77

RSMS OPERATIONS REPORT

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

Institute for Telecommunication Sciences

Boulder, Colorado 80303

ANALYSIS OF SELECTED GOVERNMENT SPECTRUM USAGE DURING THE 1989 PRESIDENTIAL INAUGURATION JANUARY 10, 1990

JOHN J. SELL
GARY GIERHART

AUTHORS

John Sell is with the Systems Engineering and Analysis Division of the National Telecommunications Administration, NTIA, Annapolis, MD, and Gary Gierhart is with the Institute for Telecommunications Sciences, NTIA, Boulder, Colorado. NTIA is part of the U.S. Department of Commerce.

ABSTRACT

Measurements of Federal land mobile usage, in selected mobile bands, relating to the 1989 Presidential inauguration were made using NTIA's RSMS Van to assess Government communications requirements for a special event of national importance. This report presents the results of analyzing the band usage data. Three bands, 138-150.8 MHz (with the exception of the 144-148 MHz segment), 162.0125-174 MHz and 406.1-420 MHz had channels designated for communications relating to inaugural events. Increased usage coinciding with the time of the President's inauguration was measured for the 138-150.8 MHz and 162-174 MHz bands. An important consideration in evaluating the results presented in this report is that they are representative of communications carried out for a planned event that proceeded according to schedule with no disruptions. Consequently, the results do not provide information on communications requirements during an emergency. The report concludes that the inaugural measurements will provide useful information on the Government's communications requirements for a special event. Additional measurements are desirable, including during an actual emergency period to provide a more complete understanding of the Government's RF spectrum requirements for dealing with extraordinary events.

KEY WORDS

Band usage
Nation wide frequency assignments
Special events
RSMS System
Channel assignments
Presidential inauguration

ACKNOWLEDGEMENTS

The authors wish to acknowledge the efforts of John Smiley and Frank Sanders of the Institute for Telecommunication Sciences, Boulder, Colorado in operating the RSMS Van to collect the inaugural period data. Appreciation is also extended to the Interdepartment Radio Advisory Committee (IRAC) representatives for the Departments of Justice and Treasury and the Air Force for providing the lists of channels designated for communications associated with the President's inauguration.

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

SECTION 3

ANALYSIS OF INAUGURAL PERIOD DATA

TABLE OF CONTENTS
(continued)

SECTION 3
(continued)

SECTION 4

SUMMARY

LIST OF FIGURES

TABLE OF CONTENTS
(continued)

LIST OF TABLES

SECTION 1

INTRODUCTION

BACKGROUND

One of the National Telecommunications and Information Administration's, NTIA, primary responsibilities is to manage the U.S. Government's use of the radio frequency spectrum.[1] As an aid to fulfilling this role, NTIA conducts field measurements of the actual use of frequency bands allocated to the Government.[2] Such measurements are made using NTIA's Radio Spectrum Measurement System, RSMS, which is installed in a motor home type vehicle called the RSMS Van. When used for this purpose, the RSMS is deployed to various locations throughout the United States for periods of at least two weeks, the minimum time required to obtain an adequate measure of frequency band usage. The resultant accumulated data has been a valuable input to understanding the Government's spectrum requirements.

To date, spectrum usage measurements were made with the express intent of portraying day-to-day usage dictated by routine operational requirements for a particular area. Although the types of operations and geographical areas differed, in each case the data acquired were about the expected norm for the site. This resulted in the creation of a data base depicting spectrum usage under normal circumstances, while providing little information on special requirements for periods of unusual activity or emergencies.

The Presidential Inauguration on January 20, 1989 presented an opportunity to obtain data on Government spectrum usage during a non-routine period. Thus, the RSMS Van was sent to Washington D.C. to measure spectrum usage prior to, during and after the President's inauguration. Figure 1-1 shows the location of the RSMS site. NTIA had conducted spectrum usage measurements from the same site in 1986, but for only two of the frequency bands used during the inaugural period.

