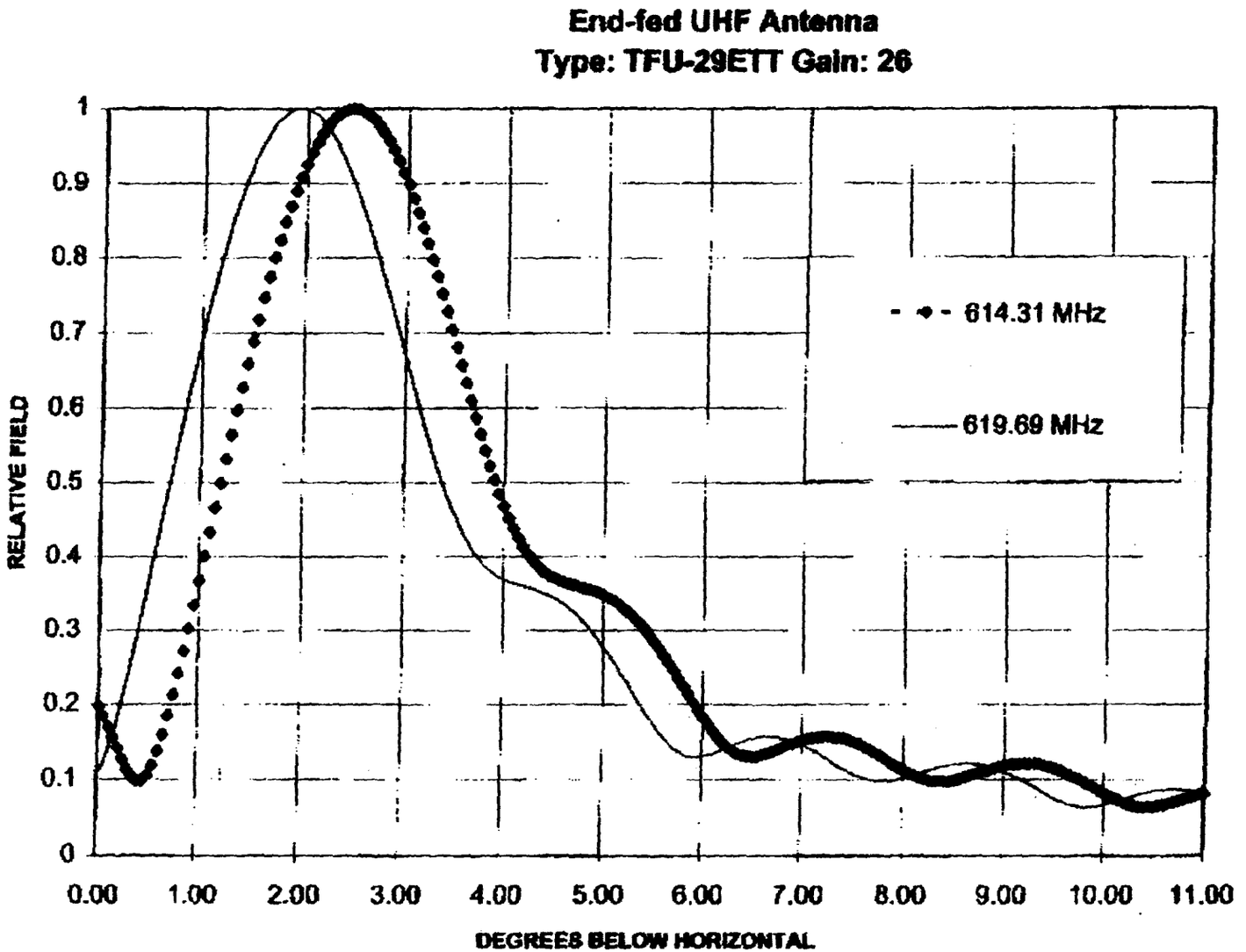
CH. 16

DTV ANTENNA PATTERN FOR KUSA



O. Bendov 7/8/97

FCC: Directional ERP = 1000 kW Omnidirectional ERP = 290 kW


End-fed UHF Antenna
Type: TFU-29ETT Gain: 26
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0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
614.31 MHz
619.69 MHz
0.00
1.00
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3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
DEGREES BELOW HORIZONTAL

AFCCE Committee on Advanced Television Systems

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