FIELD MEASUREMENT REPORT

RF EMISSION MEASUREMENTS

- FM BROADCAST COMBINER & ANTENNA SYSTEM -

INTERMODULATION AND HARMONIC STUDY REPORT

KNMB(FM) 96.7MHZ – CAPITAN, NM
KIDX(FM) 101.5MHZ – RUIDOSO, NM

EQUIPMENT

AAT FM IV-CP-3 ANTENNA SYSTEM
ANDREW AVA7-50B TRANSMISSION LINE
AAT C-IR-3-3-12K-N FILTER/COMBINER

SITE

BUCK MOUNTAIN/RUIDOSO
RUIDOSO, NM

PREPARED FOR:
MTD RADIO, INC.

MARCH 30, 2024

SUBMITTED BY:
ROBERT C. RAMSEYER
RJ COMMUNICATIONS, INC.
10026 2ND STREET NW.
ALBUQUERQUE, NM 87114
(505) 792-9711
Rob.Ramseyer@IEEE.org

TABLE OF CONTENTS

TABLE OF CONTENTS 2

INTRODUCTION AND ENGINEERING STATEMENT 3

MEASUREMENT TEST EQUIPMENT 4

MEASUREMENT TECHNIQUE AND PROCEDURES 5-6

SUMMARY 7

MEASUREMENTS, FIGURES AND TABULATED DATA

FIGURE #1 KNMB /KIDX RF SIGNAL FLOW DIAGRAM..... 5

TABLE #1 CALCULATED INTERMODULATION PRODUCTS..... 8

TABLE #2 TABULATION OF 3RD ORDER INTERMODULATION MEASUREMENTS..... 8

FIGURE #2.1 COMBINER OUTPUT 90MHZ-190MHZ PLOT W/SHIVELY 2912 NOTCH.. 8

TABLE #3 TABULATION OF HARMONIC MEASUREMENTS 9

FIGURE #2.4 (88MHZ-450MHZ) RJC-FMREJ1 FM BAND REJECT FILTER
(88MHZ-450MHZ INSERTION LOSS (S21) 10

FIGURE #2.5 SHIVELY DUAL 2912 MEASUREMENT DUAL NOTCH FILTER – TYPICAL RESPONSE
(88MHZ-108MHZ INSERTION LOSS (S21) 10

SYSTEM GAIN/LOSS TPO CALCULATIONS 11

FCC CFR 73.317 12

INTRODUCTION AND ENGINEERING STATEMENT

This firm of RJ Communications, Inc. with offices at 10026 2nd Street in Albuquerque, NM was retained by MTD Radio Inc. to perform the required emission RF measurements to show compliance with the provisions 73.317 of the Rules governing FM Broadcast Stations and FM translators operating at transmitter powers of greater than 10 watts.

This report of findings is based on measurement data collected at the KNMB, KIDX broadcast facility. This measurement data is offered as proof that the combined operations of KNMB (96.7MHz) and KIDX (101.5MHz) are in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 section 73.317 paragraph (b) through (d). In Brief, the collection of measurements presented in this report show that all possible third order inter-modulation (IM) products generated by this multiplex system are less than the maximum allowable level as required.

These measurements were derived from an RF sample taken from a directional coupler placed at the combiner system output and directly feeding the common antenna/transmission system input. KIDX and KNMB transmitters were operated to achieve full authorized ERP as currently licensed for KNMB and as specified in the KIDX construction permit #BMLH-20141217AAU.

This multiplexed system is fundamentally comprised of antenna, feedline and channel filter/combiner unit used for both KNMB and KIDX.

The data contained in this report is based on field measurements or observations by Robert C. Ramseyer, as acquired on March 30, 2024 during the test measurement period between hours of 10:30 and 14:15 MST.

