COMSEARCH®

FIELD TEST PLAN

LPFM THIRD-ADJACENT CHANNEL INTERFERENCE ANALYSIS

THE MITRE CORPORATION

CONTRACT NO. 50181

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1 Overview

Comsearch has been contracted by The MITRE Corporation (MITRE) to conduct field tests to determine the possibility of harmful interference to existing Full Power FM (FPFM) stations if Low Power FM (LPFM) stations are not subject to minimum distance separations for third-adjacent channels. Testing shall also be conducted to determine these effects in markets where the FPFM station is a translator and where a FPFM station is providing reading services for the blind on a sub-carrier. The Field Test Plan (FTP) outlines the overall design of the test, selection of test locations, procurement and assembly of hardware (portable LPFM and test equipment), field tests and data collection, and collection of public comment.

Specific operating procedures will be described in a document titled: “Test Plan Procedures” (TPP). The TPP will contain step-by-step instructions describing the setup of equipment and procedures that are called out in the FTP document. Once approved by MITRE, the FTP and TPP documents will be used by the field test team at all times as guidance during the execution of the Program and shall be followed without question or change.

2 Field Test Plan Outline

- Experimental Program Description
- LPFM Site Selection
- Metrics to be Collected
- Broadcast Test Scenarios
- Equipment Required to Execute Field Tests
- Data Collection Methodology
- Public Comment Process
- Resources

3 Experimental Program Description

The FM broadcast industry in the United States is well defined by rules and guidelines that provide station operators with a protected service contour for a corresponding class of the FPFM broadcast station. This is accomplished by a combination of one or more of the following: frequency separation, minimum separation distances between different station classifications, and Effective Radiated Power (ERP).

This experimental program will explore the effects of LPFM stations transmitting on a third-adjacent channel inside the protected service zone, F (50, 50) contour, of a FPFM station. This will be accomplished by operating a portable LPFM station within the F (50, 50) contour of an existing FPFM station while recording the audio output of several FM receivers tuned to the FPFM station. The F (50, 50) contour is defined by the FCC as “Estimated field strength exceeded at 50% of the potential receiver locations for at least 50% of the time at a receiving antenna height of 9.1 meters”. Recordings will be made to document the effects of each parameter change in the LPFM broadcast station. Public comment will be facilitated and collected before, during and after field-testing in each LPFM measurement area. All public comments will be provided at the end of the experimental program without any interpretation or modification.

Execution of this experimental program will be performed utilizing standard, off the shelf components that are integrated into portable vehicle platforms that can be driven to various places throughout the United States. The use of standard components will ensure that the data collection process is repeatable from place to place and could be easily reproduced at a later date if necessary.

3.1 Calculation of ERP for the Portable LPFM

The Effective Radiated Power (ERP) is a calculated value based on the transmitter power, directional coupler loss, transmission line loss, and antenna gain. In the case of the system as installed for this experiment, the gains and losses are listed in, Table 1.

The equation is:

$$ERP = P_{out} - L + G \qquad \text{(Equation 1)}$$

where:

ERP	= Effective Radiated Power, dBm
P_{out}	= RF power out of the exciter, dBm
L	= loss of directional coupler, cables and dividers, dB
G	= gain of antenna system referenced to a dipole antenna, dB_d.

Once the gains and losses of the system are known, and since the ERP for this experiment is a constant factor of either 10 W or 100 W (or +40 dBm and +50 dBm respectively), it becomes a simple math problem of adding the system gains and losses and solving for P_{out}. The ERP will be monitored at the directional coupler 'Incident' monitor port using a calibrated HP E4418B power meter.

The cables to be used during the experiment were tested in the Comsearch lab using a signal generator, a calibrated power meter and a spectrum analyzer to determine the loss and flatness characteristics of each cable. A block diagram of the test setup can be found in Figure 1. A photo of the results of sweeping the main cable can be found in Appendix A, Photo 1. Photo 2 shows the results of testing the 10-foot jumper cables. The signal generator swept a range of 86 MHz to 110 MHz. The RF input to the cable under measurement was at 0 dBm.

The manufacturer supplied the gain of the 2 bay antenna system verified via a phone call and data sheet from their Internet page.

The data regarding the directional coupler was collected via tests in the Comsearch lab. A 0 dBm signal was injected into the 'Transmitter' port and measurements were taken at the 'Load' and 'Incident' ports. The same test signal was injected into the port marked 'Load' and readings were taken on the

'Transmitter' and 'Reflected' port. This confirmed that the attenuation of the reflected and incident ports were equal.

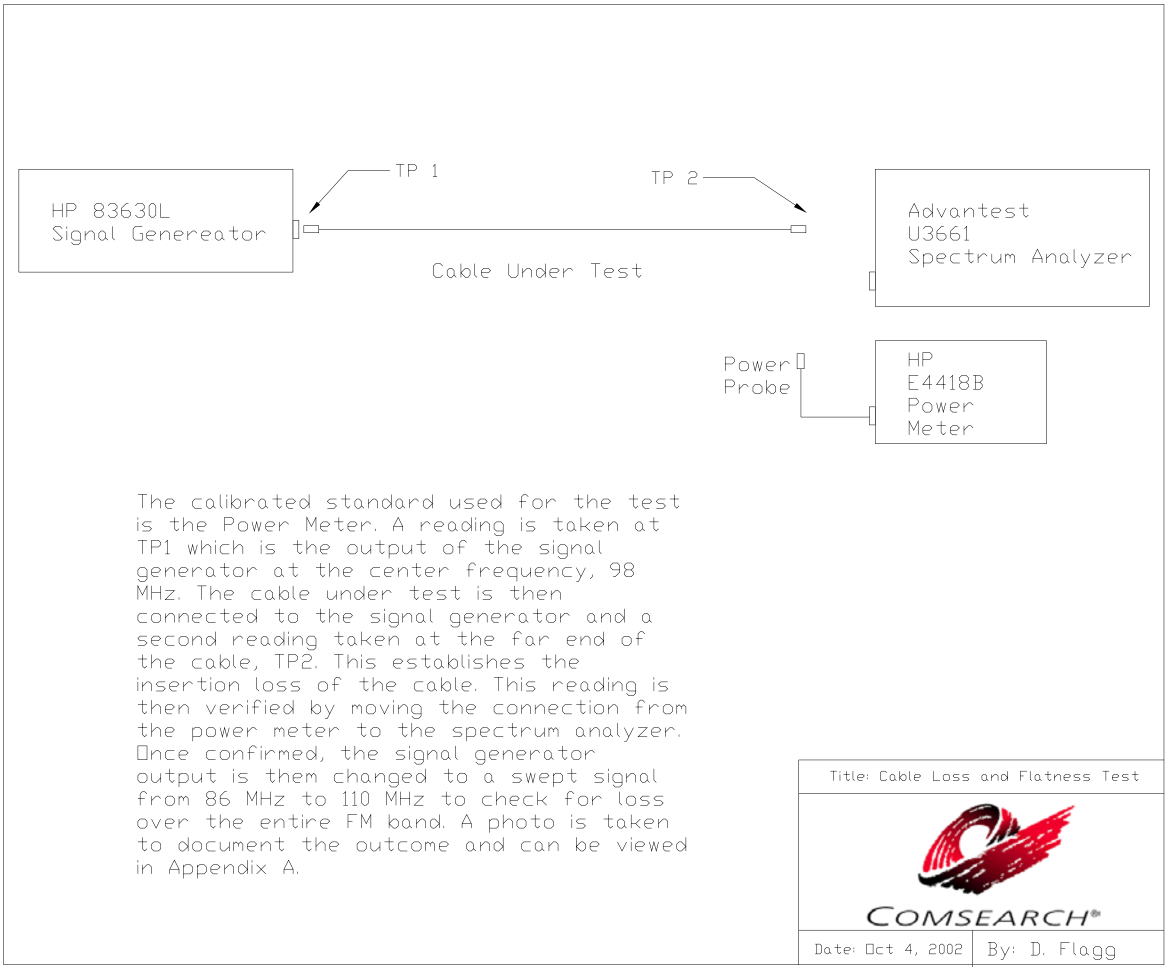


Figure - 1 Cable Loss and Flatness Test Block Diagram

Refer to Table 1 for an example of the results. Specific test information can be found in the TPP section for the desired LPFM test.

The ERP will be monitored at the directional coupler 'Incident' monitor port. The coupling factor of the 'Incident' port has a delta of approximately 2 dB over the FM frequency range. Coupling factors are listed in Table 2. The table shows the coupling factor for each LPFM frequency to be tested. Specific values will also be found in the corresponding section of the TPP for each LPFM test site.

