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| Project | **IEEE 802.16 Broadband Wireless Access Working Group** |
| Title | **A TS Antenna RPE Sensitivity Analysis for Boundary Coexistence at 10.5 GHz** |
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| Re: | Coexistence pfd Simulation Estimates in Support of TG3 Systems Design |
| Abstract | This document examines the sensitivity of inbound pfd to differences in antenna RPE at 10.5 GHz. The analysis demonstrates that worst case pfd is controlled by boresight, or almost boresight, alignment between interference and victim links. While improved RPE does reduce pfd levels, it is a secondary factor as compared to distance separation. |
| Purpose | This document is submitted to TG2a for consideration and inclusion in the amended Coexistence Practice Document for PMP systems operating below 11 GHz. |
| Notice |  |
| Release |  |
| IEEE Patent Policy |  |

# A TS Antenna RPE Sensitivity Analysis for Boundary Coexistence at 10.5 GHz

## 1.0 Introduction

In [1], a TS antenna with quite poor azimuth RPE discrimination characteristics was inadvertently selected for analysis. While the author of [1] will never admit to it, it is quite possible that the antenna selected does not exist. However, prior simulation estimates performed in [2] for EHF frequencies indicated that antenna RPE was not a controlling factor in terms of worst case pfd results. These exposures require a boresight, or almost boresight, alignment between interference and victim antennas. Consequently, antenna RPE becomes a secondary consideration as compared to distance separation.

In order to determine if the same conclusions would apply at 10.5 GHz, a much more *realistic and representative* TS antenna has been selected for simulation. The results of these simulations are described in the following. Except for TS antenna RPE and antenna gain, all of the simulation system parameters are as identified in [1].

In addition, simulations are performed for the minimum antenna RPE patterns as specified by two regulatory agencies. To ensure that there is a valid comparison of the impact of antenna RPE on boundary pfd, transmit EIRP is adjusted to conform to that of the first two antennas. Within the simulations, this is established by either assuming cell edge ATPC (reduced EIRP), or by assuming increased TX power (increased EIRP).

## 2.0 Antenna RPE

For completeness with performance comparisons, the azimuth RPE characteristics employed in [1] are repeated here as Figure 1. The RPE characteristics of the more representative antenna are illustrated in Figure 2.

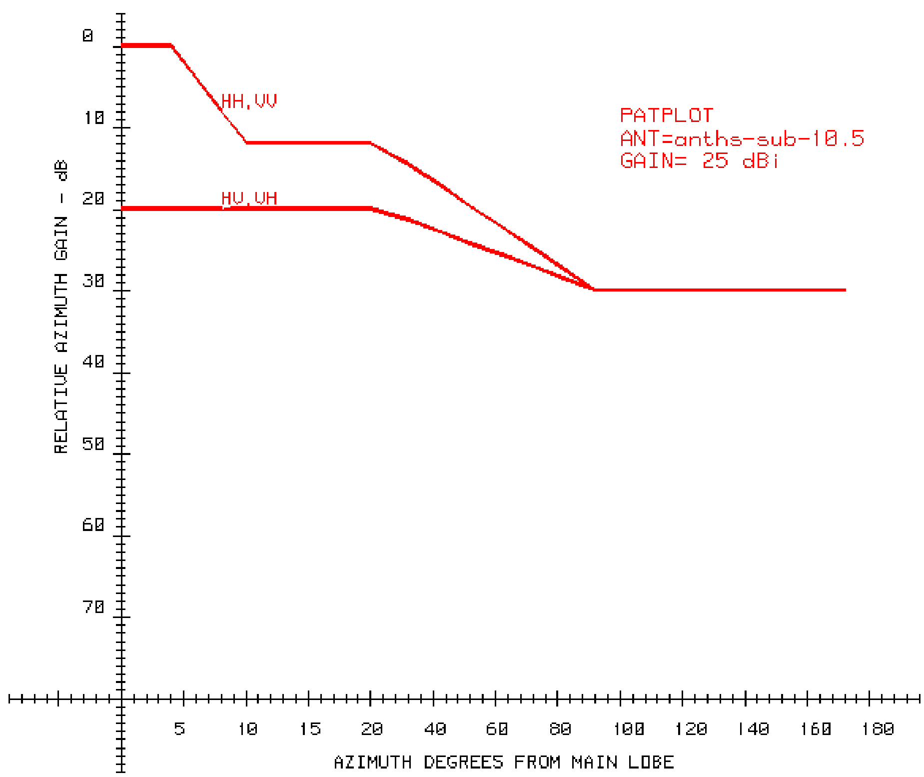


Figure 1. Poor Performance TS Antenna RPE.

