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Before the
Federal Communications Commission
Washington, D. C. 20554

In the Matter of	)	
1998 Biennial Regulatory Review Streamlining of Radio Technical Rules in Parts 73 and 74 of the Commission's Rules	)	MM Docket No. 98-93

COMMENTS
of
Hatfield & Dawson Consulting Engineers, LLC

Introduction

In this proceeding the Commission proposes a variety of procedural changes to the consideration of application processing, as well as changes in the technical standards for allocation of non-commercial educational FM stations, and changes that would allow limited "negotiated interference" agreements in cases that would not be acceptable under the present rules. In general, Hatfield & Dawson support these changes with minor reservations.

The most significant technical change proposed, however, is a proposal to adopt a single methodology for prediction of interference and service from FM stations in anomalous situations. The Commission has, for many years, consistent with the requirements of §73.313(e), accepted "supplemental showings" to demonstrate compliance or lack of compliance with the principal community coverage rules, and has, more recently, permitted such showings for showings of compliance with the main studio location rule. These showings have been evaluated by the Commission staff on a case-by-case basis. As a result of the use of these showings in main studio cases, the workload imposed by this policy has evidently increased in recent times. While adoption of the point-to-point methods ('PTP") proposed would presumably ameliorate this workload increase, recent changes in the main studio location rules themselves will probably result in the same effect. In any event, the PTP method proposed is grievously flawed. Indeed, the concept itself is probably unworkable. Essentially, what's being proposed is a "one size fits all" solution to the situations where the present "one size fits most" F(50,50) and F(50,10) rules don't work well. The present policy, requiring careful study by an experienced Commission staff engineer of the cases which are presented, is the best solution to a situation where the variability of the circumstances of those cases is great. The Commission is bound by the Communications Act to make technical determinations. In general it attempts to do so in a broad-brush manner, so as to be consistent and predictable in its actions, usually by adoption of specific rules which apply to all cases. That doesn't mean, however, that the Commission should be excused from having to make specific judgements in specific anomalous situations, as is now the case for the exceptions described in §73.313(e).

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The PTP Model Proposed in the NPRM in MM Docket No. 98-93

Careful examination of the assumptions underlying the PTP model and the path loss calculation techniques embodied in that model leads to a number of concerns regarding the accuracy of the model in circumstances which differ substantially from the "average" circumstances upon which the model appears to be based, or even in relatively common path circumstances which the model is not likely to handle correctly.

Presumably, the model is intended to provide guidance in circumstances where the characteristics of a particular propagation path or paths vary widely from "average" conditions. It is precisely under these conditions that the model is likely to yield results which may seriously underestimate and/or overestimate the actual losses likely to occur on a particular path. In addition, there are circumstances in which the contour prediction method used in the PTP model is likely to produce results which do not accurately represent the effects of diffraction losses and shadowing in some cases involving §73.315 city grade coverage requirements.

Our specific concerns regarding the assumptions and calculation techniques used in the model are described below.

Diffraction Calculation Model

The diffraction losses calculated in the PTP model are derived by "blending" the results produced by a knife-edge diffraction technique and the results produced by a smooth spherical earth technique. The knife edge calculations are based on the path Fresnel zone clearance ratio determined from the difference between the straight-line distance from the transmitter and the receiver and the height of the highest obstacle along the path, adjusted for 4/3 earth radius.

The smooth earth diffraction calculations are obtained from a curve-fit of a graph taken from a CCITT/CCIR Report titled "Propagation", Appendix to Section B.IV.3 of the Handbook "Economic and Technical Aspects of the Choice of Transmission Systems", ITU, 1971.

Although the maximum smooth earth loss relative to free-space shown on the curve is 40 dB, it is not immediately apparent from the program code available on the Commission's web site that the curve fit calculations have any limitation on the maximum negative clearance ratio, R, that the program uses in the curve fit formula, or on the maximum smooth earth loss the program will assume. In cases where the clearance ratio is quite negative (say on the order of -2 or more), the values of smooth earth loss given by the formula become extremely high (95 dB for a clearance ratio of -2.0, for example). At even more negative values of R, the smooth earth loss assumes absurd values in the hundreds of dB if no limitation is placed on the maximum curve fit loss used in the program. High negative values of R are possible in circumstances where the path between transmitter and receiver traverses a single high mountain range and both end points are at low elevations in valleys. This is not an uncommon occurrence in the mountainous areas of the "basin and range" country of the Intermountain West.