Energy-Onix	Dir. Coupler Incident	Dir. Coupler Loss	129 ft Cable	Jumper Cables	Antenna System	ERP	
Output	Port -39.0 dB@107.5 MHz	88-108 MHz					
+52.8 dBm	+13.8 dBm@107.5 MHz	0.4 dB	1.9 dBLoss	0.5 dBLoss	0.0 dBdGain	50 dBm	=100 W ERP
+42.8 dBm	+3.8 dBm@107.5 MHz	0.4 dB	1.9 dBLoss	0.5 dBLoss	0.0 dBdGain	40 dBm	=10 W ERP

Table - 1 Data Used for ERP Calculations

Directional Coupler Coupling Factors at LPFM Test Frequencies			
-39.0 dB @ 107.5 MHz	-40.5 dB @ 91.7 MHz	-40.5 dB @ 91.1 MHz	-39.6 dB @ 100.3 MHz
-39.9 dB @ 97.3 MHz	-39.1 dB @ 106.3 MHz	-39.4 dB @ 103.1 MHz	

Table - 2 Coupling Factor for Directional Coupler Incident and Reflected Ports

In addition to the above calculations and in order to obtain the correct ERP, the value of the reflected power, at the antenna, will have to be determined and added to the incident power measured at the directional coupler. The LPFM exciter controls the power output. To get the desired ERP delivered to the antenna, the RF power is monitored at the incident and reflected ports of the directional coupler of the LPFM system. In addition to the loss through the directional coupler and the coaxial cable losses, the loss created by the standing waves on the transmission line interconnecting the antenna must be accounted for. The maximum VSWR that is acceptable for these measurements will have a reflected power 10 dB below the incident power. With the transmission line losses in the LPFM setup, the reflected power is calculated to be 36.3 % at the LPFM transmission line/antenna interface for this condition.

The following equation was used to determine the reflection coefficient at the antenna:

$$R_{ant} = R_{dc} + 2*A \qquad \text{(Equation 2)}$$

where,

R_{ant} = Reflection coefficient expressed as a power ratio at LPFM antenna, dB

R_{dc} = Reflection coefficient expressed as a power ratio at LPFM directional coupler, dB

A = Attenuation of transmission line from directional coupler to antenna, 2.8 dB

The reflection coefficients at the antenna interface were calculated in 1.0 dB steps for R_{dc} values between -10 dB to –32 dB, which is the directivity limit of the directional coupler. For each of these reflection conditions the increase in power to compensate for the reflection loss, at the antenna, was calculated.

The equation used for the calculation of the power increase necessary to obtain the desired ERP is:

$$P_i = -20 + 10 * \text{Log}(100 + I) \qquad \text{(Equation 3)}$$

where,

P_i = Increase in power, dB

I = Percent of power necessary to overcome reflection loss, %

And, here I is related to R_{ant} by the following expression

R_{ant} = -20 +10*Log I, dB

Table 3 contains the percent of reflected power at the antenna and the increase of power necessary to overcome this loss to establish the desired ERP for various reflected power conditions at the directional coupler in the range of –10 to –32 dB.

Reflection Cofficient	Line Loss	Power Increase at Load	
(R_{dc})	(dB)	(I %)	(dB)
-10	2.8	36.31	1.35
-11	2.8	28.84	1.10
-12	2.8	22.91	0.90
-13	2.8	18.20	0.73
-14	2.8	14.45	0.59
-15	2.8	11.48	0.47
-16	2.8	9.12	0.38
-17	2.8	7.24	0.30
-18	2.8	5.75	0.24
-19	2.8	4.57	0.19
-20	2.8	3.63	0.15
-21	2.8	2.88	0.12
-22	2.8	2.29	0.10
-23	2.8	1.82	0.08
-24	2.8	1.45	0.06
-25	2.8	1.15	0.05
-26	2.8	0.91	0.04
-27	2.8	0.72	0.03
-28	2.8	0.58	0.02
-29	2.8	0.46	0.02
-30	2.8	0.36	0.02
-31	2.8	0.29	0.01
-32	2.8	0.23	0.01

Table - 3 Power Increase Required to Establish Desired ERP

3.2 Portable LPFM Station

A portable LPFM station (a standard CD player as a program source, a processor to accommodate the audio format changes from processed to unprocessed to news/talk, and transmitter) will be integrated into a test vehicle. This equipment will be connected to a portable tower that can be extended and lowered to achieve the desired antenna height above ground level for each test location. Two antenna heights, 10 m AGL and 30 m AGL, will be utilized. Three ERP settings, 10 W, 0 W, 100 W, will be utilized at each antenna height. Two program content settings will be utilized at each ERP setting. Of the three types of programming formats to be used during the overall experimental program, processed, unprocessed, and news/talk, only two of the program contents will be used at each of the LPFM broadcast sites eight receiver measurement locations. These formats will be rotated among all LPFM sites so that various combinations of the formats are utilized.

The scenarios stated above apply to all LPFM sites except the translator input testing where different parameters are utilized during the data collection process. Translator input scenarios include two antenna heights, 10 m AGL and 30 m AGL, eight ERP settings, 100 W, 50 W, 20 W, 10 W, 5 W, 2 W, 1 W, and 0 W, and all three types of programming formats, processed, unprocessed, and news/talk.

LPFM programming content to be used during data collection process is shown in Table 5. A spectrum analyzer and digital power meter will be used to monitor and verify the output of the exciter to maintain the calculated ERP of the transmitter during all operational periods. Two field engineers will be responsible for monitoring and changing the parameters of the portable LPFM station. A block diagram of the transmitter can be found in Figure 2.

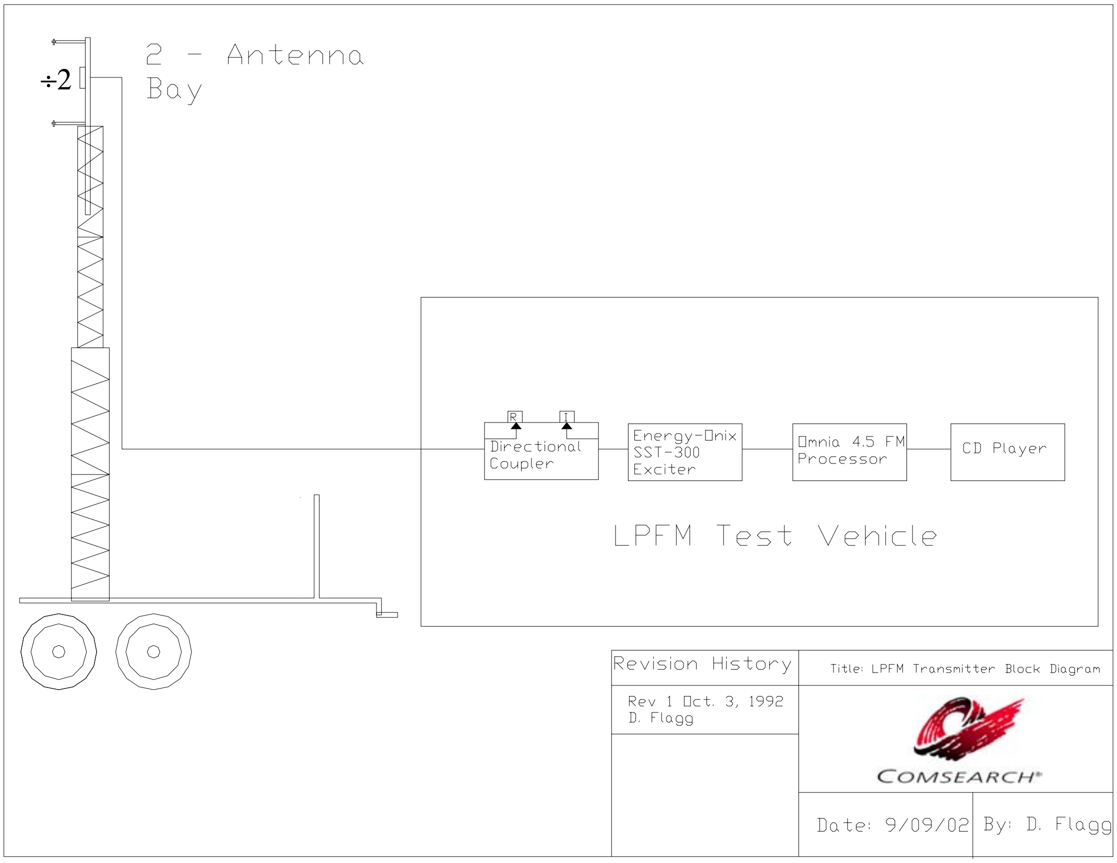


Figure - 2 LPFM Mobile Transmitter Block Diagram

3.3 Receiver Vehicle

A vehicle with multiple radio receivers (home receiver, boom box, walkman, clock radio, vehicle radio, and blind reading service when available) will be utilized to monitor the FPFM station broadcast. The vehicle will move to at least 8 different distances away from the LPFM broadcast station. The movement of the Receiver Vehicle along a radial drawn from the FPFM through the LPFM and out to the F (50, 50) contour presents the opportunity to test the effect of the LPFM signal on the FPFM signal within the F (50, 50) contour of the FPFM station. These distances will be determined by the ratio between the desired signal strength (D) of the FPFM station and the undesired signal strength (U) of the LPFM site. The D/U signal strength levels used for the selection of test receiver measurement locations will be mathematically determined for use in this experiment. A block diagram of the receiver vehicle can be found in Figure 3.

