

NTIA REPORT 84-143

SPECTRUM RESOURCE ASSESSMENT IN THE 162-174 MHz FREQUENCY BAND

FRANCIS P. FLYNN
WILLIAM M. MORAN



U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

David J. Markey, Assistant Secretary
for Communications and Information

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ABSTRACT

This report is a spectrum resource assessment of the 162-174 MHz band. Included is information on allocation, frequency assignments and agency equipment usage, along with the results of agency interviews. Present spectrum management techniques and associated problems were considered in this report. This band contained 35,275 assignments, as of January 1982, which is approximately one-quarter of all the frequency assignments in the GMF.

KEY WORDS

Amplitude Compandored Single Sideband
Land Mobile
Frequency Modulation
162-174 MHz Band
Spectrum Resource Assessment
Spectrum Management

SECTION 1

INTRODUCTION

BACKGROUND

The National Telecommunications and Information Administration (NTIA) is responsible for managing the radio spectrum allocated to the U.S. Federal Government. Part of NTIA's responsibility is to: "...establish policies concerning spectrum assignment, allocation and use, and provide the various Departments and agencies with guidance to assure that their conduct of telecommunications activities is consistent with these policies" (NTIA, 1983). In support of these requirements, NTIA has undertaken a number of spectrum resource assessments and analysis studies. The objectives of these studies are: to assess spectrum utilization, identify existing/or potential compatibility problems between systems of various departments and agencies, provide recommendations for resolving any compatibility conflicts, and recommend changes that result in more efficient and effective use of the spectrum and improved spectrum management procedures. This study addresses the 162-174 MHz frequency band.

The band 162-174 MHz is allocated internationally to Fixed and Mobile Services on a primary basis. Footnote 613 gives priority to the Maritime Mobile Service in the frequency range 161.475-162.05 MHz. These allocations have remained essentially unchanged after the World Administrative Radio Conference of 1979 (WARC-79) in Geneva, Switzerland.

In the United States, the 162-174 MHz band is essentially an exclusive Government band allocated to the Fixed and Mobile Services. A small portion of the band, 173.2-173.4 MHz, is allocated for non-Government use where the Fixed Service has a primary allocation and the Land Mobile Service is allocated on a secondary basis. In the Government portion, the band has been designated for use by the non-military Government agencies and for the military agencies non-tactical operations. The designated use is spelled out in footnote G5 and in the introduction to the channeling plan for this band. In essence, the military agencies can conduct operations in this band similar to those of the other Government agencies. Such operations would include communications for military police, base taxis, etc.

The foremost use of this band in the United States is for the Land Mobile Service. The present number of assignments amount to approximately one quarter of all the assignments in the Government Master File (GMF). The number of Government land mobile assignments has been growing at approximately five percent per year. The continuing demand for access to the available land mobile spectrum has forced an examination of the present use, and of new technologies which may promise increased efficiency in spectrum use.

This report is the first in a series of three reports on this band. The second and third reports will cover the results of a measurement program of Amplitude Compandored Single Sideband (ACSB) radio and an analysis of the ACSB measurement results. This analysis will include a comparison of the spectrum

efficiency for ACSB and FM, and an assessment of the potential impact of ACSB on the Government use of the 162-174 MHz band.

Objectives

The overall objective of this effort is to assist in the development of spectrum plans and policies for the 162-174 MHz band. Specific objectives identified for this task included:

- (1) Review the allocations and regulations pertaining to the use of the 162-174 MHz band.
- (2) Review the available information concerning the future plans for the Government utilization of this band.
- (3) Review the measurements made by the Radio Spectrum Measurement System (RSMS) van concerning the usage of the frequency band, and recommend, if necessary, changes in procedures on collection and presentation of the data.
- (4) Identify specific problem areas encountered by the Government agencies in the use of this band.
- (5) Recommend changes to the existing regulations and practices for the management of this band.

Approach

In order to accomplish the objectives of this spectrum resource assessment, the following approach was taken:

- (1) Identify existing systems operating in the band obtaining information from the GMF, Electromagnetic Compatibility Analysis Center (ECAC) and the Systems Review File (SRF).
- (2) Review the pertinent portions of the NTIA Manual of Regulations and Procedures pertaining to the use of the 162-174 MHz band.
- (3) Contact the major Government users of the 162-174 MHz band in order to ascertain the current usage and their future plans for the 162-174 MHz band.
- (4) Examine the System Review File to determine the present and future requirements of the Government agencies for the 162-174 MHz band.
- (5) Review previous reports which cover the operations in the 162-174 MHz bands.
- (6) Identify the issues that effect the spectrum management of this band and make recommendations towards their resolution.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

General Conclusions

The frequency band 162-174 MHz supports more frequency assignments and correspondingly more equipment usage than any other 12 MHz of the radio spectrum allocated to the Federal Government. This portion of the spectrum is used predominantly by the Government land mobile operations; and, these communications systems support many critical Government functions from law enforcement to fire fighting. Most Government agencies have land mobile operations in this frequency band. The inventory of equipment owned by the Government for use in this band is in excess of 100,000 units including base stations, mobiles and portables. There are no exact figures available on the equipment, and the estimate presented here is based on a survey of the major users of the band. The Federal Government's land mobile requirements include the need for numerous nationwide communication networks. These requirements must be a primary consideration in any modifications proposed to the systems and/or operational procedures presently implemented in this band.

The Federal Government has a long history of land mobile operations, and like the non-Government community, the demand for access to the land mobile spectrum continues to grow. Unlike the non-Government community, the Federal Government has numerous requirements for nationwide communication networks in the land mobile bands.

The efficiency of the utilization of the Government land mobile spectrum can be increased through implementation of sharing techniques available in the land mobile technology. For example, the introduction of Government operated community repeater and/or trunking systems in the major metropolitan areas could make mobile radio communications available to many additional users. NTIA has a considerable amount of measured data of channel occupancy which supports the feasibility of introducing such techniques into the 162-174 MHz band for the purposes of improving the efficiency of utilization of this band. NTIA should continue to investigate modulation techniques which promise to make more efficient use of the land mobile spectrum. One such program is the current investigation of Amplitude Compandored Single Sideband (ACSB) being conducted both by NTIA and the FCC.

Specific Conclusions

1. The Government use of the land mobile spectrum involves a number of unique requirements such as the Department of Agriculture's fire cache, the land management activities of the Department of Interior and numerous law enforcement activities throughout the Government. The missions of the organizations must be taken into account when evaluating Government use of the spectrum.

2. In addition to the ACSB evaluation program presently being undertaken by NTIA, another program needs to be initiated to determine the feasibility of 12.5 kHz narrowband FM for the VHF land mobile operations.

3. A cosite analysis capability could be of value to the IRAC members in their deliberations on frequency assignment matters, but the implementation of such a capability may be impracticable because of the associated requirement for detailed information on equipment characteristics and antenna site information. The information is not presently available and would be very expensive to collect and maintain.

4. NTIA's Radio Spectrum Measurement System (RSMS) van has been collecting data on the 162-174 MHz band for approximately eight years at a number of sites around the United States. This measured data indicates that in the metropolitan areas where the measurements were made, on the average, emissions were observed on ten percent of the available channels for ten percent of the time. This does not mean that these channels were not in use in the overall metropolitan area. The topic of efficiency and mission requirements will be examined in future NTIA tasks. Usage levels such as those recorded with the RSMS van can be accommodated within a trunking system without problems. Implementation of a trunking system has the potential to make available additional channels to satisfy existing requirements for nationwide communication networks. NTIA needs to investigate the possibility of implementing trunking in the VHF Government land mobile band to determine the practicality of such systems and its potential effect on the existing channeling plan.

5. The land mobile community has experienced interference problems at the upper end of the 162-174 MHz band with intermodulation products from the adjacent TV channel. The permitted spurious output levels of the TV transmitters need to be examined to determine if adjustments need to be proposed. The situation of mutual interference between TV channel 7 and the Government VHF land mobile community is of concern to a number of the Government agencies. The severity of this problem needs to be investigated.

6. The growth in the number of assignments of this band has been at a rate of approximately five percent per year. The projections are that this growth trend will continue without dramatic change.

7. A detailed examination of the existing channeling plan is inappropriate until the evaluation of the ACSB program has been completed.

Recommendations

1. NTIA should initiate a study of the feasibility of implementing 12.5 kHz FM in the VHF land mobile band as part of the evaluation of narrowband technology (ACSB).

2. NTIA should initiate a study for Federal Government application to determine the feasibility of requirements for establishing community repeaters and/or trunking systems in the VHF land mobile band to stimulate sharing and satisfy present and future land mobile requirements.

3. NTIA should initiate an investigation into the spurious levels of TV transmitters operating in the upper adjacent band to the 162-174 MHz land mobile band in order to determine if the temporary levels identified in part 73.687i of the FCC Rules and Regulations are sufficient for compatible operation between the Land Mobile and Broadcasting Services. This investigation should also examine the potential interference problem between the Land Mobile Service and the TV by determining if the standards for spurious and harmonic output are efficient for compatible operation.

SECTION 3

RULES AND REGULATIONS

ALLOCATIONS, ALLOTMENTS AND PLANS

TABLE 1 summarizes the National and International Table of Frequency Allocations along with the applicable footnotes to the National Table. As shown in TABLE 1, the bands are presently allocated nationally and internationally to the same services. The World Administrative Radio Conference (WARC) of 1979 deleted Broadcasting in the 170-174 MHz band for Regions 2 and 3. This was the only modification made by WARC-79. The U.S. Senate ratified the Final Acts of the 1979 WARC in December 1982.

In addition to these allocations tables, Chapter 4 of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (NTIA Manual) provides frequency allotments and frequency and channeling plans specifically applicable to this band. Sections 4.2.3 and 4.2.4 of the NTIA Manual provide allotments for wide area use and common use frequencies. Sections 4.3.7 and 4.3.8 of the NTIA Manual and the supplement thereto, provide channel plans for the 162-174 MHz bands. The channels are primarily 25 kHz in bandwidth although there are 16 splinter channels of 12.5 kHz within the plan. These splinter channels arise where the channeling scheme changes alternately from the even multiples of 12.5 kHz to the odd multiples of 12.5 kHz and vice versa. In the supplement to the NTIA Manual, each channel is designated a user or users which have priority on that channel. Additionally, some channels are designated for specific functions. TABLE 2 summarizes the channel plan priority designations for the 162-174 MHz band.

Along with the above allotments and plans, there are a number of coordination procedures and standards in the NTIA Manual that have specific applicability to the band under study. The titles of these are provided in TABLE 3.

Coordination Procedures and Channeling Plans for the 162-174 MHz Band

The following coordination procedures and plans are in the NTIA Manual and supplement (NTIA 1983, 1978) and are applicable to all the Government agencies.

As indicated in TABLE 2, there are 98 channels out of a possible 488 designated as all Government agencies channel(s) (AGA). The following is a procedure for recording the proposed use of the assignment to ensure other agencies operations will not be affected.

Use of AGA Channels in the Band 162-174

1. Notifying the FAS Secretariat: Before applying for authority to use an AGA (all Government agencies) channel in the bands 29.89-50, 162-174, or 406.1-420 MHz, the applicant shall inform the FAS Secretariat (by telephone) of the frequency, emission, power, and

TABLE 1

SUMMARY OF FREQUENCY ALLOCATIONS FOR THE 162-174 MHz BAND
(SEPT. 1982)

INTERNATIONAL			UNITED STATES				Remarks 5
Region 1 MHz	Region 2 MHz	Region 3 MHz	Band MHz 1	National Provisions 2	Government Allocation 3	Non-Government Allocation 4	
156.8375-174 FIXED MOBILE except aeronautical mobile 613 614 615	156.8375-174 FIXED MOBILE 613 616 617 618		161.775- 162.0125	US266 613		MARITIME MOBILE MG26	
			162.0125-173.2	US9 US11 US13 US216 US223 613	FIXED MOBILE G3		The Channeling Plan for assign- ments in this Band is shown in Section 4.3.7 of the NTIA Manual.
			173.2-173.4			FIXED Land Mobile NG124	Industrial Public safety
			173.4-174		FIXED MOBILE G5		The Channeling Plan for assign- ments in this Band is shown in Section 4.3.7 of the NTIA Manual.
174-223 BROADCASTING	174-216 BROADCASTING Fixed Mobile 620	174-223 FIXED MOBILE BROADCASTING	174-216			BROADCASTING NG115	Television broadcasting
621 623 628 629		619 624 625 626 630					

TABLE 1 (CONTINUED)

Applicable Footnotes to National Table of Allocations

US8--The use of frequencies 170.475, 171.425, 171.575 and 172.275 MHz east of the Mississippi River, and 170.425, 170.575, 171.475, 172.225, and 172.375 MHz west of the Mississippi River may be authorized to fixed, land and mobile stations operated by non-Federal forest fire-fighting agencies. In addition, land stations and mobile stations operated by non-Federal conservation agencies, for mobile relay operation only, may be authorized to use the frequency 172.275 MHz east of the Mississippi River and the frequency 171.475 MHz west of the Mississippi River. The use of any of the foregoing nine frequencies shall be on the condition that no harmful interference will be caused to Government stations.

US11--The use of the frequencies 166.250 and 170.150 MHz may be authorized to non-Government remote pickup broadcast base and land mobile stations and to non-Government base, fixed and land mobile stations in the public safety radio services (the sum of the bandwidth of emission and tolerance is not to exceed 25 kHz, except that authorizations in existence as of December 20, 1974, using a larger bandwidth are permitted to continue in operation until December 20, 1979) in the continental United States (excluding Alaska) only, except within the area bounded on the west by the Mississippi River, on the north by the parallel of latitude 37° 30' N., and on the east and south by that arc of the circle with center at Springfield, Illinois, and radius equal to the airline distance between Springfield, Illinois, and Montgomery, Alabama, subtended between the foregoing west and north boundaries, on the condition that harmful interference will not be caused to Government stations present or future in the Government band 162-174 MHz. The use of these frequencies by remote pickup broadcast stations will not be authorized for locations within 150 miles of New York City; and use of these frequencies by the public safety radio services will not be authorized except for locations within 150 miles of New York City.

US13--For the specific purpose of transmitting hydrological and meteorological data in cooperation with agencies of the Federal Government, the following frequencies may be authorized to non-Government fixed stations on the condition that harmful interference will not be caused to Government stations:

MHz	MHz	MHz	MHz
169.425	170.275	171.125	406.175
169.450	170.300	171.825	409.675
169.475	170.325	171.850	409.725
169.500	171.025	171.875	412.625
169.525	171.050	171.900	412.675
170.225	171.075	171.925	412.725
170.250	171.100	406.125	412.775

Licenses holding a valid authorization on June 11, 1962, to operate on the frequencies 169.575, 170.375, or 171.975 MHz may continue to be authorized for such operations on the condition that harmful interference will not be caused to Government stations.

G5--In the bands 162.0125-173.2, 173.4-174, 406.1-410 and 410-420 MHz, the fixed and mobile services are all located on a primary basis to the Government non-military agencies.

613--The frequency 156.8 MHz is the international distress, safety and calling frequency for the maritime mobile VHF radiotelephone service. The conditions for the use of this frequency are contained in Article 38.

In the bands 156.1-156.7625 MHz, 156.83751-157.45 MHz, 160.6-160.975 MHz and 11161.475-162.05 MHz, each administration shall give priority to the maritime mobile service on only such frequencies as are assigned to stations of the maritime mobile service by that administration (see Article 60).

Any use of frequencies in these bands by stations of other services to which they are allocated should be avoided in areas where such use might cause harmful interference to the maritime mobile VHF radiocommunication service.

However, the frequency 156.8 MHz and the frequency bands in which priority is given to the maritime mobile service may be used for radiocommunications on inland waterways subject to agreement between interested and affected administrations and taking into account current frequency usage and existing agreements.

US216--The frequencies 150.775 and 150.790, and the bands 152-152.0150, 163.2375-163.2625, 462.9375-463.1875, and 467.9375-468.1875 MHz are authorized for Government/non-Government operations in medical radio communications systems.

US223--Within 75 miles of the United States/Canada border on the Great Lakes and Saint Lawrence Seaway, use of coast transmit frequency 162.025 MHz and ship station transmit frequency 157.425 MHz, (VHF maritime mobile service channel 88) may be authorized for use by the maritime mobile service for public correspondence.

TABLE 2

SUMMARY OF 162-174 MHz CHANNEL PLAN
(SEPT. 1981)

<u>Channel Designation</u>	<u>No. of Channels</u>	<u>Channel Designation</u>	<u>No. of Channels</u>
NG	9	AGA (4)	6
C	44	AGA (6)	1
FAA	29	AGA (7)	15
J	82	AGA (8)	20
T	19	AGA (9)	4
I	66	AGA (10)	1
A	43	AGA (11)	1
DOE	14	AGA (12)	1
EPA	1	AGA (13)	1
CG	5	AGA (14)	2
FCC	2	AGA (15)	1
GSA	1	AGA (16)	1
USPS	1	AGA (17)	21
NASA	6	AGA (18)	1
I/TVA	17	AGA (35)	1
AF/AR	24	A (18)	7
DOE/I	2	C/CG (37)	1
CG/HEW	2	I/CG (37)	1
DOE/T	1	A/CG (37)	1
A/I	4	FAA/CG (37)	1
I/VA	1	AGA/CG (37)	1
I/T	2	FAA/NSF	1
CG/TRAN	1	FAA/T	1
AGA	21		
			488 TOTAL

- NOTES: (4) Available only when it is not technically feasible to use other frequencies.
- (6) Primarily for mobile stations paired with repeaters on 162.6125 MHz. Not assignable within 75 miles of the United States/Canada border on the Great Lakes and St. Lawrence Seaway. (See US223)
- (7) 12.5 kHz channel available for use in accordance with the provisions of Section 4.3.8.
- (8) Exclusively for hydrologic use. Shared with non-Government under note US13. (See Section 4.3.3)
- (9) Primarily for meteorological and quasi-hydrologic operations outside the purview of the Committee on Hydrology.
- (10) Primarily for repeaters paired with mobile stations on 162.025 MHz.
- (11) Exclusively for use in medical radiocommunication systems as provided in US216 and Section 4.3.11, NTIA Manual.
- (12) Primarily for mobile stations paired with repeaters on 166.000 MHz.
- (13) Primarily for repeaters paired with mobile stations on 165.4125 MHz.
- (14) Note non-Government use provided by US11.
- (15) AGA primarily for mobile stations paired with repeaters on 170.600 MHz.
- (16) Primarily for repeaters paired with mobile stations on 170.000 MHz.
- (17) Assignment of this frequency should take into account potential interference with TV Channel 7.
- (18) Note non-Government use provided by US8.
- (35) Exclusively for wide area use in accordance with Section 4.2.3, NTIA Manual.
- (37) Coast Guard area of use will be limited, if practicable, to 200 miles inland from Coastal Areas, and in the states bordering all navigable waterways and the Great Lakes Region.

KEY

NG	= non-Government	CG	= Coast Guard
C	= Commerce Dept.	VA	= Veterans Admin.
FAA	= Federal Aviation Adm.	TRAN	= Transportation Dept.
J	= Justice Dept.	USPS	= U.S. Postal Service
T	= Treasury Dept.	GSA	= General Services Admin.
I	= Interior Dept.	AR	= Army
A	= Agriculture Dept.	AF	= Air Force
DOE	= Energy Dept.		
HEW	= Health, Education, and Welfare Dept.		
EPA	= Environmental Protection Agency		
TVA	= Tennessee Valley Authority		
FCC	= Federal Communications Commission		
NASA	= National Aeronautics and Space Administration		
AGA	= All Government Agencies		
NSF	= National Science Foundation		

/ indicates shared priority usage

TABLE 3

COORDINATION PROCEDURES AND STANDARDS SPECIFICALLY APPLICABLE
TO THE 162-174 MHz BAND

<u>Paragraph Number</u>	<u>Title</u>
3.4	United States-Canada Coordination Agreement
5.4	Technical Standards for FM Operation in Certain Bands Between 29.89 MHz and 420 MHz (5.4.5 is specifically applicable to the 162-174 MHz Band)
8.4.6	Coordination of Hydrologic Assignments in the Bands 162-174 and 406.1-420 MHz
8.4.18	Recording the Proposed Use of AGA Channels in the Bands 29.89-50, 162-174 and 406.1-420 MHz
7.15.5	Military Training for Sensors

location of the proposed assignment. This procedure also applies to each proposed assignment whose bandwidth will overlap any portion of an AGA channel, irrespective of whether the proposed center frequency coincides with the center frequency of an AGA channel.