When the value of R is high and negative, the value of Δh is usually also quite high. In these cases, the

program compensates for high smooth earth loss value by adjusting the total loss to reflect mainly the contribution of the knife-edge losses. However, as illustrated below, the total composite loss calculated by the program may be too low in this circumstance. This makes the program conservative in cases where interference protection is important, but it errs in the wrong direction for the purposes of calculating City Grade coverage of a station's principal community. In cases where contour protection between two station separated by mountainous terrain is an issue, the PTP program is likely to underestimate the losses and not allow either station to operate with facilities which might be allowed if the actual losses were modeled more accurately.

Hatfield and Dawson has made field strength measurements in several different cases for the purposes of determining either compliance with the City Grade coverage requirements of §73.315 or the practicality of implementing an on-channel booster or adjacent channel translator within a station's 60 dBu service contour. In a number of these cases, the path losses along all of the paths to multiple locations in a given community had measured median diffraction losses relative to free space much greater than 60 dB.

In one particular case where the measurements were made at a receiving antenna elevation of 7 feet above ground with 100 foot mobile measurement runs, the combination of diffraction losses and clutter losses in the vicinity of the receiver exceeded a median value of 85 dB at numerous measurement locations. In all cases, the measurements were made in relatively open areas, such as parking lots, with no buildings within several hundred feet of the measurement run location. The propagation paths in these cases extended over multiple obstacles, with relatively flat or rolling terrain from the transmitter terrain foreground to near the end of the path, and steeper and higher mountainous terrain at the end of the path nearest the receiver. Paths of this type are quite common in the Intermountain West, in the Southwestern U.S., and in the Southeastern U.S.

For all of the paths tested in this example, the path clearances were quite negative (on the order of -2.0), and the Δh of the terrain within ± 10 kilometers of the highest obstruction was on the order of 250-300 meters, calculated using the methods shown in the PTP model. For these conditions, and a for a representative path with a Δh of 272 meters, the total diffraction loss predicted by the PTP algorithm for R = -2.0 is about 38 dB. Even assuming that the clutter losses at 7 feet AGL were on the order of 15-20 dB, the total diffraction losses were still on the order of 65-70 dB, far greater than the losses predicted by the PTP routines.

It is interesting to note that in this case, measurements were made of the field strengths produced by two stations diplexed into the same transmitting antenna with the same ERP, one at 99.1 MHz and one at 103.3 MHz. At the measurement locations where the diffraction losses were the greatest, the median value of field strength (for 100 foot mobile runs) for the two stations differed by 5-15 dB, probably due to different multipath and terrain foreground characteristics in the vicinity of the receiving antenna at the two frequencies. These data would indicate that a "safety margin" of 10-20 dB is probably appropriate for any diffraction path calculations used to predict service and interference contours for allocation purposes. The effective "safety margin" which appears to be provided by the PTP model for paths of this type is much higher, on the order of 25 or 30 dB.

Obstacle Characteristics and Treatment of Multiple Obstacles

The PTP model does not attempt to explicitly model paths with multiple obstructions by treating each obstruction separately, as do the diffraction loss calculation techniques used in other commonly used propagation models, such as the various implementations of the Longley-Rice model. Nor does the PTP model characterize the obstruction, other than to calculate its clearance relative to the site-to-site path and to apply very general "roundness" characteristics related to the Δh of the terrain in the vicinity of the obstruction. Rather, the PTP model "blends" the knife-edge diffraction losses predicted for the highest obstacle between the transmitter and the receiver (i.e. the obstacle with the most negative clearance ratio) and smooth earth diffraction losses. The "blending" ratio is based on the "roundness" factor calculated from the characteristics of the terrain located along the transmitter-receiver path

Most "modern" propagation models (i.e. those developed during the past 25 years) incorporate the actual characteristics of the obstructions (obstruction radius, actual spacing between the obstructions, the bending angle of the radio path over the obstacle, etc.) and treat multiple obstructions with some variation on a multiple knife-edge or rounded obstacle calculation technique.