MEASUREMENT TEST EQUIPMENT

MEASUREMENT TEST EQUIPMENT USED:

HEWLETT PACKARD 8594E SPECTRUM ANALYZER / S#3911A08672

HEWLETT PACKARD POWER METER 4418B / S#MY40513108

HEWLETT PACKARD 85032B 50 OHM CALIBRATION KIT / S#3135A01648

COM-TEC CHARACTERIZED PRECISION 1-5/8" INCIDENT COUPLER S# CT-VHFII-DC-2

SHIVELY 2912 CUSTOM UNABLE 88MHZ-108MHZ FM BAND DUAL NOTCH FILTER / S# RJC-FMDN-2

FM BAND REJECT FILTER (88-108MHZ) / S# RJC-FMREJ-1

MFC 3634RF-FM TUNABLE HELICAL BANDPASS FILTER / S# RJC-FMBP-1

COAXIAL MEASUREMENT TEST CABLE / 10 FEET THERMAX RG400

INMET 10DB ATTENUATOR 9070-10 / S#64684

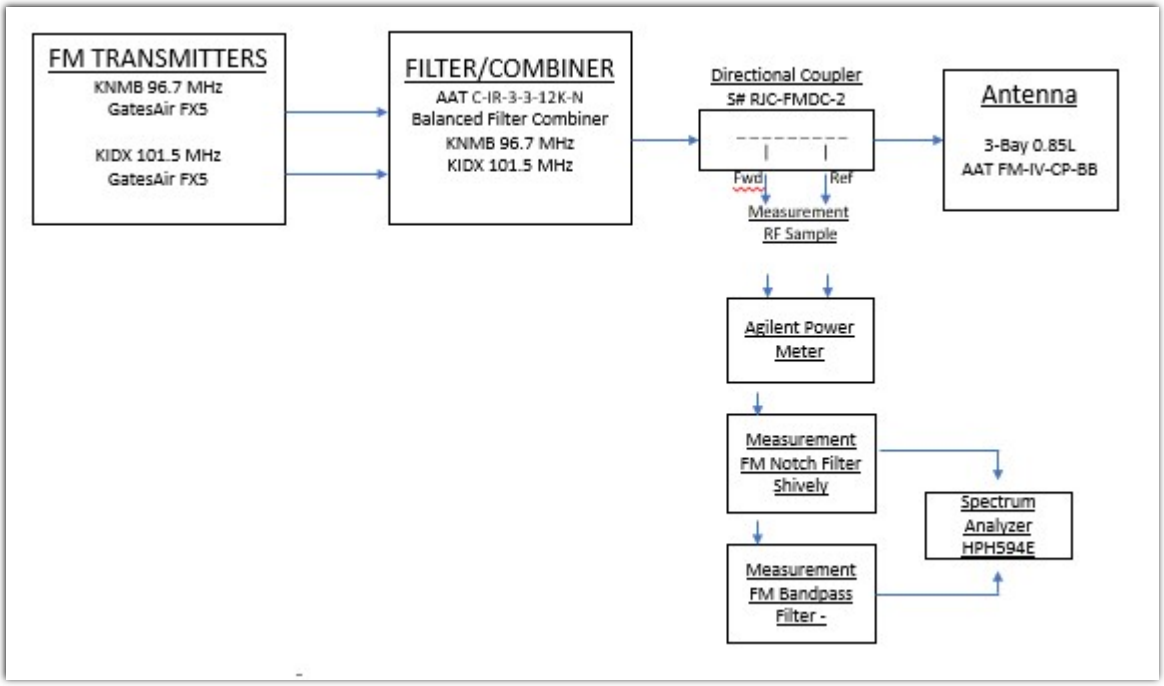
NARDA DIRECTIONAL COUPLER 50MHZ-1GHZ CHARACTERIZED FOUR PORT

MATLAB/SOFTPLOT ACQUISITION SOFTWARE / NATIONAL INSTRUMENTS GPIB ANALYZER INTERFACE

MEASUREMENT TECHNIQUE AND PROCEDURES:

A Precision Incident coupler was placed the output of the multiplexed FM combiner system and preceding the antenna/transmission system input. This coupler was used for all subsequent measurements presented in this report.

Figure 1 KNMB / KIDX RF Signal Flow



The forward port of the precision directional coupler(FMDC-3), shown in Figure 1, was used for sampling of the outgoing carriers and presence of intermodulation products and Harmonic content.