2. FAS Secretariat Responsibilities: The FAS Secretariat will record the proposed assignment, and will advise the applicant whether any other agency has, within the previous four months, reported its intention to apply for the same center frequency or for any other frequency whose bandwidth will overlap any portion of the desired AGA channel.

3. Coordinating with other Agencies: Before submitting an Application for Frequency Assignment Action, the applicant shall coordinate with any other agency(ies) whose existing or proposed operations might be affected by the applicant's use of the frequency.

4. Period of Validity: The requesting agency shall submit its application to the FAS not later than two months from the time the FAS Secretariat is notified. If the application is not submitted within this period, the foregoing notification procedure shall be repeated by the applicant.

5. Exceptions: The following uses of AGA channels are excluded from the above requirement:

- a. Wide area use of those frequencies listed in section 4.2.3.
- b. Common use of those frequencies listed in section 4.2.4.
- c. Hydrologic use of those frequencies listed in section 4.3.3. (Note, however, that non-hydrologic use of these frequencies must be notified to the FAS Secretariat.)

Available Frequencies for Wide Area and Common Use Channels

There are provisions in the NTIA Manual for providing the Government agencies with a type of service similar to the Citizen's Band (CB) non-Government operations. Such operations are covered under section 4.2.3 and 4.2.4 of the NTIA Manual. Operations which are intermittent in nature and cover a wide area are authorized on 163.1 MHz. The common use channel for land mobile operations does not require coordination and is one that is shared with other users. This service is provided for on 168.35 MHz.

In both of these situations an application for use is required by the FAS, but coordination under section 8.4.18 is not necessary. Use of these frequencies is on a non-priority basis and no protection from interference is inferred or guaranteed. Restrictions are also placed on power output and antenna gain and heights. The use of repeaters in these services is not authorized.

Excerpts From the Plan for Hydrologic
and Meteorological Operations in the
Bands 162-174 MHz

Section 4.3.3 of the NTIA Manual provides a plan for Hydrologic and Meteorological operations in the 162-174 MHz band and 406.1-420 MHz band. The following excerpts from this section pertain to the 162-174 MHz band.

1. Hydrologic Channels: This plan identified the center frequencies of channels used primarily for hydrologic operations.

169.425	170.225	171.025	171.825
169.450	170.250	171.050	171.850
169.475	170.275	171.075	171.875
169.500	170.300	171.100	171.900
169.525	170.325	171.125	171.925

a. Use by Government Agencies: Government agencies may use these frequencies only for hydrologic operations, except as indicated in section 8.4.6.

b. Use by Non-Government Agencies: As provided in note US13, non-Government fixed stations may use these frequencies for the specific purpose of transmitting hydrologic and meteorological data only when working in cooperation with agencies of the Federal Government.

c. Coordination: Agencies must coordinate with the Hydrology Subcommittee, as prescribed in section 8.4.6, when applying for an assignment on one of these frequencies.

2. Meteorological and Quasi-Hydrologic Channels: This plan identifies the center frequency as 171.75 for a channel allocated for meteorological and quasi-hydrologic operations. Coordination with the Hydrology Subcommittee is not required.

TECHNICAL STANDARDS

Internationally, there are technical standards applicable to this band given in the International Telecommunication Union (ITU) Radio Regulations [1982]. The transmitter frequency tolerances specified are either equal to or less stringent than those given in the NTIA Manual. In the Final Acts adopted at the WARC-79, both transmitter frequency tolerances and spurious emission limits applicable to this band were specified. Again, the tolerances given in the NTIA Manual are either equal to or tighter than those adopted at WARC-79. The U.S. national technical standards are sufficient for present usage.

Frequency Tolerance

The standards in Chapter 5 in the NTIA Manual call for frequency tolerance limitations for transmitting stations in the 162-174 MHz band as follows:

Fixed Stations	5	ppm
Land Stations		
Coast Stations	10	ppm
Aeronautical Stations	20	ppm
Base Stations	5	ppm
Mobile Stations		
Ship Stations	20	ppm
Survival Craft Stations	20	ppm
Aircraft Stations	5	ppm
Land Mobile Stations	5	ppm (1)

Notes

- (1) 50 ppm for transmitter with mean power of 3W or less and authorized between January 1, 1973, and January 1, 1977. Fifty ppm shall apply to wildlife telemetry with mean power less than 0.5W.

These tolerances are sufficient for present usage, but not for any narrowband technology. The frequency tolerance of a transmitter is its maximum departure of its carrier or center frequency from the assigned frequency. For a frequency of 174 MHz, the departure is 870 Hz for a tolerance of 5 ppm. The nominal channel spacing for 16F3 emission is 25 kHz and can accommodate this departure, and this tolerance is adequate protection for adjacent channel operations. However, J3E operation with the same tolerance would result in a significant adjacent channel problem if a channel spacing of 5 kHz were planned. Fortunately, equipment is available that can operate with a tolerance of 2 ppm. Particular technical standards for narrowband operation will be a function of channel spacing and available equipment, and most likely will require a tighter frequency tolerance than presently used.

Spurious Tolerance

Spurious tolerances for FM stations operating in the 162-174 MHz band are contained in Section 5.4.5 of the NTIA Manual. For other non-FM emissions, the standards for spurious emissions limit the mean power of any emission supplied to the antenna transmission line, as compared with the mean power of the fundamental, in accordance with the following:

1. On any frequency removed from the assigned frequency by more than 75 percent, up to and including 150 percent, of the authorized bandwidth, at least 25 decibels attenuation;
2. On any frequency removed from the assigned frequency by more than 150 percent, up to and including 300 percent, of the authorized bandwidth, at least 35 decibels attenuation; and

3. On any frequency removed from the assigned frequency by more than 300 percent of the authorized bandwidth, for transmitters with mean power of 5 kilowatts or greater, at least 80 decibels attenuation; and for transmitters with mean power less than 5 kilowatts, at least $43 + 10 \log P_m$ (mean power of the fundamental in Watts) decibels attenuation (i.e., 50 microwatts absolute level). There is an exception for frequency modulation maritime mobile radiotelephone equipment. The mean power of the spurious emission falling in any other international maritime mobile channel, due to products of modulation, shall not exceed a limit of 10 microwatts, and the mean power of any other spurious emission on any discrete frequency within the international maritime mobile band shall not exceed a limit of 2.5 microwatts; where, exceptionally, transmitters of mean power above 20 Watts are employed, these limits may be increased in proportion to the mean power of the transmitter.

A summary of the national technical standards applicable to the 162-174 MHz band is shown in TABLE 4.

INTERNATIONAL AGREEMENTS

United States/Canadian Coordination Agreement

The United States and Canada have negotiated an agreement, Arrangement D Part 3.4 of the NTIA Manual, on the use of the frequency band 162-174 MHz within a common border area presently defined in the NTIA Manual as the United States/Canadian Coordination Zone. This Arrangement D and Appendix II to Arrangement D, presented as Part 3.4 of the NTIA Manual, provides for the coordination of terrestrial stations in the 162-174 MHz band. Part 3.6 of the NTIA Manual indicates a procedure for resolving harmful interference from Canadian Stations.

United States/Mexican Frequency Coordination Agreement

The United States and Mexico are currently engaged in bilateral negotiations to conclude an agreement that would govern the assignment of frequencies along the common border. This agreement is being patterned on the United States/Canadian agreement for frequencies above 30 MHz that was originally adopted in 1956 and revised in 1962, 1964, and 1981.

TABLE 4

SUMMARY OF TECHNICAL STANDARDS APPLICABLE TO THE FIXED AND MOBILE SERVICES IN THE 162-174 MHz BAND

I. FM OPERATIONS - Except F9 Emissions (Excerpts from Section 5.4.7)

A. Transmitting Equipment

- 1. Carrier Power Output only as much power as is necessary to ensure satisfactory service
- 2. Frequency Tolerance
 - a. Fixed and land Stations 5 ppm
 - b. Mobile Stations 5 ppm
- 3. Frequency Deviation <5 kHz
- 4. Spurious Emissions Any emission removed from the carrier by ΔF shall be attenuated as follows:

25 dB for $.5 B_n < \Delta F \leq B_n$
 35 dB for $B_n < \Delta F < 2.5 B_n$
 X dB for $2.5 B_n < \Delta F$

where: X = 50 dB + 10 log P for P > 10 watts
 = 43 dB + 10 log P for P < 10 watts

B. Receiving Equipment

- 1. Frequency Tolerance : 5 ppm for P > 10W
25 ppm for P < 10W
- 2. Adjacent Channel selectivity and Desensitization:
 - a. P > 10 watts 80 dB Attenuation
 - b. P < 10 watts 70 dB Attenuation
- 3. Spurious Response
 - a. P > 10 watts 85 dB Attenuation
 - b. P < 10 watts 60 dB Attenuation
- 4. Intermodulation
 - a. P > 10 watts 70 dB Attenuation
 - b. P < 10 watts 50 dB Attenuation
- 5. Conducted Spurious Output -80 dBW

C. Antenna Systems

- 1. Height Above Ground Minimum Required
- 2. Gain Minimum Required
- 3. Directional
 - a. Use for Pt-to-Pt Circuits
 - b. Use for other than Omni-Directional desired service areas

II. SPLINTER CHANNEL OPERATIONS (Excerpts from Section 5.4.5)

A. Emission for FM Systems (except F9 emission)

- 1. Authorized Bandwidth (B_a) $\geq 2 (M+D)$
 where M is highest audio tone
 D is maximum frequency deviation
- 2. Any Emission Removed From The Carrier By ΔF Shall Be Attenuated As Follows:

25 dB for $.5 B_a < \Delta F \leq B_a$
 35 dB for $B_a < \Delta F < 2.5 B_a$
 Y dB for $2.5 B_a < \Delta F$

where: Y = 43 + 10 log P or 80 dB
 whichever is lesser attenuation

B. Frequency Tolerance for AM or FM Systems

- a. P > 10 watts 2 ppm
- b. P < 10 watts 5 ppm

III. WIDE AREA AND COMMON USE CHANNEL OPERATIONS (Excerpts from Section 4.2.3 & 4.2.4)

- A. Transmitter Output Power < 30 watts
- B. Gain of Base Station Antenna < 7 dB
- C. Height of Antenna Above Ground < 20 feet

SECTION 4

SPECTRUM STATISTICS

INTRODUCTION

The acquisition and use of radiocommunication facilities are essential to accomplish the wide variety of individual and interrelated (team effort) missions of the Federal agencies which serve the public in many ways. Furthermore, the essentiality of the facilities themselves is established through the Government's budget and appropriation procedures pursuant to Congressional approval and Presidential direction. Hence, the basic management question is not whether the spectrum should be used to support these activities but how it may best be used to meet the requirements to which the agencies are committed - taking into account affected occupants of the same spectrum, present and future, national and international.

The relationship between the basic mission of a given agency, the facilities needed to fulfill this mission, and the requirement for corresponding radio frequency spectrum space must be recognized, for these three are inseparable if the mission is to be accomplished. For example, the firefighting responsibilities of the Departments of Agriculture and Interior, established by Acts of Congress, cannot be accomplished without mobile communications for those actually fighting the fires; the Federal law-enforcement activities lodged in the Departments of Justice and Treasury would be literally immobilized without radiocommunication; the Federal Aviation Administration could not begin to control and protect air traffic. A common element of all these activities is for serving the public in accordance with its needs as expressed by the Congress and as directed by the President.

The 162-174 MHz band is one of three bands where Government non-military land mobile requirements are accommodated on a primary basis. Also military non-tactical land mobile requirements are accommodated on certain channels in accordance with footnote G5. The other two land bands are portions of the 30-50 MHz band and 406.1-420 MHz which are also known as the "Low-Band" and "UHF Band" in the parlance of the land mobile user. (The 162-174 MHz is known as the "High-Band.") In terms of the number of total assignments in the Government Master File (GMF), the High-Band represents approximately 25 percent of that file. There are on the order of 160,000 authorized frequency assignments in the GMF, of that total, 35,275 are High-Band assignments in a range of the spectrum just 12 MHz wide. The demand for access to the land mobile spectrum has produced increased congestion, specifically in major metropolitan areas. To identify potential problem areas resulting from this increased use, assignment trends, future plans and other spectrum information were collected and analyzed. This spectrum information is based on assignment statistics from the GMF, Spectrum Review File (SRF), discussions with Government agency personnel involved in frequency management, and RSMS measurement data. The records taken from the GMF were current as of January 1982.

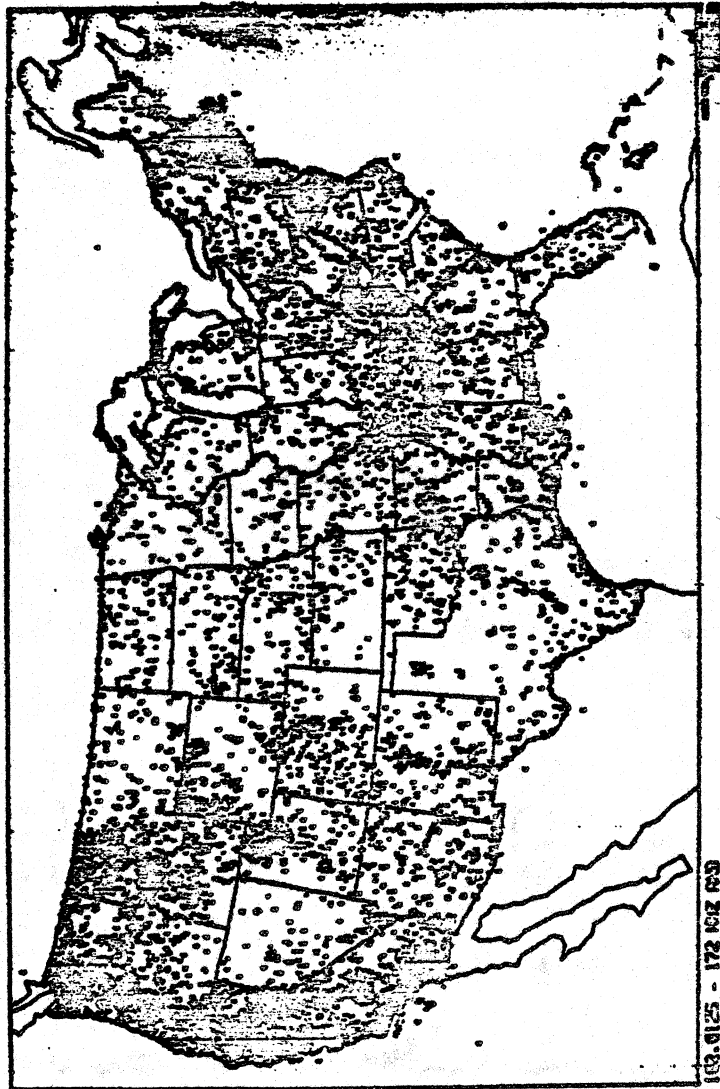
SPECTRUM STATISTICS

There were 36,275 frequency assignments listed in the GMF for the 162-174 MHz band as of January 1982. This represents an increase of approximately 10,000 assignments since 1975 [Hurt, G. and H. Kimball, 1976]. The geographical distribution of these assignments is shown as Figure 1. Major concentrations of assignments occur in the larger metropolitan areas and the coastal areas. The plot of the number of assignments per year since 1972, indicates a growth trend of approximately five percent per year, as shown in Figure 2. A tabulation of the number of assignments contained in the GMF for the 162-174 MHz band reveals that approximately 25 percent of all assignments in the GMF fall into this band. The total distribution of frequency assignments is shown in Figure 3. The spike is representative of a special purpose nationwide communication network. In order to present a concise summary, the frequency assignments were also divided into various services and finally into individual station classes within these services. These are shown in TABLE 5. The band is used extensively throughout the United States by the Government. The assignment trend data by agency for the 162.0125 to 173.2 MHz band is shown in TABLE 6. The data indicates that the band is used by the majority of Government agencies, with 90 percent of the assignments divided between nine agencies. Along with this data, a geographical plot of the assignments of these nine agencies are shown in Figure 4 through Figure 12.

RSMS Van Measurements

NTIA has actively been involved for the past eight years in monitoring the Government land mobile frequency bands. Considerable resources have been devoted to this task and numerous reports have been prepared on the measurements taken. The measurements cover the period from 1974 to the present time (Department of Commerce 1978-b, 1979-e, 1980). The RSMS monitored the Government land mobile bands at many locations throughout the United States, including urban, mountaintop and military test environments. TABLE 7 contains a partial list of sites at which measurements have been made by the RSMS van.

The measurement results presented in TABLE 7 are excerpts from the results presented for each measurement effort. As an example of these results, a sample of the data compiled for the Washington, D.C. area, June 1978b measurement effort [Department of Commerce 1978b] is presented as Figures 13, 14 and 15. Shown on Figure 13 is the summary plot for the measurements made between the frequencies 164 MHz and 165 MHz. These plots were presented for every 1 MHz for the 162-174 MHz band. The top graph shows the percentage of time each frequency was measured. The bottom graph shows the maximum and average power levels received during the measurement period. Hourly band occupancy versus time-of-day are shown in Figure 14. The bottom graph shows time-of-day band occupancy for the local channels (i.e., assigned channel within coverage area), and the top graph indicates hourly occupancy for all measured channels. Figure 15 shows overall usage distribution for the local channels as well as for all measured channels. Also compiled by the RSMS van crew, but not presented here, were GMF assignment information of the local channels, the associated usage statistics and comments from aural monitoring.



UNCLASSIFIED

Figure 1. Distribution of Fixed and Mobile Assignments from CMF as of January 1982

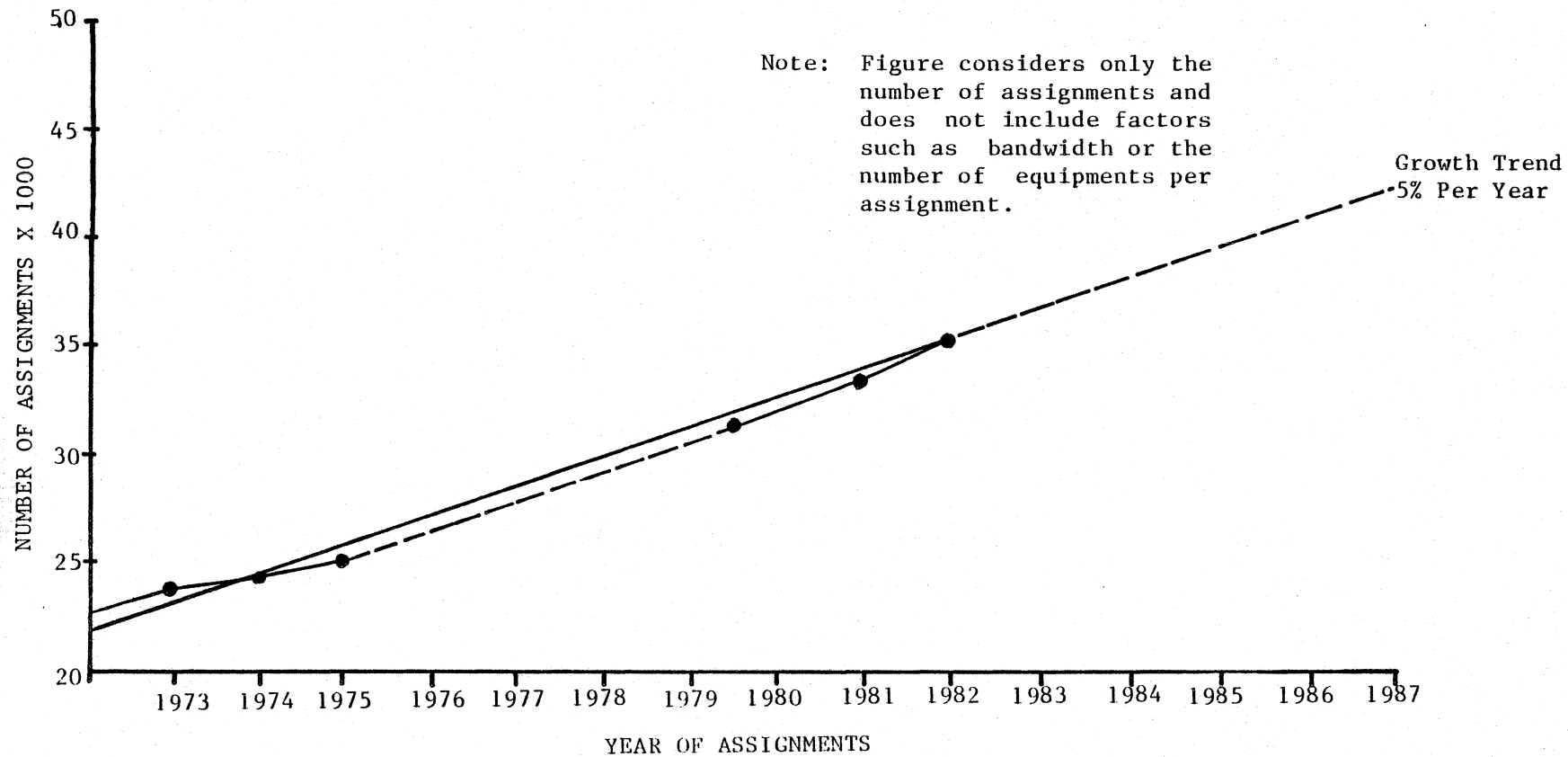


Figure 2. Statistical Usage Summary of the GMF in the Indicated Year for the 162-174 MHz Band.