In the propagation model adopted for frequency coordination and allocation use in the Land Mobile services, for example, the diffraction model uses the Epstein-Peterson rounded obstacle diffraction loss techniques taken from NBS Technical Note 101 and treats multiple obstacles as transmitter/obstacle/receiver "triads" with the total obstacle losses given by the sum of the losses for each separate obstacle. (See *A Report on Technology Independent Methodology for the Modeling, Simulation, and Empirical Verification of Wireless Communications System Performance in Noise and Interference Limited Systems Operating on Frequencies between 30 and 1500 MHz, TIA TR8 Working Group 8, 20 May 1997).* This technique can yield results which are more representative of the actual losses likely to occur in practice than does the PTP model, especially if the obstacle curvature factor is calculated based on the actual obstacle radius. Clearly, it is possible to include such techniques in a computer-based model, since the TR8 Working Group 8 model has been implemented and is now in use by various land mobile frequency coordinators.

The PTP model uses a very general representation of obstacle "roundness" based on the Δh (a form of terrain roughness factor) calculated from the standard deviation of the terrain elevation data within ± 10 kilometers of the obstruction. This technique does not yield the actual "shape" of a particular terrain obstruction, nor does it provide a reliable characterization of the actual losses in the "shadow zone" on the receiver side of a given obstruction.

The terrain sampling rate used in the PTP model (0.4 kilometers) is also too coarse to accurately model the "roundness" of individual obstructions. In some cases, a sampling rate this coarse may seriously underestimate the height of sharp terrain obstacles represented in the digital terrain data. In many cases, even the 3-second terrain data sampled at 0.1 kilometer distances yields obstruction "roundness" which differs substantially from the shape an obstacle has when it is carefully modeled using data taken from USGS 7.5 minute topographic maps. The importance of this point is not lost on engineers who analyze paths for point-to-point microwave links; the height and characteristics of these obstructions are always checked against 7.5 minute maps, and are often verified in the field as well.

The usual function of a terrain roughness or a terrain irregularity calculation in most modern propagation models is to modify the reflection coefficient for reflections between an obstacle and the receiver location. The PTP model doesn't perform any analysis of ray geometry related to a given obstruction, nor does it attempt to deal with the effects of reflections in the foreground between an obstacle and the affected receiving antenna.

These factors are very important if predictions of field strength in the "shadow" of an obstruction are an issue, as they often are in cases involving compliance with §73.315. A specific example is shown below.

Effect of Obstruction Radius and Terrain Sampling Rate on Shadow Loss Predictions

In a leading case related to the use of non-standard propagation prediction techniques for prediction of City-Grade coverage (Creswell, Oregon; 3 FCC Rcd 4608, [1988]), the Commission rejected an analysis using a prediction technique which effectively ignored the actual roundness of Creswell Butte, an obstacle which shadowed the station's proposed city of license. The analysis technique, which assumed rounded obstacle losses, but assumed too small a radius for the obstacle in question based on the 3 second digitized terrain data, underpredicted the actual losses likely to occur, and the Commission denied the station's application for a class upgrade using the proposed transmitter site.

In the Creswell case, the obstruction was a single isolated hill surrounded by relatively flat terrain. The town of Creswell was located on the immediate north side of the hill, and the proposed transmitter site was several kilometers south of the hill. The "shadow" produced by the hill extended far enough to encompass most of the town, but did not extend far into the valley floor of into the elevated terrain north of the community. When the actual "roundness" of the obstacle was taken into account (based on 7.5 minute map data), it was evident that the station was not likely to provide 70 dBu coverage over all or even 80% of Creswell.