OBJECTIVE

The objective of this task was to measure spectrum usage by the Government during a special event to: 1) quantify usage patterns during a period encompassing a special event, 2) gain insight into Government spectrum usage during periods of extraordinary communications requirements and 3) determine the need for and utility of additional measurements during special events to quantify Government spectrum usage requirements during a special event.

---

[1] NTIA, Manual of Regulations and Procedures for Federal Radio Frequency Management, National Telecommunications and Information Administration, Washington D.C., Revised January 1989.

[2] Department Organization Order 25-7, May 23, 1984

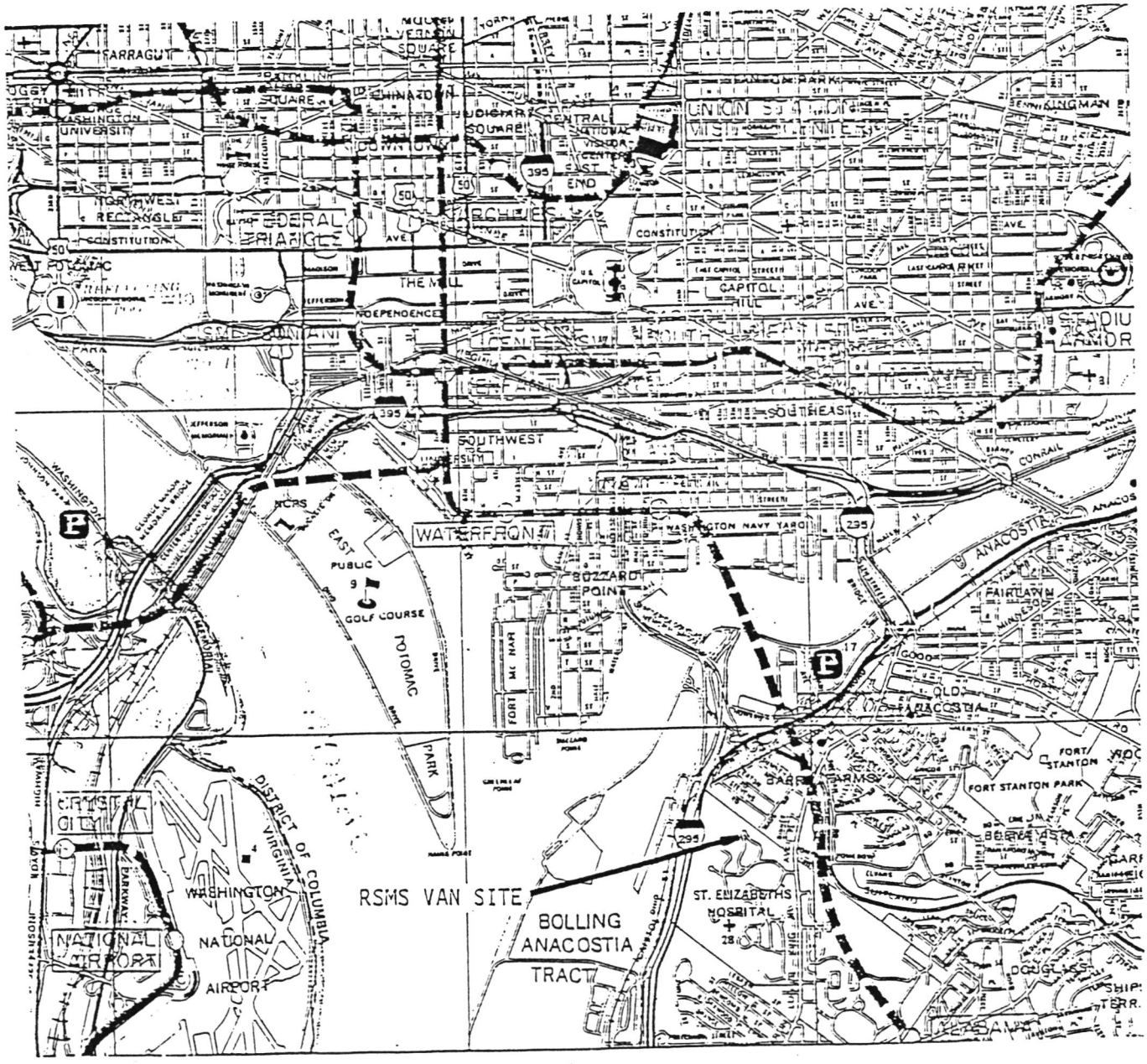

Figure 1-1. Location of NTIA's Radio Spectrum Measurement System Van on the grounds of St. Elizabeths Hospital.