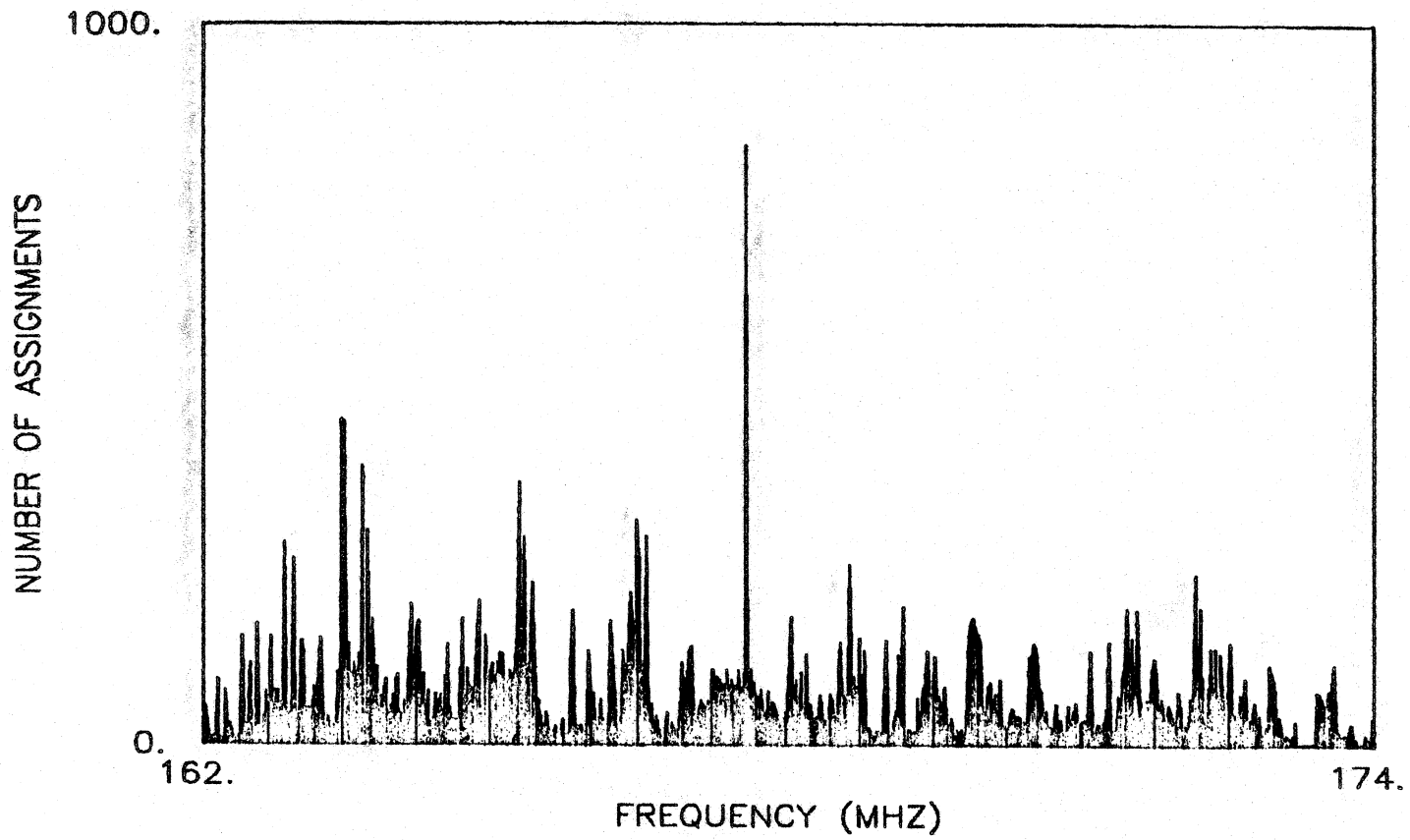


Figure 3. Distribution of Assignments vs Frequency in the 162-174 MHz Band

TABLE 5

SUMMARY OF GOVERNMENT MASTER FILE
(January, 1982)

<u>TERRESTRIAL RADIOCOMMUNICATIONS</u>	<u>Number of Occurrences in GMF*</u>
(1) FIXED SERVICE (14096)	
FX (9440), FXR (2041) pt-to-pt	11481
FXD (39), FXDR (12) telecommand fixed station	51
FXE (902), FXER (163) telemetry fixed station	1065
FXH (1316), FXHR (183) hydrologic and meteorological fixed station	1499
(2) MOBILE SERVICE (48598)	
a.) 23906	
FL (7675), FLR (3119) land station	10794
FLD (18), FLDR (4) telecommand land station	22
FLE (54), FLER (7) telemetry land station	61
FLEC (17) surface telemetering land station	17
FLH (139), FLHR (1) hydrologic and meteorological land station	140
FLU (1) aeronautical utility land station	1
MO (11756), MOR (6) mobile station	11762
MOB (340) radio beacon mobile station	340
MOD (4) telecommand mobile station	4
MOE (703) telemetering mobile station	703
MOEB (1) flight telemetering mobile station	1
MOEC (40) surface telemetering mobile station	40
MOH (3), MOHR (1) hydrologic and meteorological mobile station	4
MOP (17) portable mobile station	17
b.) AERONAUTICAL MOBILE - (359)	
FA (68), FAR 61 aeronautical station	129
FAT (16) flight test station	16
MA (213), MAR (1) aircraft station	214
c.) LAND MOBILE - (24209)	
FB (7516), FBR (2584) base station	10100
ML (13511), MLR (27) land mobile station	13538
MLP (571) portable land mobile station	571
d.) MARITIME MOBILE SERVICE (124)	
FC (31), FCR (7) coast station	38
OD (02), oceanographic data station	2
OE (2) oceanographic data interrogating station	2
MS (82) ship station	82
(3) RADIOLOCATION SERVICE (406)	
MR 406 radiolocation mobile station	406
(4) EXPERIMENTAL STATIONS (300)	
XC (49) contract development station	49
XD (57) development station	57
XE (8) export station	8
XR (15) research station	15
XT (171) testing station	171

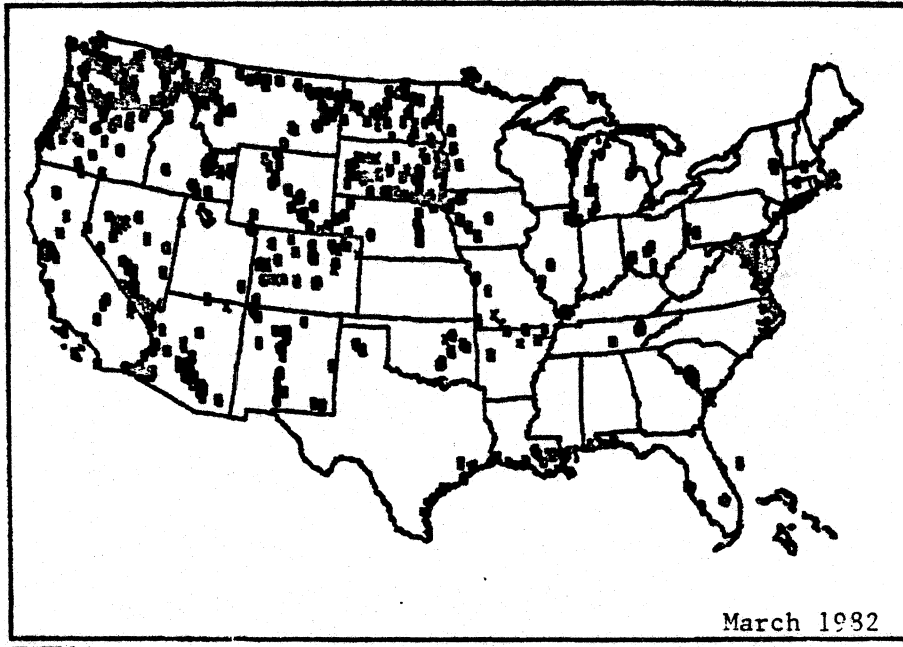
* Total number of occurrences will be greater than the number of assignments.

TABLE 6

ASSIGNMENT TREND DATA BY AGENCY FOR THE 162.0125-173.2 MHz
FIXED AND MOBILE BAND

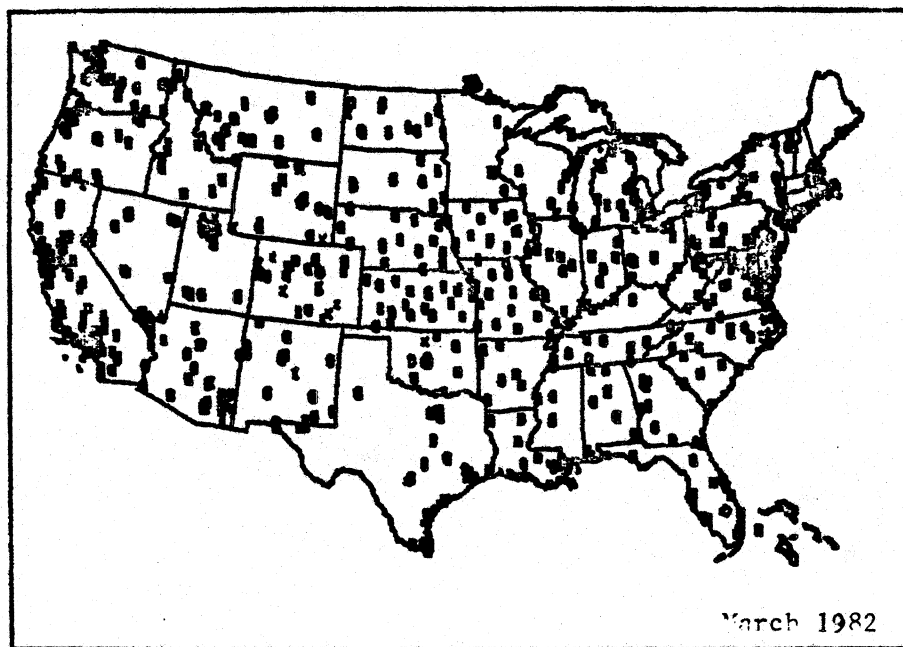
Agency	1/72	1/73	1/74	1/75	7/79	12/80	7/81	1/82
OMB	0	0	0	1	0	0	0	0
BOB	0	0	1	0	0	0	0	0
USIA	7	7	7	7	0	0	0	0
OTHR	3	0	0	0	0	0	0	0
OEP	2	0	0	0	0	0	0	0
AEC	548	494	505	558	0	0	0	0
HEW	40	64	61	58	139	0	0	0
PO	239	274	37	0	0	0	0	0
OA	0	0	0	0	1	1	1	1
CPSC	0	0	0	1	1	1	1	1
SEN	0	0	0	0	0	2	2	2
HR	0	0	0	0	2	2	2	2
LC	0	0	0	0	0	1	1	2
SC	2	2	2	2	2	2	2	2
AUSC	0	0	0	0	0	5	5	5
NS	0	0	1	1	4	6	6	6
NRC	0	0	0	0	6	6	6	6
HUD	2	1	1	4	8	8	6	6
ICA	0	0	0	0	9	9	9	9
CIA	13	13	13	14	12	12	12	11
S	10	10	12	12	26	10	10	12
USCP	3	4	5	5	8	10	12	12
FRS	13	21	14	15	22	20	20	20
SI	5	6	6	6	19	22	20	20
FCC	14	34	42	39	29	35	35	37
IBWC	18	18	18	22	28	30	38	38
L	12	13	13	14	22	35	37	40
GSA	36	54	41	41	43	45	43	46
EPA	20	30	25	30	45	50	50	50
NSF	16	15	15	14	52	54	53	53
FEMA	0	0	0	0	0	15	54	54
TRAN	44	44	52	54	75	100	99	99
NASA	89	97	102	88	122	129	128	128
HHS	0	0	0	0	0	147	148	153
CG	87	108	98	108	161	182	193	198
N	360	192	192	88	142	201	258	267
NG	0	0	0	0	80	157	311	337
VA	177	285	306	323	397	472	474	479
TVA	216	222	216	233	390	409	435	498
USPS	0	0	273	430	509	559	562	567
C	1040	1094	931	626	850	1030	1081	1120
AF	1095	1025	1063	1170	1146	1202	1228	1224
FAA	286	273	297	331	887	1146	1411	1495
DOE	0	0	0	0	882	1438	1506	1688
AR	1740	1998	1910	2106	2722	2742	2756	2780
T	843	893	1008	1083	3180	3228	3221	3754
I	3661	4003	4275	4740	5580	5575	5762	5722
A	6022	6269	6317	6317	6360	6202	6196	6336
J	4922	5392	5615	5800	6862	7417	7607	7965
TOTALS	21585	22955	23474	24343	30823	32717	33801	35245

Note: The above table reflects organizational changes (example AEC incorporated into DOE).



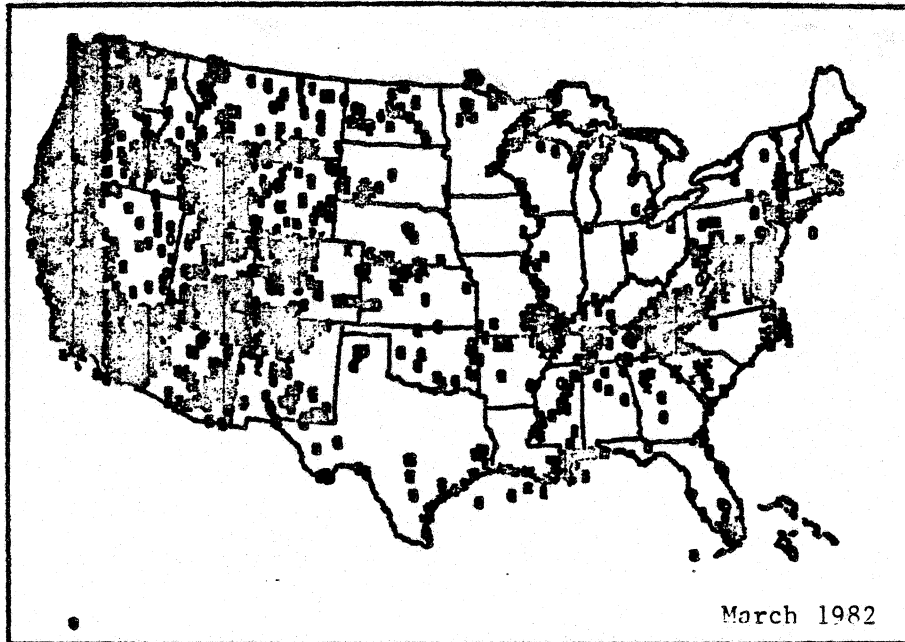
ENERGY

Figure 4. Geographical Distribution of the Department of Energy Assignments



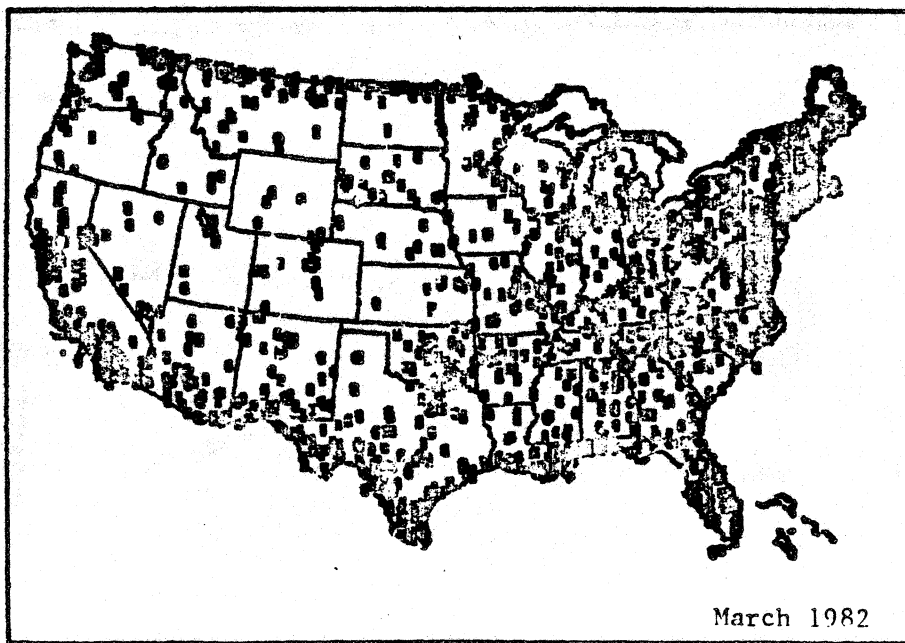
FAA

Figure 5. Geographical Distribution of the Federal Aviation Administration Assignments