To achieve adequate spectrum analyzer dynamic measurement range, a High-Q tunable bandpass was used to suppress carrier fundamentals. For harmonic measurement out of the tunable range of the carrier notch/suppression filter, an FM band reject filter was used. Each Filter(s) passband response and insertion loss was measured and used as offset applied to the measured levels. Figure 2.5 shows the typical insertion loss of the High-Q tunable FM bandpass filter. Figure 2.4 shows the response of the FM band reject filter.

Both the KNMB(96.7MHz) and KIDX(101.5MHz) transmitters were operated into the common antenna system at power levels required to achieve authorized power of 4.0kW for KNMB and 6.0kW for KIDX as specified in the construction permit.

Intermodulation and Harmonic measurements were made without modulation. Occupied bandwidth measurements were made with FM carrier test modulation of 100%.

Initial measurement of the KNMB and KIDX respective carrier amplitudes were performed to establish reference levels of the unmodulated carriers to which all subsequent mix product and harmonic measurements contained in this report are to be compared. With reference level established, a dual notch filter was inserted into the measurement to increase the dynamic measurement range of the spectrum analyzer show in Figure 2.1.

Measurements, relative to the carrier level of KNMB(96.7MHz) and KIDX (101.5MHz), were made at all third order intermodulation mixing products as calculated by the mathematical expression [2(F1)-(F2)] where F1 signifies transmitter generating the IM product, and F2 signifies frequency causing the interference. These mix products are presented in Table 1.

Tabulated results of the measurements on each calculated IM frequency were recorded and listed in Table 2. A status flag of a PASS or FAIL condition is indicated at each frequency as determined by meeting the minimum dBc attenuation required. At instances, where energy from other carriers was found present but not generated by this multiplexed system, a Local/C indication is given.

Harmonic measurements were performed with results also indicated as Pass, Fail or Local/C with results listed in Table 3.

Specific measurements were performed at frequencies of interest used by the FAA of 188.MHz, 117.9MHz and 122.9MHz. These FAA frequencies of interest were found to be equal to or less than spectrum analyzer DANL(Display Analyzer Noise Level), of -88dBm.

Measurements were also made at calculated 3rd order intermodulation frequencies. These measurements incorporated the use of a Shively 2912 dual notch cavity filter to increase spectrum analyzer dynamic range. The notch filters were set at frequencies at the two carrier frequencies of 96.7MHz and 101.5MHz and provided an additional 30.2dB and 29.5dB of carrier suppression respectively.

The notch filter carrier suppression and pass-band response was then applied as a correction factors used in Measurement results shown in Tables #2 and #3.

Occupied bandwidth measurements were also performed to demonstrate compliance with section 73.317 (b) & (c) of the FCC rules. The spectra of each station were analyzed by use of narrow span and resolution bandwidth and utilizing the max hold function of the analyzer. These measurements were acquired over a 10 minute period with typical test program material. The results of these measurements are show in Figures 2.1 and 2.3 for stations KNMB 96.7MHz and KIDX 101.5MHz respectively.

As final proof of the system IM product and spurious emission performance, a wide band search was undertaken using the Spectrum Analyzer and found to exceed the (-80dBc) requirement.

SUMMARY

The RF spectral emissions present at the multiplexed output of the transmitter combiner system for FM broadcast translator stations KNMB 96.7MHz and KIDX 101.5MHz were found to be in FCC compliance with the requirements of Section 73.317 paragraph (b) through (d) of the FCC Rules and Regulations on this date March 30, 2024.

The data contained in this report is based on field measurements or observations by the undersigned, on the dates and times indicated in the report.

This report and preparation of all technical information contained within were performed by or under the direct supervision of Robert C. Ramseyer of RJ Communications, Inc. with offices located in Albuquerque, NM.