Creswell Butte is a single isolated oblong hill which extends about 1 kilometer north and south at its base and less than 0.5 kilometers east and west. A digital representation of this obstruction taken at an 0.4 kilometer sampling rate along a north-south radial is likely to seriously underestimate the height of this hill. A digital representation of this obstruction taken at an 0.4 kilometer sampling rate along an east-west radial is likely to miss the obstruction entirely.

The terrain sampling rate proposed in the PTP model does not appear to be adequate to even begin to represent some real terrain obstacles when using the 3-second terrain database. If the program is used with 30-second terrain database, which samples actual terrain heights on a much coarser grid (with a north-south data point spacing of 0.925 kilometers) than the 3-second database, the results the program produces are likely to be seriously in error in many cases.

Clutter Loss Assumptions in the PTP Model

The PTP model performs a separate clutter loss calculation, in which clutter losses are directly related to the clearance ratio, R = (Path Clearance/Fresnel Zone Radius), over the highest obstacle along the

transmitter-receiver path. The clutter loss factor ranges between 0 and 5 dB and varies from 1 dB at R=0.80, to maximum of 5 dB at R=0.40, to 1 dB again at R=0 (grazing), and down to 0 at R -0.10. At 0.6 first Fresnel zone clearance, the clutter loss factor calculated by the PTP model is 4.0 dB.

Using the clearance ratio to establish a value of clutter loss is a rather unorthodox technique, unless it is meant to compensate for the lack of detailed path geometry calculations at the obstacle itself and to provide some estimate of foreground losses in the vicinity of the primary obstacle in the path. It is not entirely clear from the model or its description why clutter losses are handled in this fashion.

"Clutter loss" is more typically used to describe the losses in the immediate vicinity of the receiving antenna attributable to buildings, trees, power and light poles, wires, and other types of "urban clutter". The PTP model assumes a figure of 5 dB for "median clutter losses in average suburban areas in the United States."

In general, clutter losses in the receiver foreground are comparable for paths with full first Fresnel Zone clearance and for diffraction paths where the depression angle from the obstruction to the receiver is comparable to the depression angle from the transmitter to the receiver along the path with full clearance. If diffraction over an obstacle quite close to and well elevated above the receiver results in a steeper path through the clutter near the receiver than a similar full clearance path would have, then these losses are reduced for the steeper path, since the path traverses less of the clutter a longer, more oblique path. Since the PTP program adjusts the clutter loss factor based on the clearance ratio without respect to the distance between an obstruction and the receiver location, this does not appear to be basis for the use of this factor.

The use of a median clutter loss of 5 dB at a receiving antenna height of 9.1 meters is not appropriate for all areas in the United States. Several FM stations in the Fresno, California area, for example, operate with facilities which require and have been granted waivers of §73.315 of the Commission's Rules. The waiver requests were based on an alternate propagation analyses which demonstrated free space propagation and 0.6 Fresnel zone clearance to all locations within the pertinent parts of the City of Fresno and assumed median clutter losses of 2.0 dB at 9.1 meters AGL, based on the density of trees and the height of buildings typical of Fresno. Similar analyses are appropriate for Phoenix and other cities in the Southwest and for Miami and other cities in Florida.

If the PTP model were used to demonstrate compliance with §73.315 in these cases, the additional 2 dB of clutter loss (i.e. the difference between the 2 dB demonstrated in the waiver requests and the 4 dB calculated by the PTP model for 0.6 Fresnel zone clearance) would reduce 70 dBu coverage to an area less than that required under the Rule.

In other parts of the country, such as the Pacific Northwest, where there is relatively dense vegetation and where evergreen trees are commonly allowed to grow to their full height in suburban areas, the average height of the trees is about 40 feet, and a large number of evergreens grow to be taller than 100 feet. Under these conditions, the median clutter losses in suburban areas are likely to be significantly higher than 5 dB for a 9.1 meter (30 foot) receiving antenna height.