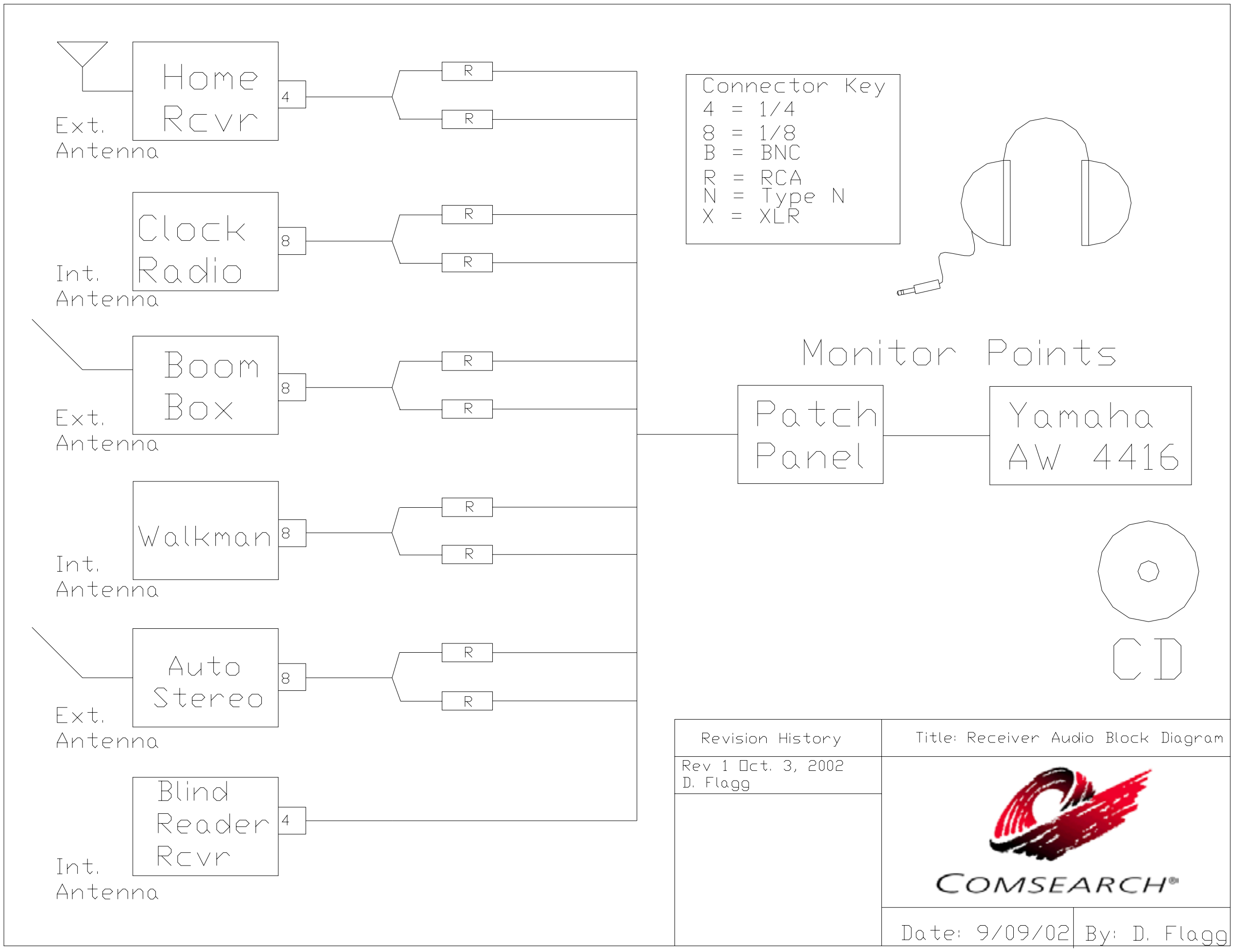


Figure - 3 Receiver Block Diagram

3.4 Collected Data Recording Samples

During each LPFM site scenario (antenna height, ERP, and program content) digital recordings will be made of all receivers for further review at a later date.

3.5 Public Comment

Public comment will be facilitated and collected for each LPFM measurement location. This process will allow the general public the opportunity to voice their opinion as to the affect, if any, that the LPFM transmission has on the reception of the FPFM broadcast.

4 Selection of LPFM Test Sites

The selection process for seven (7) LPFM test sites chosen for this experimental program was derived from a list of 39 applications provided by the FCC. These 39 LPFM applicants have operational frequencies that are on the third-adjacent channel and are located within the F (50, 50) contour of an existing FPFM licensed broadcast station.

The selected LPFM test sites are characterized by a wide spread of "distance ratios". The distance ratio for a given LPFM site and the associated FPFM station on a third-adjacent channel is defined as D_{fl}/S, where D_{fl} is the distance between the LPFM site and the associated FPFM station, and S is the nominal radius of the FPFM station's F (50,50) contour. LPFM sites were selected so that one will have a distance ratio less than 0.2, a second will have a distance ratio between 0.85 and 1.0, and the remaining site(s) will have distance ratios ranging (without excessive "gaps") between the distance ratios of the first and second sites. The site selected to meet the requirement of a distance ratio between 0.85 and 1.0 actually has a distance ratio of 0.82. When considering all the required site selection criteria for this experimental program this site fulfilled three of the SOW critical requirements, FPFM output ERP, FPFM program content, and small market demographics.

Additional information regarding the calculation of the F (50, 50) contour:
The FPFM station's F (50,50) contour was determined using the method described and presented in the FM and NTSC Channel 2-6 Propagation Curves published by the FCC. The field strength for the Class of FM Station (C, B, B1, D, FX) at the F (50,50) contour is used as an input parameter along with the FPFM Station HAAT and ERP. The FCC curves or formulas derived from the curves are used to obtain the station F (50,50) contour. The FPFM station's coordinates and the LPFM test site coordinates are used to determine the distance between them. This distance is divided by the FPFM F (50,50) contour to determine the "distance ratio" for the LPFM test site. For example, the Avon, CT. LPFM test site distance ratio was determined in the following way. The FPFM station was WCCC. From its

coordinates and the coordinates of the LPFM test site determined with a GPS receiver during the pre-measurement survey, the separation distance was found to be 3.7 miles. The WCCC F (50,50) contour was found to be 40.3 miles. The separation distance divided by the F (50,50) contour distance was calculated to be 0.09.

Table 4 contains the distance ratio for the LPFM test sites to be used in the experimental program.

Table - 4 LPFM Distance Ratios

Site	**Station**	**Contour Distance Miles**	**Separation Distance Miles**	**Distance Ratio**
Avon, CT	WCCC	40.3	3.7	0.09
Brunswick, ME	WCME	27.8	22.7	0.82
East Bethel, MN	KNOW	49.6	18.2	0.37
Owatonna, MN	KGAC	7.4	4.0	0.54
Winters, CA	KSFM	40.6	13.5	0.33
Benicia, CA	KFRC	52.3	35.4	0.68

The LPFM test sites were selected to ensure that each of three categories of maximum FPFM transmitter ERP (100 kW, 6-16 kW, and 100-500 W) is tested at least once during the course of the field tests.

The sites selected adequately represent each of the following three kinds of associated-FPFM station program content: unprocessed music, highly processed music, and news/talk. (“Processed music” is defined as music that has been altered using volume compression and/or other techniques to raise the average modulation percentage of the transmitted signal.) One site was selected for the purpose of evaluating whether minimum distance separations for third-adjacent channels are needed for FM translator stations. One site was selected for evaluating whether such separations are needed for FPFM stations that provide reading services for the blind through use of FM sub-carriers. The FPFM station associated with at least one LPFM site shall serve a minority market. One LPFM site selected will be associated with a FPFM station serving a small-market area.

Other criteria utilized during the site selection process included terrain, population distribution, and FPFM transmit antenna HAAT.

Actual LPFM test sites were chosen with minimum contact of the LPFM applicants and the corresponding FPFM stations. See Table 5 for overall site data.

The following contours found in Figures 4 through 10 provide a visual reference for both the distance ratio and the calculate FPFM contour for each test site selected for this experimental program. These are the protected contours of the respective FPFM stations. The contours were calculated using code created by the FCC Office of Engineering and Technology (OET) staff and proprietary terrain code from Communications Data Services. The contours were created by calculating the Antenna Height Above Average Terrain (HAAT) and Effective Radiated Power (ERP) for each of the 120 radials at 3 degree intervals. Both HAAT and ERP were calculated for each radial using a three arc second terrain database and the linearly interpolated antenna gain.