March 30, 2024

Respectfully Submitted,

Robert C. Ramseyer
Electrical Engineer

RJ Communications, Inc.
10026 2nd Street NW.
Albuquerque, NM 87114

(505) 792-9711 / Office#
Rob.Ramseyer@IEEE.org

Table 1 - Calculated Third Order Intermodulation Products in MHz [(2*F1)-F2]

IM Product Frequencies:

			F2	
	F1		96.7	101.5
KNMB	96.7		0	91.9
KIDX	101.5		106.3	0

Table 2 – Third Order Intermodulation Tabulated Measurement Data

KNMB(FM) 96.7MHz	TPO = 3,720 Watts			ERP = 4,000 Watts						Required Attenuation= (-80.0dBc)		
KIDX(FM) 101.5MHz	TPO = 5,570 Watts			ERP = 6,000 Watts						Required Attenuation= (-80.0dBc)		
WHERE:	I.M. Level Normalized (dBm) = [(I.M. Measured) - (I.M. Filter Insertion Loss)]						Normalized Absolute value refernced as (dBm)					
	I.M. (dBc) = [(I.M. Measured - I.M. Filter Loss) - (F1CarrRef - F1FilterNotchLoss)]						Relative to F1 Ref. Carrier referenced as (dBc)					
[(2xF1)-(F2)]	F1	F2	F1	F1 Filter		I.M.	I.M.	I.M.	I.M.	I.M.	(>=0) = PASS	Measurement	PASS/FAIL
Calculated TOI	Transmit	Interfering	Carrier Ref. F1 (S.A.)	Notch Depth Loss @ F1		Measured I.M. Level	Insertion Filter Loss	Normalized I.M. Measured	Required Atten.	Refernced to Carrier	I.M. Delta Margin	Notes	PASS/(Local/C)
Product MHz	MHz	MHz	dBm	dB		dBm	dB	dBm	dBc	dBc	dB (+/-)		
0	96.7		16.62	30.2		0	0.58		-80			REF @ 96.7	
0	101.5		18.18	29.5		0	0.98		-80			REF @ 101.5	
91.9	96.7	101.5	16.62	30.2		-82.15	0.58	-81.57	-80	98.19	18.19		PASS
106.3	101.5	96.7	18.18	29.5		-81.55	0.98	-80.57	-80	98.75	18.75		PASS

FIGURE 2.1

Combiner Output 90 MHz - 190 MHz Spectrum with Shively 2912 Notch at 96.7 MHz / 101.5 MHz