INTERIOR

Figure 6. Geographical Distribution of the Department of Interior Assignments



JUSTICE

Figure 7. Geographical Distribution of the Department of Justice Assignments

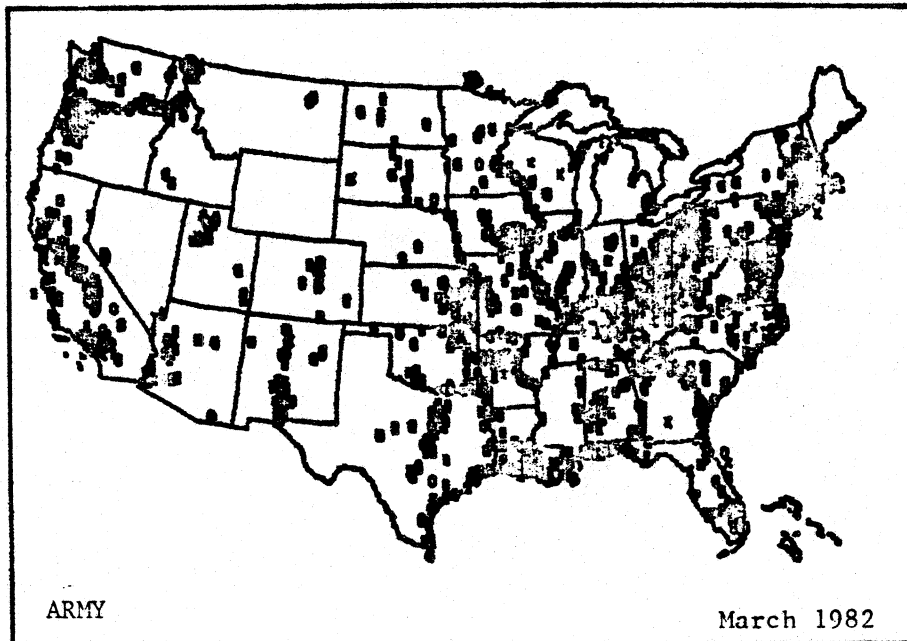


Figure 8. Geographical Distribution of the Department of the Army Assignments

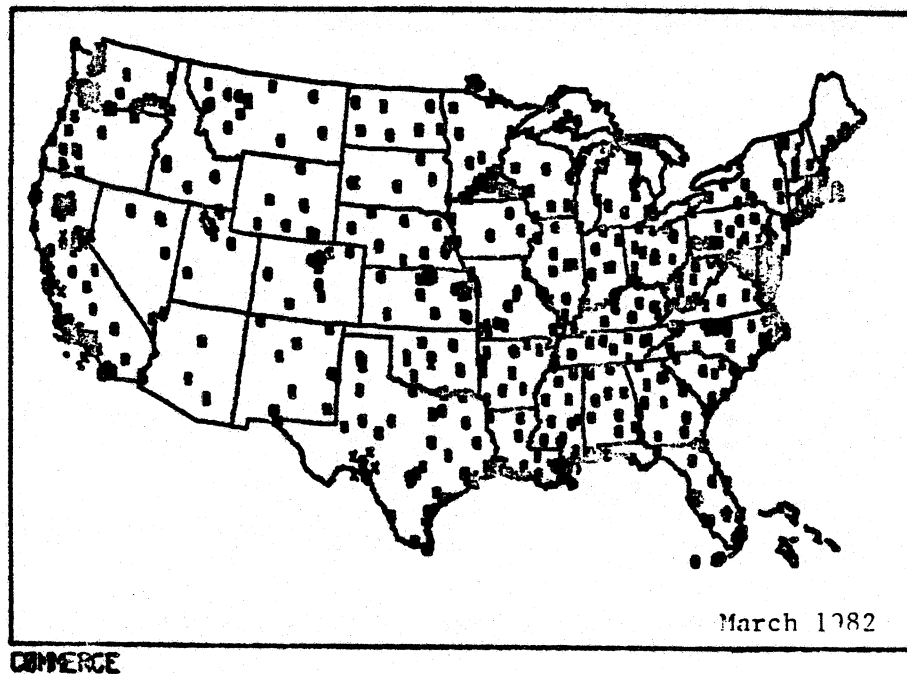
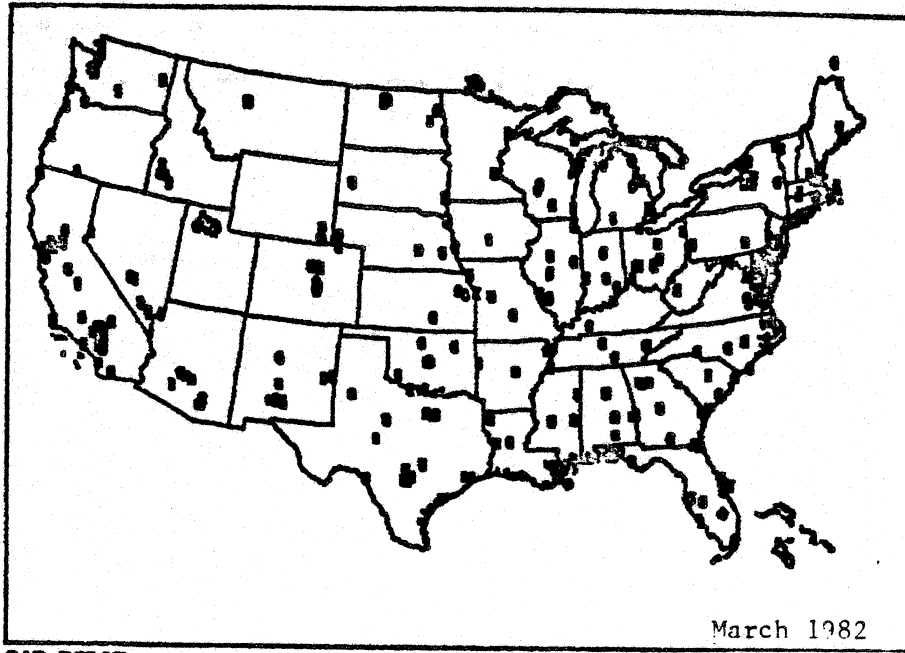
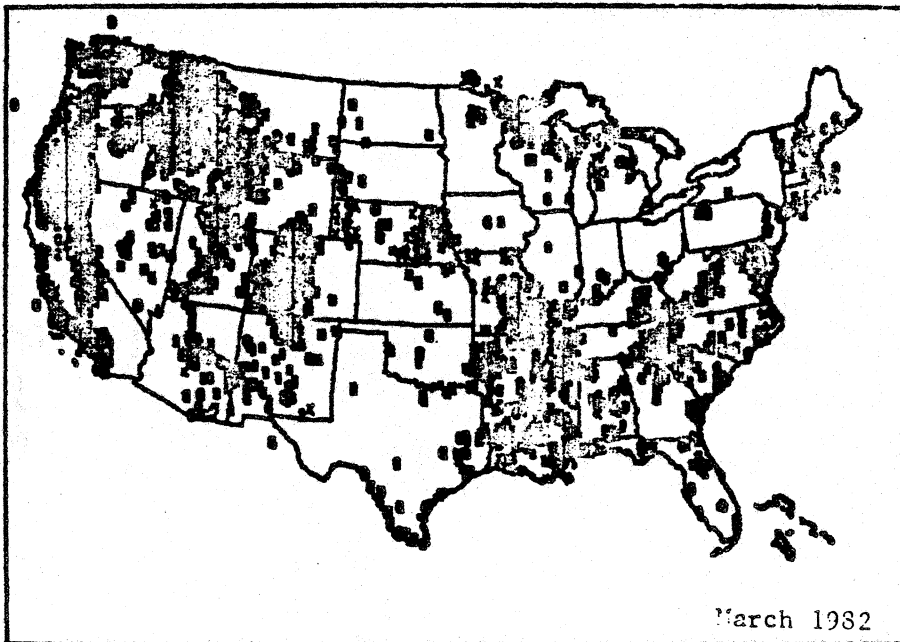


Figure 9. Geographical Distribution of the Department of Commerce Assignments



AIR FORCE

Figure 10. Geographical Distribution of the Department of the Air Force Assignments



AGRICULTURE

Figure 11. Geographical Distribution of the Department of Agriculture Assignments

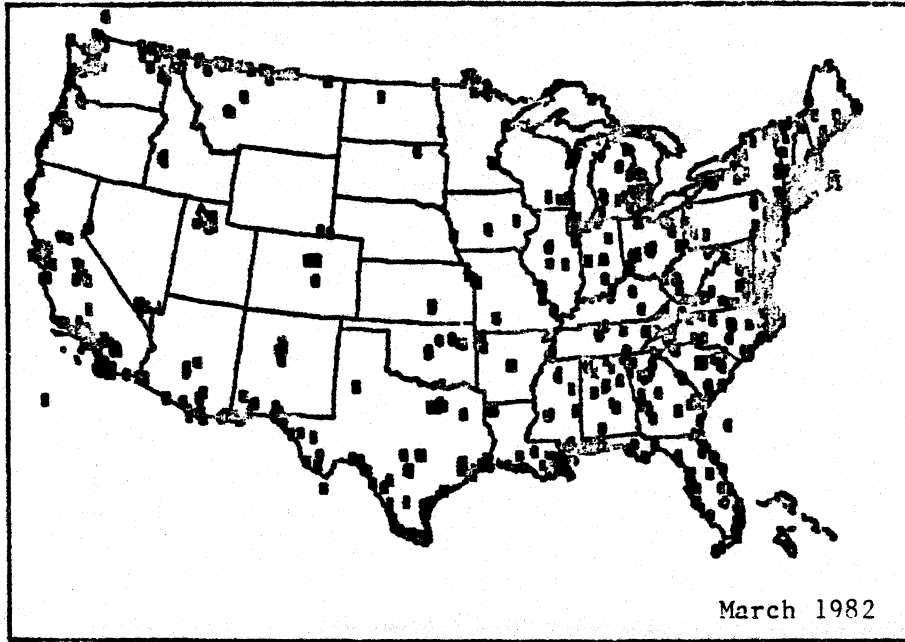


Figure 12. Geographical Distribution of the Treasury Department Assignments

TABLE 7

SUMMARY OF RECENT MEASUREMENT RESULTS
FOR THE 162-174 MHz BAND

MEASUREMENT AREA	MEASUREMENT DATES	CHANNELS MEASURED		CHANNEL USAGE $\geq 0.5\%$				
				LOCAL		ALL COVERAGE		RADIUS (km)
		LOCAL	ALL	NO.	%	NO.	%	
NORFOLK, VA	3/78	77	N/A	34	44	57	N/A	80
WASHINGTON, D.C.	6/78	216	479	115	53	137	29	56
DETROIT, MICH.*	1-2/79	67	479	35	52	159	33	64
BUFFALO, NY	3/79	41	479					55
MALONE, N.Y.*	3/79	16	479	10	60	278	58	40
BOSTON, MA	5-6/79	68	479	34	50	111	27	64
N.Y.C., N.Y.	11/79	116	479	60	52	124	26	40
DENVER, COLO.	3-4/80	116	479	45	39	79	22	48

Notes:

1. A local channel is defined for the purpose of these measurements as an assigned channel within the expected measurement radius of the RSMS van.

*Data obtained from the percentage usage graphs.

NA - Not Available

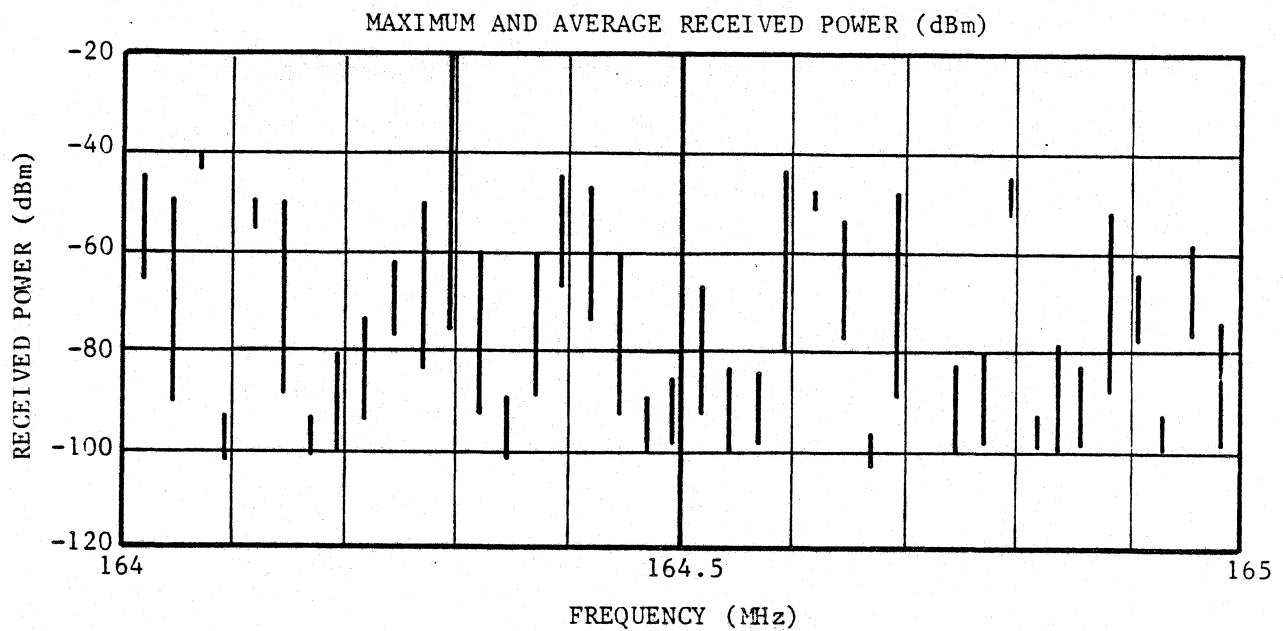
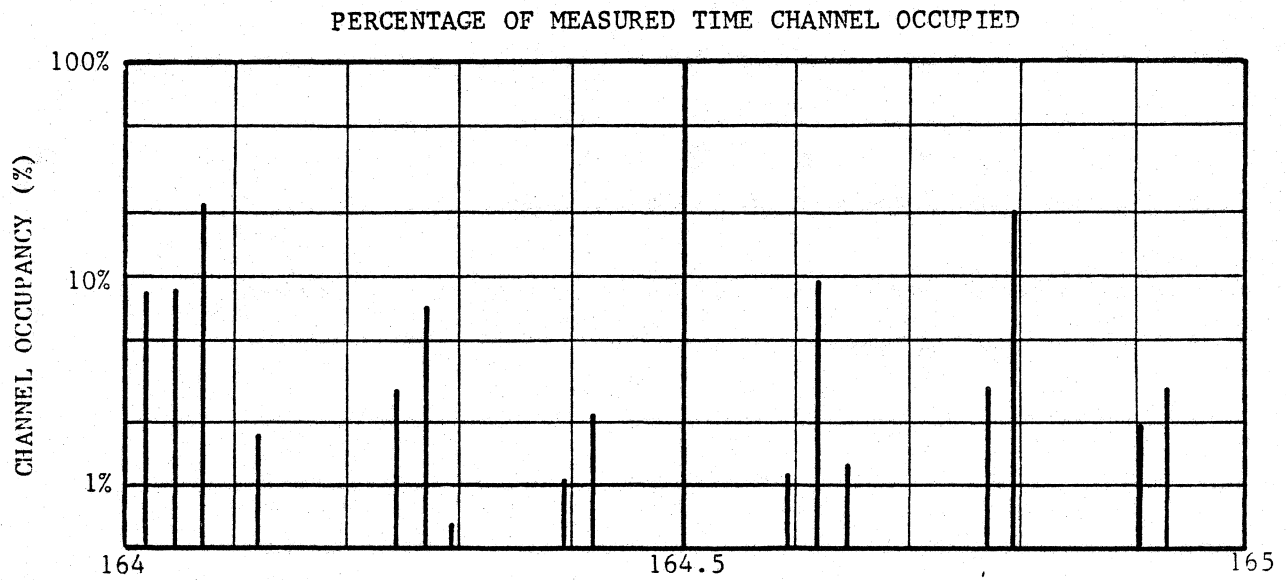
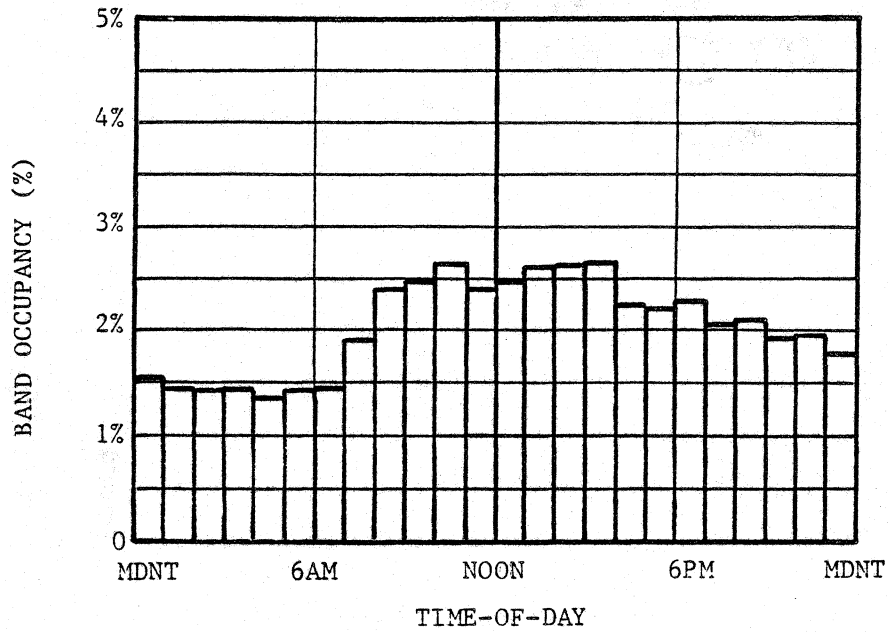


Figure 13. Example Summary Plot, 164-165 MHz

ALL 479 MEASURED CHANNELS



ALL 216 LOCAL GMF CHANNELS

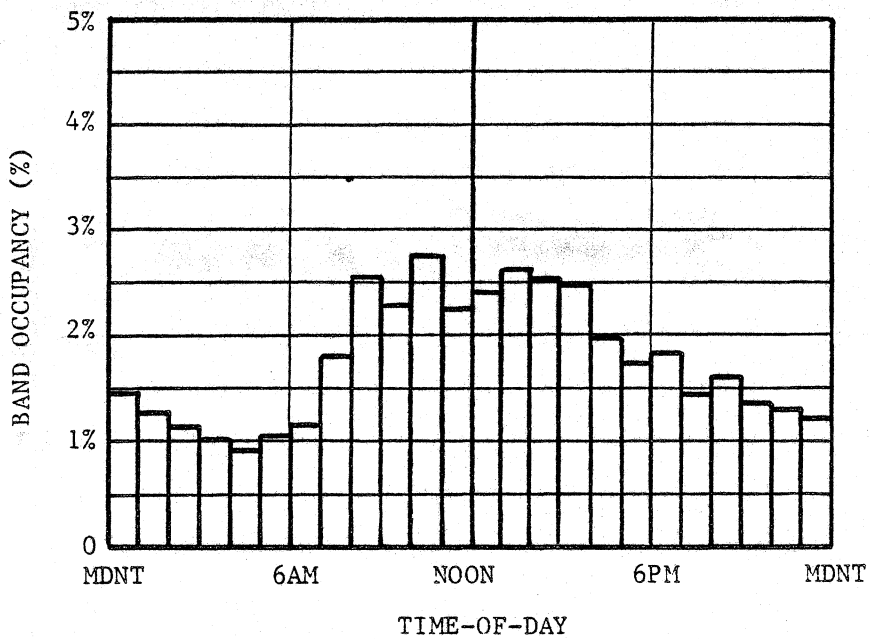


Figure 14. Example Time-of-Day Band Occupancy, 162-174 MHz

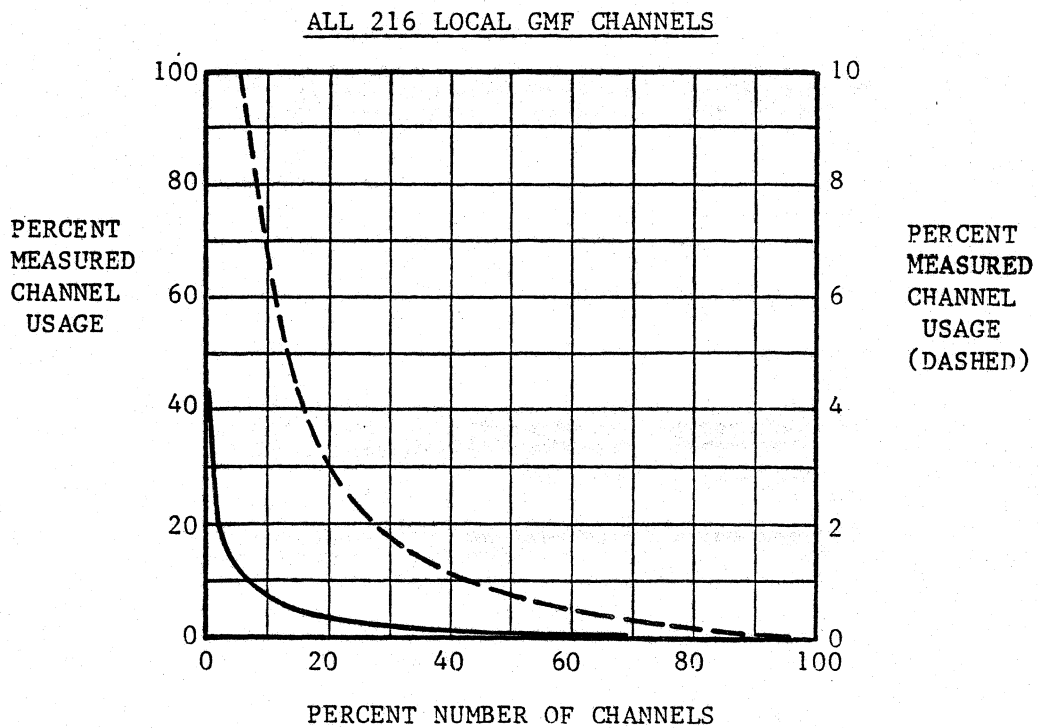
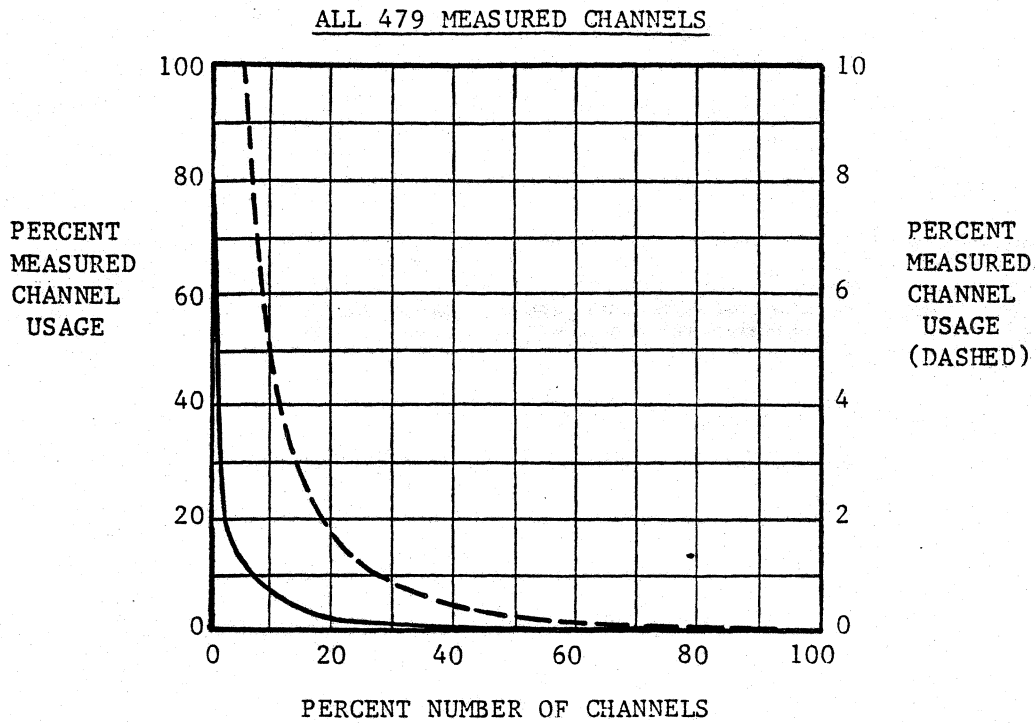


Figure 15. Example Measured Channel Usage Distribution, 162-174 MHz

Appendix B provides measured channel occupancy for eight sites measured since 1978. The data indicate that in the metropolitan areas where measurements were made, on the average, emissions were measured on ten percent of the available channels for ten percent of the time.

When any examination of the RSMS measured data is made, it is necessary to keep in mind that the statistics generated as a result of these measurements do not directly reflect the Government's use of and requirements for access to the VHF land mobile spectrum. It has been pointed out in a previous report (Crandall, 1982) that the Government's use of the land mobile spectrum is so diverse that it is difficult to choose a location where measurements would present an accurate picture of the spectrum utilization. Expected coverage for land mobile environment are contained in Appendix B. The RSMS measurement reports on those sites in proximity to the Canadian border indicate a level of implied usage that is greater than the actual usage. This result is obtained because the RSMS monitoring system picks up the Canadian usage of the 162-174 MHz band.

There are a number of differences in communication requirements and uses among Government agencies. There are certain Government assignments that are used only in times of emergencies or during special events. Examples of these types of uses are Agriculture's fire cache and Treasury's assignments for Presidential security which would be used when the President is to be or is in that particular area.

Government agencies use the spectrum in support of congressionally mandated mission requirements which vary in degree depending upon requirement, Presidential directive, or other operational limitations. Uses such as these are in support of high priority missions which dictate the high availability and reliability of communications but not necessary high on-the-air usage. The measurement sites to date have been in urban areas where some of the major users of this band are not concentrated. Agriculture, Interior, and Energy operations are concentrated in national parks, forests, and other remote areas. In contrast, some operations are used in both metropolitan and remote areas such as energy operations for power and line maintenance. Additionally, the military agencies are significant users of this band also, but their utilization is more or less concentrated around military installations and not the urban areas of the United States.

Channel usage cannot be determined from GMF statistics alone. When spectrum is scarce, especially in the urban areas, the RSMS measured data may be used to determine available spectrum in a particular area, verify advantages of certain frequency sharing schemes, and be used in comparison with previous measurement efforts to determine growth and usage trends. The RSMS monitoring program supplements and complements the frequency assignment records in the GMF.

Future use of the RSMS van involving measurements of this band should address not only the on-the-air channel occupancy but also the missions that are served by this usage.

Future and Planned Systems from the Systems Review File

An examination of the Systems Review File was made to determine present and future plans for the 162-174 MHz band. Presently, there are seventeen systems in the File. The number of systems do not reflect the total present or future use for the 162-174 MHz since many systems have been operational before the system review process was initiated for the 162-174 MHz band. A review of the File indicated that many of the newer systems are digital. This trend is substantiated from the information received in agency interviews (Appendix A) where applications for voice scrambling are projected to have significant growth potential. Other systems provide message dispatch, multiple access, telemetry and command. These systems are tabulated in TABLE 8.

A NATIONWIDE SYSTEM (NOAA Weather Radio Service)

NOAA Weather Radio is a service of the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. It provides continuous broadcasts of the latest weather information directly from National Weather Services offices. Taped weather messages are repeated every four to six minutes and are routinely revised every one to three hours or more frequently if needed. Most of the stations operate 24 hours daily. The broadcasts are tailored to weather information needs of people within the receiving area.

During severe weather, National Weather Service forecasters can interrupt the routine weather broadcasts and substitute special warning messages. The forecasters can also activate specially designed warning receivers. Such receivers either sound an alarm indicating that an emergency exists, alerting the listeners to turn the receivers up to an audible volume, or when operated in a muted mode, are automatically turned on so that the warning message is heard. "Warning alarm" receivers are especially valuable for schools, hospitals, public-safety agencies and news media offices.

NOAA Weather Radio broadcasts are made on one of seven high-band frequencies ranging from 162.40 to 162.55 megahertz (MHz). These frequencies are not found on the average home radio now in use. However, a number of radio manufacturers offer special weather radios to operate on these frequencies, with or without the emergency warning alarm. Also, there are now many radios on the market which offer standard AM/FM frequencies plus the so-called "weather band" as an added feature.

The National Weather Service operates about 370 stations. Approximately 90 percent of the Nation's population is within listening range of a NOAA Weather Radio broadcast. Figure 16 shows the location of these stations within the continental United States.

TABLE 8

SYSTEMS DOCUMENTED IN THE SRF FOR THE 162-174 MHz BAND

<u>Agency</u>	<u>System Name</u>
J	FBI Land Mobile Radio Communications System
HEW	Integrated Medical and Behavioral Lab. Meas./ System and Space Technology Applied to rural Papago advanced health care.
NASA	SEASAT-A- terminated due to satellite malfunction
T	Digital Voice Protection System
J	Digital Voice Protection System
DOE	Digital Voice Privacy System
N	Classified System
J	INS Enforcement Land Mobile Radio System
I	TVA Dam Failure Radio Warning System
J	U.S. Marshals Service Enforcement Land Mobile Radio Communication System
FAA	Runway Lighting Control System
NASA	Paging System
C	Weather and Disaster System
DOE	NEST Digital Voice Privacy Systems
AF	Radio Alert Sensor
AR	Covert Duress Sensor
NASA	Global Magnetic Survey Mission

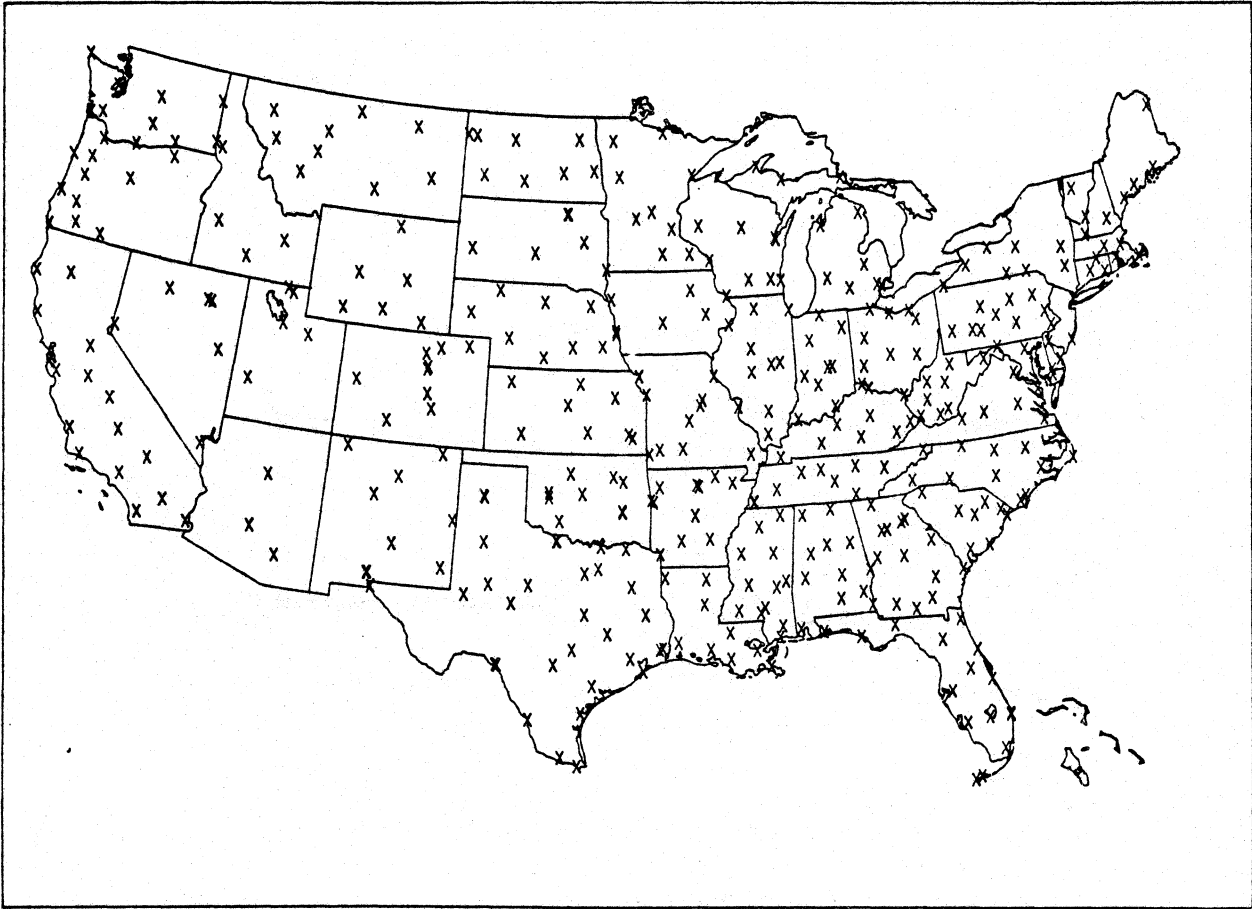


Figure 16. The Location of the NOAA Weather Radio Service Stations in the 162-174 MHz Band.

SECTION 5

SPECTRUM MANAGEMENT ISSUES

Spectrum Management Considerations

The previous two sections have provided a synopsis of the rules and regulations and have discussed the Government's usage of the 162-174 MHz band. This section discusses specific spectrum management aspects of the band.

The 162-174 MHz band supports land mobile radiocommunication operations which are essential to the functions of many Government agencies. However, a survey of major users of the band indicates that there are more than 100,000 base, mobile, or portable stations in use, although exact equipment counts are not kept by NTIA or the user agencies. No exact figures are available on the equipment inventory. The frequency management offices of the Government agencies do not keep precise records on the numbers of land mobile radios as a regular part of their operations.

The topics which are discussed in this section are:

1. Cosite Analysis Capability
2. Improvement in Spectrum Utilization, and
3. Interference with TV Channel 7

Cosite Analysis Capability

Some of the government agencies have expressed a concern about the lack of an antenna siting procedure to cover the situation when a new communications system is being introduced into the environment. In essence, such a procedure would be a cosite analysis capability. NTIA has considered developing such a capability on a number of occasions, most recently by Crandall (1982).

Development of a cosite analysis capability is not recommended because it would require an extensive equipment data collection effort with respect to the antenna sites used by the Government. A computer data base would also have to be established to store the information and have it readily available for the analysis program. This data collection would turn out to be a major program effort by itself.

Amplitude Compandored Single Sideband (ACSB)

NTIA is presently assessing the potential impact that Amplitude Compandored Sideband (ACSB) may have on the VHF Land Mobile Service. This program is not scheduled for completion until some time in FY83, and no conclusions have been drawn concerning its value as a spectrum efficient system. Whatever the conclusions, they must be considered in light of the present systems employed and functions being served by the Government land mobile operations.

The principal distinction between Government and non-Government land mobile operations is the communication networks necessary to satisfy the stated requirements. In the non-Government, the networks cover geographic areas which are relatively small compared to the area of the United States. At most, these communication networks are statewide or regional, such as those communication networks the State Police might have in operation. The requirements of the Federal Government are quite different. Many of the Government agencies have requirements for interstate and nationwide communication networks. Not only is the requirement for the nationwide networks, but the agencies, in support of their respective missions, frequently move personnel and radio equipment around the country on short notice. In such instances, the requirements exist for the communication equipment to be compatible in both modulation and frequency with the agencies' local networks. The agencies must also have the authorization to operate no matter where they are required to go in the United States. Examples would include the Federal law enforcement organizations and the DOA's fire cache.

The equipment inventory of the Government agencies for the VHF land mobile bands is large, with the larger agencies having tens of thousands of units. The agencies having these large inventories must proceed with care when evaluating a new land mobile radio which employs a different type of modulation. Numerous questions arise concerning reliability of new systems, incompatibility of systems and logistics and funding problems involved with changeover to a completely new type of radio system. In practical terms, it would be difficult for agencies with large inventories and requirements for nationwide networks to changeover to systems employing a different modulation type. As a result, any new requirement must be treated on a system basis rather than replacement of individual radios. All these factors will be considered in the evaluation of the ACSB VHF radio.

Trunking

Trunking is a system design developed by the telephone industry which employs switching devices at each telephone exchange such that a large number of users can be served over a much smaller number of talk paths or trunks. When a call is made, a talk path is established which was previously used by another user and will be used soon by others. The next call made on the same number will not necessarily be connected by the same talk path. The use of trunking achieves a higher degree of facility loading and utilization for a telephone system.

Trunking is an aspect of land mobile communications which is beginning to become increasingly important. Trunking is a method which leads to a more efficient use of the available land mobile spectrum. It has some similarity to the electronic switching system of the telephone system. When a telephone call is made, switching devices are utilized which give access to the necessary facilities to complete the call. There is no guarantee that the next time the same number is called from the same location that the same path will be used in completing the call. A similar method is utilized in land mobile trunking systems. In this situation, the facilities utilized are different frequency channels. Trunking provides an improvement in channel loading, and increasing channel availability through a switching network of communication channels. In this way, the situation in which one channel is overloaded while another channel is unused, can be avoided.

The major users of the 162-174 MHz band, when interviewed, identified as a particular problem, the difficulty of finding an available channel in the major metropolitan areas of the United States. A trunking system has the potential for alleviating the current difficulty. The RSMS measurements on channel usage tend to support this concept. TABLE 7 lists data extracted from Figures 17 through 21 giving the "on the air time" for 10 percent of the available channels in a given 24-hour period. Ten-channel trunking systems are now in operation which are designed to handle up to 1000 mobiles. Such a system could accommodate the usage indicated in these measurements without exhausting the overall system capacity (FCC, 1967). Implementation of such systems has the potential to make existing channels available for those agencies with unsatisfied requirements for nationwide communication networks.

NTIA should take the lead in encouraging the implementation of trunking in the 162-174 MHz band. A major increase in efficient use of the radio spectrum would certainly result. NTIA should initiate a study on the best way to approach trunking for Government land mobile operations. An earlier study (Crandall, 1982) arrived at a similar conclusion.

Along with trunking, NTIA should encourage the use of "community repeaters." The community repeater is a technology transfer from the private sector. Control of repeater stations is one important application of tone squelch. When included in the base, repeater, and mobile stations, the tone squelch helps maintain positive control of the repeater. By assigning different tones to several users, many can share the repeater with little mutual interference (Hurt G., 1976). Spectrum can be conserved with the proper application of this technology.

Cellular radio is another approach at improved spectrum efficiency, however, there is little or no application to the Government since mobile radio telephone needs can be satisfied through the use of commercial equipment.

Narrowband VHF/FM

Another area of spectrum efficiency that NTIA should investigate is the feasibility of reducing the present channel spacing to 12.5 kHz. NTIA is now funding an investigation to assess the feasibility of ACSB for Government land mobile operations. Implementation of 12.5 kHz FM has a number of attractive aspects. The two aspects which are most attractive are the compatibility with existing systems and the potential for doubling the number of channels. NTIA should fund an experimental program to develop working models for a 12.5 kHz FM system. The cost of such a program should be reasonable. An existing FM radio could be modified to demonstrate the feasibility of the narrowband FM.

Interference Problems with TV Channel 7

The topic of interference with TV channels in the upper adjacent band did arise during the agency interviews. Interference reports indicate that the audio and video carriers of TV channel 7 mix and form intermodulation products which fall in the Government land mobile band between 170.55 and 170.95 MHz. Operation

of TV transmitters and their spurious output levels is covered in part 73.687i of the FCC Rules and Regulations. The present level of spurious output is indicated as being temporary. What is needed is an investigation into this interference problem with the objective of recommending a Government stance with respect to this problem.

Not all the interference experienced is to the land mobile community. Cases of interference to TV from land mobile systems has prompted the FAS to include assignment guidelines for frequencies at the upper end of this land mobile band. This is an area that is also in need of further investigation.

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APPENDIX A

AGENCY INTERVIEWS

Interviews were conducted with the major Government users of the frequency band 162-174 MHz. The criteria for selection of the agencies to be interviewed was set at those having more than 1000 records in the GMF in the 162-174 MHz band. The agencies interviewed were:

- Department of Justice
- Department of Agriculture
- Department of Interior
- Department of Energy
- Department of Treasury
- Department of the Air Force
- Department of the Army
- Department of Transportation (FAA)
- Department of Commerce

The remaining portion of this annex identifies the questions asked and a summary of the responses received.

Summary of Interviews

QUESTION 1:

Do you have unsatisfied requirements in the 162-174 MHz frequency band at the present time? If yes, specify.

RESPONSE:

In general, the agencies interviewed indicated that they did not have any unsatisfied spectrum requirements in this band. Four of the agencies did indicate problems in coordinating new assignments with Canada. It was also pointed out that it is no longer possible to obtain an exclusive frequency for use in establishing a new nationwide communications network in this band.

QUESTION 2:

What trends do you envision in equipment usage? Specifically for the following systems:

A. Single channel voice systems

1. tone-controlled squelch
2. selective tone signalling
3. tone-remote control
4. interstitial channel use
5. narrowband technology

B. Digital System

1. Speech Scrambling
2. Message dispatch
3. Multiple access
4. Telemetry and Telecommand

C. Wideband Systems Status

1. Multichannel
2. Telemetry

RESPONSE:

(A) Single Channel Voice Systems:

The agencies indicated that little current use is made of tone-coded squelch in the 162-174 MHz band. A few of the agencies have employed such techniques on a limited basis and plan to consider them in new equipment purchases.

The largest users of the band do utilize interstitial channels to satisfy some of their requirements. No dramatic increase in the use of interstitial channels was forecasted.

The agencies did indicate an interest in the new narrowband technologies but at the same time, it was pointed out that there are practical problems associated with implementation of systems having a different modulation technique. This is especially true when dealing with agency requirements for nationwide communication networks.

(B) Digital Systems:

The Government use of digital modulation techniques in the 162-174 MHz band involves the collection of hydrological data and voice scrambling. By far, the most wide spread application is for voice scrambling and it is also the one area that has been projected to have significant growth potential.

DOJ - Scrambling and will increase and indicated within five years, most land mobile systems will be using encrypted digital voice. Significant use of remaining items but limited.

DOC - Supports scrambling
No on the rest

FAA - No digital or Wide BW

DOI - Message dispatch (Voice)

AF - Some use for scrambling, also hydrological
Narrow BW

T - Scrambling and message dispatch
No Wideband
No multiple access

DOE - Scrambling
No on the rest

DOA - Little use today. Some telemetry and message dispatch.

ARMY- Scrambling. Will expand.

(C) Wideband Systems Status:

Wideband systems, greater than a single voice channel, are utilized by a number of the agencies although each agency indicated that such systems do not make up a significant portion of their respective operations. With one exception, the agencies interviewed did not foresee a significant growth in the use of wideband systems in this band. In fact, their use was being discouraged in many instances because of its inefficient usage.

QUESTION 3:

What are your specific Spectrum Management problem areas?

- A. Geographic Location
- B. Cosite
- C. International Sharing
- D. Interagency Sharing
- E. Other

RESPONSE:

The problem areas identified repeatedly by the agencies are identified below. Items (a) and (b) were the most consistently identified problem areas.

- (a) Coordination of frequency assignments with Canada;
- (b) Cosite problems associated with antenna site management;
- (c) Congestion of channels in metropolitan areas;
- (d) Interference received from TV Channel 7.

QUESTION 4:

What is your criteria for band saturation?

RESPONSE:

The interview results point out the fact that there are no universal definitions of, or criteria for, frequency band saturation.

QUESTION 5:

What is your criteria for frequency reuse?

RESPONSE:

The responses received as a result of this question indicate that the agencies interviewed consider frequency reuse on a case by case basis. Geography seems to be the major factor in determining conditions for reusing a particular channel. In addition to geography, potential intermodulation products are also considered by many of the users.

QUESTION 6:

What is your projected growth?

RESPONSE:

No specific figures were available on the anticipated growth of the land mobile service in the 162-174 MHz band. The agencies interviewed anticipate a continued growth in their land mobile operations. Specific areas of highest anticipated growth involve those operations concerned with security activities, the weather service operations, and in the law enforcement areas.

QUESTION 7:

Are there any repeaters in the Washington Area that could be used in ACSB testing?

RESPONSE:

This question was discarded shortly after initiation of the measurement program. It should be pointed out that the agencies have been helpful to NTIA in regards to the measurement program and cooperated on each occasion when assistance was requested.

QUESTION 8:

Do you break up your assigned frequencies by services? If so, do you use standard pairing for your two-frequency simplex operations?

RESPONSE:

The responses indicate that the agencies do not separate their respective assignments within the band by service with the exception of the hydrological channels. The responses to the second question were split half and half. Some of the agencies use standard pairing for transmitter-receiver pairing.

QUESTION 9:

Do you take into account usage (service) by other agencies when you assign a frequency?

RESPONSE:

The agencies all responded on a positive note to this question. In order to protect their own operations, it is necessary to consider the operations of other agencies using the same frequency or adjacent channels.

QUESTION 10:

Does your agency use or plan to employ trunking in the utilization of this band?

RESPONSE:

All responses stated that there is no present use of trunking in the 162-174 MHz band, and that there are no current plans to implement such a system in this frequency band.

QUESTION 11:

Has your agency made use of Annex I of the NTIA Manual?

RESPONSE:

See question 12.

QUESTION 12:

Do you have any suggestions for the improvement of Annex I of the NTIA Manual?

RESPONSE:

The majority of responses indicated that little use is made of the material available in Annex I of the NTIA Manual. Of those that do make some use of Annex I only one had any comments on how to improve its effectiveness. Another agency pointed out a need for a selectivity curve for tone paging systems. The suggested improvement in Annex I concerned changing the labeling of the graphs to make them easier to understand.

QUESTION 13:

Do you anticipate any new type of frequency management problems to appear in the future for this band?

RESPONSE:

The agencies, in their responses to this question, expressed their concern for continuing to maintain their present level of effectiveness in satisfying their agency's land mobile requirements in this band. In addition to the frequency management problems identified earlier, the agencies indicated a need to examine Government frequency sharing requirement needs.

QUESTION 14:

What aspects of the operation and use of this band do you think should be addressed?

RESPONSE:

This question resulted in a number of areas to be examined for possible investigation in the future. Included in the responses are:

- o Determination of channel loading factors
- o Coordination frequency assignments with Canada
- o Sharing channels with paging systems
- o Long-range plans for use of the band
- o Potential use of trunking
- o Sharing potential with use of tone controlled squelch.

QUESTION 15:

How accurate are your GMF Records for this band?

RESPONSE:

All the agencies that were interviewed stated that the GMF records of assignment were accurate and up-to-date.

APPENDIX B

RSMS Measurements

Introduction

Presented in this appendix are the statistical summaries and measured band usage results for each RSMS measurement effort listed in TABLE 7 of this report. An extract of the 162-174 MHz band usage information as supplied in the references [Department of Commerce (1978, 1978a, etc.)] are the source of data for this appendix.

For each of these summaries a specific measurement site was selected. An ideal site would be one which any transmitter operating in the area of interest could be detected. Unfortunately, the real world usually contains many transmitters whose signals will be above the threshold of the RSMS receiver part of the time and below the threshold part of the time. Although such transmitters make the interpretation of measurements less reliable, knowledge of coverage available from a measurement site is a crucial part of the channel usage assessment process.

In order to demonstrate this variability of coverage from a measurement site, a computer program (RAPIT) was used to make area predictions for a hypothetical base, mobile and hand-held portable transmitter to a typical RSMS receiver. This model called RAPIT incorporates the Longley-Rice Terrain model which is described in Hufford et. al (1982) (NTIA - Report 82-100).

The input to the program consisted of the transmitter parameters in Table B-1 and the RSMS receiver parameters in Table B-2.

Figure B-1 is a reproduced output of the program for a base station indicating values prescribing smooth terrain characteristics, ground constants and climate. The principal feature in Figure B-1 is the table of predicted minimum available power vs distance.

To find the typical measurement range of the RSMS van, simply read down each column to find the first distance at which the minimum available power equals the sensitivity of the receiver. Using a sensitivity of -112 dBm for the RSMS and linear interpolation on the interval, we find the values listed in TABLE B-3, along with other values for mobile and portable transmitters. In TABLE B-4 are values obtained for average terrain irregularities for base, mobile and portable transmitters.

TABLE B-1

TRANSMITTER PARAMETERS USED AS INPUT INTO RAPIT

	Base	Mobile	Portable
Frequency	168 MHz	168 MHz	168 MHz
Polarization	Vertical	Vertical	Vertical
Antenna height	30 M	2 M	2 M
Transmitter power	20 dBW	14 dBW	3 dBW
Antenna gain	8 dBi	0 dBi	-5 dBi
Line Losses	0	0	0

TABLE B-2

RECEIVER PARAMETER USED OR INPUT INTO RAPIT

Frequency	168 MHz
Polarization	Vertical
Antenna Height	10 M
Antenna gain	2 dBi
Line losses	2 dB
*Sensitivity	-112 dBm

*not used as input, but required for range determination

PARAMETERS FOR AVAILABLE POWER

	XMTF	RCVR
POWER:	20.0 DBM	
LINE LOSSES:	11.0 DB	2.0 DB
ANT GAIN:	8.0 DBI	2.0 DBI
ANT HT ABOVE GND:	30.0 M	10.0 M
	98.4 FT	32.8 FT
ANT SITING:	GOOD	GOOD
SERVICE: MOBILE	FREQ: 168.0 MHZ	POLARZ: VERTICAL
CLIMATE: CONT TEMP	GROUND CONSTANTS: .005 S/M, 15.	
TERRAIN DELTA H: 0.0 M. 0.0 FT	PREDICTION CONFIDENCE: 50. %	

PREDICTED MINIMUM AVAILABLE POWER (DBM)
WITH A MINIMUM RELIABILITY OF:

DISTANCE (KM)	FREE SPACE LOSS (DB)	RELIABILITY OF:				
		10%	50%	90%	95%	99%
70.0	114	-94	-102	-107	-109	→112
72.0	114	-95	-103	-109	-110	-113
74.0	114	-95	-104	-110	→112	-115
76.0	115	-96	-105	→-111	-113	-116
78.0	115	-97	-107	-113	-114	-118
80.0	115	-96	-108	-114	-116	-119
82.0	115	-96	-109	-115	-117	-121
84.0	115	-96	-110	-116	-118	-122
86.0	115	-96	-110	-117	-119	-122
88.0	116	-96	-110	-117	-119	-123
90.0	116	-96	-110	-118	-120	-124
92.0	116	-96	-110	-118	-120	-124
94.0	116	-96	-111	-118	-120	-125
96.0	117	-100	-111	-119	-121	-125
98.0	117	-100	-111	-119	-121	-125
100.0	117	-100	-111	-119	-122	-126
102.0	117	-100	→-112	-120	-122	-126

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Figure B-1. Reproduced Output for RAPIT Using Base Parameters and Smooth Terrain.

TABLE B-3

EXPECTED OPERATIONAL RANGES FOR SMOOTH TERRAIN

Reliability	10%	50%	90%	95%	99%
Base Range	--	102(63.4)	77(48)	72(44.7)	70(43.4)
Mobile Range	--	26.5(16.4)	25(15.5)	24.5(15.2)	24(14.9)
Hand-Held Portable Range	13.5(8.4)	13.0(8.1)	13.0(18.1)	12.5(7.8)	122.5(7.8)

Note: all ranges in kilometers (miles in brackets)

TABLE B-4

EXPECTED OPERATIONAL RANGES FOR AVERAGE TERRAIN

Reliability	10%	50%	90%	95%	99%
Base Range	--	116(72)	72(44.7)	70(43.5)	65(40.4)
Mobile Range	--	27(16.8)	25(15.5)	24(14.9)	23.5(14.6)
Hand-Held Portable Range	10(6.2)	10(6.2)	9.5(5.9)	9.5(5.9)	9.5(5.9)

TABLE B-5

USAGE SUMMARY FOR 162-174 MHz BAND
 NORFOLK, VA (March 1978)

NORFOLK, VIRGINIA GMF 780101		MARCH 1978 SCANS 16561	CASS 174.163 THRESHOLD (dBm) -112	
BAND (MHz)	CHANNELS MEASURED	MEASURED	CHANNELS WITH	USAGE
		> = 0.5%	0.5-0.1%	< = 0.1%
162-174	77 : 402	34 : 23	9 : 17	34 : 362

NOTES:

1) Assigned channels used are given first, and unassigned channels second; i.e., assigned: unassigned.

2) A channel is taken as assigned if it has a center frequency assignment within 50 miles of the measurement site that is made according to the channelization plan of the NTIA Manual, Section 4.3.7.

APPLICABLE ONLY TO FIXED GOV'T CHANNELS WITHIN 50 MI.
INCLUDED ARE 77 OF THE 479 CHANNELS MEASURED.

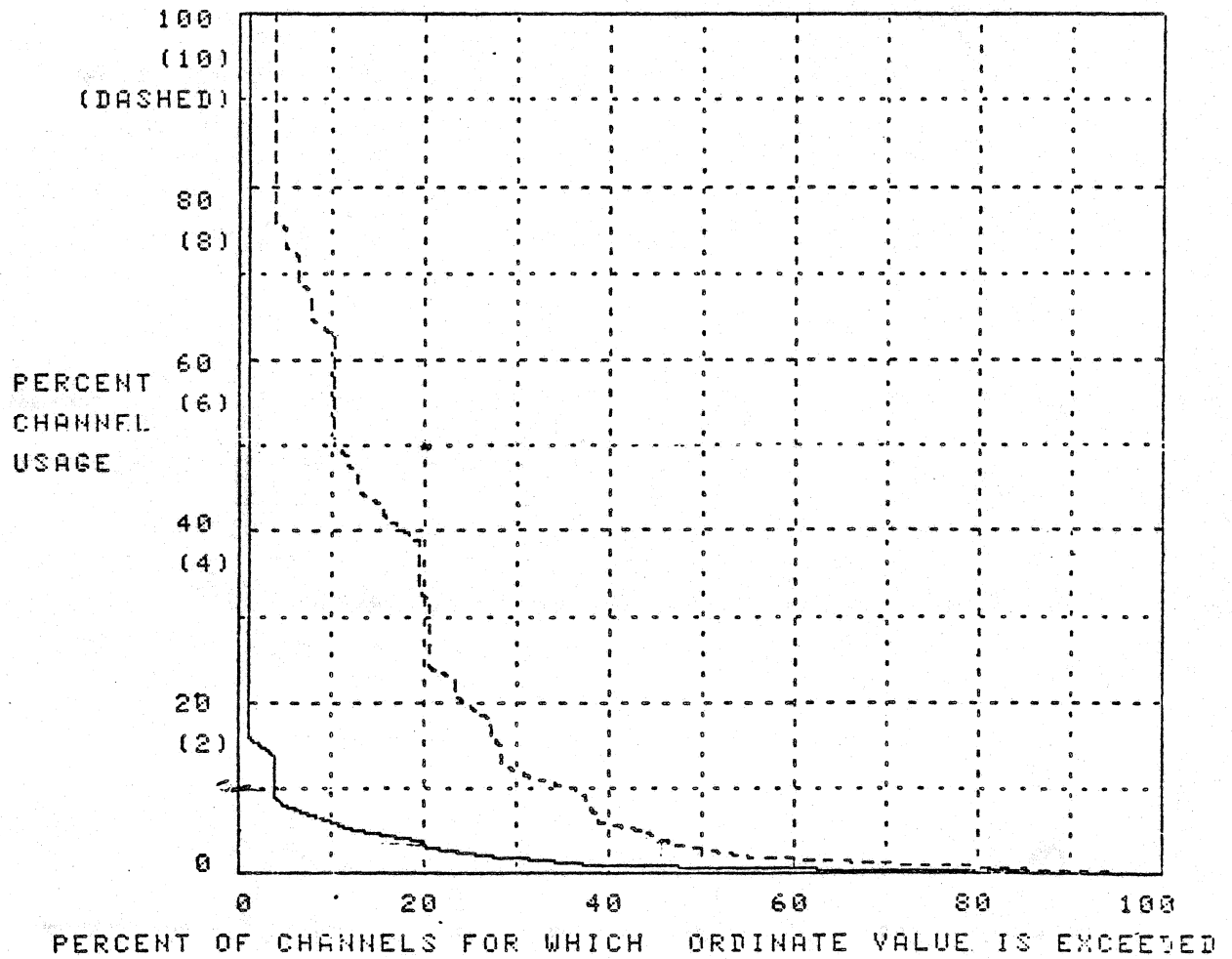


Figure B-2. Channel Usage Distribution for 162-174 MHz Band
Norfolk, Virginia (March 1978)

APPLICABLE ONLY TO ALL CHANNELS.
INCLUDED ARE 479 OF THE 479 CHANNELS MEASURED.

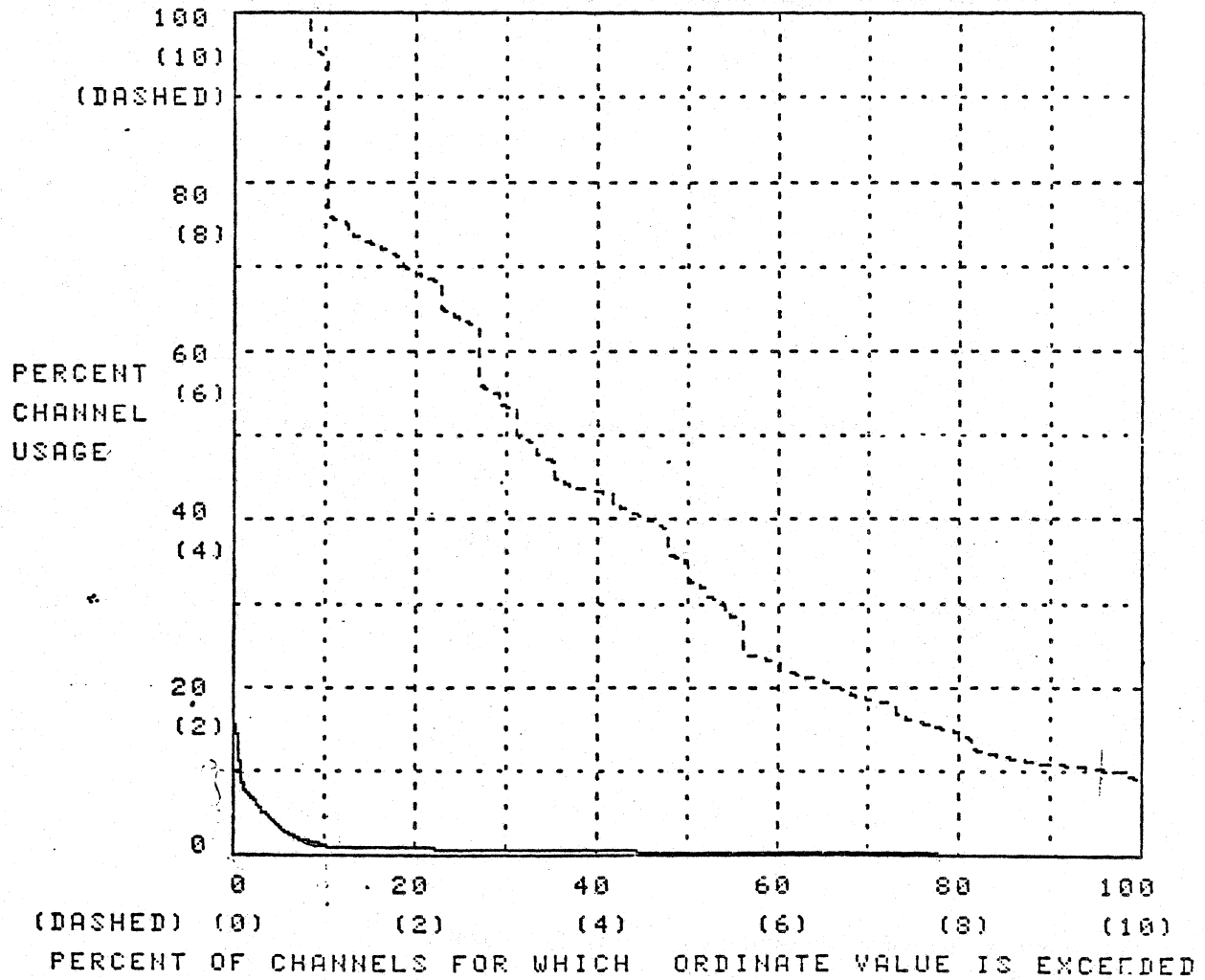


Figure B-3. Channel Usage Distribution for 162-174 MHz Band
Norfolk, Virginia (March 1978)

TABLE B-6

USAGE SUMMARY FOR 162-174 MHz BAND
WASHINGTON, D.C. (June 1978)

JUNE 1978 CASS 165.001
SCANS 13847 THRESHOLD (dBm) -106

<u>CHANNELS MEASURED</u>	<u>MEASURED</u>	<u>CHANNELS WITH</u>	<u>USAGE</u>
	100-0.5%	0.5-0.1%	0.0-0.0%
<u>216 : 263</u>	<u>115 : 59</u>	<u>44 : 34</u>	<u>57 : 170</u>

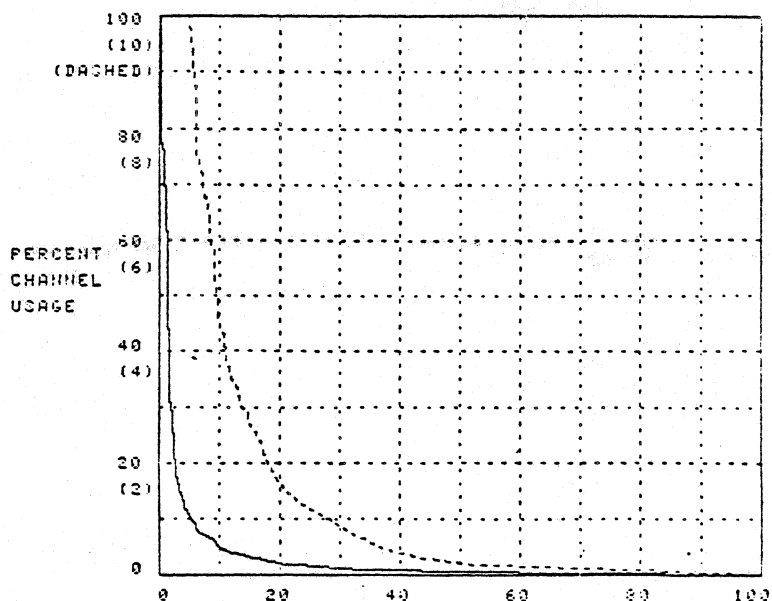
Maximum average hourly usage for all channels = 2.6% between 10 a.m. and 11 a.m.

Maximum average hourly usage for "local" channels = 2.8% between 10 a.m. and 11 a.m.

NOTES:

The number of channels with "local" assignments (i.e., assigned within 25 mi of the Capitol, according to the channelization plan of the NTIA Manual, Section 4.3.7) is given to the left of the colon; the number of channels without "local" assignments is given to the right of the colon. The notation "115 : 59" in the second column, for example, indicates that of the channels with measured usage of 0.5% or more, 59 did not have "local" assignments. A more detailed explanation of this table is found in Section 2.

162-174 MHz CHANNEL USAGE DISTRIBUTION
ALL 479 CHANNELS IN THE BAND



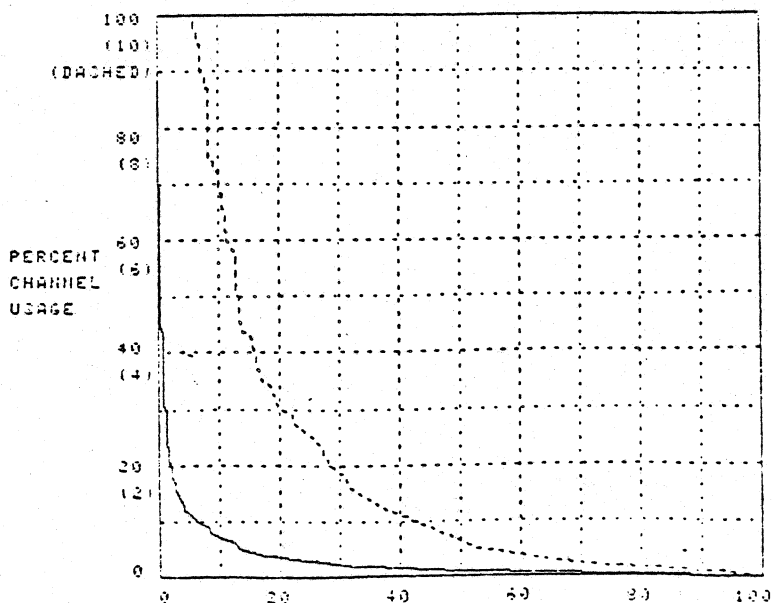
Channel usage distribution for 162-174 MHz band.

WASHINGTON, DC
MF 780601

JUNE 1978
SCANS 13847

CASS 165.001
THRESHOLD (dBm) -106

162-174 MHz CHANNEL USAGE DISTRIBUTION
ALL 216 FIXED GOVERNMENT ASSIGNMENTS < 25 MI OF CAPITOL



Channel usage distribution for 162-174 MHz band.

Figure B-4. Channel Usage Distribution for 162-174 MHz Band.
Washington, DC (June 1978)

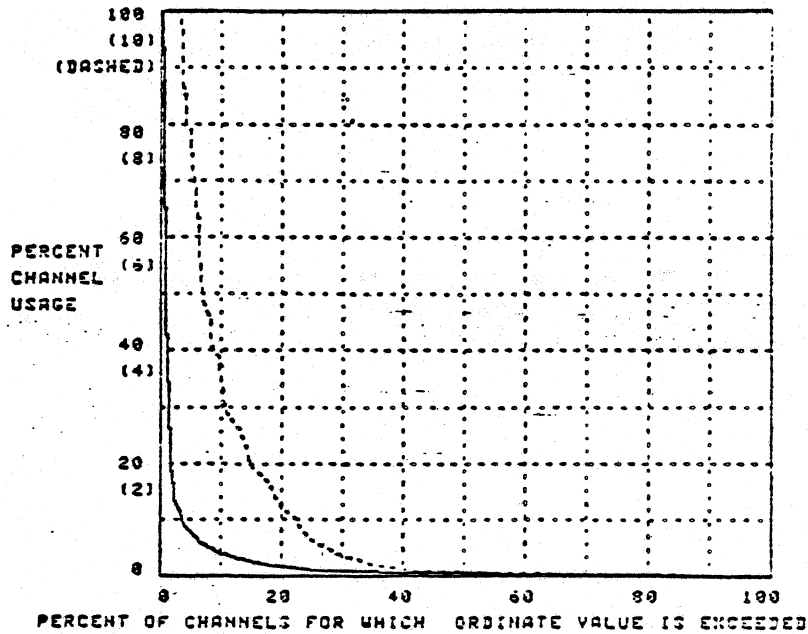
TABLE B-7

USAGE SUMMARY FOR 162-174 MHz BAND
DETROIT, MICHIGAN (January - February 1979)

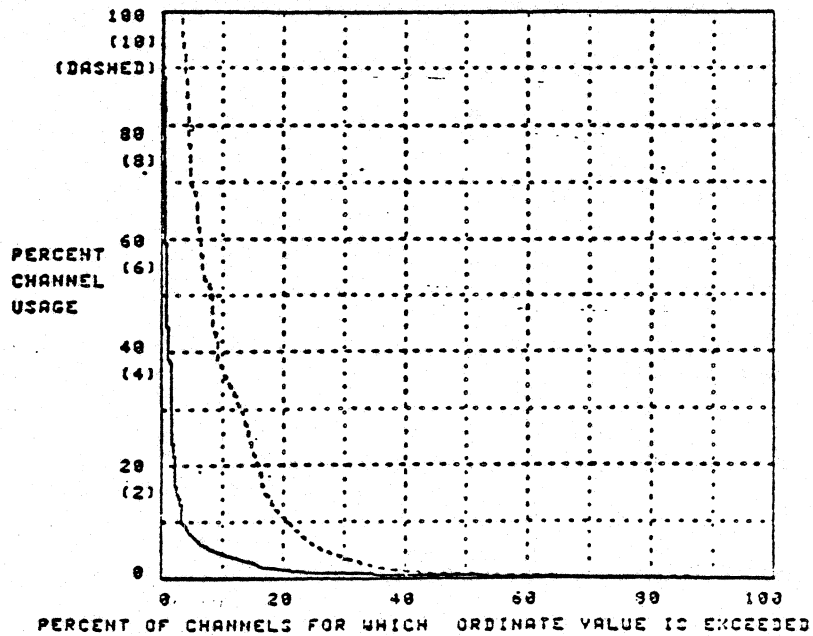
GMF 780601		THRESHOLD (dBm) -112		
CHANNELS MEASURED	<u>MEASURED CHANNELS WITH USAGE</u>			
	> = 20%	= 0.5%	0.5-0.1%	< = 0.1%
67 : 11 (87)	1 : 0 (4)	32 : 5 (55)	10 : 4 (14)	25 : 2 (18)

NOTES:

- 1) Channels with local GMF assignments are given first, and those with local Canadian Master File (CMF) assignments given second; i.e., GMF:CMF.
- 2) A channel is taken as locally assigned if it has a channel center frequency assignment that is within 40 mi of the RSMS.
- 3) Channel center frequencies for GMF channels are defined by the channelization plan of the NTIA Manual, Section 4.3.7. Data for GMF channels included 32,625 scans.
- 4) Channel center frequencies for CMF channels are taken as 12.5 kHz (1/2 GMF channel) below the GMF channels. While this method was convenient for measurement purposes (O-GMF), it does not correspond to a Canadian channelization plan and misses most Canadian channels. Data for O-GMF channels included 24,828 scans.
- 5) Values provided in parentheses are for ICMF channels where such channels are: (a) local CMF channels, or (b) either are selected from TABLES 5.13 through 5.24 by a usage $\geq 0.1\%$ and CMF assignment(s) with no other assignments except possibly GMF area assignments; i.e., MINI-GMF codes (TABLE 4.1) of AXXXXA or OOOXOA where $0 \leq X \leq 9$ and $1 \leq A \leq 9$ in TABLES 5.13 through 5.24.

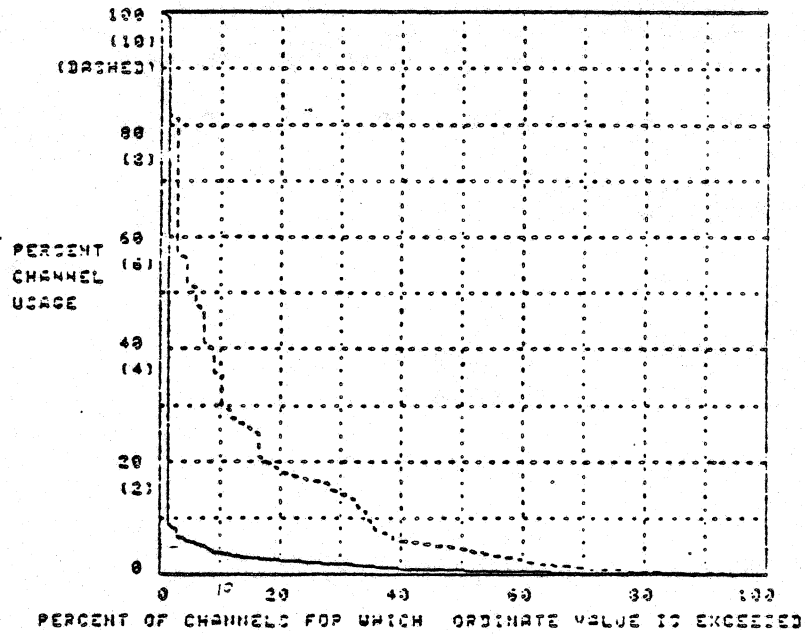


Channel usage distribution for the 162-174 MHz band, all 479 channels with no frequency offset.

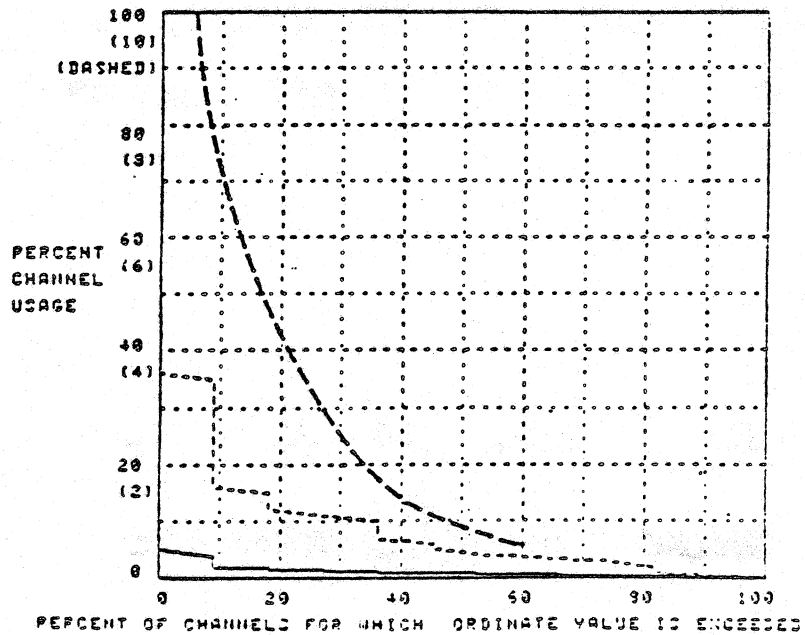


Channel usage distribution for the 162-174 MHz band, all 479 channels with -0.0125 MHz offset.

Figure B-5. Channel Usage Distribution for the 162-174 MHz Band Detroit, Michigan (Jan.-Feb. 1979).



Channel usage distribution for the 162-174 MHz band, 67 local GMF channels.

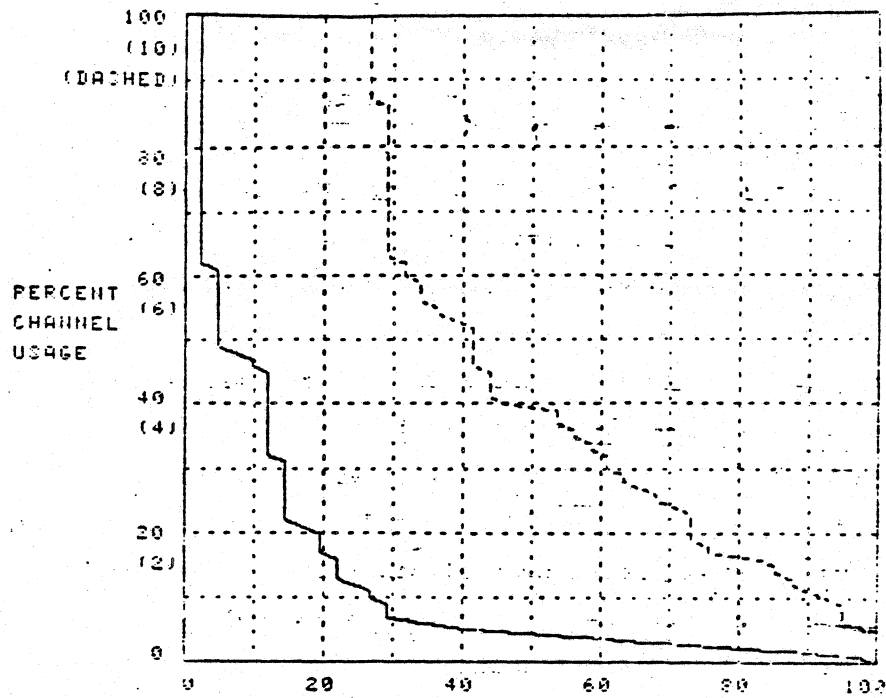


Channel usage distribution for the 162-174 MHz band, 11 local GMF channels, and 87 ICMF channels.

Figure B-6. Channel Usage Distribution for the 162-174 MHz Band Detroit, Michigan (Jan.-Feb.).

BUFFALO, N.Y.

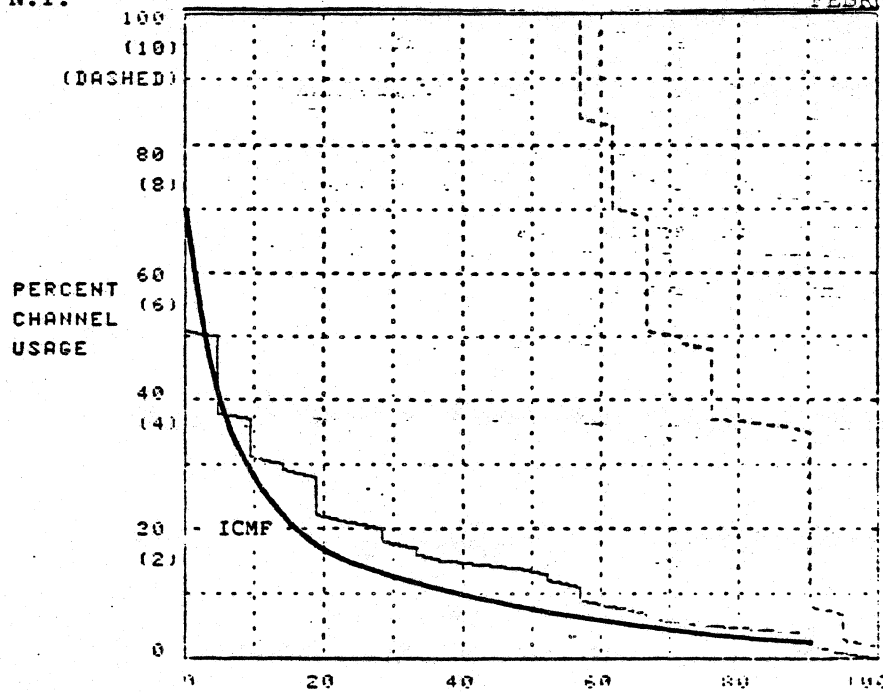
MARCH 1979



Channel usage distribution for the 162-174 MHz band, 41 local GMF channels.

BUFFALO, N.Y.

FEBRUARY 1979

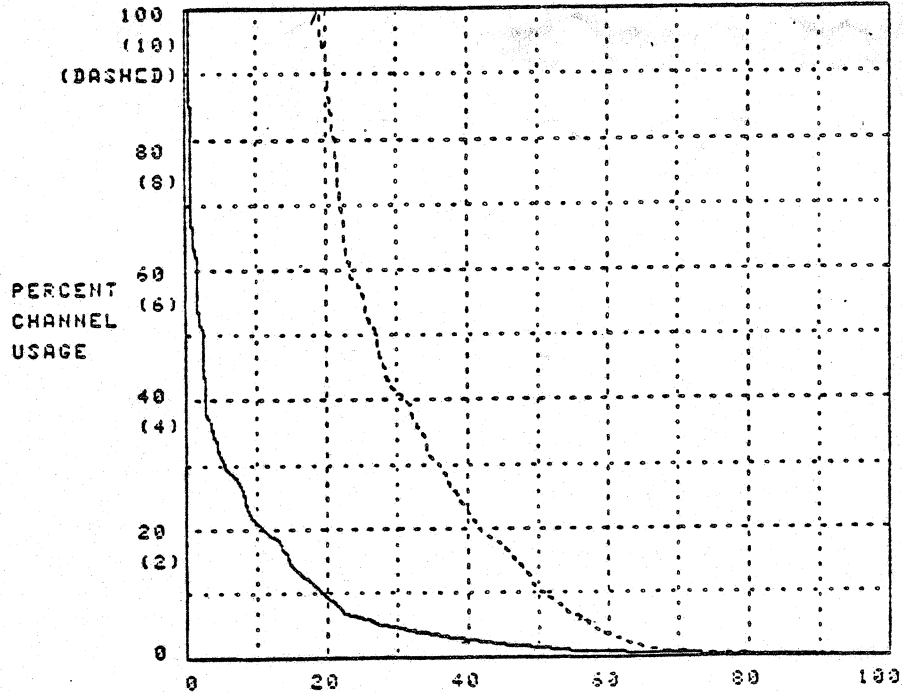


Channel usage distribution for the 162-174 MHz band, 21 local CMF channels, and 312 ICMF channels.

Figure B-7. Channel Usage Distribution for the 162-174 MHz Band Buffalo, New York (March 1979).

MALONE, N.Y.

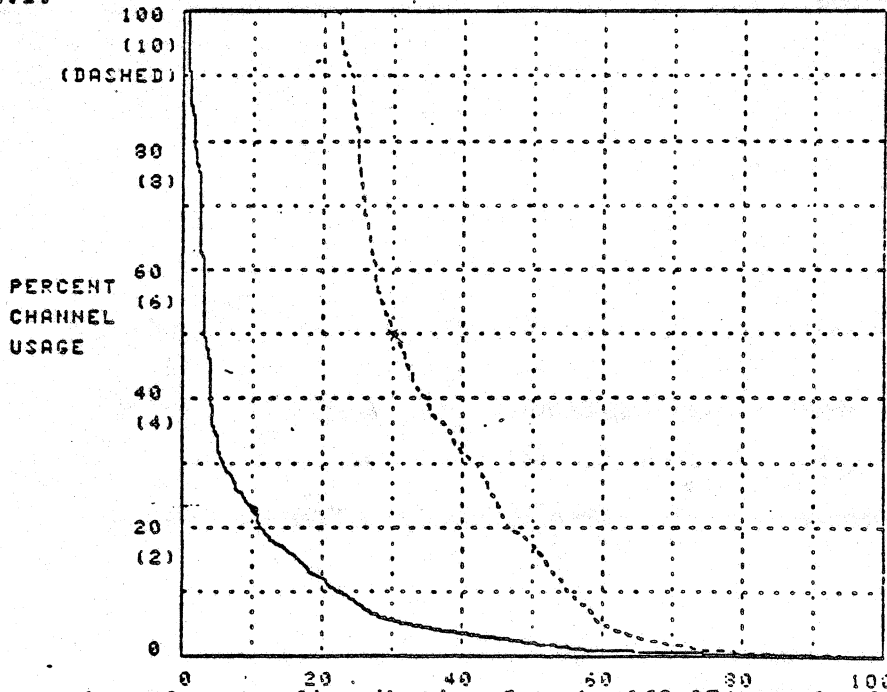
MARCH 1979



Channel usage distribution for the 162-174 MHz band, all 479 channels with no frequency offset.

MALONE, N.Y.

MARCH 1979



Channel usage distribution for the 162-174 MHz band, all 479 channels with -0.0125 MHz offset.

Figure B-7. Channel Usage Distribution for the 162-174 MHz Band Malone, New York (March 1979).

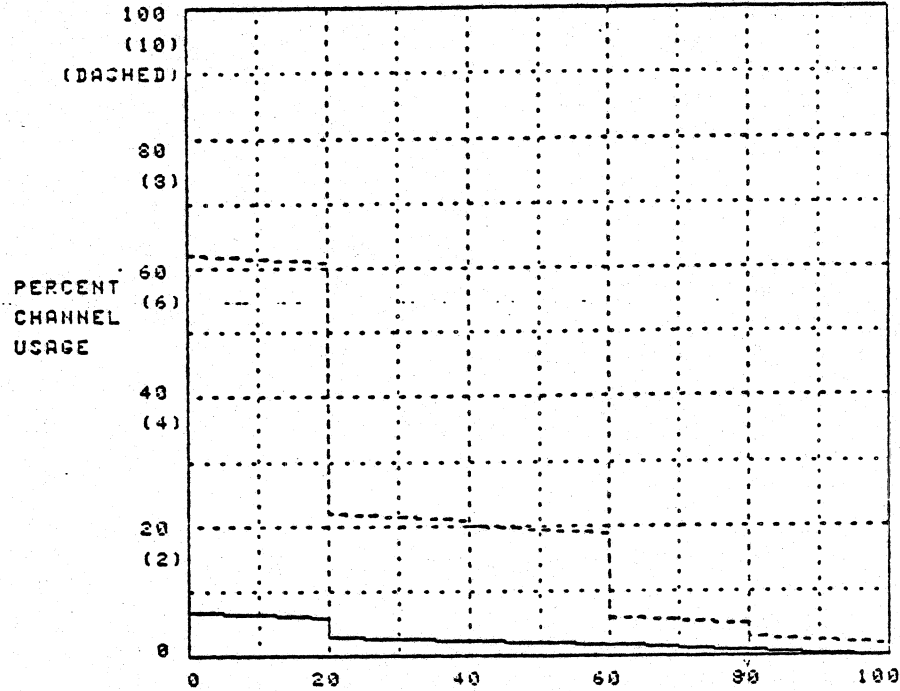


Figure 7.1. Channel usage distribution for the 162-174 MHz band, 5 local GMF channels.

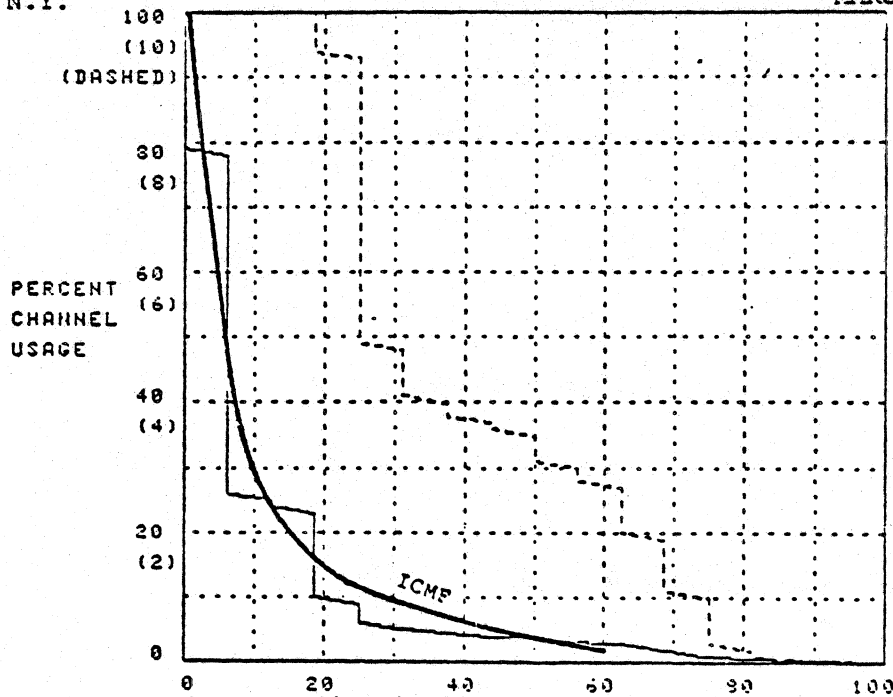


Figure 7.2. Channel usage distribution for the 162-174 MHz band, 16 local CMF channels, and 229 ICMF channels.

Figure B-8. Channel Usage Distribution for the 162-174 MHz Band Malone, New York (March 1979).

TABLE B-9

USAGE SUMMARY FOR 162-174 MHz BAND
MALONE, NEW YORK (March 1979)

GMF 780601		THRESHOLD (dBm) -112		
CHANNELS MEASURED	High Usage ($\geq 20\%$)	Usage ($\geq 0.5\%$)	Low Usage (0.5-0.1%)	No Usage ($\geq 0.1\%$)
5 : 15 (229)	0 : 3 (37)	4 : 12 (184)	1 : 1 (23)	0 : 3 (22)

NOTES:

- 1) Channels with local GMF assignments are given first, and those with local CMF assignments given second; i.e., GMF:CMF.
- 2) A channel is taken as locally assigned if it has a channel center frequency assignment that is within nominal coverage range of the RSMS.
- 3) Channel center frequencies for GMF channels are defined by the channelization plan of the NTIA Manual, Section 4.3.7. Data for GMF channels included 19,582 scans.
- 4) Channel center frequencies for CMF channels are taken as 12.5 kHz (1/2 GMF channel) below the GMF channels. While this method was convenient for measurement purposes (O-GMF), it does not correspond to a Canadian channelization plan and misses most Canadian channels. Data for O-GMF channels included 28,174 scans.
- 5) Values provided in parentheses are for ICMF channels where such channels are: (a) local CMF channels, or (b) either are selected from TABLES 5.13 through 5.24 by a usage $\geq 0.1\%$ and CMF assignment(s) with no other assignments except possibly GMF area assignments; i.e., MINI-GMF codes (TABLE 4.1) of AXXXXA or 000XOA where $0 \leq X \leq 9$ and $1 \leq A \leq 9$ in TABLES 5.13 through 5.24.
- 6) Nominal coverage range is 25 and 60 mi for the GMF and CMF assignments, respectively (TABLE 4.3).

TABLE B-10

USAGE SUMMARY FOR 162-174 MHz BAND
BOSTON, MASS (May - June 1979)

Channels Measured(a)	Continuous Usage (>= 90%)	High Usage (>= 20%)	Significant Usage (>= 0.5%)	Questionable Usage (0.5-0.1%)	No Usage (<0.1%)
68 - 411	1 : 0	5 : 5	34 : 77	11 : 23	23 : 311

Highest Hourly % Occupancy (b)	Highest Occupancy Hour	Usage Threshold (dBm)	Coverage Radius (mi)	Scans (8 a.m. - 5 p.m)	
5.4	2.7	11 a.m. 11 p.m.	-112 (c)	40	33086

NOTES:

(a) The number of channels with "local" assignments (i.e., within the coverage radius and on exact center channel frequency) is given to the left of the colon and the number without "local" assignments is given to the right of the colon. For example, 19 : 316 indicates 19 local channels and 316 channels without local assignments.

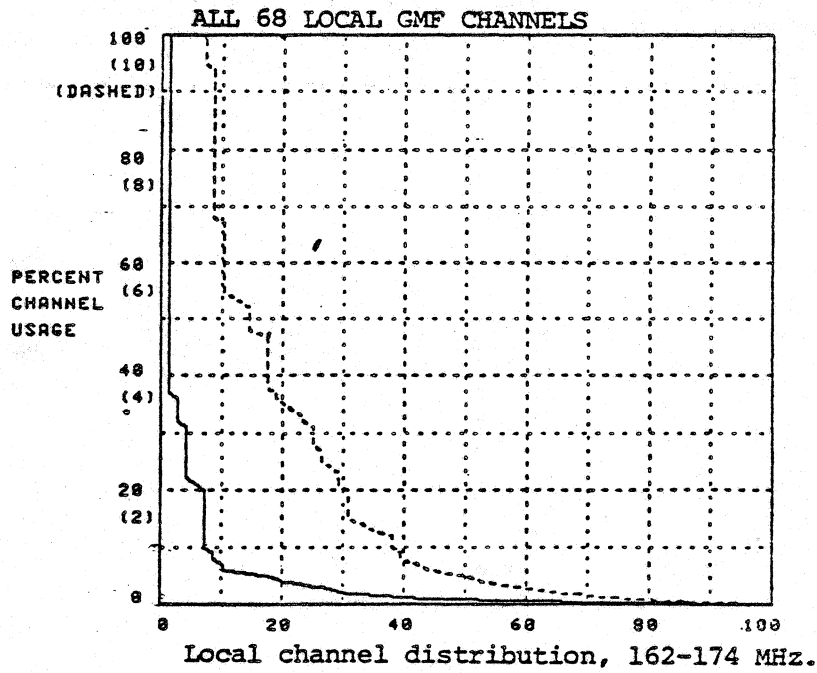
(b) The number to the left of the " " is for "local" channels grouped together and the number to the right of the " " is for all channels in the band grouped together.

(c) Threshold varied as follows: -112, 19%; -113, 6%; -114, 14%; -115, 61%.

BOSTON, MASS.
GMF 790301

MAY-JUNE 1979
SCANS 33086

CASS 212.001
THRESHOLD (dBm) -112
(or as low as -115)



BOSTON, MASS.
GMF 790301

MAY-JUNE 1979
SCANS 33086

CASS 212.001
THRESHOLD (dBm) - 112
(or as low as -115)

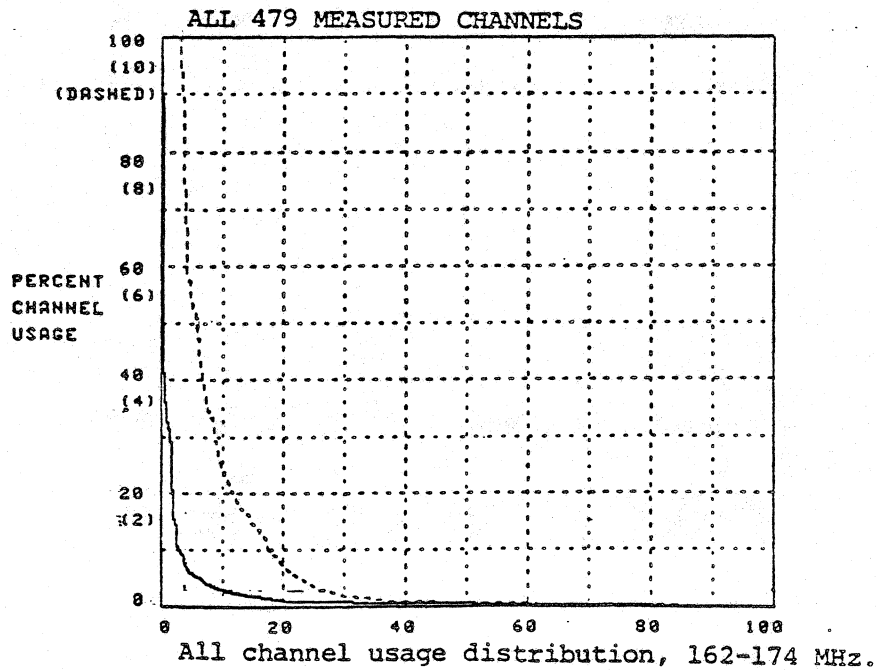


Figure B-9. Channel Usage Distribution for the 162-174 MHz Band Boston, Mass. (May-June 1979).

TABLE B-11

USAGE SUMMARY FOR 162-174 MHz BAND
NEW YORK CITY (November 1979)

Channels Measured(a)	Continuous Usage (>= 90%)	High Usage (>= 20%)	Significant Usage (>= 0.5%)	Questionable Usage (0.5-0.1%)	No Usage (<0.1%)
116 : 363	1 : 0	5 : 2	60 : 64	17 : 41	39 : 258

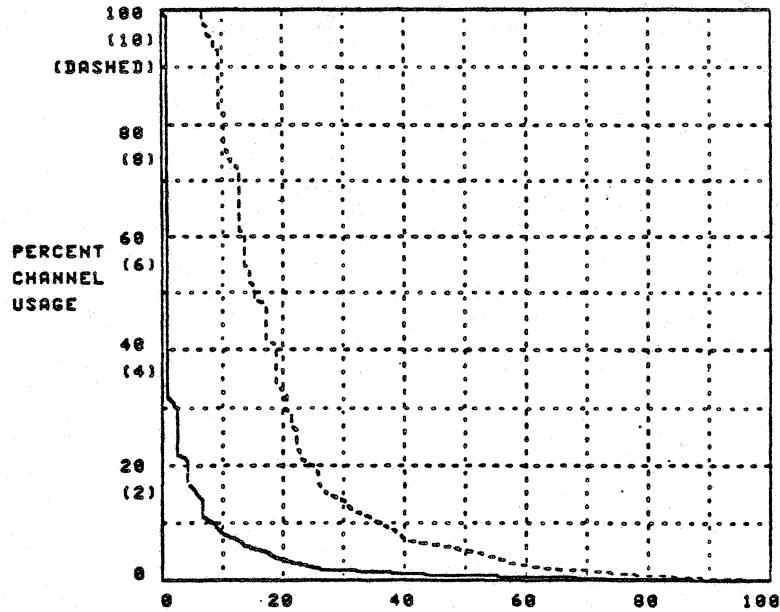
Highest Hourly % Occupancy (b)	Highest Occupancy Hour	Usage Threshold (dBm)	Coverage Radius (mi)	Scans (8 a.m. - 5 p.m)
4.0	1.6 9 a.m. 11 a.m.	-101	25	20863

NOTES:

(a) The number of channels with "local" assignments (i.e., within the coverage radius and on exact center channel frequency) is given to the left of the colon and the number without "local" assignments is given to the right of the colon. For example, 17 : 318 indicates 17 local channels and 318 channels without local assignments. "Non-local" or other channels may actually be within the coverage radius and not counted as local because they are not assigned on exact center channel frequency, and/or they may be associated with wideband assignments that cover more than one channel.

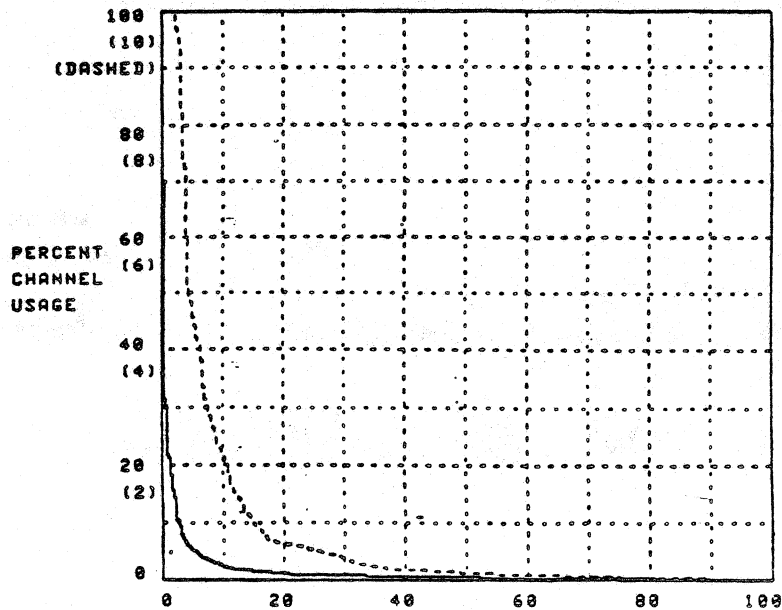
(b) The number to the left of the " " is for "local" channels grouped together and the number to the right of the " " is for all channels in the band grouped together.

ALL 116 LOCAL GMF CHANNELS



Local channel distribution, 162-174 MHz.

ALL 479 MEASURED CHANNELS



All channel usage distribution, 162-174 MHz.

Figure B-10. Channel Usage Distribution in the 162-174 MHz Band
New York, New York (November 1979).

TABLE B-12

USAGE SUMMARY FOR 162-174 MHz BAND
DENVER, CO (March - April 1980)

Channels Measured(a)	Continuous Usage (>= 90%)	High Usage (>= 20%)	Significant Usage (>= 0.5%)	Questionable Usage (0.5-0.1%)	No Usage (<0.1%)	
116 : 363	1 : 3	3 : 6	45 : 34	13 : 35	58 : 294	
Highest Hourly % Occupancy (b)	Highest Occupancy Hour	Usage Threshold (dBm)	Coverage Radius (mi)	Scans (8 a.m. - 5 p.m)		
2.4	1.6	10 a.m.	10 a.m.	-112	30	34351

NOTES:

(a) The number of channels with "local" assignments (i.e., within the coverage radius and on exact center channel frequency) is given to the left of the colon and the number without "local" assignments is given to the right of the colon. For example, 14 : 321 indicates 14 local channels and 321 channels without local assignments. "Non-local" or other channels may actually be within the coverage radius and not counted as local because they are not assigned on exact center channel frequency, and/or they may be associated with wideband assignments that cover more than one channel.

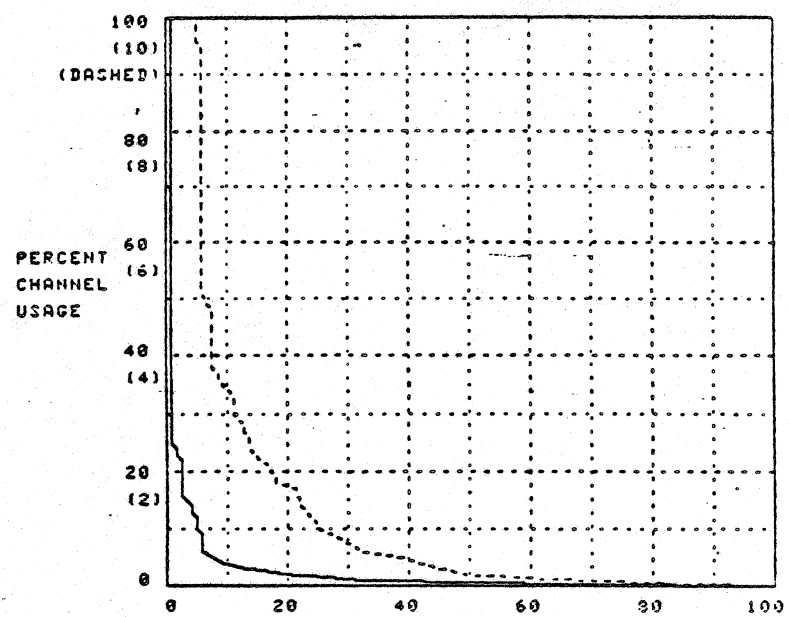
(b) The number to the left of the " " is for "local" channels grouped together and the number to the right of the " " is for all channels in the band grouped together.

DENVER, COLO.
GMF 800201

MAR-APRIL 1980
SCANS 34351

CASS 235.001
THRESHOLD (dBm) -112

ALL 116 LOCAL GMF CHANNELS



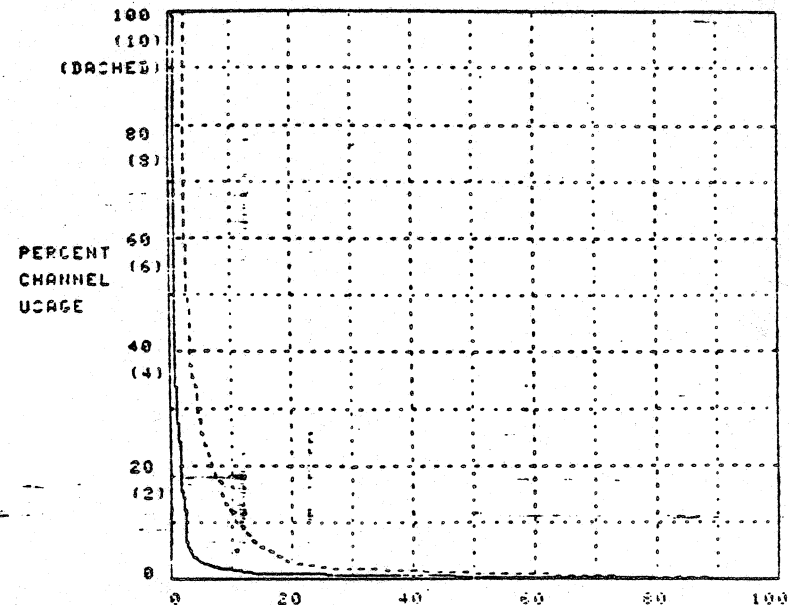
Local channel distribution, 162-174 MHz.

DENVER, COLO.
GMF 800201

MAR-APRIL 1980
SCANS 34351

CASS 235.001
THRESHOLD (dBm) -112

ALL 479 MEASURED CHANNELS



All channel usage distribution, 162-174 MHz.

Figure B-11. Channel Usage Distribution in the 162-174 MHz Band
Denver, Colorado (March-April 1980).

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