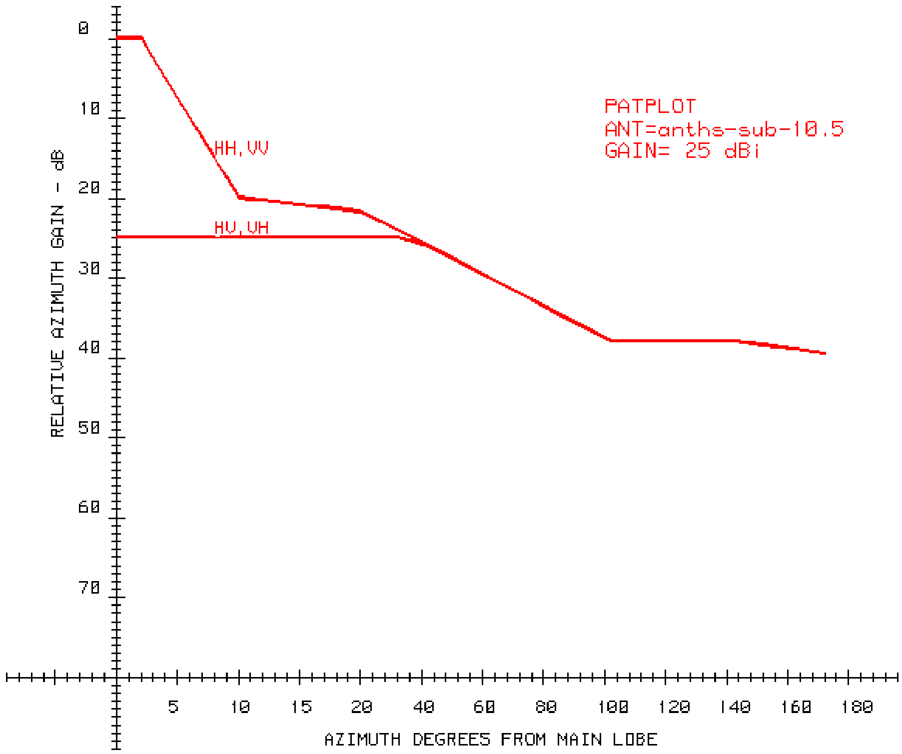


Figure 2. Improved Performance TS Antenna RPE.

## 3.0 Simulation Results and Discussion

Again, for completeness and performance comparisons, the pfd CDF simulation estimates of Figure 4 -[1] are illustrated as Figure 3. This simulation estimate applied to full power LOS interference vectors at cell edge.

Figure 4 illustrates a comparable simulation for the antenna with improved RPE. A comparison of Figure 3 and Figure 4 indicates that the magnitude of worst case pfd exposure levels are essentially the same. There is a modest reduction in the CDF percentage of exposures that can be attributed to the narrower 3 dB beam width of the improved antenna. For reduced pfd levels (distance dependent), there is a notable reduction in the CDF percentages. This can be attributed to the much sharper roll off rate of the main lobe beam width. As a consequence of this increased antenna discrimination, the percentage of pfd exposures at some given pfd level are correspondingly reduced.

It would be expected that any proposed improvement in antenna RPE beyond that of Figure 2 would be modest and not result in any significant improvements in pfd. In any event, it would not impact worst case pfd. Thus, as was found in [2], onerous antenna RPE requirements cannot be supported from an inter-operator coexistence perspective.