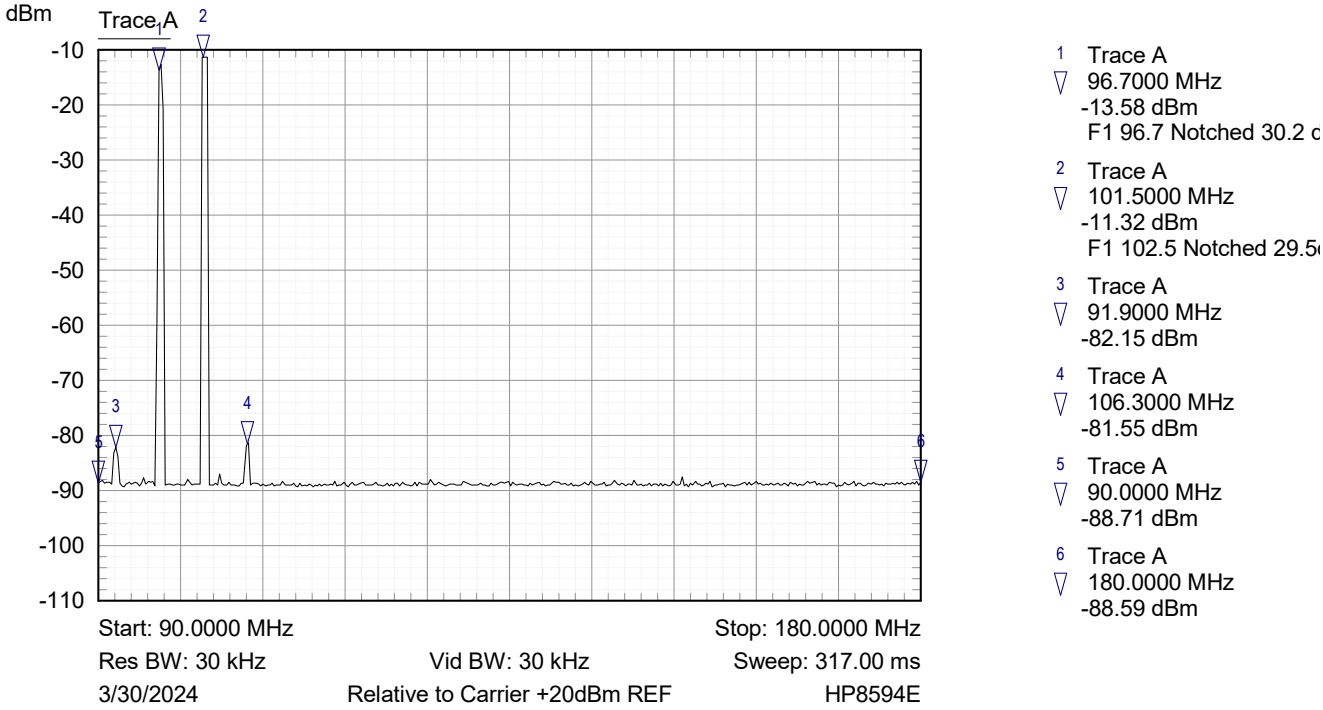
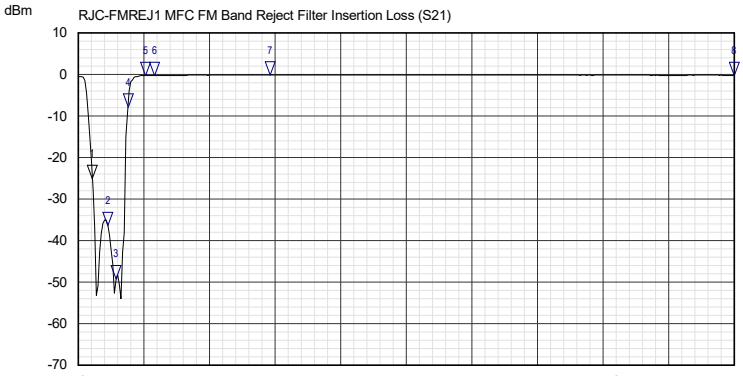


Table 3 – Harmonic Tabulated Measurement Data

Table 3 - Carrier Harmonic Emissions 2nd thru 7th											
WHERE:	Harmonic Level(dBc) = [(F1CarrRef)-(F1NotchFilterLoss)-(F1Filter Loss)-(HarmonicMeasure Relative to F1 and represented as (dBc)										
Calculated	F1	F1	F1 Filter Notch	Normalized	Level	Filter	Required	Reference	(>=0) = PASS		
Harmonic	Transmit	Carr Ref	Passband Loss	Carr Ref	Measured	Loss	Atten.	to Carrier	Delta Margin	Measurement	PASS/FAIL
Product MHz	MHz	dBm	dB		dBm	dB	dBc	dBc	dB (+/-)	Notes	Local/C
96.7 REF	96.7	16.6					0	0	0	Carrier Reference	
193.4		16.6	0.94	15.66	-77.8	0.09	-80	93.4	13.4	2nd	PASS
290.1		16.6	0.97	15.63	-75.1	0.16	-80	90.6	10.6	3rd	PASS
386.8		16.6	1.03	15.57	-79.3	0.19	-80	94.7	14.7	4th	PASS
483.5		16.6	1.17	15.43	-83.9	0.21	-80	99.1	19.1	5th	PASS
580.2		16.6	1.28	15.32	-86.8	0.24	-80	101.9	21.9	6th	PASS
676.9		16.6	1.64	14.96	-87	0.39	-80	101.6	21.6	7th	PASS
101.5 REF	101.5	18.2					0	0	0.0	Carrier Reference	
203		18.2	0.94	17.26	-72.4	0.09	-80	89.6	9.6	2nd	PASS
304.5		18.2	0.97	17.23	-71.9	0.16	-80	89.0	9.0	3rd	PASS
406		18.2	1.03	17.17	-75.1	0.19	-80	92.1	12.1	4th	PASS
507.5		18.2	1.17	17.03	-80.7	0.21	-80	97.5	17.5	5th	PASS
609		18.2	1.28	16.92	-86.9	0.24	-80	103.6	23.6	6th	PASS
710.5		18.2	1.64	16.56	-86.2	0.39	-80	102.4	22.4	7th	PASS

