

**Engineering Report
Regarding a Study of the Impact of Increased
Transmission Power
As Proposed for Channel 6 DTV Stations
On Noncommercial Educational FM Station Reception**

**NPR Labs
March 18, 2011**



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The Commission's current Notice of Proposed Rulemaking ("Notice"), proposes to increase the maximum transmitted power of digital television stations on channels 2 to 6 ("low-VHF") from 10 kW to 40 kW, referenced to a height above average terrain of 305 meters.¹ Because most noncommercial educational FM (NCE-FM) stations operate on special reserved channels that are adjacent in frequency to channel 6, there is a potential for DTV out-of-band emissions that are compliant with the FCC's emission mask to interfere with NCE-FM stations in the vicinity of channel 6 transmitter. NPR prepared this study to determine whether, and to what extent, the blanket increase in power proposed by the Commission may increase the interference to reception of existing NCE-FM stations. As discussed further, below, the study identified a substantial number of NCE-FM stations that would receive interference from just nine current channel 6 DTV stations.

Methodology

There are nine full-service DTV stations operating currently on television channel 6. These stations, with their current facilities, are shown in the following table. Three stations are authorized in TV Zone I, in which the FCC proposes the ERP increase. For these stations, the maximum ERP was determined according to the modifications to §73.622(f), as described in Appendix A of the Notice, taking into account the DTV station's antenna height. For example, WEDY, New Haven, Connecticut, operates with 0.4 kW at a height of 88 meters, which the Notice proposes could be increased to 40 kW as its antenna height is less than 305 meters. WRGB, Schenectady, New York, and WPVI-TV, Philadelphia, Pennsylvania, have antenna heights greater than 305 meters, which allows their respective ERPs to be increased according to the formula:

$$ERP_{\max} = 98.57 - 33.24 * \log_{10}(HAAT)$$

No change in the ERP of channel 6 DTV stations in Zones II and III is proposed in the Notice. However, it is apparent that four of the six stations in these zones currently operate at less than maximum facilities. This study assumes that these broadcasters would undertake transmitter improvements as presently allowed, employing the maximum ERP for their present height:

$$ERP_{\max} = 103.35 - 33.24 * \log_{10}(HAAT)$$

¹ Notice of Proposed Rulemaking in EM Docket No. 10-235, adopted November 30, 2010.

Full-Service Channel 6 DTV Stations by TV Zone, Showing Present and Proposed ERP**

Ch. 6 Call Sign	TV Zn.	Sta- tus	City	St.	File Number	Facility ID	HAAT (m)	Pres. ERP (kW)	Prop. ERP (kW)
WEDY*	I	LIC	New Haven	CT	BLEDT- 20060906ABJ	13595	88	0.4	40
WRGB	I	CP	Schenectady	NY	BPCDT- 20080307AAK	73942	396	4.64	16.8
WPVI- TV	I	CP	Philadelphia	PA	BPCDT- 20080208ADW	8616	332	7.56	30.2
WUOA	II	CP	Tuscaloosa	AL	BPCDT- 20100716ADI	77496	395	45	45
WCES- TV	II	LIC	Wrens	GA	BLEDT- 20090612ACF	23937	429.4	7.9	21.7
KBSD- DT	II	CP	Ensign	KS	BPCDT- 20090630ADJ	66414	216.8	31	45
KTVM- TV	II	CP	Butte	MT	BPCDT- 20100409AAZ	18066	591.3	19.2	19.2
KWNB- TV	II	LIC	Hayes Center	NE	BLCDDT- 20090604ABL	21162	221	11.9	45
WABW- TV	III	LIC	Pelham	GA	BLEDT- 20090612ACC	23917	378.9	10.5	28.7

** Zone 2 and 3 proposed ERP shown for maximum facilities under present rules

*WEDY was granted substitution to channel 41 on March 16, 2011; current channel 6 operation is assumed

In 1998, NPR commissioned a study of the effect of DTV emissions (“emissions study”) on channel 6 on a variety of fixed and mobile FM receivers tuned to reserved band channels, (88.1-91.9 MHz).² The instant study derived its RF interference ratios from the 1998 report, which NPR believes is still appropriate, as the interference mechanism is essentially one of digital emissions that are *co-channel* to the desired FM signal, against which receivers have minimal ability to discriminate. NPR’s extensive analog FM receiver testing over the past several years has reinforced the finding that co-channel interference rejection has not changed significantly.

