

JAMES B. HATFIELD, PE
BENJAMIN F. DAWSON III, PE
THOMAS M. ECKELS, PE
STEPHEN S. LOCKWOOD, PE
DAVID J. PINION, PE

PAUL W. LEONARD, PE
ERIK C. SWANSON, EIT
THOMAS S. GORTON, PE

HATFIELD & DAWSON
CONSULTING ELECTRICAL ENGINEERS
9500 GREENWOOD AVE. N.
SEATTLE, WASHINGTON 98103

TELEPHONE
(206) 783-9151
FACSIMILE
(206) 789-9834
E-MAIL
lockwood@hatdaw.com
MAURY L. HATFIELD, PE
CONSULTANT
BOX 1326
ALICE SPRINGS, NT 5950
AUSTRALIA

ENGINEERING REPORT:

INTERMODULATION MEASUREMENTS ON COMBINED FM ANTENNA SYSTEM

Awbrey Butte
Bend, Oregon

May 2001

INTRODUCTION

Spectrum measurements intended to detect unwanted intermodulation products were made on the combined FM antenna system located on the KTVZ Tower, Awbrey Butte, Bend, Oregon. These were made between 12 p.m. and 4 a.m. on the 14th of May 2001. The measurements were made with both stations operating into the combined Shively 68108B antenna. Both stations were operating with the correct power with normal modulation while measurements were being made. Spectrum measurements were made to confirm that all operating stations comply with “§73.317 *FM Transmission System Requirements*” as required by the Construction Permits and to assure that the combiner was operating correctly.

STATIONS

The following stations will operate at this site.

Call	Frequency	Power (ERP)
KPXA	104.1 MHz	35.0 kW
KQAK	105.7 MHz	40.0 kW

COMBINED ANTENNA MEASUREMENTS PROCEDURE

The measurements were made using a Hewlett Packard 8591E Spectrum Analyzer from a sample element installed in the wattmeter rigid line section in the combined transmission line. A tunable bandpass cavity with a 26 dB of attenuation was used to make measurements at levels more than 80 dB below the FM signals. An additional 20 dB attenuator was used to assure that the Spectrum Analyzer was not producing any internal intermodulation products. A Hewlett Packard 8640B Signal Generator was connected to a Narda 3020A Bi-Directional Coupler to tune the bandpass cavity to the desired frequency. See enclosed Test Setup Diagram.

The bandpass cavity was tuned to the frequency of each of the predicted intermodulation products. Measurements were made on each potential intermodulation product frequency

from 88 MHz to 108 MHz ($x F1 \pm x F2$). Frequencies above 108 MHz were swept for any observable intermodulation products. For products that were close in frequency to operating transmitters, the specific carriers were turned off to observe these intermodulation products. Enclosed are the spectral graphs of the measurements of the occupied bandwidth of each station.

An additional test setup was used for these measurements. This consisted of two sets of Microwave Filter 6367-2 Tunable Notch Filters. These filters were placed in line with both stations notched to make measurements at levels more than 80 dB below the FM signals. An additional 20 dB attenuator was used to assure that the Spectrum Analyzer was not producing any internal intermodulation products. See test setup diagram.

The mix products of $2 \times 104.1 \text{ MHz} - 105.2 = 102.5 \text{ MHz}$ and $2 \times 104.1 \text{ MHz} - 105.2 = 313.9 \text{ MHz}$ were observed to be above -80 dBc (no more that -77 dBc) in some configuration of the test set up. Three sample elements were interchanged to check these measurements. The 102.5 MHz and 313.9 MHz mix products were not observable using all of sample elements for the wattmeter line section. As the these products were only observable using certain sample elements we expect that these products were produced in the less than ideal connections of sample elements.

CONCLUSION

This facility fully complies with the requirements of §73.317. There are no harmonics or mix products that exceed the requirements as set forth in §73.317.

STATEMENT OF ENGINEER

This Engineering Report, which is part of applications for license for FM stations located on the KTVZ Tower on Awbrey Butte, Bend, Oregon, been prepared under my direct supervision. All representations contained herein are true to the best of my knowledge. I am an experienced radio engineer whose qualifications are a matter of record with the Federal Communications Commission. I am a partner in the firm of Hatfield and Dawson Consulting Engineers and am Registered as a Professional Engineer in the States of Washington and Alaska.

15 May 2001

Stephen S. Lockwood, P.E.