APPROACH

The following approach was taken to accomplish the above objective.

1. Special frequency use requirements of agencies having an assigned role in the President's Inauguration were identified by the IRAC.

2. The RSMS Van was used to make spectrum usage measurements prior to, during and after the inauguration.

3. The inaugural period data was analyzed, using standard LMR analyses techniques.

4. Additional analyses were performed on band usage data to determine the magnitude of the effect of inaugural channel usage.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

The Federal Government's responsibility in times of national crises requires the capability to establish reliable radio communications on short notice. Other events of national importance, such as the Presidential Inauguration or visits by foreign heads of state, also require that reliable radio communications be readily available. One way of satisfying this need is to make use of frequency assignments that are assigned for use nationwide, but NTIA has no data to quantify the actual spectrum usage by government agencies during a period of extraordinary activity.

As a beginning towards collecting such data, NTIA has conducted band usage measurements over a period encompassing the 1989 Presidential Inauguration ceremony. Measurements began on January 18 and continued through January 26,1989. Three frequency bands were measured, 138-150.8 MHz (excluding the 144-148 MHz segment),162.0125-174 MHz and 406.1-420 MHz. NTIA was provided with lists of channels within each of these bands that were to be used for communications associated with inaugural events. These are referred to as inaugural channels in this report.

Two forms of usage were determined for each of the three frequency bands, one showed relative usage of the inaugural channels and the other showed band usage based on consideration of local plus nationally assigned channels. The number of channels comprising the basis for the later analyses were 265, 330 and 273 for the 138-150.8, 162.0125 and the 406.1-420 MHz bands respectively.

The conclusions drawn from analyzing the data accumulated during the inaugural period are given below.

MAJOR CONCLUSIONS

The following are major conclusions resulting from analyzing the inaugural data.

1. During the inaugural period, the Departments of Defense, Justice and Treasury designated a combined total of 128 channels for special communications associated with the President's inauguration. Seventy four (58%) of the channels used to meet this requirement were assigned for use nationwide. Hence the channel requirements were met by using both local and nationwide assignments.

2. Spectrum usage measurements made during the Presidential inaugural period provided useful information concerning Government spectrum requirements for a special event. In comparison with the post-inaugural period, there was increased usage on inaugural channels before and during the day of the President's inauguration.

3. The inaugural ceremony proceeded as planned with no disruptions requiring extraordinary radio communications. Consequently, the measured spectrum use data obtained from this task are not representative of an emergency situation.

4. Measurements of band usage during periods of National emergencies would be useful in quantifying the Federal Government's requirements for RF spectrum during these periods. A system similar to the RSMS LMR, but installed in cases suitable for quick deployment by air transport is required to conduct these measurements.

5. Washington D.C. is not truly representative of other areas in the United States with respect to Government channel assignments. The D.C. area has the highest concentration of local LMR channel assignments of any that has been measured with the RSMS.

SPECIFIC CONCLUSIONS

138-150.8 MHz Band

1. In the 138-150.8 MHz band, 105 channels were designated by the Department of Defense to be used for communications relating to inaugural events. Thirty five of the 105 channels are assigned for use in the Washington D.C. area, but 70 are assigned for nationwide use. Consequently these channels were readily available for inaugural communications without conflicting with local requirements.