LPFM CHNL	Freq. MHz	LPFM Location	State	LPFM Content	FPFM CHNL	Freq. MHz	FPFM Format	Distance Ratio	Separation Distance	Contour Distance	FPFM Class	FPFM Pwr Out	FPFM HAAT
298	107.5	Avon 3rd Adjacent Measurement	CT	Processed News/Talk	295	106.9	Rock	0.09	5.95 km 3.66 miles	64.95 km 40.33 miles	B	23 kW	221 m
247	97.3	Brunswick 3rd Adjacent Measurement	ME	Un-Processed News/Talk	244	96.7	News / Talk	0.82	36.54 km 22.70 miles	44.73 km 27.79 miles	B1	15.5 kW	127 m
219	91.7	East Bethel 3rd Adjacent Measurement	MN	Un-Processed Processed	216	91.1	PBS	0.37	29.29 km 18.20 miles	79.75 km 49.58 miles	C	100 kW	400 m
292	106.3	Owatonna 3rd Adjacent Measurement Translator Output	MN	Processed News/Talk	289	105.7	PBS	0.54	6.44 km 4.0 miles	11.91 km 7.4 miles	FX	.170 kW	103 m
216	91.1	Owatonna Translator Measurement Translator Input	MN	Processed Un-Processed News/Talk	213	90.5	PBS				FX	.170 kW	103 m
276	103.1	Winters 3rd Adjacent Measurement	CA	News/Talk Un-Processed	273	102.5	Hip Hop	0.33	21.73 km 13.50 miles	65.32 km 40.58 miles	B	50 kW	152 m
262	100.3	Benicia 3rd Adjacent Measurement	CA	Un-Processed Processed	259	99.7	Oldies	0.68	56.97 km 35.39 miles	84.12 km 52.27 miles	B	40 kW	396 m

Table - 5 LPFM/FPFM Site Datasheet

4.1 Avon, CT

Avon, CT has been chosen as the field-testing demonstration site.

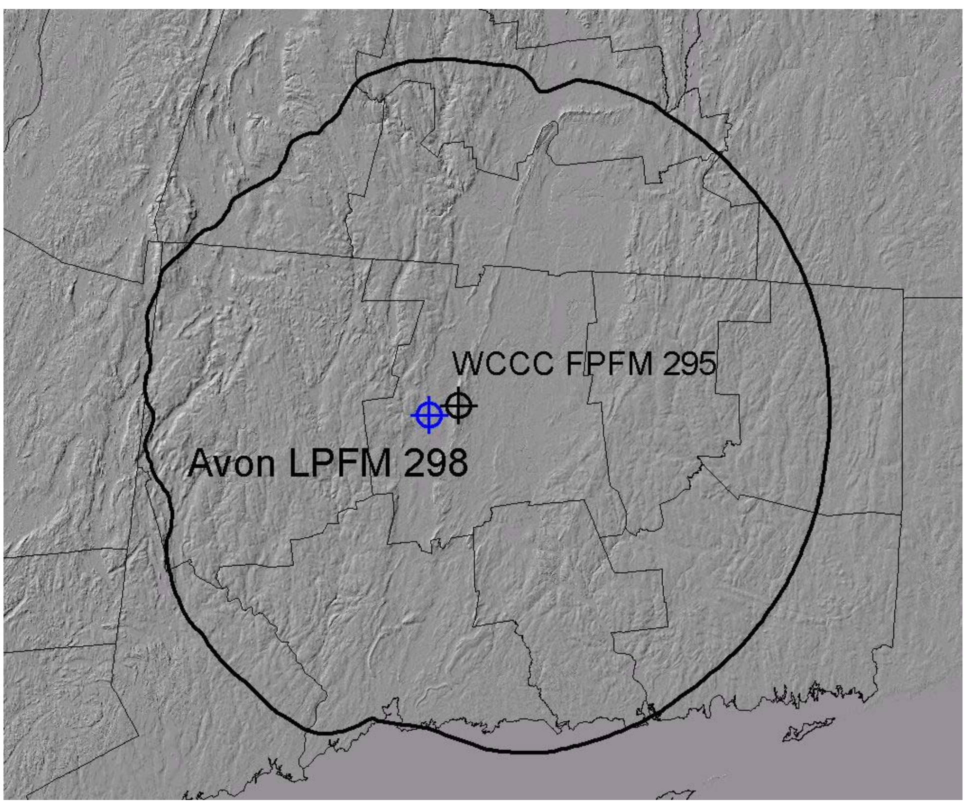
4.1.1 RFP Compliance

This LPFM test site is located in a region that covers urban, suburban and rural areas. This location includes flat and hilly terrain and is located approximately 5.95 km from the FPFM station. Its associated FPFM station, WCCC-FM, is a Class B station with a HAAT of 221 m and a transmitter ERP of 23 kW.

4.1.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio – 0.09
- FPFM program content - processed music

Figure - 4 Avon, Ct



4.2 Brunswick, ME

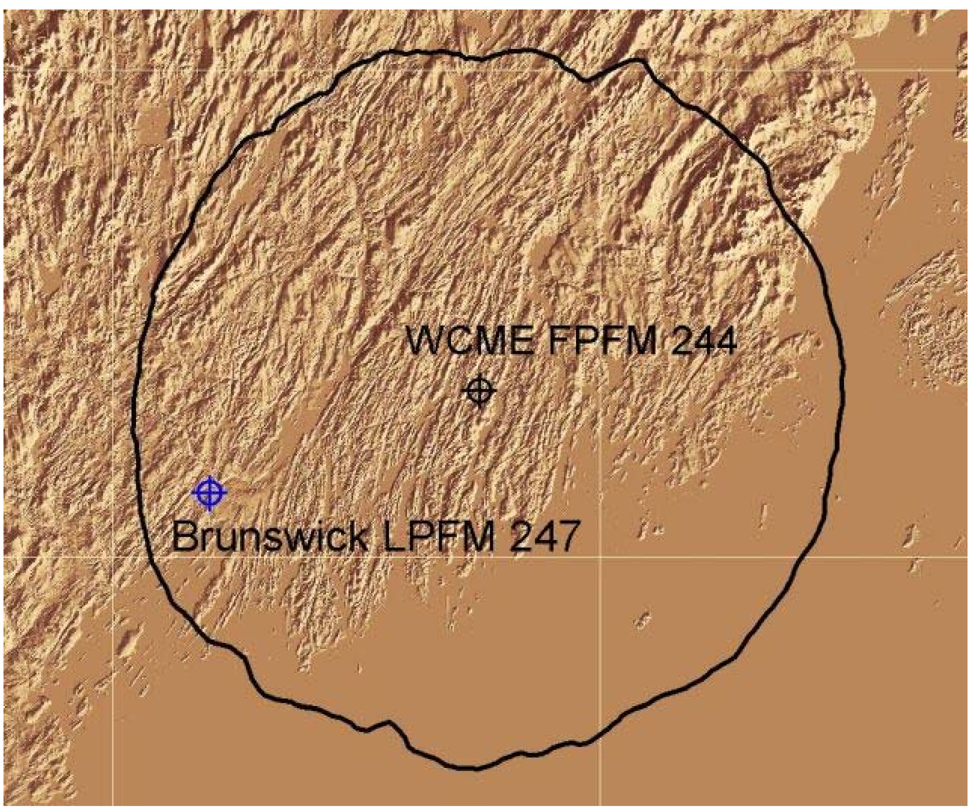
4.2.1 RFP Compliance

This LPFM is located in a region that covers urban, suburban and rural areas. The terrain is flat and hilly, covered by trees, and located approximately 36.54 km from the FPFM station. Its associated FPFM station, WCME, is a Class B1 station with a HAAT of 127 m and a transmitter ERP of 15.5 kW.

4.2.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio - 0.82
- FPFM transmitter ERP – 6-16 kW
- FPFM program content – news/talk