Hatfield & Dawson Consulting Engineers

PREDICTED INTERMODULATION PRODUCTS 88-150 MHz

AWBREY BUTTE KQAK/KXPA ANTENNA

5	x	104.1 MHz	-	4	x	105.7 MHz	97.7 MHz
4	x	104.1 MHz	-	3	x	105.7 MHz	99.3 MHz
3	x	104.1 MHz	-	2	x	105.7 MHz	100.9 MHz
2	x	104.1 MHz	-	1	x	105.7 MHz	102.5 MHz
2	x	105.7 MHz	-	1	x	104.1 MHz	107.3 MHz
3	x	105.7 MHz	-	2	x	104.1 MHz	108.9 MHz
4	x	105.7 MHz	-	3	x	104.1 MHz	110.5 MHz
5	x	105.7 MHz	-	4	x	104.1 MHz	112.1 MHz
5	x	104.1 MHz	-	3	x	105.7 MHz	203.4 MHz
4	x	104.1 MHz	-	2	x	105.7 MHz	205.0 MHz
3	x	104.1 MHz	-	1	x	105.7 MHz	206.6 MHz
2	x	104.1 MHz					208.2 MHz
1	x	104.1 MHz	+	1	x	105.7 MHz	209.8 MHz
2	x	105.7 MHz	+			=	211.4 MHz
3	x	105.7 MHz	-	1	x	104.1 MHz	213.0 MHz
4	x	105.7 MHz	-	2	x	104.1 MHz	214.6 MHz
5	x	105.7 MHz	-	3	x	104.1 MHz	216.2 MHz
5	x	104.1 MHz	-	2	x	105.7 MHz	309.1 MHz
4	x	104.1 MHz	-	1	x	105.7 MHz	310.7 MHz
3	x	104.1 MHz	+			=	312.3 MHz
1	x	105.7 MHz	+	2	x	104.1 MHz	313.9 MHz
2	x	105.7 MHz	+	1	x	104.1 MHz	315.5 MHz
3	x	105.7 MHz	+				317.1 MHz

4	x	105.7 MHz	-	1	x	104.1 MHz	320.3 MHz
5	x	104.1 MHz	-	1	x	105.7 MHz	414.8 MHz
4	x	104.1 MHz					416.4 MHz
1	x	105.7 MHz	+	3	x	104.1 MHz	418.0 MHz
2	x	105.7 MHz	+	2	x	104.1 MHz	419.6 MHz
1	x	104.1 MHz	+	3	x	105.7 MHz	421.2 MHz
4	x	105.7 MHz					422.8 MHz
5	x	105.7 MHz	-	1	x	104.1 MHz	424.4 MHz