FIGURE 4.2 - RJC-FMREJ1 FM BAND REJECT FILTER MFC88-108MHz

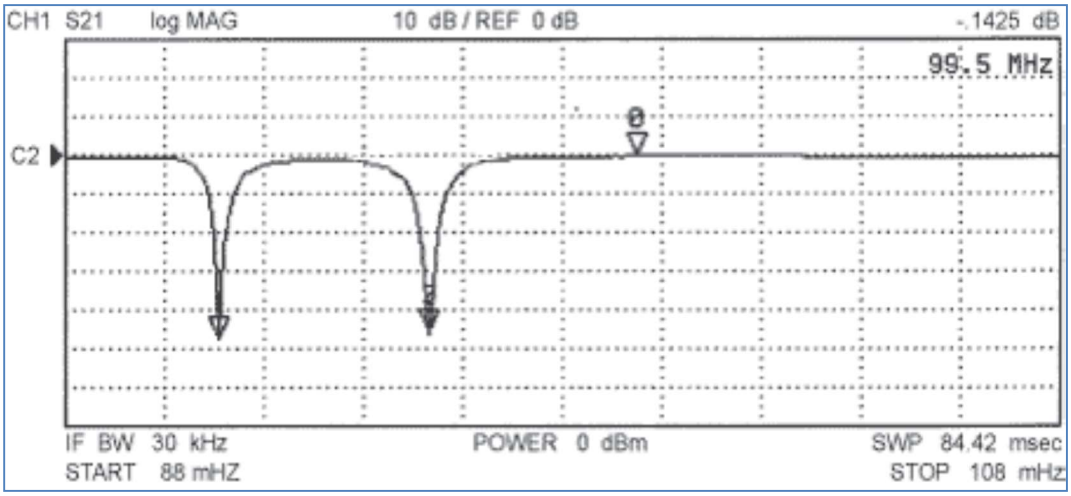
INSERTION LOSS (S21)



Mkr	X-Axis	Value	Notes
1 ▽	88.0000 MHz	-25.08 dBm	
2 ▽	96.7000 MHz	-36.44 dBm	F2 / Notch Depth
3 ▽	101.5000 MHz	-49.14 dBm	F2 / Notch Depth
4 ▽	108.0000 MHz	-7.90 dBm	
5 ▽	117.9000 MHz	-0.32 dBm	
6 ▽	122.9000 MHz	-0.28 dBm	
7 ▽	188.2250 MHz	-0.12 dBm	
8 ▽	450.0000 MHz	-0.25 dBm	

MEASUREMENT: FM Band Reject Filter MFC-88-108MHz (RJC-FMREJ-1)
88MHz-450MHz Band Reject Filter Response – Insertion Loss

FIGURE 4.3 SHIVELY DUAL 2912 HI-Q NOTCH FILTER RESPONSE– (TYPICAL)



MEASUREMENT: FM Band Dual Notch Configuration (S# RJC-FMDN-2)
TUNED/MEASURED Filter Response @:
96.7 Tuned Notch Depth for measurements = (-30.2dB)
101.5MHz Tuned Notch Depth for measurements = (-29.5dB)
91.9MHz Insertion Loss = (-0.58B) / Attenuation at calculated 3rd order IM. (TOI)
106.3MHz Insertion Loss = (-0.98dB) / Attenuation at calculated 3rd order I.M.) (TOI)

Exhibit - A

SUMMARY:
System Gain/Loss/TPO Calculation

STATION: KNMB(FM) 96.7MHz	DBK			
Transmitter Power Output (TPO) / GatesAir FX5	5.71	dBk	3.72	kW
Combiner loss	-0.47	dB	0.90	loss ratio
Transmission line loss	-0.36	dB	0.92	loss ratio
Antenna input power	4.88	dBk	3.07	kW
Antenna power gain	1.14	dB	1.3	gain ratio
ERP (Avg.)	6.02	dBk	4.00	kW