Figure - 5 Brunswick, ME



4.3 East Bethel, MN

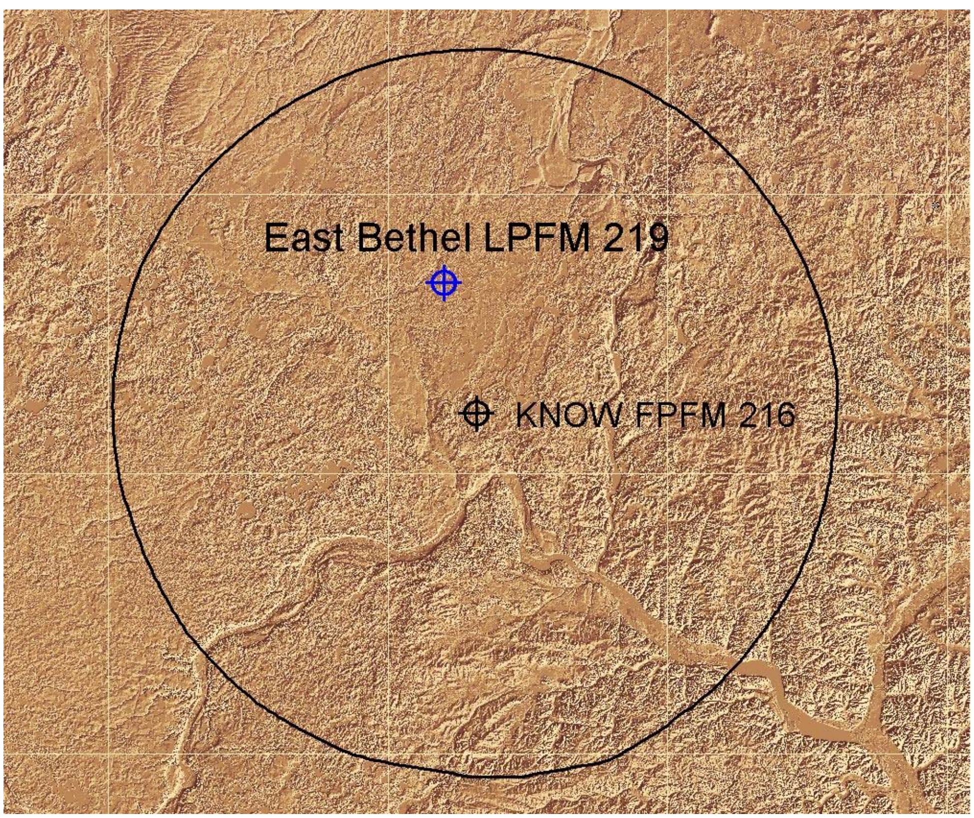
4.3.1 RFP Compliance

This LPFM site is located in a region that is suburban and rural. The terrain is flat, covered with trees, and located approximately 29.29 km from the FPFM station. Its associated FPFM station is KNOW-FM. KNOW-FM is a Class C station with a HAAT of 400 m and a transmitter output ERP of 100 kW. KNOW-FM is a NPR affiliate that has a reading service for the blind.

4.3.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio - 0.37
- FPFM transmitter ERP – 100 kW
- FPFM program content – unprocessed music and news/talk
- Blind reading service

Figure - 6 East Bethel, MN



4.4 Owatonna, MN (Translator Output)

Both third-adjacent channel separation testing and translator input testing is to be performed in this community.

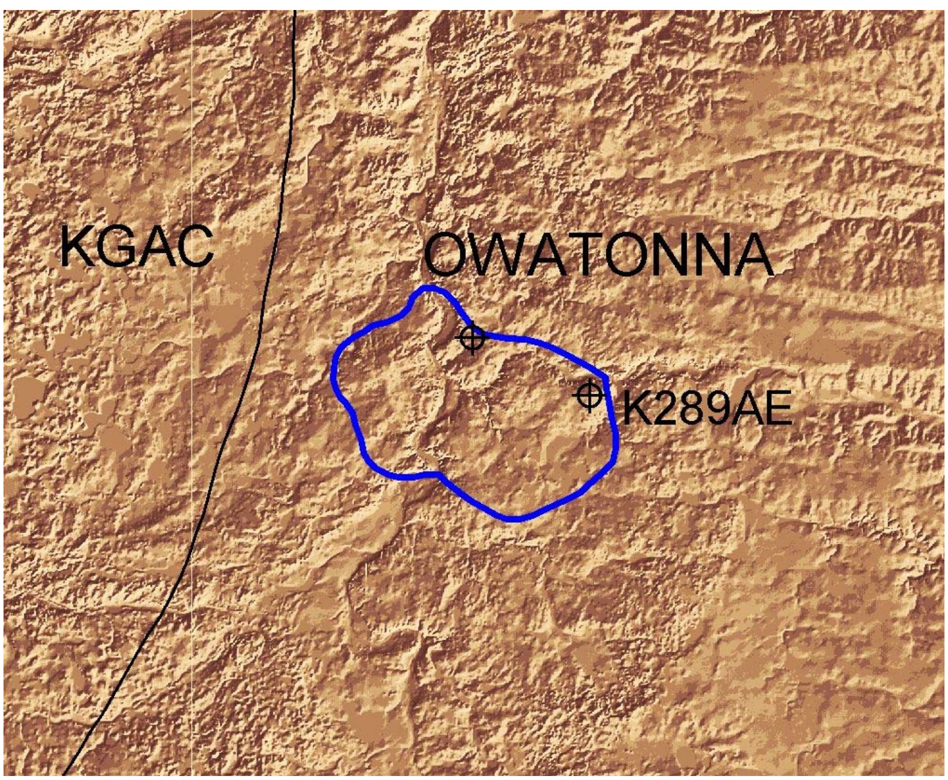
4.4.1 RFP Compliance

This LPFM site is located in a region that is suburban and rural. The terrain is flat, hilly, covered with trees, and is located approximately 6.44 km from the FPFM translator facility. Its associated FPFM station is KGAC. This translator station has a HAAT of 103 m and a transmitter output ERP of 0.170 kW. The FPFM programming is NPR Classical.

4.4.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio - 0.54
- FPFM transmitter ERP – 0.170 kW
- FPFM program content – unprocessed music

Figure - 7 Owatonna, MN – Translator Output



4.5 Owatonna, MN (Translator Input Test)

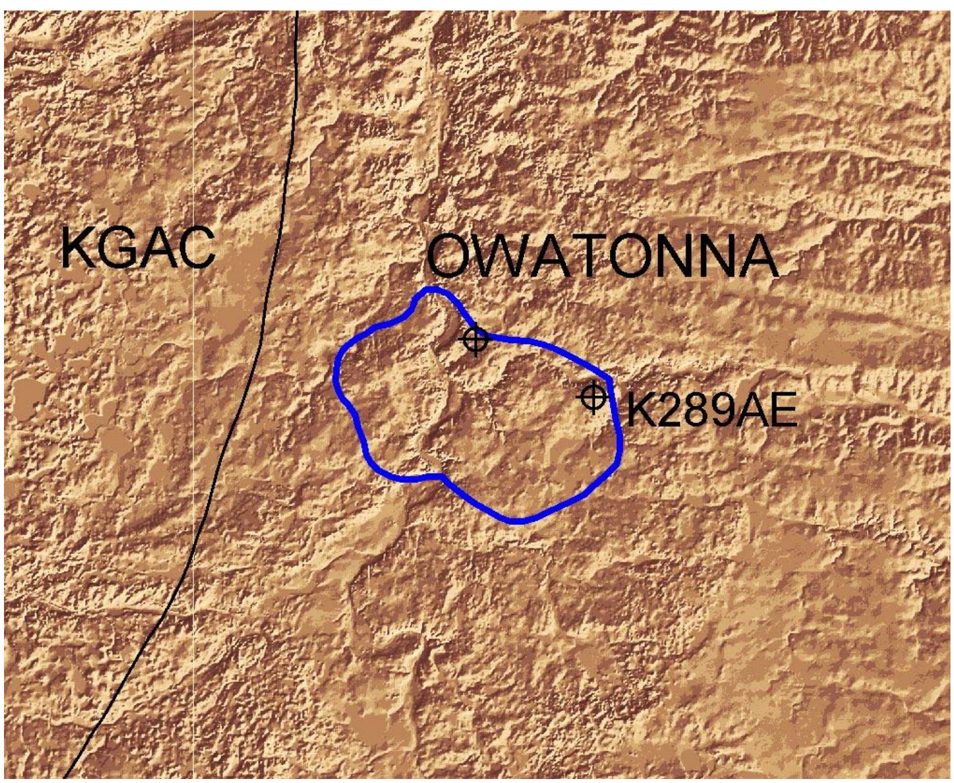
4.5.1 RFP Compliance

This LPFM site is located in a region that is suburban and rural. The terrain is flat, hilly, and covered with trees. The LPFM will be located as near as possible to the FPFM translator facility where it can be raised into the main receive beam from the donor FPFM station. Its associated FPFM station is KGAC. This translator station has a HAAT of 103 m and a transmitter output ERP of 0.170 kW. The FPFM programming is NPR Classical.

4.5.2 Experimental Program Compliance

- Translator input test
- FPFM transmitter ERP – 0.170 kW
- FPFM program content – unprocessed music