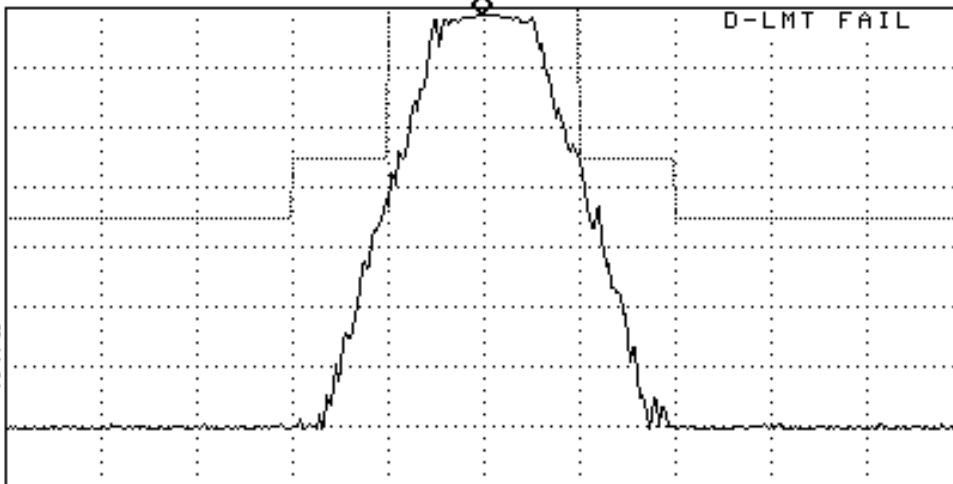
00:05:32 MAY 14, 2001

REF -5.0 dBm AT 10 dB

MR 104.097 MHz
-6.34 dBm

PEAK
LOG
10
dB/

MA SB
SC FC
CORR



CENTER 104.100 MHz
RES BW 10 kHz

VBW 10 kHz

SPAN 1.200 MHz
SWP 36.0 msec

RL

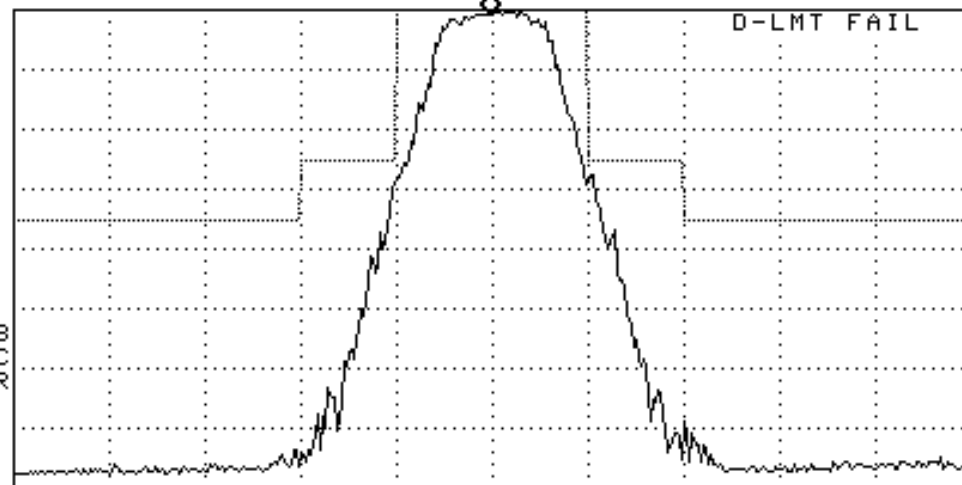
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REF -5.0 dBm AT 10 dB

MR 105.697 MHz
-5.62 dBm

PEAK
LOG
10
dB/

MA SB
SC FC
CORR



CENTER 105.700 MHz
RES BW 10 kHz

VBW 10 kHz

SPAN 1.200 MHz
SWP 36.0 msec

RL

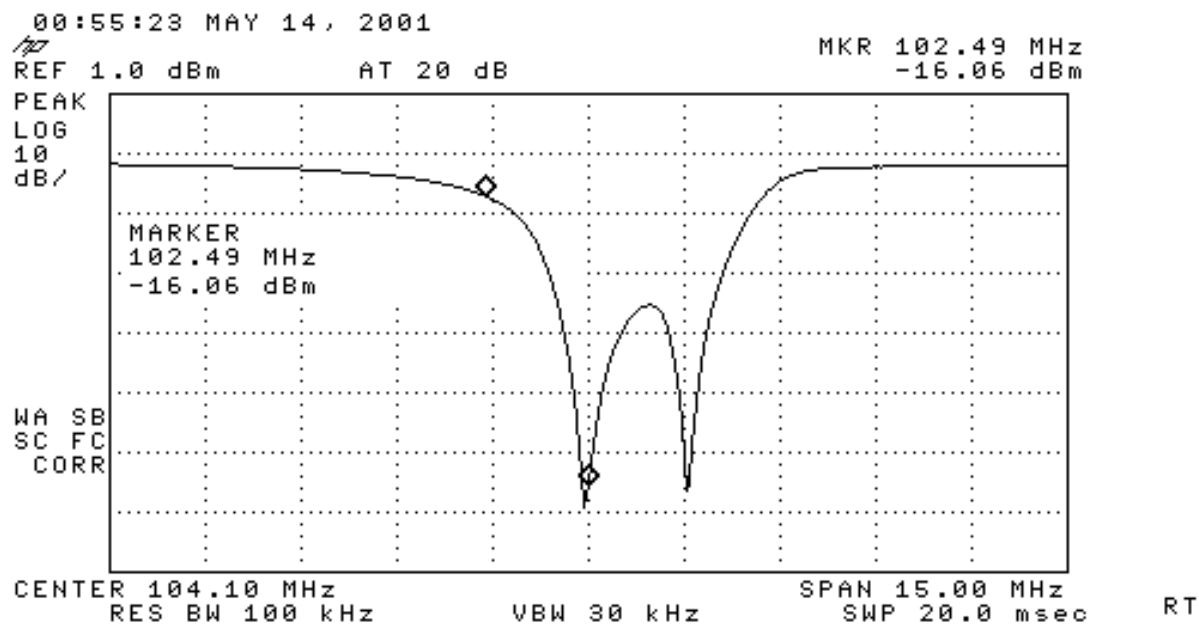
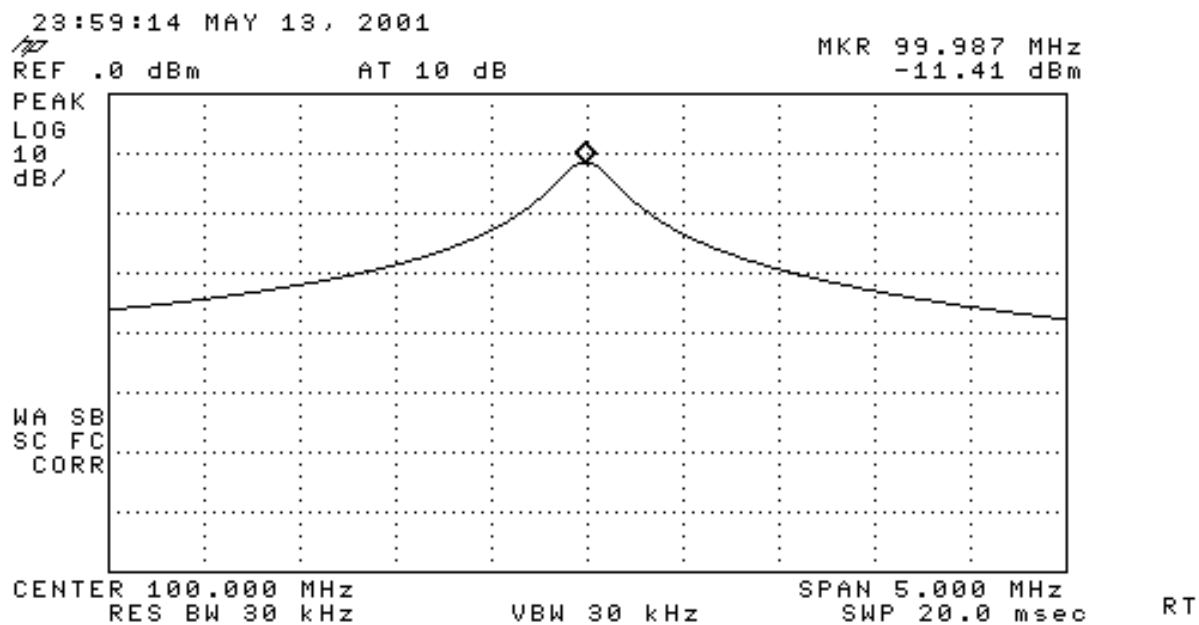
**HATFIELD & DAWSON
CONSULTING ENGINEERS**