For these reasons, it is inappropriate to use a single value for clutter losses in the PTP model and to

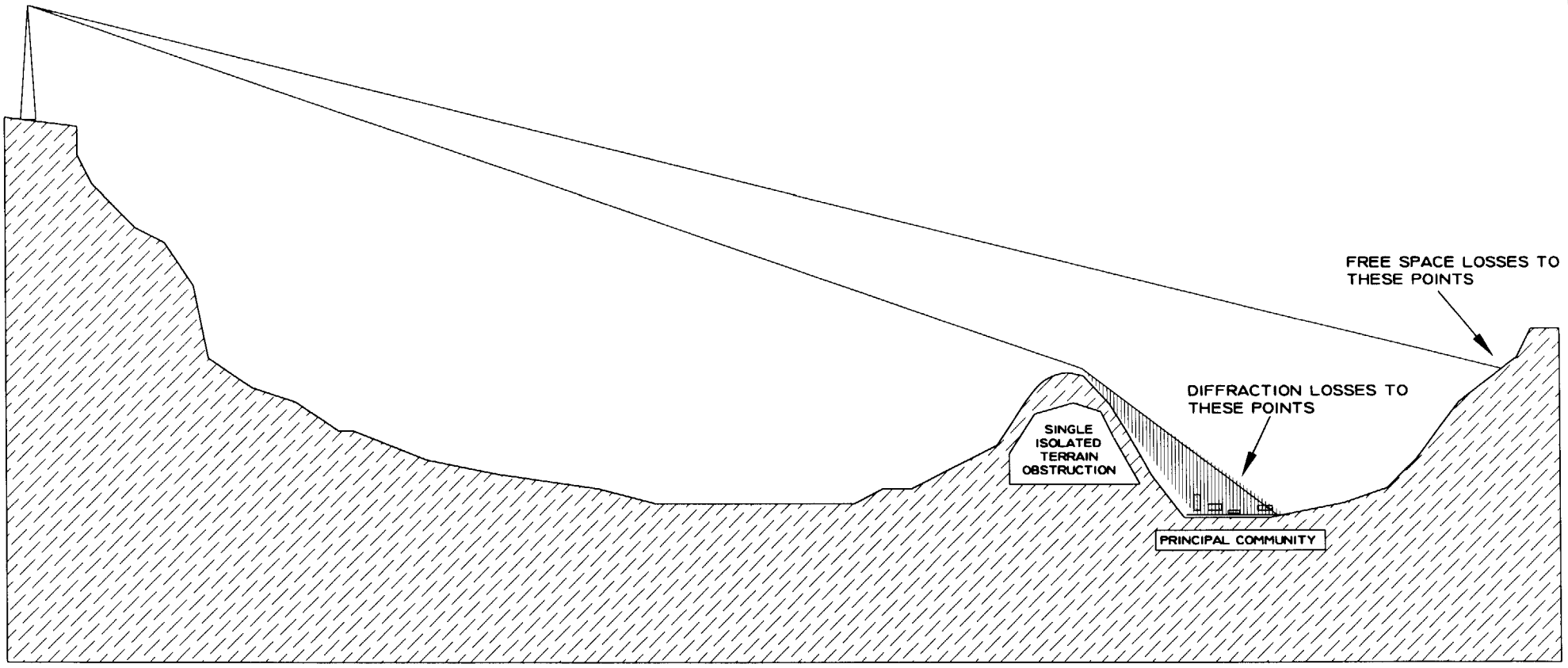
attempt to apply it across the entire United States as if clutter loss conditions were uniform everywhere.

Contour Prediction Methodology

The contour prediction model used in the PTP model locates the desired contour by performing a linear curve fit of the logarithmic field strength data versus distance from the transmitter site. The program includes "traps" to limit the effect of low field strengths very near the transmitter site, the effects of a "brief rise" in predicted field strength above the specified field strength, and radials where the field strength never reaches the desired value.