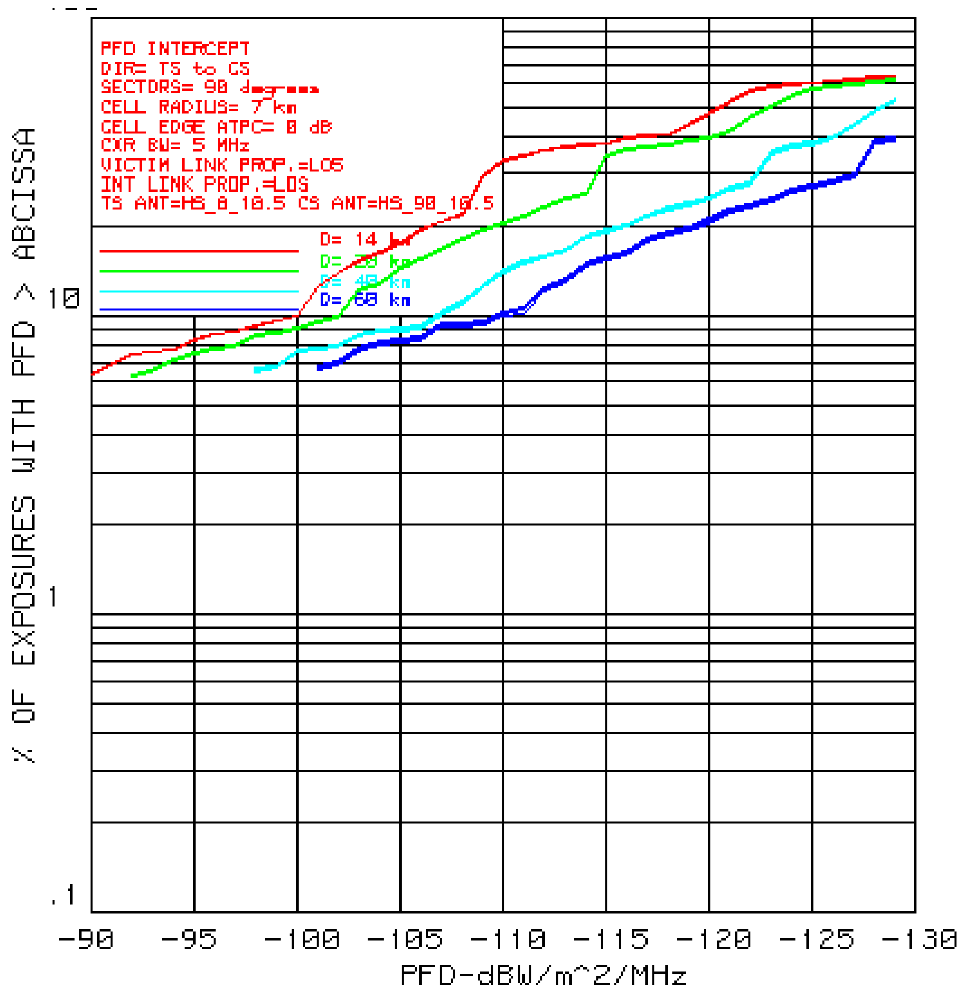

Figure 3. CDF Simulation Estimate for a Poor Performance TS Antenna.