Figure - 8 Owatonna, MN – Translator Input



4.6 Benicia, CA

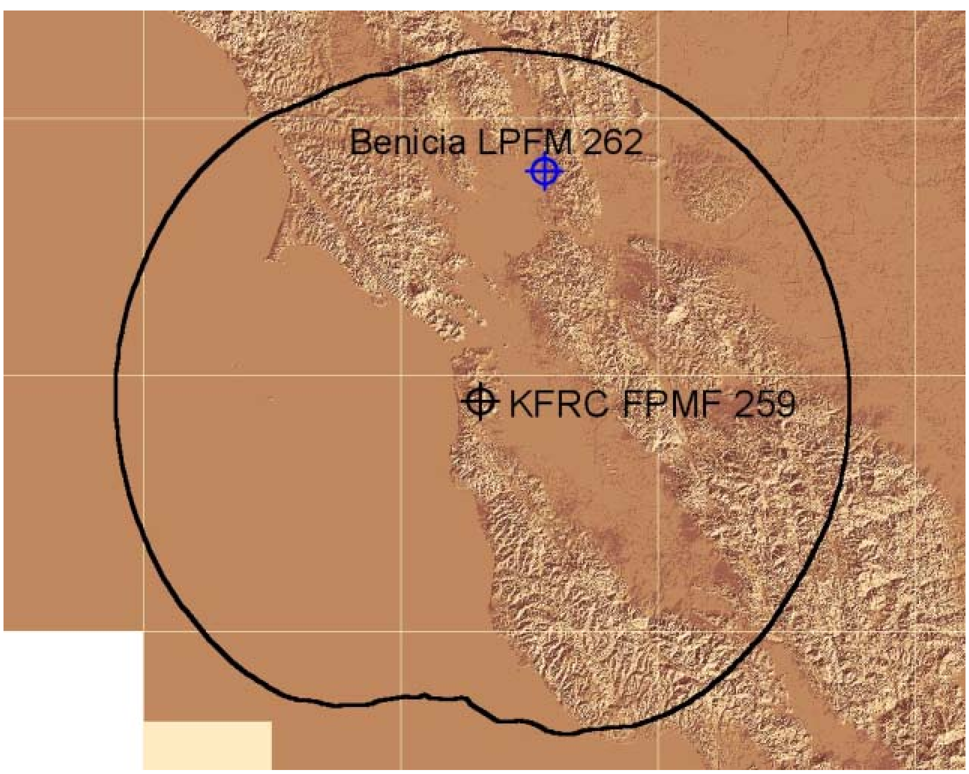
4.6.1 RFP Compliance

This LPFM site is located in a region that is suburban and rural. The terrain is hilly, mountainous, covered with trees, and is located approximately 56.97 km from the FPFM transmitter. Its associated FPFM station is KFRC-FM. The FPFM transmitter facility has a HAAT of 396 m and a transmitter output ERP of 40 kW.

4.6.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio - 0.68
- FPFM program content – processed music

Figure - 9 Benicia, CA



4.7 Winters, CA

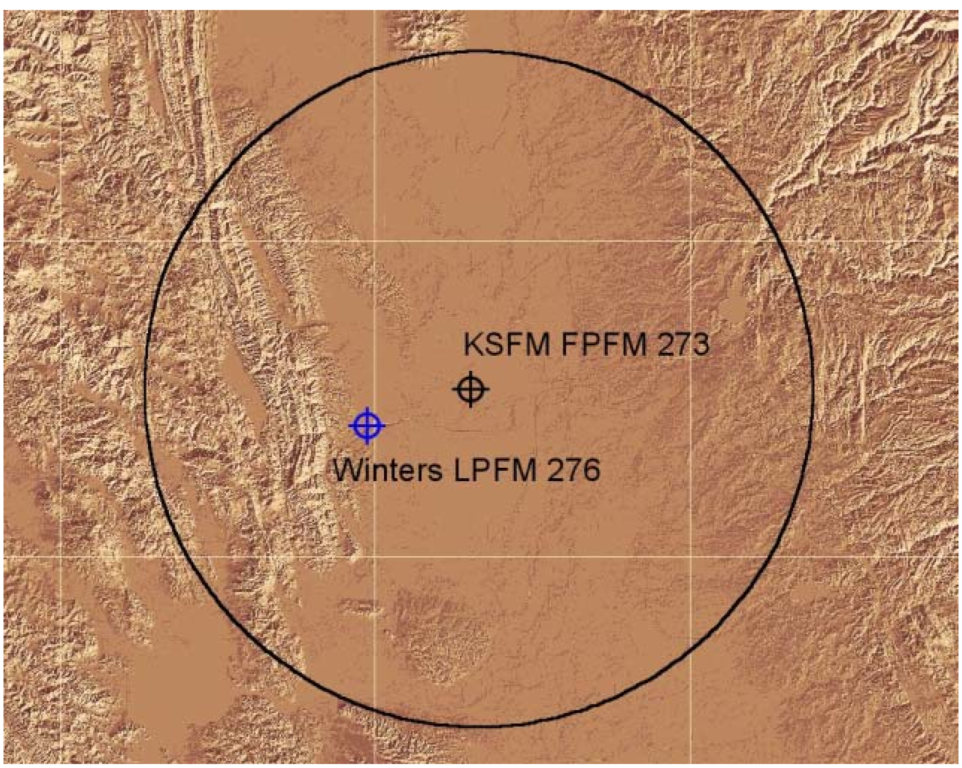
4.7.1 RFP Compliance

This LPFM site is located in a region that is suburban and rural. The terrain is hilly, mountainous, covered with trees, vineyards, and orchards. It is located approximately 21.73 km from the FPFM transmitter facility. Its associated FPFM station is KSFM. This transmitter facility has a HAAT of 152 m and a transmitter output ERP of 50 kW. The FPFM format is Hip-Hop processed music.

4.7.2 Experimental Program Compliance

- Third-adjacent channel separation test
- Distance ratio - 0.33
- Minority Market
- FPFM program content – processed music

Figure - 10 Winters, CA



5 Collected Metrics

During the data collection process the following metrics will be collected:

5.1 Receiver Test Vehicle Metrics

Data to be entered in LPFM Receiver Test Data Sheet (Figure 11) is shown below:

- Date of each test
- Call sign of FPFM station
- ID number for each recording
- Latitude and longitude of each test location
- Comments from test technician regarding interference before/during test and format of FPFM program
- Start time of each recording
- Spectrum analyzer measurements (LPFM and FPFM stations)
- 2 minutes of recorded programming from each receiver. This data consists of 2 minutes of audio recording from 5 different receivers at 12 different AGL / program content / ERP combinations from at least 8 different test locations. A 9th location will be tested if the engineer conducting the test detects interference while at the 8th location.

5.2. Transmitter Test Vehicle Metrics

Data to be entered in Transmit Test Vehicle Log (Figure 12) is shown below:

- Date of test
- Call sign of FPFM station
- Transmit frequency of both LPFM and FPFM stations
- Latitude and longitude of LPFM site
- Local time of test
- Power meter measurements of the incident power from the transmitter and the reflected power from antenna system

- A record of all ON/OFF changes, AGL changes and programming format changes corresponding to all test sequences
- Cable losses at the frequency of the LPFM under test
- Directional coupler coupling factor for the frequency of the LPFM under test

Avon, Connecticut LPFM Site												
Date of Test	Site Lat/Lon N W			FPFM WCCC 106.9 MHz Processed		LPFM 107.5 MHz	Dir. Coup. -39.0 dB	ERP 100 W 10 W	Incident Port 13.8 dBm 3.8 dBm			
	Location 1 Lat Lon: N W											
	30m 10W P	30m 0W P	30m 100W P	30m 10W T	30m 0W T	30m 100W T	10m 10W P	10m 0W P	10m 100W P	10m 10W T	10m 0W T	10m 100W T
Start Time of Recording												
FPFM SpecAn (dBm)												
LPFM SpecAn (dBm)												
Auto RX Rec ID#	AV115P1	AV111P1	AV118P1	AV115T1	AV111T1	AV118T1	AV125P1	AV121P1	AV128P1	AV125T1	AV121T1	AV128T1
Interf. W/O LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
FPFM Format	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T
Interf. W/ LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Clock Radio Rec ID#	AV115P2	AV111P2	AV118P2	AV115T2	AV111T2	AV118T2	AV125P2	AV121P2	AV128P2	AV125T2	AV121T2	AV128T2
Interf. W/O LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
FPFM Format	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T
Interf. W/ LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Boom Box Rec ID#	AV115P3	AV111P3	AV118P3	AV115T3	AV111T3	AV118T3	AV125P3	AV121P3	AV128P3	AV125T3	AV121T3	AV128T3
Interf. W/O LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
FPFM Format	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T
Interf. W/ LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Walkman RX Rec ID#	AV115P4	AV111P4	AV118P4	AV115T4	AV111T4	AV118T4	AV125P4	AV121P4	AV128P4	AV125T4	AV121T4	AV128T4
Interf. W/O LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
FPFM Format	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T
Interf. W/ LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Home RX Rec ID#	AV115P5	AV111P5	AV118P5	AV115T5	AV111T5	AV118T5	AV125P5	AV121P5	AV128P5	AV125T5	AV121T5	AV128T5
Interf. W/O LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
FPFM Format	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T	P U T
Interf. W/ LPFM	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N

Figure - 11 LPFM Receiver Test Data Sheet

LPFM Transmit Test Vehicle Log				
Date	**LPFM Site Name:**	**LPFM Freq.**	**Test Site GPS Coordinates**	**Local Time of Test**
	Avon	107.5 MHz	N	
	FPFM Call Sign:	**FPFM Freq.**	W	
	WCCC	106.9 MHz		
Cable Losses		**Directional Coupler Coupling Factor**		
129' Cale	1.9 dB	Incident and Reflected		
10' Jumper Cable	0.5 dB	-39.0 dB		
VSWR Check Power Meter Readings				
Incident	Reflected			
NOTES:				

Transmitter Actions				
Time on	Time Off	Height AGL	Format	Watts ERP

Figure - 12 Transmit Test Vehicle Log

Transmitter Actions				
Time on	Time Off	Height AGL	Format	Watts ERP

Figure – 12 (Cont) Transmit Test Vehicle Log

6 Broadcast Test Scenarios

6.1 LPFM Site Determination for Third-adjacent Channel Separation Tests

6.1.1 Plot Initial Site Coordinates for LPFM

- Use topographic maps to determine the LPFM location based on application filed with the FCC

6.1.2 Conduct Site Surveys

- Go to specified LPFM sites to determine the feasibility of using the selected site.
- Make sure that the FPFM station is received clearly at the selected site.

