

**Report of Inter-Modulation
Product Measurements**

for

**Operation of the Combined FM System
for**

**K246AM, 97.1 MHz
K296HH, 107.1 MHz**

**Located at
Jamestown, North Dakota**

Prepared By	Prepared For
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1 Introduction

This report of findings provides evidence to show that the operation of the combined FM facility for K246AM, 97.1 MHz and K296HH, 107.1 MHz located in Jamestown, North Dakota, is in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 Section 73.317, and specifically as related to potential intermodulation products that may occur and must typically be below the limit specified by 73.317 paragraph (d).

Intermodulation (IM) products can potentially violate section 73.317 paragraph (d) requirements and are commonly generated from radio stations operating into multiplexed facilities and at congested antenna broadcast sites when inadequate transmitter to transmitter isolation is provided.

In brief, the collection of measurements presented in this report establishes that predictable IM products generated by the operation of these stations are less than the maximum allowable level as required by section 73.317(d). Further, the present study investigated possible spurious emissions up to 1 GHz and found no spurious emissions exceeding allowable levels.

A variety of equipment was employed to collect the data recorded herein, including:

- Anritsu Sitemaster S332E, Spectrum Analyzer
- Copper Mountain TR1300/1 VNA for adjusting and recording attenuation levels of notch and bandpass filters used for testing
- Notch and bandpass filters for suppressing high power signals into the front end of the spectrum analyzer
- Attenuators for adjusting the signal levels to optimize the dynamic range of the instrumentation without exceeding input power limits
- A directional coupler installed at the system output to the antenna

Measurements to verify compliance with section 73.317 (d) were made at the directional coupler installed at the output of the overall combiner system.

2 Transmission System

The stations included in this combined system are listed in Table 1 where the level of spectral emissions required for 73.317(d) are calculated based on station transmitter power output (TPO) and listed in the last column.

Table 1 - Combiner System Stations Considered in IM Study

Call Sign	Frequency	ERP (W)	Required Level per 73.317(d)*
K246AM	97.1 MHz	250	-69 dB
K296HH	107.1 MHz	250	-69 dB

*Calculated based on approximate TPOs of 400W

The installed filter/combiner system is designed to provide adequate isolation to ensure that interfering signals and any resulting intermodulation products are sufficiently attenuated to satisfy the section 73.317 paragraph (d) requirement. A functional diagram showing the layout of the combined transmission system is illustrated in Figure 1. All stations operated at licensed power for the duration of compliance measurements.

The directional coupler used for measurements is factory calibrated with a typical directivity of >30 dB and a coupling level that has generally a flat response across the FM band within approximately +/- 0.5 dB. The coupling level was chosen to ensure signal levels can be adequately measured within the dynamic range of the spectrum analyzer.

The forward ports of the output directional couplers are used for sampling all outgoing carrier levels and IM products. The sampled signal was fed by shielded cable into an Anritsu Sitemaster S332E spectrum analyzer.