**KPXA AND KQAK
REFERENCE STATION SIGNALS**

Awbrey Butte

Bend, OR

May 2001



HATFIELD & DAWSON
CONSULTING ENGINEERS

FILTERS
TELEWAVE BANDPASS CAVITY
AND MICROWAVE NOTCH FILTERS

Awbrey Butte

Bend, OR

May 2001

KPXA	104.1MHz	34kW
KQAK	105.7MHz	40kW

COMBINED FM SIGNALS

SHIVELY ANTENNA FEEDLINE

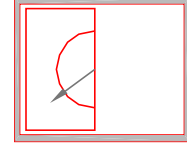
NARDA 3020A BI-DIRECTIONAL COUPLER

3ft LDF1-50

6ft LDF4-50A

50 Ω DUMMY LOAD

50 dB SAMPLE SLUG



WATT METER

RAMSEY RSG-1000
SIGNAL GENERATOR

3ft LDF1-50

SIGNAL GENERATOR USED
TO TUNE BANDPASS CAVITY

TELEWAVE
TWPC 1005-1
BAND PASS CAVITY

3ft LDF1-50

FLUKE 20 dB
ATTENUATOR

HP 8591E
SPECTRUM ANALYZER

LAPTOP
COMPUTER

HATFIELD & DAWSON
CONSULTING ENGINEERS

SCHEMATIC DIAGRAM
KPXA & KQAK ANTENNA SYSTEM TEST SETUP I

AWBREY BUTTE SITE BEND, OR 5/2001

KPXA	104.1MHz	34kW
KQAK	105.7MHz	40kW

COMBINED FM SIGNALS

SHIVELY ANTENNA FEEDLINE

3-1/8" RIGID LINE SECTION

50 dB SAMPLE SLUG

WATT METER

TUNED TO
104.1MHz

TUNED TO
105.7MHz

MICROWAVE FILTER CO
B6367-2
DOUBLE CAVITY NOTCH FILTER (2)

HP 8591E
SPECTRUM ANALYZER

FLUKE 20 dB
ATTENUATOR

LAPTOP
COMPUTER

HATFIELD & DAWSON
CONSULTING ENGINEERS

SCHEMATIC DIAGRAM
KPXA & KQAK ANTENNA SYSTEM TEST SETUP II

AWBREY BUTTE SITE BEND, OR 5/2001