2. Figure 2-1 shows the relative usage on the 105 DOD inaugural channels. The unfilled bar in the figure indicates the daily band usage i.e. the combined hourly band usage averaged over the period of from 0800 to 1700 hours. The solid and cross hatched bars indicate the range (maximum and minimum) of hourly band usage values from which daily band usage was calculated. DOD's daily band usage was 4.3% and 6.3% respectively before and on inauguration day with the average hourly channel usage reaching a high of 9.3% on inauguration day.

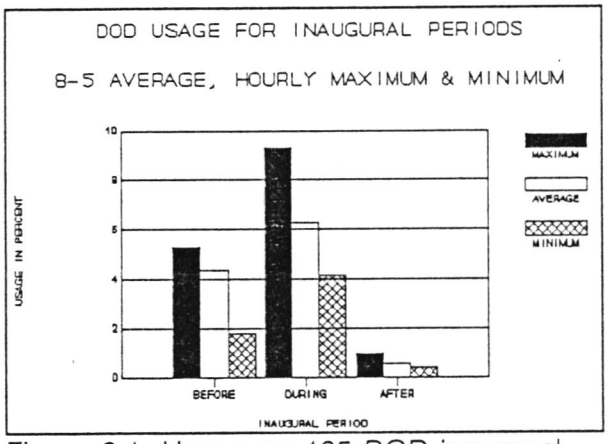

Figure 2-1. Usage on 105 DOD inaugural channels.

3. The 138-150.8 MHz band was the only band where the number of inaugural channels comprised an appreciable percentage of the total number of channels used to determine band usage. Within this band, 105 or 40% of the 265 used in the analysis were inaugural channels. Examination of channel usage distributions, Table 3-2, show that the increased usage on inauguration day was caused by activity on inaugural channels.

4. Results obtained from analyzing band usage data for the 138-150.8 MHz band for all 265 channels are presented in Figure 2-2. The highest daily band usage, 3.8%, was observed on inauguration day with the hourly band usage ranging from 2.5% to 4.9%.

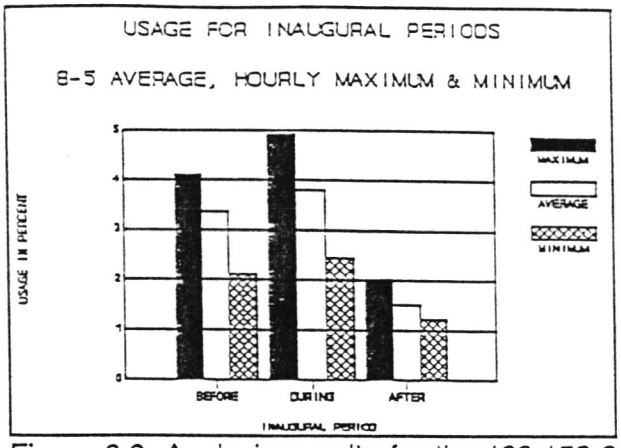

Figure 2-2. Analysis results for the 138-150.8 MHz band, 265 channels.

162.0125-174 MHz Band

1. In the 162.0125-174 MHz band, 9 channels were designated by the Department of Justice and 11 by the Department of the Treasury for inaugural communications. Four of the designated channels are assigned for use nationwide.

2. Separate analyses were performed to show relative inaugural channel usage by Justice and Treasury. The results shown in Figures 2-3 and 2-4 indicate that Justice's daily band usage on inauguration day was 4.1% while the corresponding usage for Treasury was 10.9%. Maximum hourly band usage on inauguration day was 8.9% for Justice and 14% for Treasury. In comparison to the post inaugural period, both agencies show increased usage on their inaugural channels during the pre-inaugural period and on inauguration day.

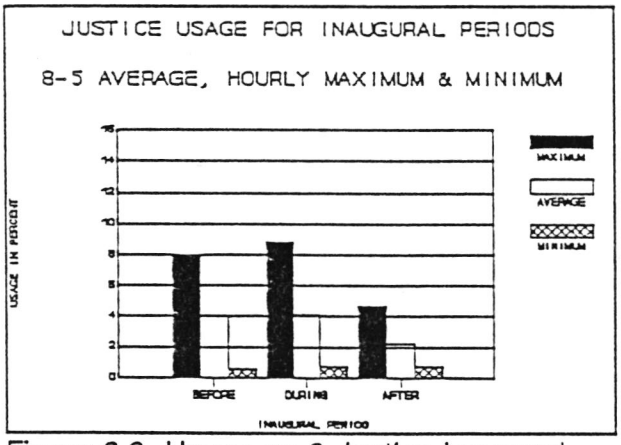

Figure 2-3. Usage on 9 Justice inaugural channels.

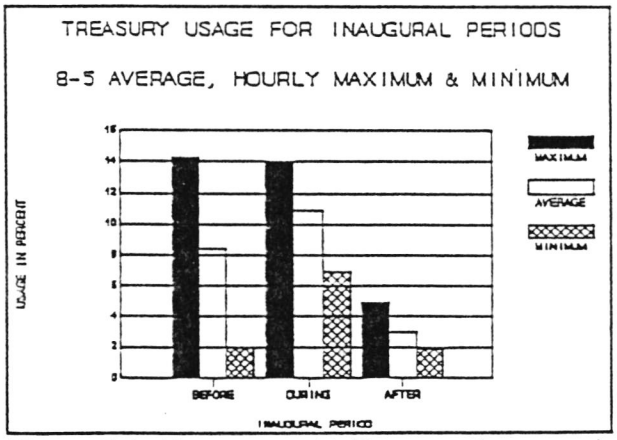

Figure 2-4. Usage on 11 Treasury inaugural channels.

3. The results obtained from analyzing band usage data for the 162.0125-174 MHz band for all 330 channels are presented in Figure 2-5. The highest usage occurred before inauguration day where the daily band usage was 4.2% with the hourly band usage ranging from 2.6% to 5.5%.

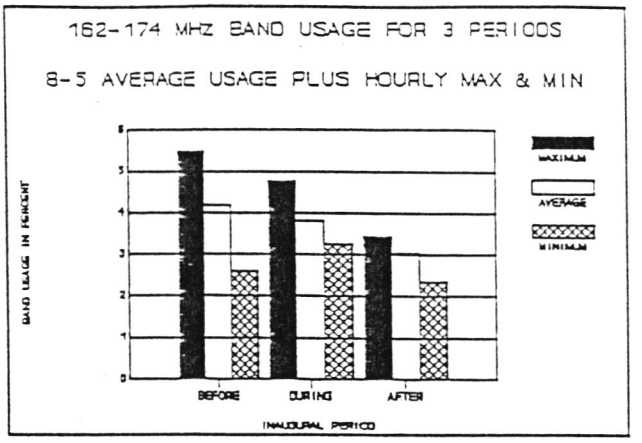

Figure 2-5. Analysis results for the 162.0125-174 MHz band, 330 channels.-

4. Examination of channel usage distributions, Table 3-5, revealed that the increased usage manifest in Figure 2-5 for the pre-inaugural period and on inauguration day was primarily due to high usage on channels other than those designated for inaugural use.

5. Tabulations of channel usage by Justice and Treasury on inauguration day indicate that Justice's use varied considerably throughout the day. In contrast, Treasury's usage was more constant and higher in magnitude. See Tables 3-7 and 3-8.

406.1-420 MHZ BAND

1. Within the 406.1-420 MHz band, Treasury had 3 channels designated for inaugural use. These 3 channels comprised only 1% of the total of 273 used as the basis for determining band usage.

2. Figure 2-6 shows the measured usage on the three Treasury inaugural channels in the 406.1-420 MHz band. Treasury's daily band usage was 2.5% and 5.1% respectively before and on inauguration day with the maximum hourly band usage of 8.3% occurring on inauguration day.