STATION: KIDX(FM) 101.5MHz	DBK			
Transmitter Power Output (TPO) / GatesAir FX5	7.46	dBk	5.57	kW
Combiner loss	-0.45	dB	0.90	ratio
Transmission line loss	-0.37	dB	0.92	ratio
Antenna input power	6.64	dBk	4.61	kW
Antenna power gain	1.14	dB	1.30	gain ratio
ERP (Avg.)	7.78	dBk	6.00	kW

(ix)(A) For a station authorized pursuant to §73.215 or Sec. §73.509, a showing that the root mean square (RMS) of the measured composite antenna pattern (encompassing both the horizontally and vertically polarized radiation components (in relative field)) is at least 85 percent of the RMS of the authorized composite directional antenna pattern (in relative field). The RMS value, for a composite antenna pattern specified in relative field values, may be determined from the following formula:

RMS=the square root of:

[(relative field value 1)^2 + (relative field value 2)^2 +....+ (last relative field value)^2]

total number of relative field values

(B) where the relative field values are taken from at least 36 evenly spaced radials for the entire 360 degrees of azimuth. The application for license must also demonstrate that coverage of the community of license by the 70 dBu contour is maintained for stations authorized pursuant to §73.215 on Channels 221 through 300, as required by §73.315(a), while noncommercial educational stations operating on Channels 201 through 220 must show that the 60 dBu contour covers at least a portion of the community of license.

(d) Applications proposing the use of FM transmitting antennas in the immediate vicinity (*i.e.* 60 meters or less) of other FM or TV broadcast antennas must include a showing as to the expected effect, if any, of such approximate operation.

(e) Where an FM licensee or permittee proposes to mount its antenna on an AM antenna tower, or locate within 3.2 km of an AM antenna tower, the FM licensee or permittee must comply with §73.1692.

[28 FR 13623, Dec. 14, 1963, as amended at 34 FR 14222, Sept. 10, 1969; 37 FR 25841, Dec. 5, 1972; 43 FR 53738, Nov. 17, 1978; 48 FR 29508, June 27, 1983; 51 FR 17028, May 8, 1986; 54 FR 9804, Mar. 8, 1989; 56 FR 57294, Nov. 8, 1991; 62 FR 51058, Sept. 30, 1997; 63 FR 70047, Dec. 18, 1998]

§73.317 FM transmission system requirements.

(a) FM broadcast stations employing transmitters authorized after January 1, 1960, must maintain the bandwidth occupied by their emissions in accordance with the specification detailed below. FM broadcast stations employing transmitters installed or type accepted before January 1, 1960, must achieve the highest degree of compliance with these specifications practicable with their existing equipment. In either case, should harmful interference to other authorized stations occur, the licensee shall correct the problem promptly or cease operation.

(b) Any emission appearing on a frequency removed from the carrier by between 120 kHz and 240 kHz inclusive must be attenuated at least 25 dB below the level of the unmodulated carrier. Compliance with this requirement will be deemed to show the occupied bandwidth to be 240 kHz or less.

(c) Any emission appearing on a frequency removed from the carrier by more than 240 kHz and up to and including 600 kHz must be attenuated at least 35 dB below the level of the unmodulated carrier.

(d) Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log_{10} (Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

(e) Preemphasis shall not be greater than the impedance-frequency characteristics of a series inductance resistance network having a time constant of 75 microseconds. (See upper curve of Figure 2 of §73.333.)

[51 FR 17028, May 8, 1986]

§73.318 FM blanketing interference.

Areas adjacent to the transmitting antenna that receive a signal with a strength of 115 dBu (562 mV/m) or greater will be assumed to be blanketed. In determining the blanketed area, the 115 dBu contour is determined by calculating the inverse distance field using the effective radiated power of the maximum radiated lobe of the antenna without considering its vertical radiation pattern or height. For directional antennas, the effective radiated power in the pertinent bearing shall be used.

(a) The distance to the 115 dBu contour is determined using the following equation: