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PROCEDURE TO EVALUATE CHANGES TO THE FM BROADCASTING TABLE OF A--ETC(U)
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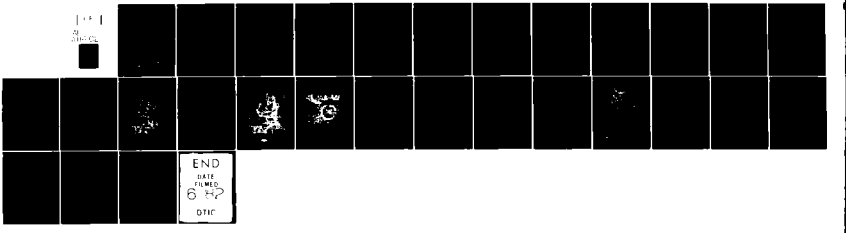

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Systems Research &
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Washington, D.C. 20590

Procedure to Evaluate Changes to the FM Broadcasting Table of Assignments to Determine If Interference to Aeronautical Radio Facilities Could Result

Charles W. Cram

February 1982

Final Report

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

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16. Abstract

For several years the FAA has been receiving complaints of interference to ILS Localizer facilities in the 108 - 112 MHz band, VOR facilities in the 108 - 118 MHz band, and ATC communication facilities in the 118 - 136 MHz band from FM broadcasting stations in the 88 - 108 MHz band. In 1978, the FAA published a report documenting a test program performed by the National Aviation Facilities Experimental Center (NAFEC) that investigated the problem of FM interference to avionic receivers. At the request of the FAA, the Radio Technical Commission for Aeronautics established Special Committee, SC-141, to study the problem and recommend methods to reduce the potential for interference to avionic receivers. One of RTCA's recommendations was that changes to the Table of FM Assignments administered by the FCC should be evaluated during the rulemaking process necessary to make such changes, to determine whether interference to aeronautical radio facilities could result. The purpose of this report is to describe a procedure for evaluating changes to the Table of FM Assignments using methods described in the NAFEC report.

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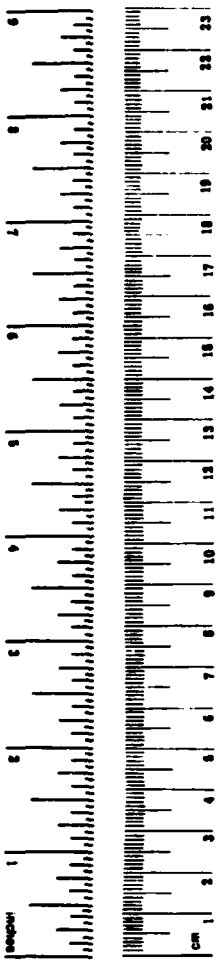
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

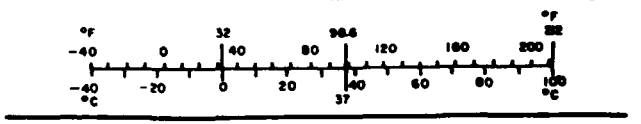
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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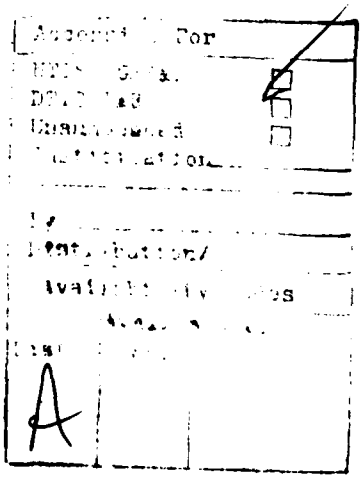


LIST OF FIGURES

1. BACKGROUND AND PURPOSE

For several years the Federal Aviation Administration (FAA) has been receiving complaints of interference to Instrument Landing System (ILS) Localizer facilities in the 108 - 112 MHz band, Very High Frequency Omnidirectional Radio Range (VOR) facilities in the 108 - 118 MHz band, and Air Traffic Control (ATC) communication facilities in the 118 - 136 MHz band from Frequency Modulated (FM) broadcasting stations in the 88 - 108 MHz band. In 1978, the FAA published a report documenting a test program performed by the National Aviation Facilities Experimental Center (NAFEC now known as the FAA Technical Center) that investigated the problem of FM interference to avionic receivers (FAA-RD-78-35, "Interference in Communications and Navigation Avionics from Commercial FM Stations"). At the request of the FAA, the Radio Technical Commission for Aeronautics (RTCA) established a Special Committee (SC-141) to study the problem and recommend methods to reduce the potential for interference to avionic receivers. One of RTCA's recommendations was that changes to the Table of FM Assignments administered by the Federal Communications Commission (FCC) should be evaluated during the rulemaking process necessary to make such changes, to determine whether interference to aeronautical radio facilities could result. The purpose of this report is to describe a procedure for evaluating changes to the Table of FM Assignments using methods described in FAA-RD-78-35.

2. EVALUATION METHOD

a. Venn Diagram Procedure

(1) Description. FAA-RD-78-35 describes a procedure for determining whether interference is likely using a Venn diagram technique. The procedure developed at the FAA Technical Center involves plotting interfering signal level contours for FM stations which could produce interference to communication and navigation facilities due to 2 or 3 signal third order intermodulation products or receiver desensitization. Testing performed at the FAA Technical Center determined that intermodulation interference to avionic receivers was likely if the prime interfering signal level contour of one FM station intersected the secondary interfering signal level contour of another in an area where aircraft would be operating on the victim frequency. The secondary interfering signal level for communication and navigation receivers was found to be -30 dBm at the input to the victim receiver. The prime interfering signal levels were found to be -10 dBm for communication receivers and -20 dBm for navigation receivers. A single FM broadcasting signal with a level of -10 dBm at the input to the victim receiver was also found to cause interference to both types of avionics receivers due to receiver desensitization.

(2) Venn Diagram Calculations. Intermodulation products of concern are found using the following equations:

$$f_0 \pm BW = 2f_1 - f_2 \quad (1)$$

or:

$$f_0 \pm BW = f_1 + f_2 - f_3 \quad (2)$$

where:

f_0 = the victim communication or navigation frequency

f_1, f_2, and f_3 = interfering FM broadcasting frequencies

BW = factor to account for receiver bandwidth and the width of the intermodulation spectrum BW is assumed to be one channel width (50 kHz)

Prime and secondary interference contours can be calculated using the following equation:

$$d = \frac{\text{antilog } ((EIRP - P - C - LR) / 20)}{f} \quad (3)$$

where:

d = contour radius in nautical miles (nmi) or kilometers (km)

EIRP = Equivalent Isotropic Radiated Power of the FM station in dBm. Radiated power levels for FM stations are expressed in Effective Radiated Power (ERP). EIRP = ERP + 2.2 dB

P = the contour power level desired either -10, -20, or -30 dBm

C = 37.8 dB for d in nmi or 32.4 dB for d in km

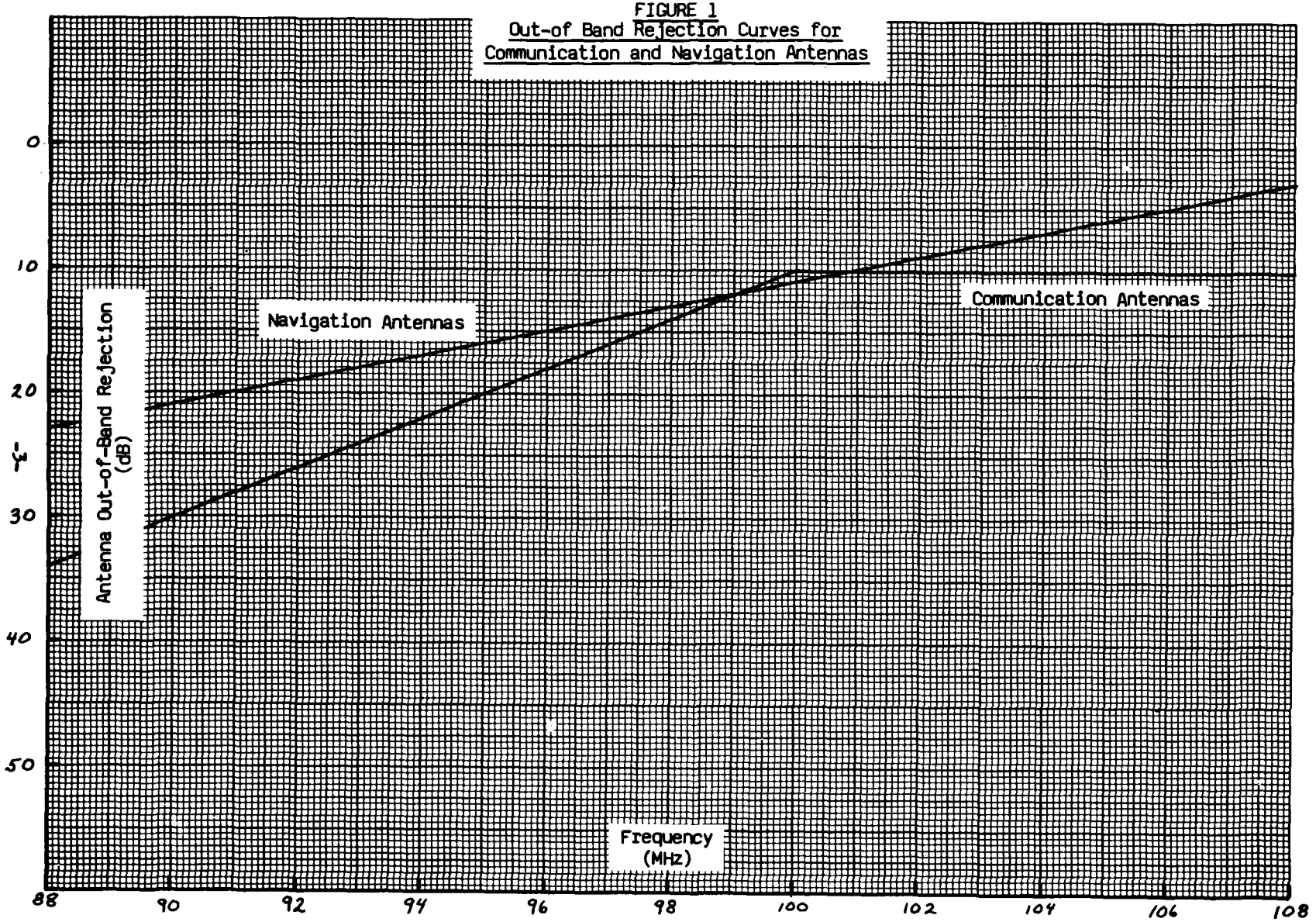
LR = Antenna rejection factor (See Figure 1) equal to:

Communication antennas
10 dB for FM stations from 100 - 108 MHz and
10 dB + 2 dB/MHz for each MHz below 100 MHz for FM stations from 88 - 100 MHz

Navigation antennas
3 dB + 1 dB/MHz for each MHz below 108 MHz for all FM stations

f = FM station frequency in MHz

FIGURE 1
Out-of Band Rejection Curves for
Communication and Navigation Antennas



b. Procedure to Evaluate Changes to the FM Assignment Table

Proposed changes to the FM assignment table are published periodically in the Federal Register. The following procedure should be used to determine the potential impact of a proposed change in the FM assignment table on ATC communication and navigation facilities in the area.

(1) FM Stations in the Area. Identify all the FM stations that would be located within 30 nmi of the city listed in the notice if the proposed change in assignment was implemented. Also identify any frequencies which may be assigned to a city in the area but are as yet unoccupied. When compiling these stations list their frequency and/or channel, latitude and longitude, and EIRP (or ERP). Other useful information would be station class, the city where it is located, and its call sign.

Note: If the ERP of the station is not available assume the maximum allowable for the Class of station and Zone specified in the notice (See Appendix A).

(2) Communication and Navigation Facilities in the Area. Identify the ATC communication and navigation frequencies within 30 nmi of the city listed in the notice. When compiling these facilities list their ATC function (VOR, ILS, etc.), latitude and longitude, and service volume dimensions (See Appendix B). Also note the location of airports in the area where the above facilities may be located.

(3) Receiver Desensitization Study. If any airports in the area have an ILS, VOR, Air Traffic Control Tower (ATCT), or Flight Service Station (FSS) or if an FAA remote communication site is in the area, calculate the distance at which the proposed FM station could cause receiver desensitization by using Equation 3 with P = -10 dBm. The proposed FM station should not be located any nearer than this distance (d) to the airport, remote communication site, or ILS approach path. If other stipulations set forth by the FCC do not prevent siting the FM station within the distance to FAA facilities calculated above, a comment should be submitted to the FCC indicating those areas where the FM station should not be located.

(4) Intermodulation Study. Using the frequencies of the FM stations identified in step 1 for f_1, f_2, and f_3, calculate, using Equations 1 and 2, the 2 and 3 signal third order intermodulation products which would correspond with ATC frequencies ($f_0 \pm BW$) identified in step 2. If no intermodulation products correspond with ATC frequencies in the area, no comment to the FCC would be necessary. If, however, intermodulation products do correspond to ATC frequencies in the area, the following calculations should be made separately for each interfering intermodulation combination:

(a) Plot on a map the location(s) of the existing FM station(s) in the intermodulation combination and the location and service volume of the victim ATC facility.

(b) Calculate using Equation 3 the -10 or -20 dBm contour distance(s) (depending on whether the victim is a communication or navigation facility) and the -30 dBm contour distance(s) for the existing interfering FM station(s) in the intermodulation combination and plot them on the map.

(c) Calculate using Equation 3 the -10 or -20 dBm contour distance (depending on whether the victim is a communication or navigation facility) and -30 dBm contour distance for the proposed station in the intermodulation combination (unless otherwise stated in the FCC notice, assume the maximum allowable station ERP for the given Zone and Class, See Appendix A).

(d) Using the map produced in steps a and b, and the contour distances calculated in step c, determine what, if any, areas might exist where the FM station proposed in the notice could not be located without the prime and secondary interference contours intersecting for a two signal intermodulation product. For a three signal product, the prime contour of one station must not have a common area of intersection with the secondary contours of the other two stations. If the interfering contours do intersect but the area of intersection does not fall within the victim facility's service volume, interference should not be a problem.

The area where the proposed FM station should not be located should be made known to the FCC by commenting on the proposed change. If the FCC notice specifies the location of the proposed FM station and if this location falls within the area where the proposed FM station (at maximum EIRP) should not be located, determine, using Equation 3 in reverse, the maximum EIRP allowable for an FM station at that location to insure that interference would not occur. The comment to the FCC should then indicate the option of moving the proposed FM station to another location outside of the indicated area or reducing the EIRP of the proposed station to the level calculated.

3. EXAMPLE

a. Reference

An interesting example of a change in the FM Assignment Table was found in the June 18, 1981 issue of the Federal Register, Vol 46, No. 117, pages 31895 - 31898. This rulemaking action made changes to the FM assignments in Rhinelander, Tomahawk, and Wausau, Wisconsin. Although this was a Final Rule action and not a Notice of Proposed Rulemaking, for this example, it was treated as if it were a notice.

b. Description

The purpose of the notice was to reassign Channel 300 (107.9 MHz) from Rhinelander to Wausau, substitute Channel 224A (92.7 MHz Class A station) for Channel 261A (100.1 MHz Class A station) at Tomahawk, and substitute Channel 262 (100.3 MHz) for Channel 300 at Rhinelander. Since the only change at Tomahawk involved a low power Class A station and no major airport facilities are in the immediate vicinity of Tomahawk, a study of the change at Tomahawk was not deemed necessary (Channel 224A at Tomahawk was, however, considered in the Rhinelander interference study). The changes at Wausau and Rhinelander were studied in depth.

c. FM Station Lists

According to the first step of the evaluation procedure, a list of the FM stations within 30 nmi of each of the cities to be studied was compiled. Figure 2 shows those for Wausau; Figure 3 shows those for Rhinelander.

d. ATC Facilities Lists

According to the second step of the procedure, Figures 4 & 5 show the ATC facilities and major airports identified within 30 nmi of Wausau and Rhinelander.

e. Interference Study for Wausau, Wisconsin

(1) Receiver Desensitization Study. Central Wisconsin Airport and Wausau Municipal Airport are in the general vicinity of the proposed Channel 300 in Wausau. The distance at which desensitization could occur is found using Equation 3:

$$d = \frac{\text{antilog } ((82.2 - (-10) - 37.8 - 3.1)/20)}{107.9}$$

$$= 3.4 \text{ nmi}$$

The notice stated in paragraph 7 that the assignment of Channel 300 could be made no closer than 11.5 statute miles (9.9 nmi) east-northeast of Wausau. Therefore, the 3.4 nmi separation from the two airports listed (and their ILS approach paths) is easily met.

(2) Intermodulation Study. A typical intermodulation computer program was used to determine if the 2 and 3 signal third order intermodulation products of the FM stations near Wausau would fall on ATC frequencies in the area. Only one potential conflict was identified assuming BW in Equations 1 & 2 was $\pm$50 kHz:

FIGURE 2

FM Assignments Within 30 NMI of Wausau

Channel	Frequency (MHz)	Class	City	Call Sign	Lat/Long	ERP
270	101.9	C	Wausau	WDEZ	44 58 58 N 89 36 06 W	100 KW
206	89.1	E	Wausau (Educational)	WESD	44 53 56 N 89 35 39 W	.012 KW
238	95.5	C	Wausau	WIFC	44 55 14 N 89 41 31 W	98 KW
215	90.9	E	Wausau-Mosinee (Educational)	WHRM	44 55 14 N 89 41 31 W	77 KW
293	106.5	C	Marshfield	WLJY	44 38 41 N 89 51 11 W	100 KW
250	97.9	C	Stevens Point	WSPT	44 32 17 N 89 35 43 W	50 KW
210	89.9	E	Stevens Point (Educational)	WWSP	44 31 21 N 89 32 27 W	.3 KW
300	107.9	C	Proposed assignment in Wausau assume 100 KW ERP			

FIGURE 3

FM Assignments Within 30 NMI of Rhinelander

Channel	Frequency (MHz)	Class	City	Call Sign	Lat/Long	ERP
240	95.9	A	Minocqua	WWMH	45 51 27 N 89 42 01 W	3 KW
262	100.3	C	Rhinelander [1] (proposed)	WRHN	45 38 08 N 89 22 42 W	100 KW
287	105.3	C	Antigo	WRLO	45 22 04 N 89 08 20 W	100 KW
224	92.7	A	Tomahawk (assigned but not yet occupied assume 3 KW)			
248	97.5	C	Rhinelander (assigned but not yet occupied assume 100 KW)			

[1] Station parameters are for WRHN as it presently exists on Channel 300

107.9 MHz	+	95.5 MHz	-	97.9 MHz	=	110.3 MHz
proposed station		WIFC Wausau		WSPT Stevens Point		ILS at Central AP

The locations of these stations and the service volume for the ILS at Central Airport were plotted on a map (See Figure 6). Using Equation 3, the -20 and -30 dBm contours of WIFC and WSPT were calculated and plotted. A prime level of -20 dBm was used because the victim was a navigation facility, the ILS localizer for runway 08 at Central Airport. For interference to occur the -30 dBm contours of WIFC and WSPT must have a common area of intersection with the -20 dBm contour of the proposed station.

FIGURE 4
ATC Assignment Within 30 NMI of Wausau

Frequency (MHz)	ATC Function	Lat/Long	Service Volume
111.6	Wausau VOR	44 50 49 N 89 35 11 W	Standard
121.5 122.4 122.5 123.6	Wausau FSS	44 55 46 N 89 37 44 W	"
110.3	ILS Central AP	44 47 05 N 89 38 43 W	" "
124.4	App/Dep Central AP	44 47 00 N 89 40 00 W	"

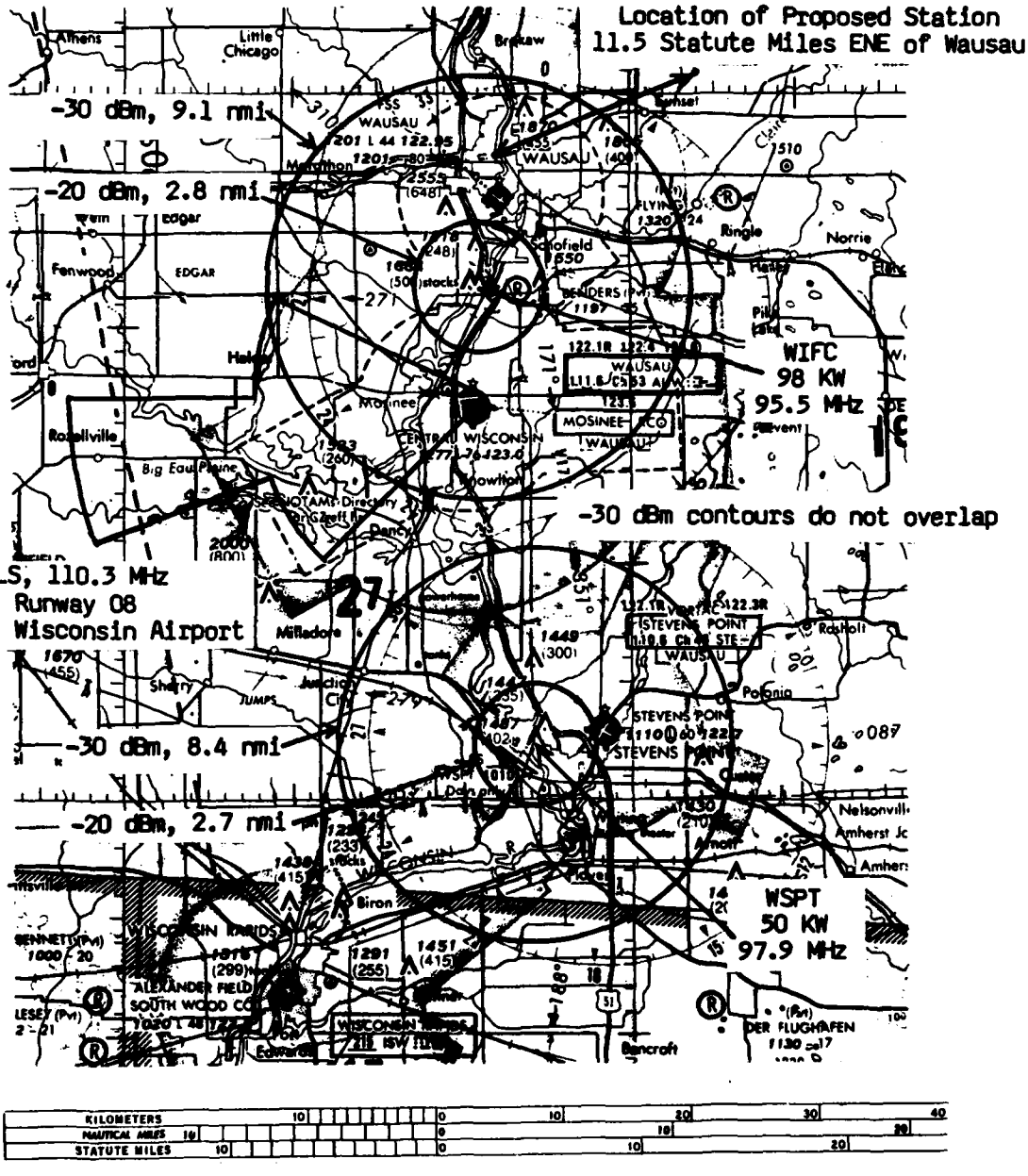
AIRPORTS - Central Wisconsin Airport at Mosinee
Wausau Municipal Airport

FIGURE 5
ATC Assignments Within 30 NMI of Rhinelander

Frequency (MHz)	ATC Function	Lat/Long	Service Volume
133.6	En Route Com Rhinelander	45 38 02 N 89 35 11 W	Standard
111.3	ILS Rhinelander-Oneida AP	45 37 52 N 89 26 58 W	"
109.2	Rhinelander VOR	45 38 02 N 89 27 28 W	"

AIRPORTS - Rhinelander-Oneida County Airport

FIGURE 6
Intermodulation Study at Wausau



In Figure 6 it can be see that the -30 dBm contours of WIFC and WSPT do not intersect, therefore this intermodulation combination should not cause any interference. Therefore, no comment to the FCC on the proposed change in Wausau is necessary since interference from either desensitization or intermodulation is unlikely.

(3) Hypothetical Intermodulation Study. For the sake of argument, if WSPT were a 100 KW station instead of a 50 KW station, the -30 dBm contours of WIFC and WSPT would intersect in the vicinity of Central Airport (the shaded area in Figure 7). Assuming that this was the case the -20 dBm contour distance for the proposed station, calculated using Equation 3, was found to be 10.7 nmi. Therefore, to avoid interference, the proposed station should be located at least 10.7 nmi away from the area of potential interference near Central Airport. The area bounded by the oval in Figure 7 shows where the proposed FM station should not be located. Again, the restriction in the notice that the proposed station must be at least 9.9 nmi ENE of Wausau (approximately 17 nmi from Central Airport) would prevent interference from occurring. However, if this restriction did not exist, a comment on the notice should be submitted to the FCC requesting that the proposed station be located outside of the area indicated in the study. Appendix C contains an example of how such a comment should be presented.

f. Interference Study for Rhinelander, Wisconsin

(1) Receiver Desensitization Study. Rhinelander-Oneida County Airport is in the general vicinity of the proposed Channel 262 (100.3 MHz) in Rhinelander. Using Equation 3, the distance at which desensitization could occur was found to be 1.5 nmi. Figure 8 is a map showing the location of the airport, the ILS service volume, and WRHN (the station presently on Channel 300 which is being changed to Channel 262 by this notice). WRHN is presently 2.5 nmi from the airport and the front course service volume of the ILS localizer for runway 09 is oriented away from WRHN. In addition, there have been no complaints of interference from the existing WRHN and, since the proposed change would increase the frequency separation between WRHN and the ATC facilities at the airport, the probability that desensitization interference could occur would actually decrease.

(2) Intermodulation Study. The same intermodulation computer program used in the Wausau study was used to determine if intermodulation interference was possible due to the frequency change in Rhinelander. Assuming BW in Equations 1 & 2 was $\pm$50 kHz, no 2 or 3 signal third order intermodulation products conflicting with the ATC facilities in Rhinelander were identified. Therefore, no comment to the FCC on the proposed change in Rhinelander is necessary since interference from either desensitization or intermodulation is unlikely.

FIGURE 7
Hypothetical Intermodulation Study at Wausau

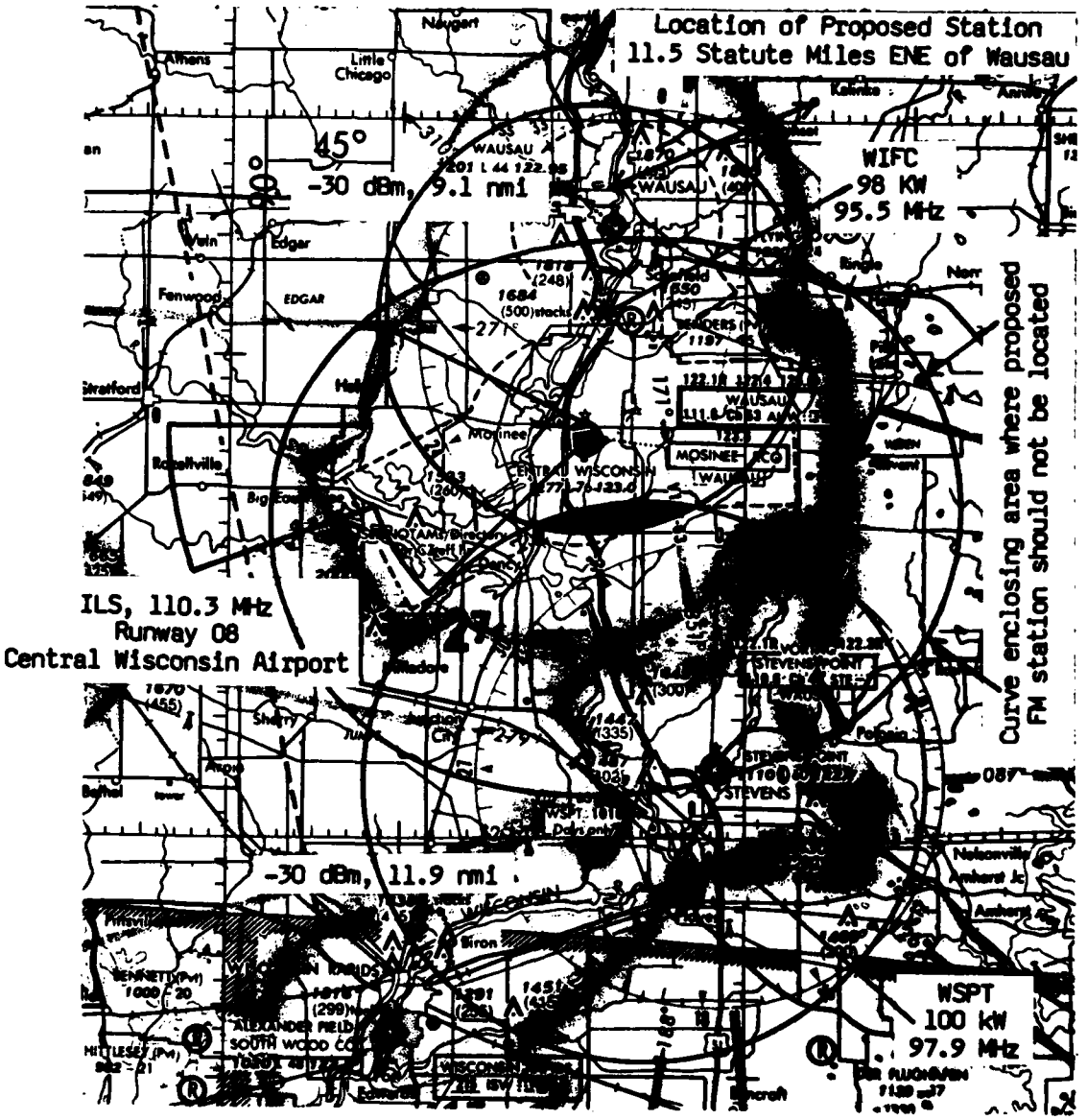
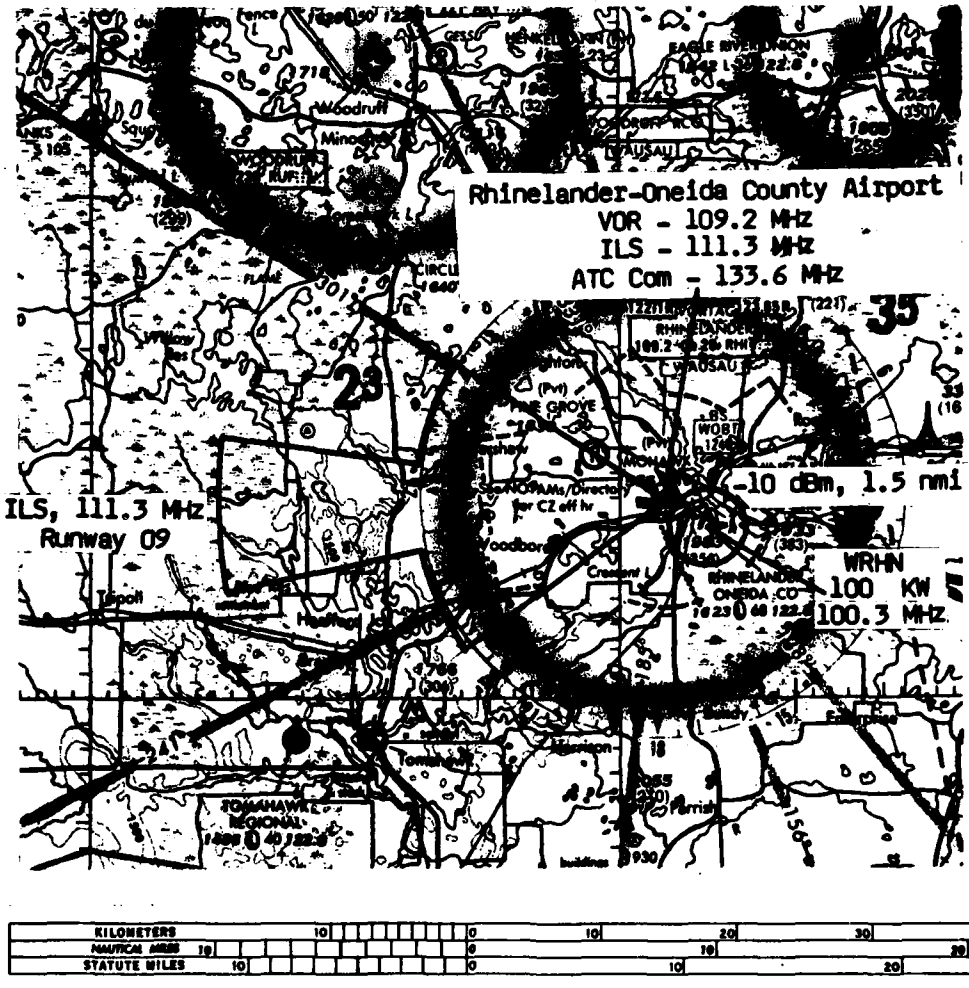


FIGURE 8
Desensitization Study at Rhinelander



4. RECOMMENDATIONS

a. The recommendation of RTCA SC-141 to evaluate proposed changes in the FM table of assignments should be adopted by the FAA and FCC.

b. Proposed changes to the FM table of assignments should be submitted by the FCC to the FAA and evaluated using the procedure described in this report.

c. The evaluation procedures contained in this report could be very tedious and time consuming, particularly if a large number of intermodulation combinations result from a proposed change. Therefore, automation of the procedure described should be considered.

5. REFERENCES

a. Airport/Facility Directory, East Central U.S., March 20, 1980.

b. DO-176, "FM Broadcast Interference Related to Airborne ILS, VOR, and VHF Communications," Final Report, RTCA SC-141, 9/18/81.

c. FAA order 6050.4B, "Frequency Management Engineering Principles: Criteria and Guidelines for Assigning VHF/UHF Air/Ground Communication Frequencies," 10/19/81.

d. FAA Order 6050.5B, "Frequency Management Engineering Principles: Geographical Separation for Navaid Frequency Assignments," 5/19/80.

e. Federal Communications Commission, Rules and Regulations, Part 73, "Radio Broadcast Services," 47 CFR Part 73, August 1976.

f. "FM Broadcast Station in Rhinelander, Tomahawk, Washburn, and Wausau, Wis.; Changes made in Table of Assignments," BC Docket No. 78-92, RM-2979 & RM-3086, Federal Register, Vol. 46, No. 117, June 18, 1981.

g. Sawtelle, E., Dong, J., "Interference in Communications and Navigation Avionics from Commercial FM Stations," FAA-RD-78-35, July 1978.

APPENDIX A DESCRIPTION OF SECTIONS OF PART 73 OF THE FCC RULES AND REGULATIONS

Part 73, Subpart B of the FCC Rules and Regulations governs the assignment of FM Broadcasting Stations. Paragraphs of Subpart B which pertain to this report are outlined below.

1. Paragraph 73.201, Numerical designation of FM broadcast channels

   Since notices of changes to the FM assignment table will reference FM stations by channel number and not by frequency, it is important to know the frequencies corresponding to each channel number. Figure A-1 lists the FM channel numbers and their corresponding center frequencies.

2. Paragraph 73.202, Table of Assignments

   This paragraph lists the FM Assignment Table for each state giving channels authorized for assignment in each city. In Figure A-2, the Assignment Table for Wisconsin (subject of the example in the report) is reproduced. Channels designated with an "A" are for Class A stations. All other listed channels are for Class B stations in Zones I and Ia and for Class C station in Zone II.

3. Paragraph 73.205, Zones

   This paragraph describes the three zones into which the United States and possessions are divided when assigning FM broadcasting stations. Figure A-3 is a map showing the three zones. Zone I is the crosshatched area in the Northeast and Midwest. It includes the states of Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania, Delaware, Maryland, the District of Columbia, West Virginia, Ohio, Indiana, Illinois, and parts of Maine, New Hampshire, Vermont, New York, Virginia, Wisconsin, and Michigan. Zone Ia includes that portion of California below the 40th parallel (also crosshatched in Figure A-3), Puerto Rico, and the Virgin Islands. Zone II includes Alaska, Hawaii, and the remainder of the U.S. not included in Zones I and Ia.

4. Paragraph 73.206, Classes of commercial channels and stations operating thereon.

   This paragraph describes the technical characteristics of the three classes of FM commercial broadcasting stations. Class E, noncommercial educational stations discussed in Subpart C, have similar maximum station parameters as Class B stations in Zones I and Ia, and Class C stations in Zone II.

   a. Class A stations are assignable in all zones. The effective radiated power of Class A stations is restricted to a maximum of 3 KW with a maximum antenna height above average terrain of 300 feet.

b. Class B stations are assigned in Zones I and Ia. The effective radiated power of Class B stations is restricted to a maximum of 50 KW with a maximum antenna height above average terrain of 500 feet.

c. Class C stations may be assigned only in Zone II. The effective radiated power of Class C stations is restricted to a maximum of 100 KW with a maximum antenna height above average terrain of 2000 feet.

FIGURE A-1
FM Channel Numbers and Center Frequencies

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
201	88.1	235	94.9	268	101.5
202	88.3	236	95.1	269	101.7
203	88.5	237	95.3	270	101.9
204	88.7	238	95.5	271	102.1
205	88.9	239	95.7	272	102.3
206	89.1	240	95.9	273	102.5
207	89.3	241	96.1	274	102.7
208	89.5	242	96.3	275	102.9
209	89.7	243	96.5	276	103.1
210	89.9	244	96.7	277	103.3
211	90.1	245	96.9	278	103.5
212	90.3	246	97.1	279	103.7
213	90.5	247	97.3	280	103.9
214	90.7	248	97.5	281	104.1
215	90.9	249	97.7	282	104.3
216	91.1	250	97.9	283	104.5
217	91.3	251	98.1	284	104.7
218	91.5	252	98.3	285	104.9
219	91.7	253	98.5	286	105.1
220	91.9	254	98.7	287	105.3
221	92.1	255	98.9	288	105.5
222	92.3	256	99.1	289	105.7
223	92.5	257	99.3	290	105.9
224	92.7	258	99.5	291	106.1
225	92.9	259	99.7	292	106.3
226	93.1	260	99.9	293	106.5
227	93.3	261	100.1	294	106.7
228	93.5	262	100.3	295	106.9
229	93.7	263	100.5	296	107.1
230	93.9	264	100.7	297	107.3
231	94.1	265	100.9	298	107.5
232	94.3	266	101.1	299	107.7
233	94.5	267	101.3	300	107.9
234	94.7				

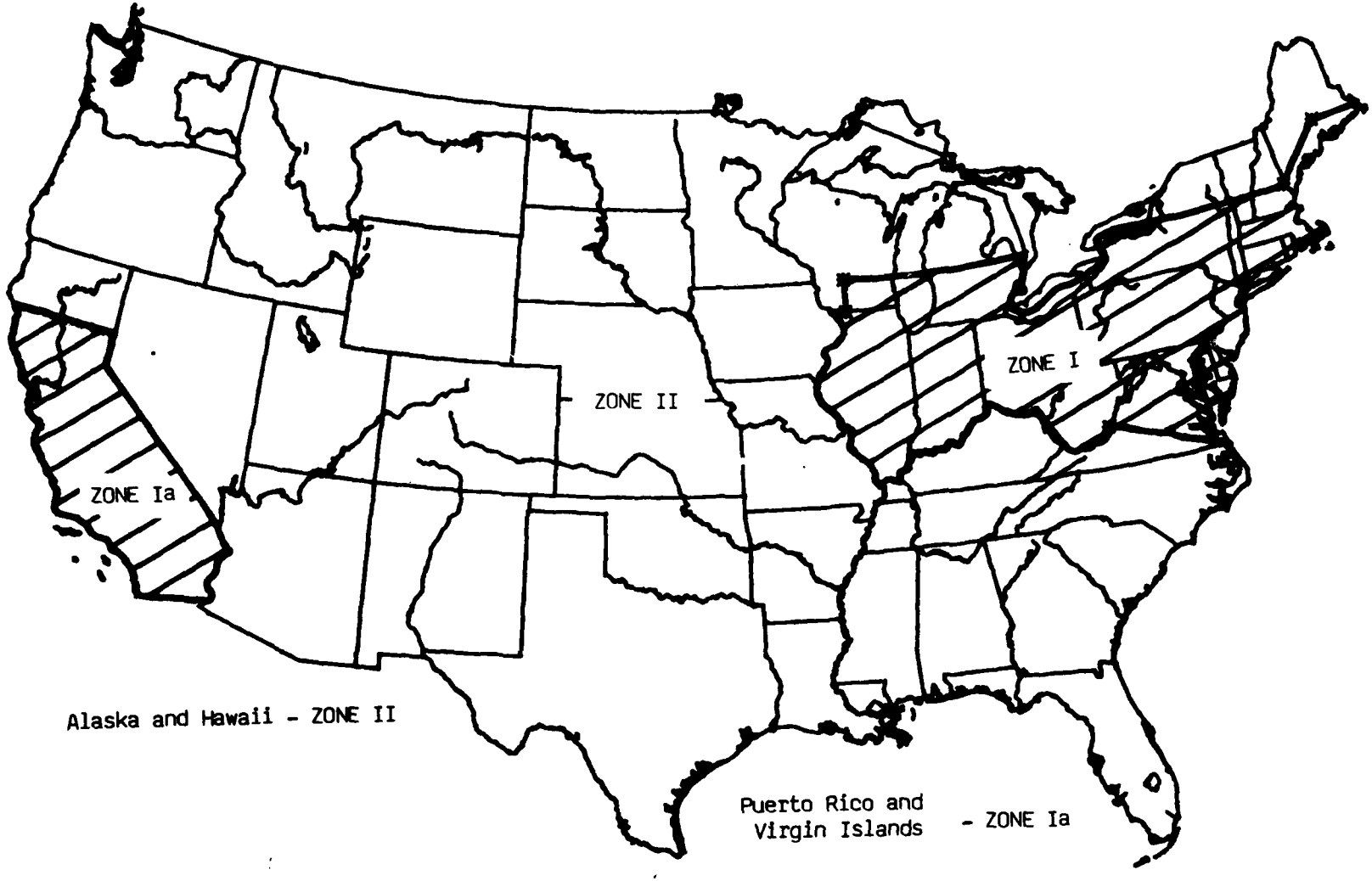
FIGURE A-2
FM Assignment Table for Wisconsin

	Channel No.
Wisconsin:	
Antigo	287
Appleton	280
Ashland	240A
Beaver Dam	237A
Beloit	287A
Berlin	272A
Chippewa Falls	288A
Dodgeville	257A
Durand	240A
Eagle River	232A
Eau Claire	231, 264, 283
Fond du Lac	296A
Fort Atkinson	297
Green Bay	240A, 253, 266
Greenfield Township	285
Hartford	285A
Hayward	221A, 269A
Janesville	260
Kaukauna	285A
Kenosha	236, 245
Kewaunee	224A
La Crosse	227, 240A, 285A
Ladysmith	279
Lancaster	249A
Madison	251, 268, 273, 281
Manitowoc	221A, 272A
Marinette	236
Marshfield	293
Mauston	221A
Medford	257A
Menomonee Falls	252A
Menomonie	221A
Merrill	228A
Middleton	292A
Milwaukee	227, 233, 239, 243, 247, 256, 271, 275, 299
Minocqua	240A
Monroe	229
Neenah-Menasha	232A, 261A
Neillsville	298
New London	228A
New Richmond	296A
Oconto	296A
Oshkosh	244A, 280A
Park Falls	252A
Platteville	296A
Port Washington	261A
Portage	261A
Prairie Du Chien	232A
Racine	221A, 264
Reedsburg	285A
Rhinelander	248, 300
Rice Lake	242, 249A
Richland Center	265A
Ripon	240A
River Falls	292A
Sauk City	244A
Shawano	257A, 274
Sheboygan	249A
Shell Lake	237A
Sparta	246
Stevens Point	250
Sturgeon Bay	230, 261A
Sun Prairie	221A
Tomah	255
Tomahawk	261A
Viroqua	272A
Watertown	231
Waukesha	291
Waupaca	224A
Waupun	257A
Wausau	238, 270
Wauwatosa	279
West Bend	228
West Salem	261A
Whitehall	272A
Wisconsin Dells	[1] 296A
Wisconsin Rapids	277

[1] Any application must specify maximum power and antenna height or equivalent.

NOTE: Table is as it appeared before the changes made at Wausau, Washburn, Tomahawk, and Rhinelander were approved.

FIGURE A-3
Zones of the United States Used
for Making FM Broadcasting Assignments



APPENDIX B DESCRIPTION OF SERVICE VOLUMES FOR FAA COMMUNICATION AND NAVIGATION FACILITIES

1. Communication Facilities - There are no standard service volume dimensions for FAA communication facilities. Each service volume is tailored to the operational needs of the particular ATC sector with which it is associated. If the actual service radius and altitude of the victim communication facility are not known, the typical values given in Figure B-1 may be used.

2. ILS Service Volumes - Figure B-2 shows top and side views of the ILS service volumes for front course. Service volume #1 is the preferred standard, however service volume #2 is widely used in uncongested areas. If the particular ILS facility has a back course, the ranges and altitudes of the back course will generally be similar to one of the service volumes shown in Figure B-2.

3. VOR Service Volumes - Figure B-3 shows the standard service volumes for VOR facilities.

NOTE: The service volumes dimensions given above for communication and navigation facilities are not absolute limits. Expanded service volume distances may be authorized to meet operational requirements.

FIGURE B-1
Typical Service Volume Dimensions
for ATC Communication Facilities

Service	Service Volumes Altitudes in Feet (Meters)		Service Volume Range in Nautical Miles (km)
	Maximum	Minimum	
Precision Approach Radar	5000 (1500) AGL	Ground Level	15 (28)
Helicopter	5000 (1500) AGL	Ground Level	30 (55)
Tower Control (local)	10000 (3000) AGL	Ground Level	30 (55)
Approach Control	25000 (7500) AGL	Ground Level	60 (111)
Departure Control	25000 (7500) AMSL	Ground Level	60 (111)
Low Altitude En Route	18000 (5500) AMSL	1000 (300) AGL	60 (111)
High Altitude En Route	45000 (13700) AMSL	18000 (5500) AMSL	150 (280)
Super High En Route	45000 (13700) AMSL	24000 (7300) AMSL	200 (370)
Ground Control	100 (30) AGL	Ground Level	2-10 (3.7-18.5)
Clearance Delivery	100 (30) AGL	Ground Level	2-10 (3.7-18.5)
ATIS	25000 (7500) AMSL	Ground Level	60 (111)
FSS	5000 (1500) AGL	Ground Level	40 (74)

FIGURE B-2
Standard Service Volumes for ILS Facilities

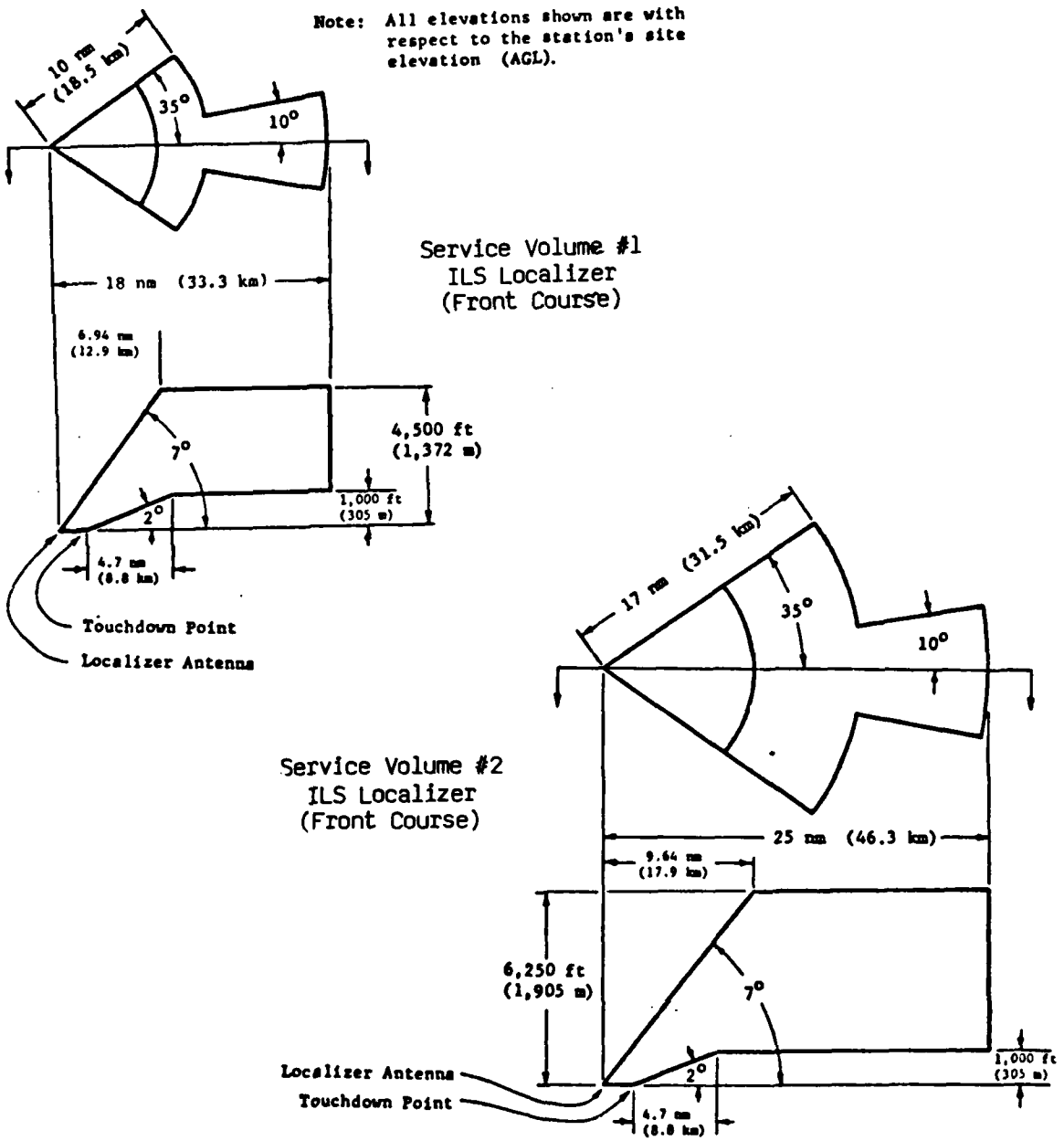
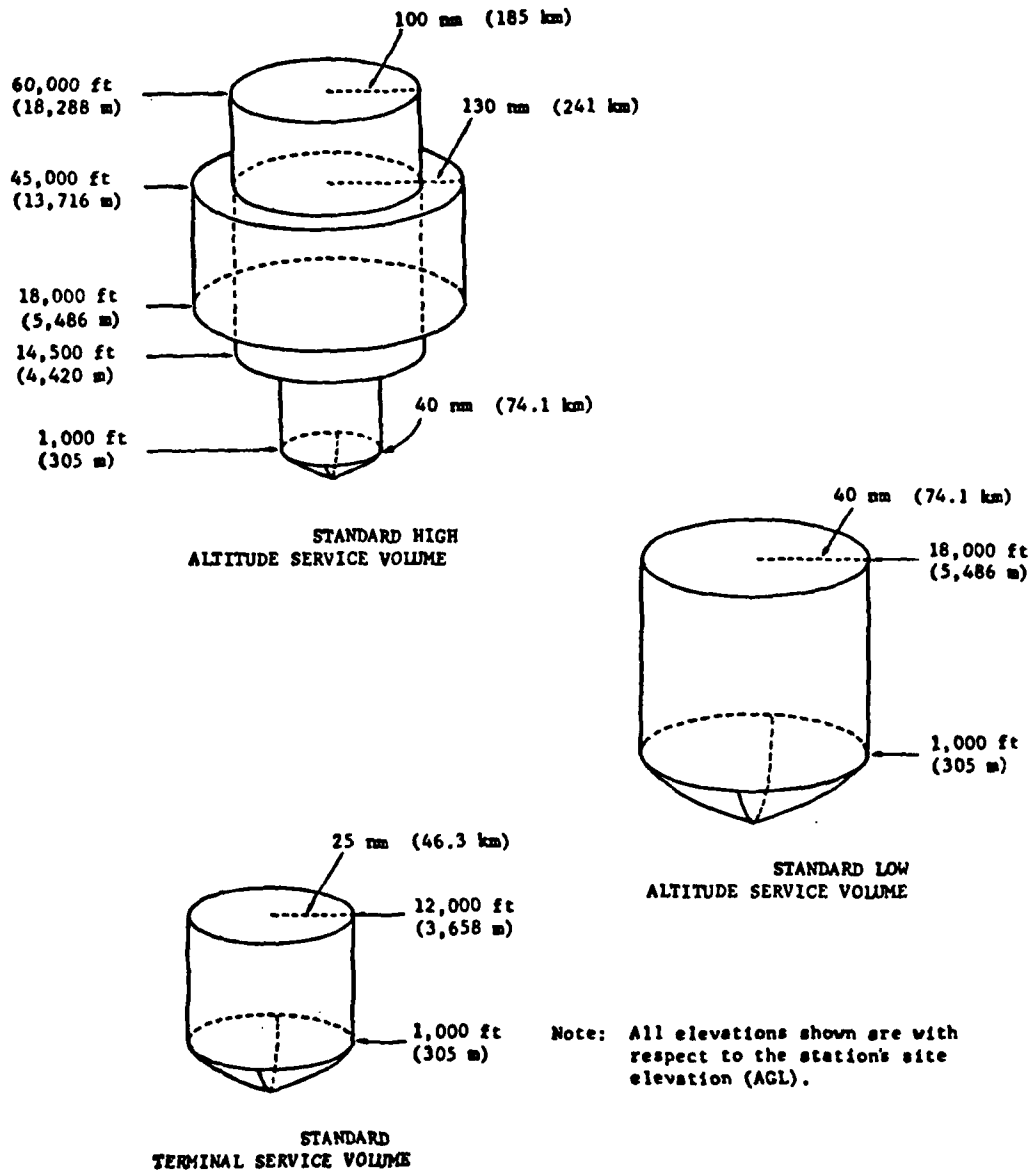


FIGURE B-3
Standard Service Volumes for VOR Facilities



Note: All elevations shown are with respect to the station's site elevation (AGL).

APPENDIX C SAMPLE COMMENT TO THE FCC ON A PROPOSED CHANGE IN THE FM ASSIGNMENT TABLE

Comments to the Federal Communications Commission on a particular change to the FM Table of Assignments should be submitted in a letter addressed to the Secretary of the FCC. The Secretary of the FCC will change periodically, therefore, if the name of the current Secretary is unknown, leave the name out of the title block of the letter. The letter should reference the docket and rulemaking numbers given in the Federal Register Notice, contain a description of the potential problem (including a copy of the engineering study), and specify the action which should be taken to eliminate the problem. The following is a sample of such a letter:

William J. Tricarico
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Reference: Notice of Proposed Rulemaking
Docket No. 78-92
RM-2979 & RM-3086

Dear Sir:

We have reviewed the above referenced Notice of Proposed Rulemaking and have the following comment. The purposed reassignment of Channel 300 to Wausau, Wisconsin could potentially cause interference to the Instrument Landing System (ILS) Localizer at the Central Wisconsin Airport in Mosinee, Wisconsin, due to a predicted 3 signal third order intermodulation combination of the signal from the proposed FM station with the signals from WIFC in Wausau and WSPT in Stevens Point, Wisconsin.

The attached engineering study was performed according to the procedures set forth in FAA Reports FAA-RD-78-35 and DOTFAA/RD-82/4. The figure included with the study shows that the -30 dBm (secondary) interference contours of WIFC and WSPT intersect in the vicinity of the airport. If the proposed Channel 300 were located within 10.7 nmi (prime interference contour distance) of the area of intersection, interference could result to the ILS Localizer used for runway 08 at this airport.

Please take due consideration of the potential for interference to the users of this critical navigation aid when considering the reassignment of Channel 300 to Wausau, Wiscoinsin. We request that the rules adopted specify that Channel 300 be located outside of the area indicated.

Sincerely,

Attachment

APPENDIX 4 - ACRONYMS

AGL - Above Ground Level

AMSL - Above Mean Sea Level

AP - Airport

ATC - Air Traffic Control

ATCT - Air Traffic Control Tower

dB - Decibels

dBm - Decibels referenced to one milliwatt

EIRP - Equivalent Isotropic Radiated Power

ERP - Effective Radiated Power

FAA - Federal Aviation Administration

FCC - Federal Communications Commission

FM - Frequency Modulation

FSS - Flight Service Station

IF - Intermediate Frequency

ILS - Instrument Landing System

km - kilometer

MHz - Megahertz

NAFEC - National Aviation Facilities Experimental Center (now known as the FAA Technical Center)

nmi - nautical miles

RTCA - Radio Technical Commission for Aeronautics

VOR - Very High Frequency Omnidirectional Radio Range

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