The NPR emissions study tested six FM receivers, listed in the table below. These included home stereo, portable and automotive receivers (of which four were used for the Electronic Industry Association’s In-Band On-Channel digital radio compatibility tests).

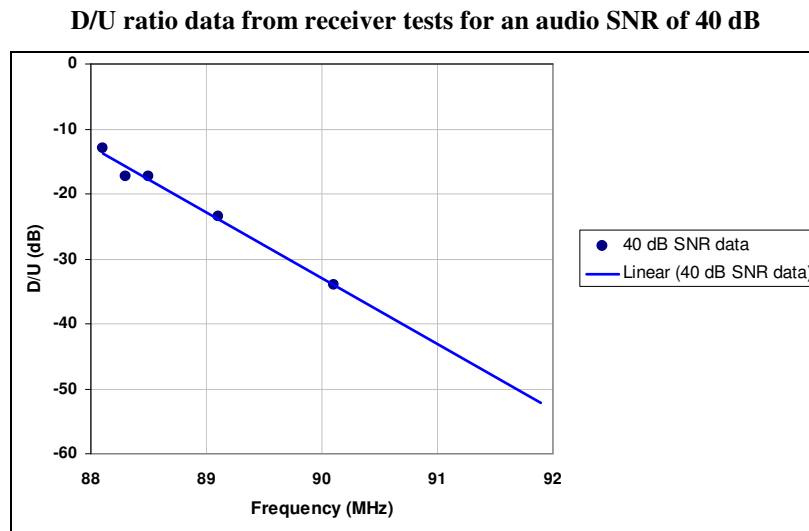
Receiver Number	Receiver Model	Receiver Description
1	Denon TU-380 RD	Home Hi-Fi RBDS
2	Pioneer SX-201	Home Hi-Fi Competitive
3	Panasonic RX-FS430	Competitive Portable
4	Delco 16192463	Auto
5	Denon TU-680NAB	Home Hi-Fi Top of the Line
6	Audiovox AV 220 ETR	Auto after market

² *DTV Channel 6 Interference to FM Band Reception – Final Report*, National Public Radio, July 24, 1998. This report was filed with the Commission in 1998. Tests were performed at NASA’s Lewis Research Center in Cleveland, Ohio by the Digital Radio Test Laboratory - Mr. Thomas Keller, senior consultant.

The emissions study conducted laboratory measurements with an 8-VSB exciter to generate the DTV signal operating on TV channel 6. The DTV out-of-channel emissions were adjusted to simulate the FCC February 23, 1998 emissions mask and four other emission masks. For this study, the measurements were compiled from tests with an emission mask corresponding to the “Method 1” currently required for full-service DTV stations.³ The tests objectively measured the interference to FM stereo transmissions operating on frequencies in the lower 2 MHz of the FM band caused by out-of-channel emission of a DTV transmitter operating on TV channel six.

The interfering audio noise was measured using the CCIR weighting filter and quasi-peak detection (Psophometric). The tests recorded the audio signal-to-noise ratios versus RF desired-to-undesired (D/U) ratios at each reserved band frequency (88.1 to 91.9 MHz) at signal powers of -56 (medium strength) and -71 dBm (low strength). Although the measurements were collected for SNRs up to 45 dB, the D/U ratio criteria for this study were derived for an audio SNR of -40 dB. In consumer tests conducted recently by NPR, this represented a level of background noise at which mean opinion scores of listeners were dropping rapidly, particularly for speech programming, to a level of 3.1, corresponding to only “fair” quality. This impairment also related to the level at which 50% of listeners found the noise to be “annoying” or “slightly annoying.” At lower SNRs, mean opinion scores fell to “poor” levels and leave-on decisions began to drop significantly.⁴

Data from the laboratory measurements was available at 88.1, 88.3, 88.5, 89.1 and 90.1 MHz, as shown as points in the following graph. A linear regression line was used to determine the appropriate D/U ratios at all reserved band frequencies.



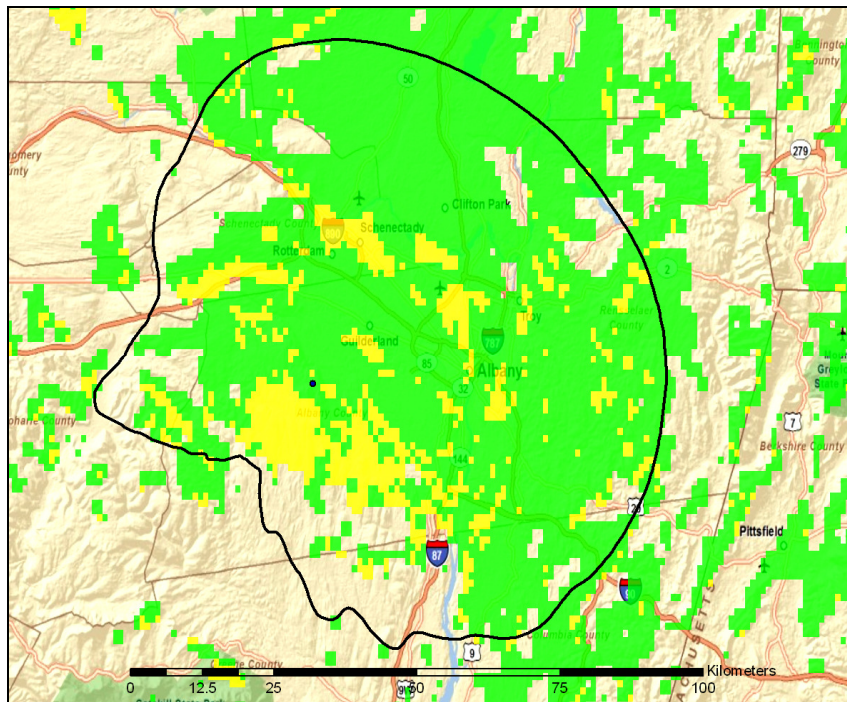
³ The DTV emission mask was adopted in FCC Memorandum Opinion and Order on Reconsideration of the 6th Report and Order, Released 23 February 1998, and codified in Section 73.622(h) of the FCC Rules (47 CFR 73.622). The details for Method 1 were specified in Commission’s Public Notice in DA 05 1321, May 10, 2005.

⁴ *Consumer Ratings Of Impaired Audio At Various Signal/Noise Ratios*, Ellyn Sheffield, Towson University, John Kean and Dan Schwab, NPR Labs-National Public Radio.

To prepare coverage maps that realistically predict coverage, NPR employed a terrain-sensitive pathloss model to determine and show the actual effects of terrain on coverage. This model uses the sophisticated propagation algorithm called the Terrain Integrated Rough Earth Model (TIREM), developed at the Joint Spectrum Center (JSC, formerly ECAC) in Annapolis, Maryland. TIREM uses detailed terrain profiles to compute values of basic transmission loss from point to point. The model evaluates the profile between two sites and, based on the geometry of the profile, selects automatically the most probable mode of propagation from various knife-edge models, a rough-earth diffraction model, and line-of-sight models. When combined with the United States Geological Survey (USGS) 30-arc second terrain database, as has been done, the TIREM model is an accurate available means of predicting signal strength from both the FM station and the DTV station.

The map presented here shows TIREM-computed desired-to-undesired (D/U) ratios for the predicted effect on FM station coverage, for NCE-FM stations in the 88.1 to 91.9 MHz range, from potential interference from a DTV station operating on TV Channel 6 (82-88 MHz). In all cases, the FM station is treated as the desired station, so negative D/U ratios indicate areas for higher DTV station signal strengths. An FM threshold of 40 dBμ was selected, under which no D/U ratios were computed.⁵ A 2-meter receiving antenna height was assumed for all cases.

Map showing coverage and interference calculations for WVCR-FM, Ch. 202B1, Loudonville, NY



⁵ It should be noted that field strengths predicted at 2 meters above ground with TIREM represent substantially higher field strengths with the FCC's F(50,50) curves, which assume a receive height of 9.1 meters.

The map, above, shows a sample of the coverage calculations for WVCR-FM, Ch. 202B1, Loudonville, New York under present conditions. Locations in green and yellow exceed the minimum service criteria of 40 dB μ at 2 m above ground; whereas locations in green exceed the D/U value for interference from digital television station WRGB, channel 6, in Schenectady (transmitter not shown on map). For this study, population is counted within the NCE-FM station's 60 dB μ contour, and must be above the minimum field strength criteria. Locations in yellow are below the D/U threshold and receive interference, and again, only population within the NCE-FM station's 60 dB μ contour is counted for interference. The map study is then repeated with the proposed or maximum allowable (Zone II and II) channel 6 facilities.