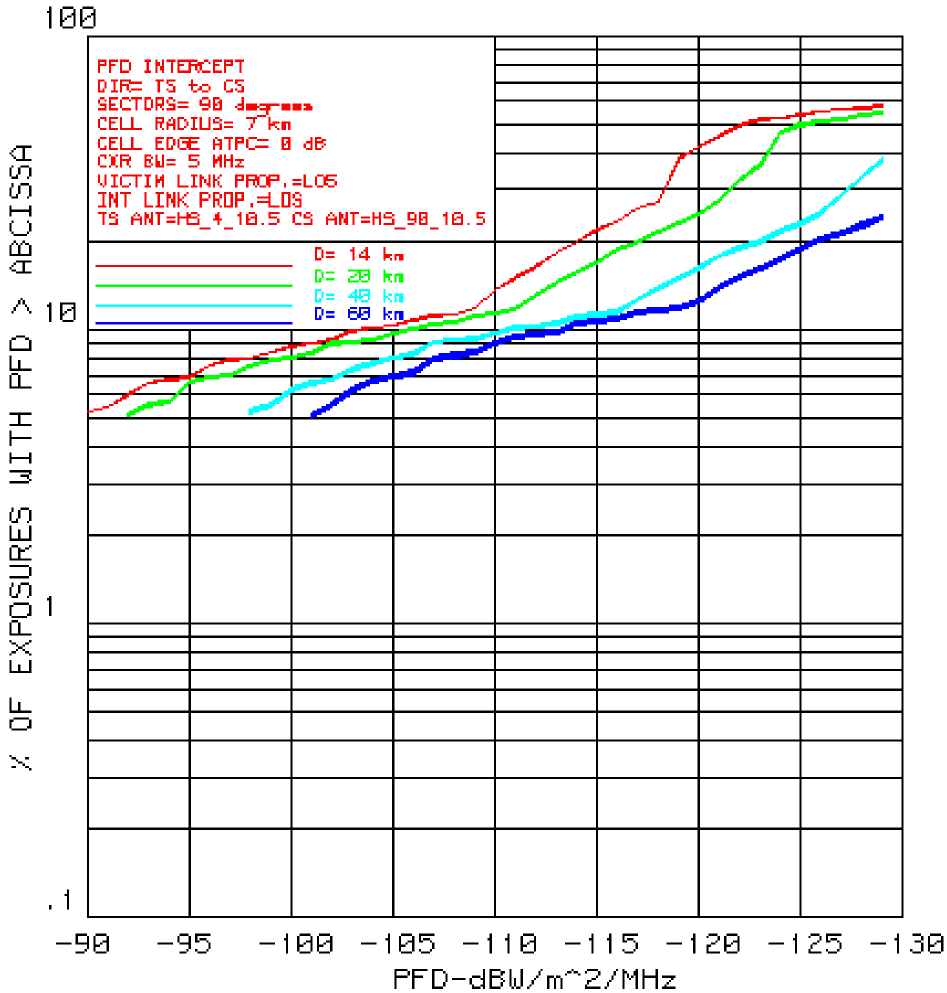


Figure 4. CDF Simulation Estimate for an Improved Performance TS Antenna.

However, it has been noted that some jurisdictions, for example [3], currently impose more severe RPE limits than identified by Figure 2. The RPE limits specified are illustrated on Figure 5 and approximate those of a 1.25 m parabolic antenna. The gain of such an antenna is approximately +38 dBi, which is 13 dB greater than that assumed in both [1] and in this analysis. While this is great for the link budget, it is difficult to believe that the size of such an antenna would be acceptable in the majority of PMP operational environments.

Nevertheless, it does provide an opportunity to examine what would be the impact of such an antenna on boundary coexistence. To develop valid comparisons of the impact of improved RPE, it is necessary to assume equal EIRP levels. Consequently, when compared against full power transmission for the reference model, cell edge ATPC of 13 dB is assumed for the subsequent simulation.