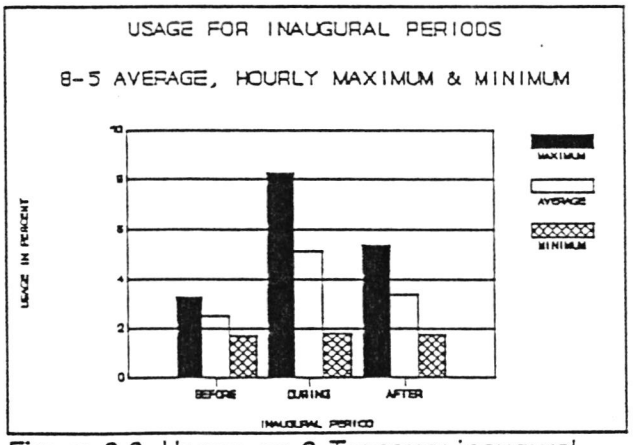

Figure 2-6. Usage on 3 Treasury inaugural channels.

3. Figure 2-7 shows the results obtained from analyzing band usage data for all 273 channels within the 406.1-420 MHz band. The daily band usage for all three inaugural periods changed very little, 2.4% to 2.7%. Of the three bands used for inaugural communications, the 406.1-420 MHz band had the least variation in daily band usage over the three inaugural periods.

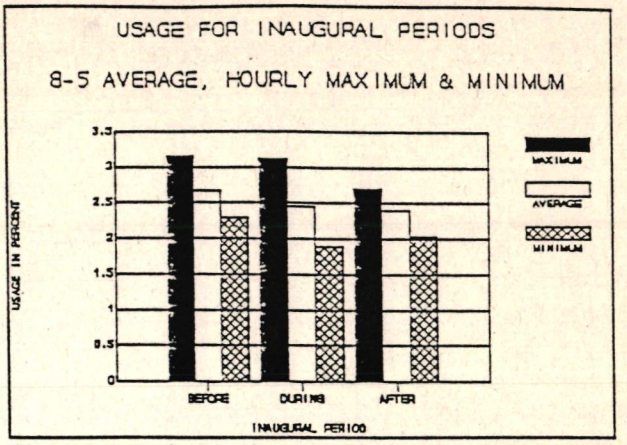

Figure 2-7. Analysis results for the 406.1-420 MHz band, 273 channels.

4. Examination of channel usage distributions, Table 3-10, for this band shows that heavy usage on channels other than the 3 designated for inaugural use masked the usage on the inaugural channels. These results were expected because of the small percentage of inaugural channels compared to the total considered in the analysis.

RECOMMENDATIONS

The following are NTIA staff recommendations based on the findings of this report. NTIA management will evaluate these recommendations to determine if they can be or should be implemented from policy, regulatory, or procedural viewpoint. Any action to implement these recommendations will be via separate correspondence modifying established rules, regulations and procedures.

1. NTIA should create a nationwide federal government frequency pool to meet communications requirements for extraordinary events.

2. NTIA should continue conducting measurements of the federal government's spectrum usage during extraordinary events in order to gain an understanding of the requirements for such usage.

3. NTIA should develop a quick response measurement capability (i.e. a portable version of the current RSMS LMR system) to enable spectrum usage measurements to be made during extraordinary events.

SECTION 3

ANALYSIS OF INAUGURAL PERIOD DATA

INTRODUCTION

A certain amount of preparatory work must be accomplished prior to taking the RSMS on a field trip in order to maximize the data collection process. Computer selects are made of the Government's master frequency files (GMF) and the FCC's frequency files for assignments within the area where the RSMS van is to be located. The primary purpose of these computer searches is to give the measurement personnel an indication of expected spectrum use.

An additional preparatory action was undertaken for the inaugural measurements because of the unique events that would be taking place during the measurement period. Agencies having an assigned role in the upcoming inaugural ceremonies, that required use of the RF spectrum, were asked to inform NTIA of their frequency plans. The IRAC representatives for the Department of Justice, the Department of the Treasury, and the Air Force responded with lists of frequencies that would be used for telecommunication functions associated with the President's inaugural ceremony.