In the table below, WVCR-FM shows a population served (in the absence of DTV interference) of 708,111, with 180,874 of that number receiving interference, amounting to 26 percent of WVCR's potential population. Under the increased power proposed for channel 6 stations, the population of interference increases by 42,396, to 229,270, or 32 percent of WVCR's potential population. This is an increase of 6% in population that would receive interference if WRGB increased ERP to the maximum allowed in the Commission's Notice.

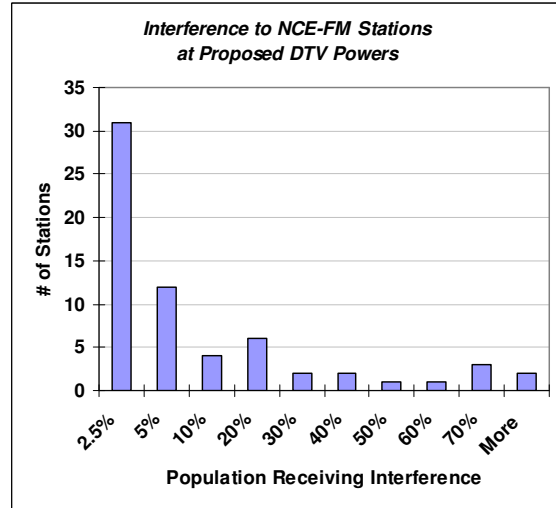
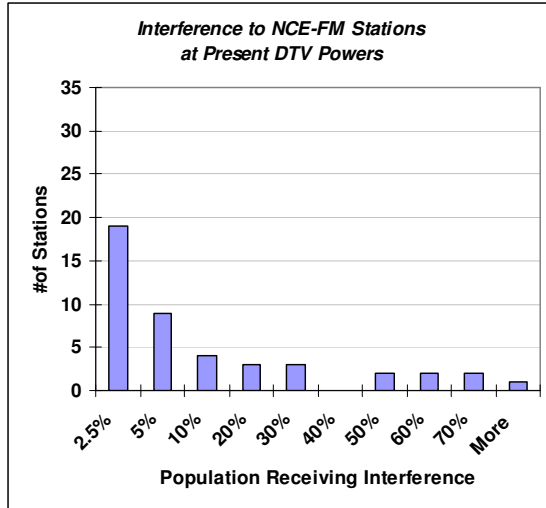
Population within 60 dBμ contour of WVCR-FM meeting criteria below	Population (2000 Census)	Percent Population
Total served (green and yellow)	708,111	-
Present area receiving interference (yellow)	180,874	26
Area receiving interference at proposed WRGB operation	229,270	32
Change in population receiving interference	42,396	6

This method was applied to all 1735 licensed NCE-FM stations operating in the reserved band (88.1 to 91.9 MHz, inclusive) in late February, 2001. Table 1 summarizes the effects of DTV interference to NCE-FM stations for the nine channel 6 stations, at their current ERP and at increased ERP as proposed by the NPRM.

Table 1 lists only the 60 NCE-FM stations having the greatest interference from current channel 6 stations as a percentage of their service population. "Service (Pop.)" refers to the population within the 60 dB μ service contour of each NCE-FM station who receives a terrain-limited signal, as discussed above. The three columns to the right, respectively, show the population of interference for the NCE-FM station with the most-critical channel 6 station operating at the ERP proposed by the NPRM, the percentage of this population relative to the current service population, and the increase in interference over the current conditions. Stations that have no entries in these three columns are affected by channel 6 stations that are already at their maximum facilities, as defined by the NPRM. All percentages are rounded to the nearest whole percent. It is notable that magnitude of interference is not reserved for the NCE-FM stations on the lowest-frequency channels: interference may affect large percentages of the station's population on any reserved band channel.

For the existing nine DTV stations on channel 6, this study found that under present channel 6 power limits, 19 NCE-FM stations have interference of up to 2.5%, 9 have

interference to between 2.5% and 5%, and 17 stations have interference to more than 5% of potential service population (seven exceeding 40%). These results are summarized in the histograms, below, showing present DTV powers on the left and proposed powers on the right.



Under the channel 6 power limits proposed in the Notice, 31 NCE-FM stations have interference of up to 2.5%, 12 have interference to between 2.5% and 5%, and 21 stations have interference to more than 5% of potential service population. Considering that these numbers relate to only nine channel 6 DTV stations, it is apparent that each DTV station affects numerous NCE-FM stations. Increases in the number of channel 6 DTV stations will multiply the numbers of affected NCE-FM stations.