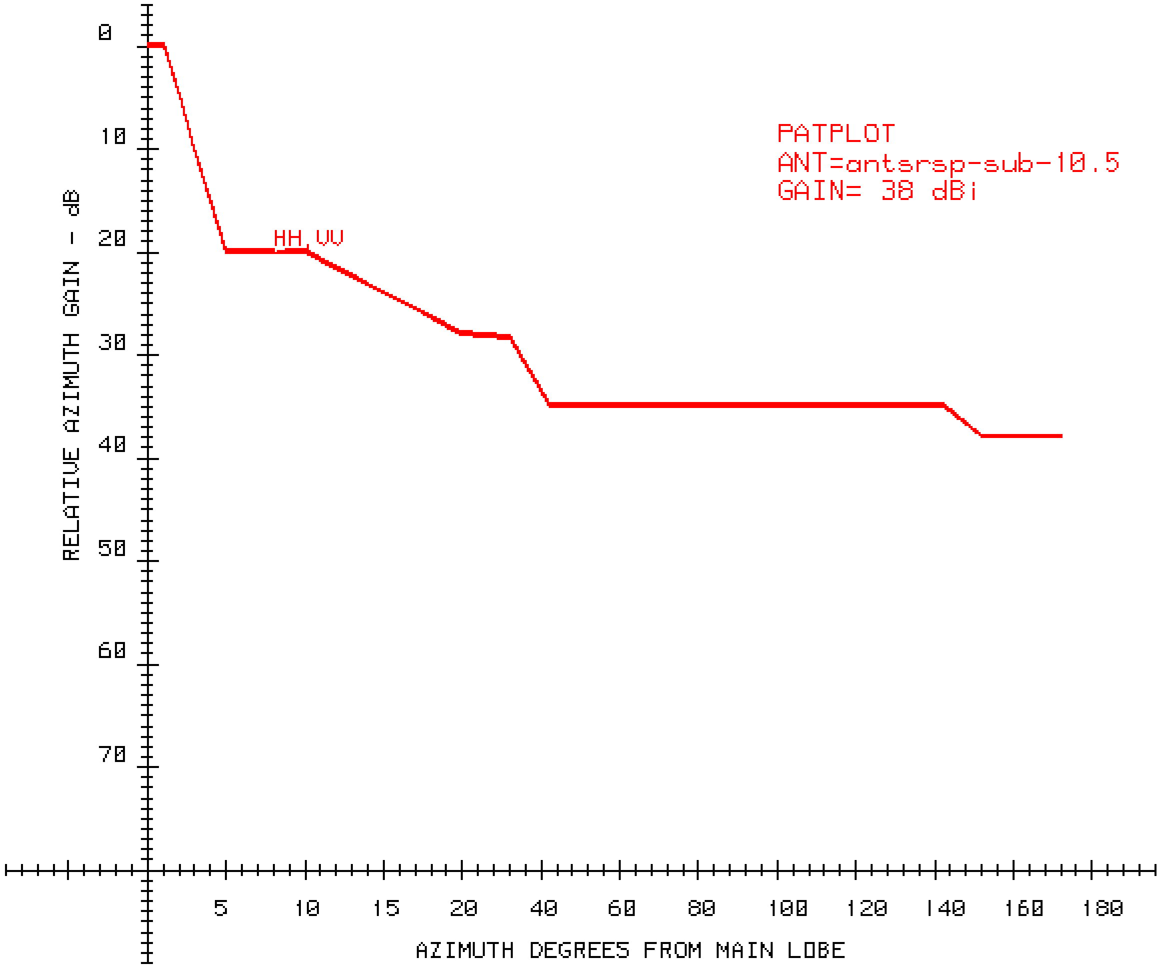


Figure 5. TS Azimuth RPE for a Regulatory Specified Antenna.

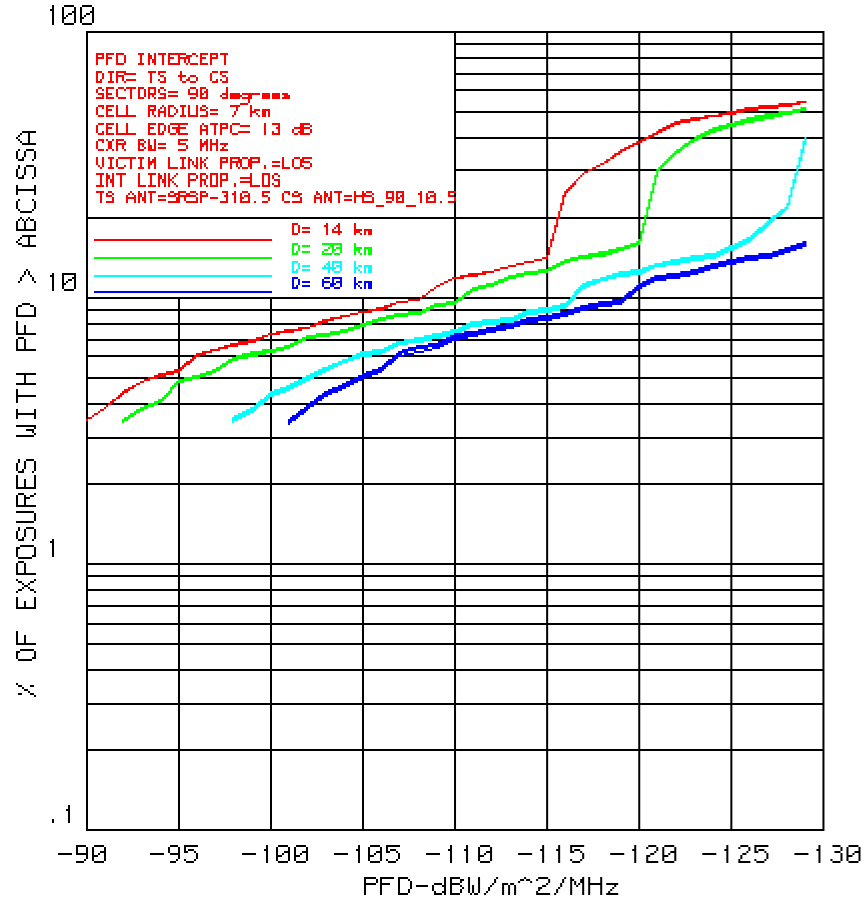


Figure 6. CDF Simulation Estimates for a Regulatory Specified Antenna.

Figure 6 illustrates the CDF results of the simulation. As expected, worst case pfd levels are essentially unchanged. As compared to Figure 4, critical pfd levels that are greater than -105 dBm/m$^2$/MHz have a CDF reduction of between 1 - 2 percent. This would hardly support the coexistence necessity for an antenna with such stringent RPE characteristics.

