

**Technical Notes on IBOC Interference Maps and Population Studies
Supplied on CD-ROM to the FCC**



September 24, 2008

A total of 49 FM public radio stations were selected from the 50 largest U.S. markets for further analysis in the DRCIA (Digital Radio Coverage and Interference Assessment) project.¹ The stations were chosen to provide approximately the same distribution of facilities by FCC Class, as represented by all public radio stations in these markets.

Analog mobile coverage was prepared from a link-budget derived minimum field strength of 37 dBu, taking into account laboratory-measured receiver sensitivity, environmental noise and a vehicular antenna efficiency of -6 dBd. The interference ratios were determined from laboratory measurements of OEM and after-market mobile radios, as described in the NPR Labs report “Report to the Corporation for Public Broadcasting - Digital Radio Coverage & Interference Analysis (DRCIA) Research Project” released in July, 2008.²

Receiver interference criteria are based on a 40 dB weighted quasi-peak audio signal-to-noise ratio, by psophometer measurement, compliant with ITR-R Recommendation 468-4. The psophometer impairment level was determined by listener ratings with 30 participants using a variety of program genre, on CCIR-type 5-point MOS scale.³ A 40 dB WQPSNR was rated as the lowest step of “Good” quality before dropping to “Fair” quality.⁴ These ratings were determined for listeners in a fixed indoor environment rather, not a mobile environment. However, NPR Labs used median (50th percentile) location predictions for desired and interfering signals, which when combined with Raleigh fading effects and an independently-varying interferer would result in substantially higher interference noise at some locations. The effect of interference fading supports the 40 dB WQPSNR impairment criteria for 50% of locations.

Calculations of coverage were performed in a version of the *CSPT* RF planning software, developed by the Institute for Telecommunication Sciences (Boulder, Colorado) for NPR Labs. Based on extensive drive-test measurement data, NPR Labs used the Terrain Integrated Rough Earth Model (TIREM) as the most accurate path loss model available to calculate field strengths. Globe 1 km terrain data was used for all studies.

The population was enumerated in *CSPT* using the highest resolution centroid data available from the 2000 Census. Population studies were performed for analog coverage

¹ The San Juan, Puerto Rico market lacked computer population data. Consequently, 49 population studies are provided.

² The full report may be downloaded at <http://www.nprlabs.org/publications/reports/200807151043-DRCIAFinalReport-Full.pdf>.

³ *Consumer Ratings Of Impaired Audio At Varying Signal/Noise Ratios*, Dr. Ellyn Sheffield, John Kean and Dan Schwab, all NPR Labs, 2008 NAB Engineering Conference Proceedings.

⁴ The National Radio Systems Committee’s *Subjective Evaluation of Audio Degraded by Noise and Undesired FM Signals*, NRSC-R31, November 17, 1982, determined a rating of “very annoying” for 40 dB, and recommended that FM planning factors be based on a 50 dB stereophonic SNR.

in three conditions: with analog-only interference, with 1% IBOC hybrid interference and with 10% IBOC hybrid interference. The raw data, along with calculations of the relative impacts are provided in the spreadsheet file accompanying this document and map folders.

The population numbers in the included spreadsheet list the raw data from our CSPT census reports for each station, representing the non-duplicated population receiving interference-limited service ("No Interference") and those who would receive service, absent interference ("Interference"). The "Total" is the sum of these two population groups.⁵

The population was counted only within the station service contour, which in the case of these stations, are all a F(50,50) 60 dBu field strength. Three groups of population were counted, but a "No Signal" group was not included. Thus, the "total population numbers in the spreadsheet *do not* represent the total population within the service contour. Since a terrain-sensitive prediction model was used, we only counted service that was available within the contour, rather than the total population within the service contour assumed by the FCC. However, this is consistent with our previous population studies in NPR Labs' *DRCIA Report*.

The spreadsheet "Compare" tab calculates the percentage of predicted interference populations for 1% and 10% IBOC transmission power, after subtracting analog-to-analog interference percentages from each. Graphs of the interference population percentages for each station are included on separate tabs labeled "1% IBOC chart" and "10% IBOC chart", respectively.

⁵ The population is counted by "centroid retrieval" (using the highest resolution data available from the U.S. Census) by matching the centroid points with the hundreds of thousands of grid blocks generated by the CSPT coverage and interference calculations. Due to mathematical rounding in the computer during the calculation, and the granularity of the centroids, it is possible for the status of small numbers of individual grid blocks to differ between the separate studies. Since centroid retrieval is an all-or-none enumeration, this "dither" may cause variation in the counts, when we exclude the No Signal population.