6.1.3 Determine Receiver Test Locations

- The predicted distances for the receiver van from the LPFM were determined using the Terrain Integrated Rough Earth Model (TIREM)[1]. The Contract Statement of Work (SOW) stated that the first point of separation was to be 0.01 mile, or where the LPFM signal (undesired, U) transmitted at an ERP of 10 W and an antenna AGL of 10 m is 40 dB greater than the signal predicted by the TIREM model for the FPFM Signal (desired, D), whichever is greater. In every case the predicted

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[1] TIREM was used to calculate the desired (D) and undesired (U) signal levels at the various test locations for each LPFM site. Both the D and U signal were calculated by the TIREM and produced the field strength level in dBµV/m. The input parameters for TIREM were: HAAT and ERP for both the FPFM and LPFM, and the distance from the FPFM and LPFM to the test location of interest. The height of the receiving antenna at the test location was six feet. TIREM is a method of predicting field strength over the earth's surface. Comsearch uses TIREM in its propagation and interference studies. TIREM was adapted from NBS Technical Note 101. Comsearch has installed and adapted the TIREM program in its various analytical programs. The Comsearch TIREM program in Microsoft Excel format was used for the calculations of field strength at the various LPFM test receiver locations in this project.

level for -40 dB D/U ratios was found to be at a distance closer than 0.01 mile. Therefore a 0.01mile distance separation from the LPFM site will always be used as the first test location. The most distant point is determined where the D/U ratio is 0 dB predicted by the TIREM model when the LPFM signal is transmitted at an ERP of 100 W and an antenna height AGL of 30 m. If the point where the D/U equals 0 dB is less than 5 miles then that point is moved to 5 miles from the FPFM station and plotted as the 8th test location. There are six measurement point intervals between these two points. The separation distance between these measurement points is a geometrically derived sequence of measurement locations of increasing distance intervals. The measurement points will be on a line or as close as possible to a line that is drawn from the FPFM through the LPFM and extended outwards to the F (50,50) contour of the FPFM station.

- Using data collected in sections 6.1.1 and 6.1.2 along with the calculated data from the previous step, determine the geographic locations for the collection of the audio sample data.

The formula for determining the distance multiplier for the test locations is:

$$K=10^{[\log(L/F)]/(N-1)} \qquad \text{(Equation 4)}$$

where:

K	= Multiplier
L	= Last (farthest) distance
F	= First (nearest) distance
N	= Number of total test locations

Distances (L) and (F) are in relation to the LPFM. As an example, Avon's nearest site, (F) is at .01 miles and the farthest, (L) is at 5 miles due to the 5 miles minimum requirement in the SOW. The actual point where the D/U equals 0 dB is at approximately 0.35 miles. Locations will be mapped with a mapping program as closely as possible to these geographic coordinates. These locations will be numbered beginning with the closest to the LPFM designated as Location 1. This numbering scheme will continue to be used when making audio recordings during the field test phase of the experiment. The chart in Table 6 contains the Location ID numbers, distances from location to location, and multipliers for each LPFM site.

AGL Location #	Avon miles	Brunswick miles	East Bethel miles	Owatonna miles	Winters miles	Benecia miles
1	0.010	0.010	0.010	0.010	0.010	0.010
2	0.024	0.028	0.024	0.027	0.024	0.027
3	0.059	0.076	0.059	0.072	0.059	0.073
4	0.143	0.210	0.143	0.195	0.143	0.199
5	0.349	0.578	0.349	0.524	0.349	0.538
6	0.847	1.592	0.847	1.409	0.847	1.458
7	2.058	4.389	2.058	3.791	2.058	3.950
8	5.000	12.100	5.000	10.200	5.000	10.700
Multiplier	2.43	2.76	2.43	2.69	2.43	2.71

Table - 6 Location ID Numbers and Distances from LPFM to Test Locations

6.1.4. LPFM Antenna Heights for Testing and Determination of HAAT

Two LPFM radiation centerline heights will be used for the LPFM interference testing. They are 10 m and 30 m radiation centerlines above ground level (RCAGL). For each of the sites where the portable LPFM will be placed, the determination of HAAT for the two antenna RCAGL heights above ground level will be calculated and recorded. The calculation method to be used in the HAAT determination is described in FCC Rules Part 73. In general, the Part 73 calculation method takes eight radials (45° apart) from the point of interest, and at distances between 2 and 10 miles from the point of interest, takes 50 equally spaced increments and determines the height at each of the 50 points. For each radial, the average height along it is determined by summing the height at each point and dividing by 50. Then the average terrain height of the eight radials is determined by summing the average of the eight radials and dividing by eight. If there are significant bodies of water along any of the radials the entire radial, or portions of it, may be eliminated in the calculation to determine height of the average terrain for the point of interest.

6.2 Translator Input Third-adjacent Channel Separation Test

6.2.1 Conduct Site Survey

- Determine at least 4 possible LPFM sites by visiting the area around the translator station. Specifically look at the translator station's immediate area to ascertain whether or not the LPFM will be located in the main beam of the receive antenna.
- Sites listed as 'possible' will have large enough areas to locate the portable LPFM vehicle and tower, while being in the main beam of the translator receive antenna and permitting some movement, of the LPFM tower, if necessary, to meet the SOW requirements.
- Use mapping programs, GPS receiver and translator to determine exact location.

6.2.2 Determine Test Locations and LPFM site position

- Exact placement of the LPFM will not be accomplished until the site is accessed during the test process.
- The optimum LPFM site will be co-located with the FPFM translator station.

  If the optimum LPFM site at 10m Height AGL and 1 W ERP causes no interference to the input of the translator, continue testing the remaining heights, ERPs and formats as listed in the TPP. If the site nearest to the translator station causes interference at 10 m height AGL and 1 W ERP, then move the LPFM to the next selected site and repeat the test at 10 m and 1 W ERP. If no interference is detected, then raise the tower to the 30 m height AGL and increase output power to 100 W ERP and again check for interference. If there is still no interference noted, then move the LPFM slightly closer to the translator station and repeat the height and ERP test. Once the condition of 10 m, 1 W ERP with no interference detected and 30 m, 100 W ERP with interference detected is met at this site, then continue with the remaining tests. Interference shall be detected by monitoring the output of the translator on the receivers in the Receiver Test vehicle.

- Receiver Test Vehicle will be located at two coordinates. The first will be at ½ the distance between the FPFM site and the F (50,50) contour of the FPFM station. The second location shall be at the F (50,50) contour. Both locations will be as close as possible to a line drawn from the FPFM through the LPFM and extended to the F (50,50) contour.
- At no time will the ERP and height exceed the upper limit of 100 W ERP and 30 m.
- ERP conditions tested will include 0, 1, 2, 5, 10, 20, 50 and 100 W ERP.
- All three LPFM content formats will be used
- Deploy all equipment in both the transmitter and receiver test vehicles and proceed with testing

7 Equipment

- Commercially available 300 Watt LPFM station consisting of:
    - 300 Watt Energy-Onix Exciter
    - A 3-Band Audio Processor/Digital Stereo Generator (Omnia 4.5 FM) with processing presets
    - 129 foot RF cable (Times Microwave T-Com 400, Ultraflex) See data sheet in Appendix A
    - Two (2) 10-foot jumper cables (for connection from splitter to each antenna)
    - 1 Circularly polarized FM broadcast 2 bay antenna

    - 1 Directional coupler manufactured by the Connecticut Microwave Corporation
    - CD Player, Sony model CDP-CE275
    - Trailer mounted tower
- Two vehicles (one tower tow & LPFM vehicle and one receiver test vehicle)
- 2 spectrum analyzers – Advantest U3661
- HP E4418B Power Meter
- Yamaha AW 4416 Professional Audio Workstation
- Blank CD media
- GPS receiver, Garmin GPSMAP 76S (Used to verify LPFM site and receiver location coordinates)
- Receivers consisting of
    - Vehicle mounted stereo as factory installed by Ford in receiver test vehicle
    - Boom box, Sony CFD-F5000
    - Home receiver, Kenwood VR-605
    - Walkman FM radio, Sony Walkman SRF-M35
    - Clock radio, RCA RP3755
    - Blind reader service radio, supplied by The Minnesota State Services for the Blind, manufactured by Success.

Above listed receivers are representative of equipment in use by the public at large and persons using the Blind Reader Service. Selection of the above units was made after investigating the currently available models at the local Best Buy and Circuit City, both of which are nationwide chain stores. Stereo receivers have been selected in all cases (except the case of the Blind Reader receiver which had no stereo model available) because the stereo signal is the more likely than the mono signal to be interfered with in the course of the experiment. Major brand names were given the highest weight in the selection determination. Equally weighted in the selection process was the availability of an earphone jack. The earphone jack allows the output of the receiver to be directly connected to the recorder, thus eliminating the need to use microphones, which may induce background noise from the inside of the vehicle. All of the selected receivers are equipped with digital tuners. This was done so that we could eliminate the possibility of any of the receivers being mistuned, which could be misconstrued as interference. Median priced units currently available at the time of purchase were selected for this experiment.