However, if we assumed that there was no ATPC applied at cell edge, then the critical pfd levels simply move to the left by 13 dB. This would invalidate the system model in [1] and that used in this report. This just simply reinforces the repeated statement that operator coordination will be required for acceptable coexistence to be a reality.

A second regulatory example is illustrated on Figure 7. This is the most severe ETSI requirement [4] for frequency range 3 (TS2, 8.5-11 GHz). The differences in RPE between the two regulatory requirements are quite significant as can be identified by comparing Figure 7 with Figure 5. The rationale for this difference is not known to the author.

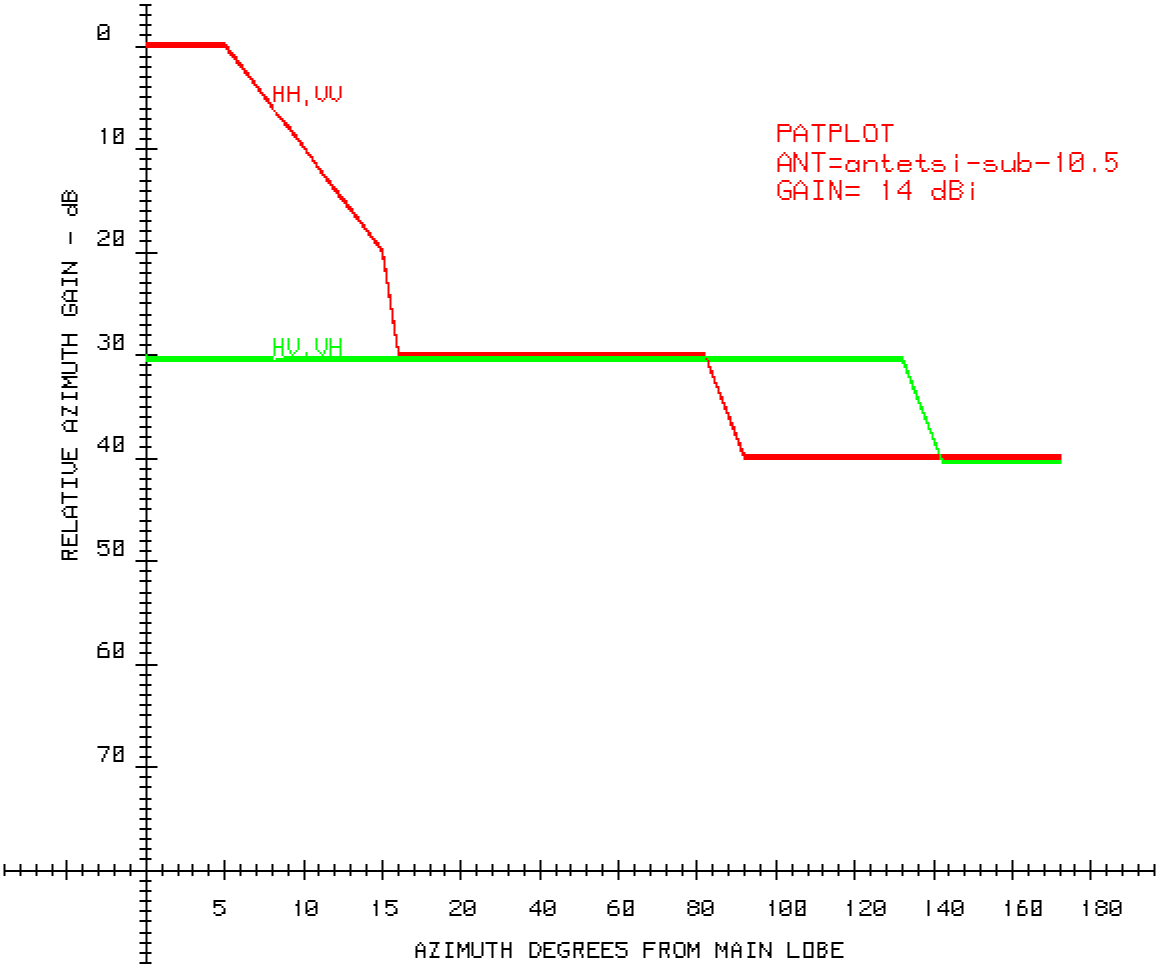


Figure 7. RPE Requirement for an ETSI Specified Antenna

Although differing in detail, the RPE requirements for the ETSI antenna are comparable to those of the representative antenna as defined by Figure 2. The 3 dB beamwidth of the ETSI antenna is larger, hence we would expect an increased percentage of CDF values at worst case levels. In the range 15 to 100 degrees, the ETSI RPE requirements are somewhat more severe than those of the representative antenna. We would thus expect that in the secondary range of pfd levels(< -105 dBW/$m^2$/MHz), CFD percentages would be better than that of the representative antenna.