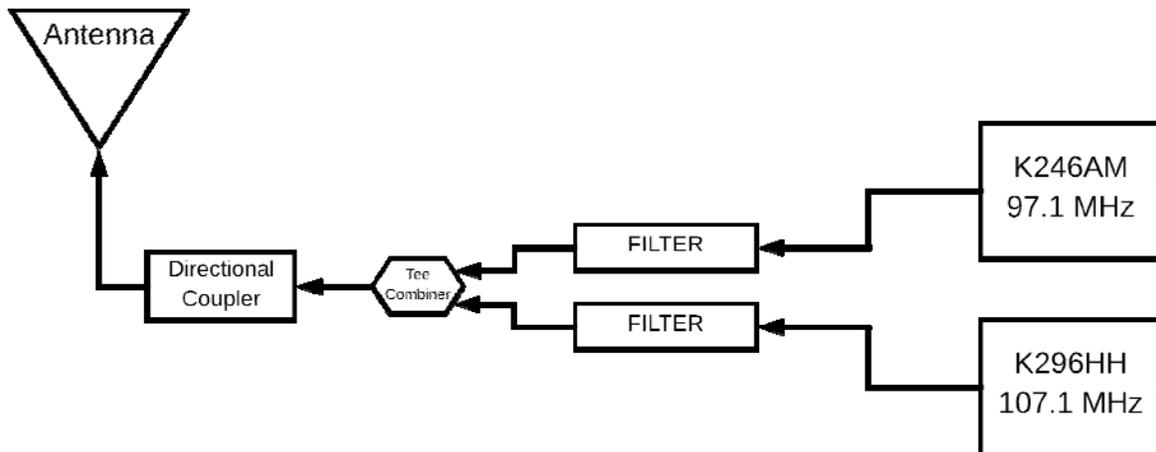


Figure 1 - Combiner System Layout Diagram

3 Product Measurements

Measurements were made to assess the level of potential intermodulation products that might exist at the output of the combined system with specific attention given to third order IM products (of the type $2F_1 - F_2$). The collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by the operation of these stations are less than the maximum allowable level as required by section 73.317(d), and further, that no products or harmonics exist in excess of required levels. The present study investigated possible spurious emissions up to 1 GHz and found no spurious emissions exceeding allowable levels.

The relative output signal levels for the system carriers are measured first to establish reference levels for other measurements. As stated in CFR Title 47, Section 73.317, measurements of spectral emissions are compared to the level of the unmodulated carrier.

It is sometimes inconvenient to establish this carrier reference level using the actual unmodulated carrier during operation of the station. As an approximation to this, it is generally accepted that the power of the transmitter output can be estimated from the modulated signal using a 300 kHz resolution bandwidth (RBW)¹ which serves to integrate the power in the modulated signal. This method of establishing the carrier reference level is used here as a basis for comparing the potential IM product levels.

The potential third-order product frequencies for the combined system are calculated and listed in Table 2. The FM facility for KJTW, 89.9 MHz operates from the same structure and so is included in the potential 3rd order product table.

Table 2 - Potential Third Order IM Products

		F2 MHz (Interfering Frequency)		
		89.9	97.1	107.1
F1 MHz (Transmitter Frequency)	97.1	104.3		87.1
	107.1	124.3	117.1	

¹ NRSC-G201-A, NRSC-5 RF Mask Compliance: Measurement Methods and Practice, National Radio Systems Committee, April 2010.

The reference signal level for each transmitter as recorded at the output directional coupler are listed in Table 3 and are used as the reference level for possible IM products.

Table 3 - Transmitter Forward Power Reference Levels

Call Sign	Carrier Frequency (MHz)	Transmitter Forward Reference 300 kHz RBW
K246AM	97.1 MHz	1.17 dBm
K296HH	107.1 MHz	2.67 dBm

The IM product measurements recorded are listed in Table 4. The signal level referenced to the carrier level is shown in the last column. Additionally, the spectrum was scanned up to 1 GHz and levels of potential harmonics were below required levels.

Table 4 - Product Measurements - Combined System

Carrier Frequency (MHz)	Interfering Frequency (MHz)	Product Frequency (MHz)	Bandpass or Nothch Insertion Loss at Product Frequency (dB)	IM Level Displayed, 1 kHz RBW (dBm)	Adjusted Reading (dBm)	Carrier Reference Level (dBm)	Level Referenced to Carrier (dB)	Requirement (dB)	Level relative to Requirement (dB)
97.1	107.1	87.1	-9.9	-115.9	-106.0	1.17	-107.2	-69	-38.2
97.1	89.9	104.3	-9.8	-113.9	-104.1	1.17	-105.3	-69	-36.3
107.1	97.1	117.1	-0.5	-105.1	-104.6	2.67	-107.3	-69	-38.3
107.1	89.9	124.3	-0.5	-114.3	-113.8	2.67	-116.4	-69	-47.4

All product levels for the combined system meet requirements.

4 Conclusions

Based upon the observations and measurements recorded in this document, I, Eric R. Wandel, find the operation of the combined FM system for stations:

- K246AM, 97.1 MHz
- K296HH, 107.1 MHz

as described herein and located near the intersection of 4th Ave SW and 17th St SW in Jamestown, North Dakota, to be in compliance with the requirements of CFR Title 47, Section 73.317 as related to generation of intermodulation products.

Respectfully submitted by Eric R. Wandel, P.E.

Exhibit A – Citation from CFR Title 47, Section 73.317

Code of Federal Regulations

TITLE 47 - TELECOMMUNICATION
CHAPTER I - FEDERAL COMMUNICATIONS COMMISSION
SUBCHAPTER C - BROADCAST RADIO SERVICES
PART 73 - RADIO BROADCAST SERVICES
Subpart B - FM Broadcast Stations

§ 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 $43 + 10 \text{Log}_{10}(\text{Power, in watts})$ 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.)