Table 1 – 60 NCE-FM Stations Receiving Greatest Interference from Channel 6 DTV Stations

Callsign	FM Channel	Current			NPRM Increased DTV-6 Power		
		Service (Pop.)	DTV-6 Interference (Pop.)	Interference (%)	DTV-6 Interference (Pop.)	Interference (%)	Interference change (%)
WXVU	206	231,725	176,326	76%	206,885	89%	13%
WPEB	201	104,813	71,277	68%	73,719	70%	2%
WBFR	208	428,733	263,655	61%	*		
WYBF	206	276,099	151,997	55%	179,920	65%	10%
WVSU-FM	216	381,873	199,023	52%	204,530	54%	1%
WRUC	209	105,423	44,257	42%	82,124	78%	36%
WMFT	205	607,992	254,234	42%	260,666	43%	1%
WLJR	203	299,125	88,166	29%	101,240	34%	4%
WVCR-FM	202	708,111	186,874	26%	229,270	32%	6%
WGIB	220	730,661	156,283	21%	157,894	22%	0%
WRDV	207	275,829	49,557	18%	50,534	18%	0%
WXPB	203	4,759,554	704,574	15%	759,538	16%	1%
WAMC-FM	212	1,225,445	180,525	15%	247,259	20%	5%
WPGL	214	101,816	7,852	8%	9,554	9%	2%
WMHT-FM	206	866,291	61,688	7%	92,479	11%	4%
WNHU	204	398,324	21,987	6%	62,516	16%	10%
WAFJ	202	482,171	25,435	5%	38,034	8%	3%
WCDB	215	186,322	9,218	5%	29,261	16%	11%
WAYT	201	454,348	20,297	4%	23,691	5%	1%
KJLF	213	47,140	1,992	4%	2,267	5%	1%
WQAI	208	187,867	7,493	4%	11,495	6%	2%
WFSU-FM	205	617,406	24,063	4%	24,914	4%	0%
WGRS	218	175,283	6,392	4%	*		
KFRD	205	48,755	1,573	3%	2,011	4%	1%
WLJK	206	515,716	14,192	3%	25,650	5%	2%
WUAL-FM	218	342,330	8,961	3%	9,833	3%	0%
WSRN-FM	218	177,566	4,103	2%	20,776	12%	9%
WJHO	209	63,597	1,401	2%	*		
KQLR	209	48,218	990	2%	990	2%	0%
WBHM	212	1,075,267	20,842	2%	*		
WPKN	208	1,541,002	29,114	2%	*		
WJCK	202	191,495	3,161	2%	3,161	2%	0%
WSJL	201	156,373	2,342	1%	2,836	2%	0%
WVYC	201	66,902	830	1%	*		
KAIG	210	84,188	1,034	1%	1,082	1%	0%
WKNG-FM	206	19,474	222	1%	*		
WJSR	216	47,311	509	1%	663	1%	0%
KAPC	217	46,882	447	1%	447	1%	0%
WBJY	207	307,450	2,823	1%	3,622	1%	0%
WAPJ	210	41,335	378	1%	*		
WBYO	205	215,859	1,649	1%	5,825	3%	2%
WDIY	201	363,881	2,573	1%	14,209	4%	3%
WHYY-FM	215	5,399,626	6,504	0%	*	0%	
KPNE-FM	219	49,071	44	0%	605	1%	1%
KANZ	216	68,819	43	0%	66	0%	0%
WMHS	201	75,711	0	0%	3,194	4%	4%
WKDU	219	942,167	0	0%	30,147	3%	3%
WPKT	213	1,727,969	0	0%	49,118	3%	3%
WDNR	208	60,644	0	0%	1,691	3%	3%
WZZD	201	86,363	0	0%	1,950	2%	2%
WHVP	216	53,873	0	0%	1,088	2%	2%
WNJT-FM	201	417,456	0	0%	8,065	2%	2%
WRXC	211	128,217	0	0%	2,391	2%	2%
WFGB	209	355,128	0	0%	5,408	2%	2%
WSHU-FM	216	1,696,967	0	0%	13,332	1%	1%
WJCS	207	401,562	0	0%	2,349	1%	1%
WJMJ	205	1,104,526	0	0%	5,689	1%	1%
WESU	201	332,972	0	0%	1,681	1%	1%
WMNR	201	126,741	0	0%	537	0%	0%

* Offending channel 6 station already at maximum facilities (no change in channel 6 interference).