These assumptions are confirmed by the simulation of Figure 8 that can be compared against that of Figure 4.

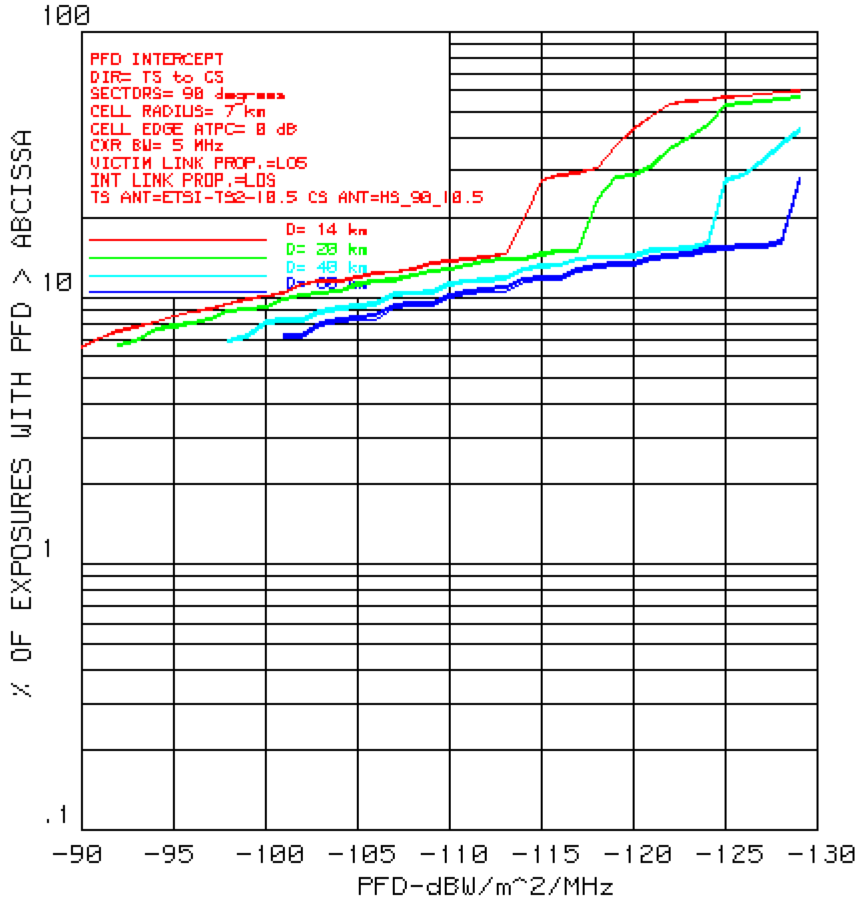


Figure 8. CDF Simulation Estimates for an ETSI Specified Antenna.

All of the simulations reach an identical conclusion. It is distance separation that controls pfd and antenna RPE is a secondary parameter. Hence this does beg the question, as to why very stringent RPE requirements are set at large angular offsets? However, note that the preceding does not deal with the RPE limits that may be desired for intra-system C/I operation. This is a separate issue, but it has nothing to do with coexistence.

## 4.0 References

[1] "Coexistence Co-Channel Boundary pfd Simulations at 10.5 GHz (Inbound)",

C802.16.2a-02/01, 01/12/02.

[2] "Coexistence of Fixed Broadband Wireless Access Systems; IEEE Computer Society, September 10, 2001.

[3] "Technical Requirements for Line-of-Sight Radio Systems Operating in the Fixed Service in the Band 10.55-10.68 GHz", Industry Canada, Spectrum Management, Standard Radio System Plan, SRSP-310.5, Issue 1, September 29, 1990.

[4] "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 3 GHz to 11 GHz band, ETSI EN 302 085 v1.1.1, (2000-06).