8 Data Collection Methodology

8.1 Outline of Third-adjacent Channel Separation Measurements

- Determine HAAT for Selected Test Sites
- D/U Signal Level Verification
- Verify Locations for Receiver Test Vehicle
- Receiver Vehicle Initial Set-up for D/U Verification
- Receiver / Transmitter Setup for Data Collection
- Create CD's for Playback
- Daily Data Back-up
- Send Backups to Comsearch in Ashburn Using an Overnight Service such as FedEx (traceable)
- Deliver Sound Recordings to MITRE Within 5 Business Days of Test Date

8.2 Outline of Distance Separation Measurements for Translator FPFM Stations

- Conduct Site Surveys
- Determine HAAT for Selected Test Site
- Verify 2 Test Locations
- Receiver / Transmitter Setup for Data Collection at Translator Station
- Back-up Collected Data to CD
- Create CD's for Playback
    - Send Backups to Comsearch in Ashburn Using an Overnight Service Such as FedEx (traceable)

- Deliver Sound Recordings to MITRE Within 5 Business Days of Test Date

9 Public Comment Process

Public comment will be facilitated and collected for each LPFM measurement location. This process will allow the general public the opportunity to voice their opinion as to the affect, if any, that the LPFM transmission has on the reception of the FPFM broadcast.

Announcements will be placed in the dominant newspaper and on the FPFM radio station under test at each LPFM measurement location. Announcements will be made two weeks before and during performance of the tests at each LPFM measurement location. Announcements are designed to facilitate the general public's awareness of the:

- Tests being conducted
- Opportunity for the public to provide comments on any potential interference experienced
- Schedule for testing
- Medium in which comments should be submitted
- Deadline for comments to be received

Comments will be collected two weeks prior to, during, and for two weeks after the performance of the tests at each LPFM measurement location. All comments collected will be included in the final report, organized by LPFM measurement location.

10 Resources for Data Collection

10.1 Equipment

- All equipment listed in section 7

10.2 Field Personnel Required

- Two field engineers will be assigned to the LPFM Transmitter Vehicle

- One field engineer will be assigned to the Receiver Vehicle
- Field Lead will be assigned to the Receiver Vehicle

10.3 Comsearch Support Personnel – Ashburn, VA

- One field engineer will be utilized full time sorting the data and producing the final CD's.

Appendix A

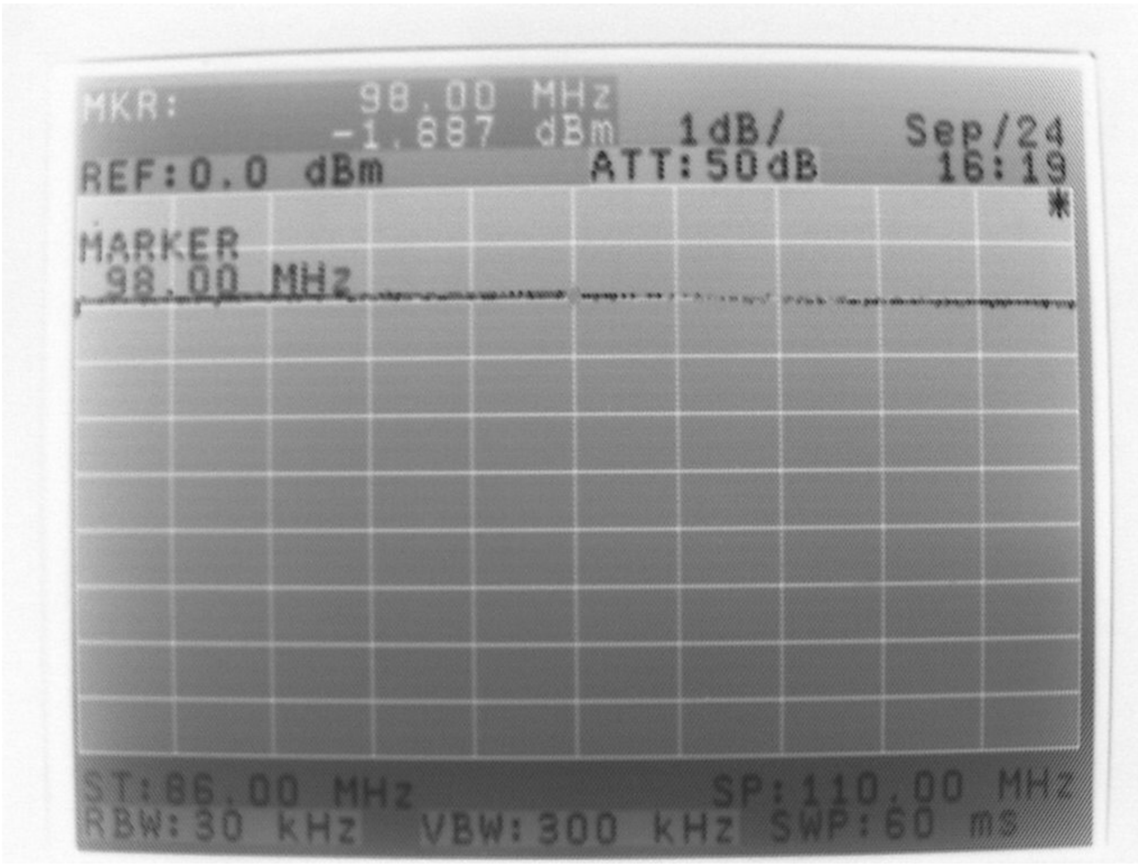

Photo 1- 129 Foot Main Cable Data

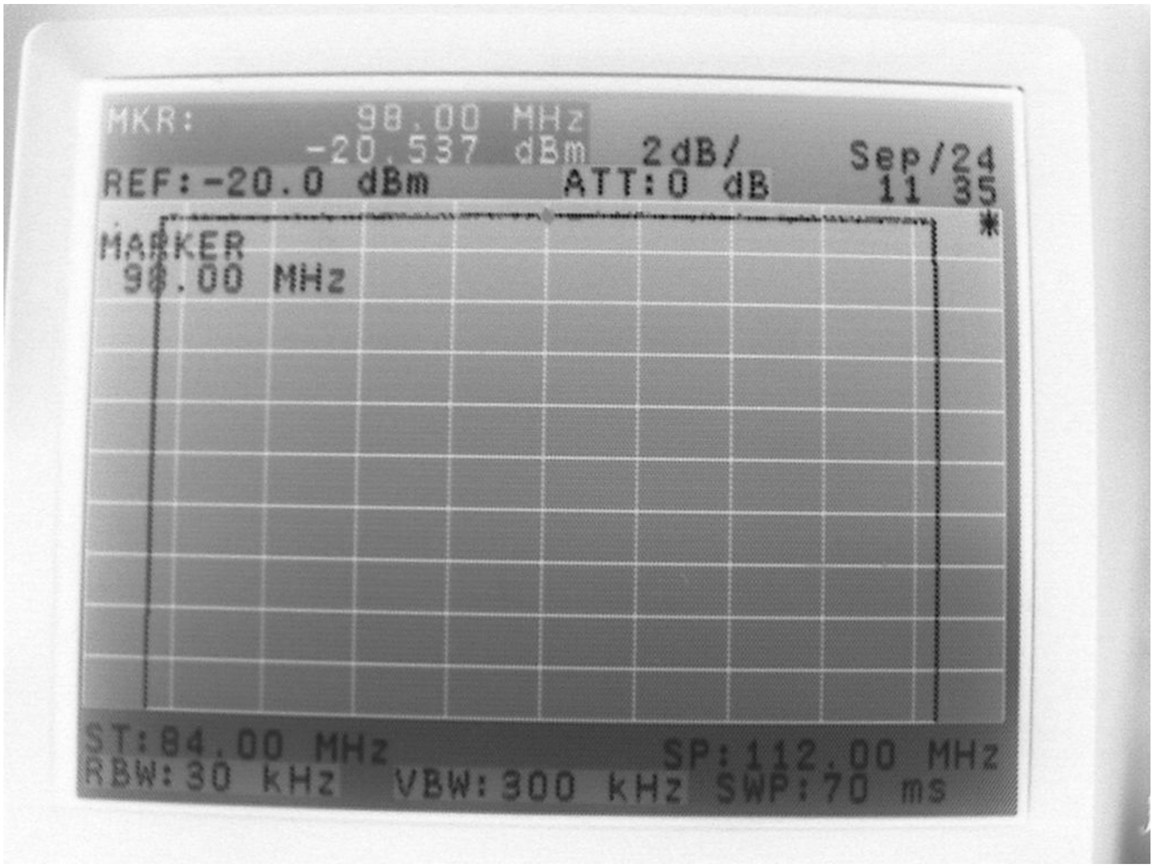

Photo 2 - 10 Foot Jumper Cable Data