The examples shown in the PTP model description appear to assume that predicted field strength levels will drop below the desired value no more than a few times before reaching the final desired threshold many miles from the transmitter. This assumption is overly optimistic. In Seattle, for example, a radial running westward from any of the local FM transmitter sites traverses a whole series of north-south trending glacial drumlins or hills on both sides of Puget Sound before reaching its ultimate free-space propagation limit for any given contour level. Reaching the predicted 60 dBu contour under these conditions, for example, may involve dropping well below this level as many as 10 times or more on the western shadowed slopes of these hills before reaching an ultimate free space limit on the east facing side of yet another hill. It is not entirely clear how the proposed log-linear curve fit will perform under these circumstances—but such circumstances are by no means rare!

Another circumstance in which the contour location technique may yield inaccurate results is shown in the following diagram:



HATFIELD & DAWSON
CONSULTING ENGINEERS

PATH LOSSES FROM TRANSMITTER
OVER SINGLE ISOLATED TERRAIN OBSTRUCTION

The diagram represents a small community (the principal community for an FM station) which is shadowed from the FM transmitter site by a single isolated obstacle. Beyond the obstacle the terrain is flat at first, but rises in the direction of the radial from the transmitter site to the receiver locations beyond the community. Under these circumstances, the predicted field strength may drop well below the 70 dBu value required for City Grade coverage in the shadowed area such that measurements of the FM field strength over a grid of locations within the community would not demonstrate 70 dBu field strength over 80% of the community. However, the predicted field strength could increase again to 70 dBu or more either along the flat terrain beyond the shadow zone of the obstruction or along the rising terrain beyond the community. Under these circumstances, the PTP program could well locate the contour beyond the limits of the community, even though the actual shadowing produced by the obstruction would prevent actual 70 dBu coverage of the community. This is not simply a hypothetical set of circumstances; it represents conditions quite close to those in the Creswell, Oregon case as well as several other cases in which obstructions close to small communities raised issues with respect to compliance with §73.315.

Conclusions about the PTP Model

All useful present day propagation models are site and propagation path specific models which take into account the actual characteristics of the terrain obstructions between the transmitter site and the receiver locations of interest. A great deal of progress has been made in refining these models and their accuracy during the past 10-15 years. Much of this work has been accomplished by the land mobile community and is relatively unknown to broadcasters. The PTP model largely does not avail itself of these techniques and is a relatively "coarse" model compared to other models and techniques which are both readily available and easily implemented as computer algorithms.

While the PTP model may represent a step forward from the simplistic F(50,50) and F(50,10) curves used to perform allocation analysis today, its drawbacks and limitations in its present form appear to outweigh its advantages, and it is certainly not adequate as a "one size fits all" propagation tool which will provide uniformly "correct and final" answers in all circumstances independent of good engineering judgement.

Other Matters

1. Negotiated Interference

While we support the idea that limited negotiated interference agreements should be allowed, it is essential that proposals for facilities under such a rule must be supported by complete technical details. This allows the parties to the agreement and others to evaluate the compliance of the agreements with the appropriate rules. To support such agreements, technical showings must include all assumptions, with calculated examples of the interference showings, so that the proposals can be analyzed by the Commission staff and others. In general, interference calculations should be used rather than overlap calculations.

2. Class C Antenna Height Requirements

In the mountainous portions of the United States most transmitter sites which meet the present 300 meter HAAT requirement are located such that the terrain in some directions is substantially more elevated than that in others. The Commission has recognized this situation by, for example, granting class C status to stations serving Denver, Co. from sites in the Front Range by using less than the normal 8 radial calculation. If a new class of station, C0, is created, stations which have HAAT in excess of the minimum 450 meters on at least 4 radials should be allowed to retain class C status.

3. First-Come First-Served Processing

The use of the first-come first-served principle has worked well in the FM services, and should be extended to other services <u>except</u> to FM translators. FM translators are secondary services and should not be afforded any procedural protection against other alternatives, either by other translators or by licensed primary services.

4. Class D Licenses

While the Commission's effort to mitigate the allocation difficulties which are created by the anomalous class D license circumstances are laudable, no rule should be adopted which leads to the deletion of such licenses by placing them at the mercy of other licensees of higher class. Many low powered class D licensees in urban areas are the only source of specialized programming which serves small audiences or interest communities, and preservation of these services is far more important than the elimination of their minimal effect on the allocation scheme.

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