The list provided by the Air Force contained 105 frequencies assigned within the 138-150.8 MHz band, 70 of which have operational area designations in the GMF of US, USA or USP. A US designation permits operation in all 50 States plus the District of Columbia, USA excludes Alaska and Hawaii and USP includes all areas covered by the US designation plus Puerto Rico and Territories and Possessions, but not Trust Territories of the Pacific Islands. The Department of Justice listed 9 assignments in the 162.0125-174 MHz band. The Department of Treasury's list contained 11 assignments in the 162.0125-174 MHz band and 3 in the 406.1-420 MHz band.

All discrete frequencies are referred to in this report by generic channel numbers that have no relation to published channel plans. Thus, frequencies contained in the list provided by the Air Force are referred to as DOD channels 1-105, the Department of Justice's as Justice channels 1-9, and the Department of Treasury's as Treasury channels 1-11 and 1-3 for the 162.0125-174 MHz and 406.1-420 MHz respectively. Collectively, all the above channels are referred to as inaugural channels.

MEASUREMENTS

Radio Spectrum Measurement System

The RSMS consists of two independent computer controlled systems, one is used to conduct measurements within bands used for land mobile radio, the LMR system, and the other is used to conduct measurements within bands allocated to the radiodetermination service, the RADAR system. The LMR system was used to measure band usage during the inaugural period.

Data Collection

Normally the RSMS computer is programmed to measure band usage in hourly increments, but because of the brief time span required for the President's inauguration and the desirability of obtaining data on all three bands, this interval was shortened to 20 minutes. Under this scheme, each band was measured sequentially for 20 minutes of each hour. Measurements commenced on the January 18 at 11:25 AM and continued through January 26 until 3:30 PM.

DATA ANALYSES

General

In addition to separation by frequency band, the inaugural data was divided into three additional categories based on the time period during which the data was collected, the pre-inaugural period, January 18 and 19 (BEFORE), Inauguration day, January 20 (DURING) and the post-inaugural period, January 23 through January 26 (AFTER). Data obtained during the post-inaugural period was used as the Washington D.C. base line for routine operations within the inaugural bands. It was assumed that during this period, all communications concerning the inaugural events ceased and band usage had returned to normal.

Although data has been collected for 24 hour periods, past experience in analyzing band usage data has shown that the daily period of 0800 to 1700 hours for weekdays essentially describes band utilization. This same time period was used in analyzing the band usage data obtained for the inaugural period.

Ordinarily, band usage is determined based on measured activity on all channels assigned within a 50 mile radius of the RSMS site. In analyzing the inaugural data, a 20 mile radius was considered to be more appropriate because activities concerning the President's inauguration would be confined to a smaller area.

Definitions

A number of the terms used in presenting the results of analyzing the inaugural data are subject to different interpretations. Because of this, the specific meanings of these terms as used in this report are given below.

1. **Hourly Band Usage:** The average usage of all channels during a one hour period.

2. **Daily Band Usage:** The average of the hourly band usage during the period of from 0800 to 1700 hours.

3. **Maximum Hourly Band Usage:** The largest value within the data set used to compute daily band usage.

4. **Minimum Hourly Band Usage:** The smallest value within the data set used to compute daily band usage.

5. **Hourly Channel Usage:** The average usage of a single channel during a one hour period.

6. **Maximum Hourly Channel Usage:** The maximum usage measured on a single channel during any one hour period.

ANALYSIS

138-150.8 MHz Band

A total of 265 channels was used to calculate band usage of the 138-150.8 MHz band. The 20 mile radius select of the GMF identified 195 locally assigned channels, 35 of which were contained in the list of 105 inaugural channels provided by DOD. Since all 105 inaugural channels were to be measured, the 70 DOD channels not included in the computer select were added to the 195, bringing the total to 265 channels. The composition of the channel set is: 160 (60%) are local channels normally assigned to the D.C. area, 35(13%) are local channels designated for inaugural use ,and 70(27%) are nationwide assignments that were designated to be used during the inaugural period only.

Figure 3-1 shows the hourly band usage measured during the three inaugural periods. Hourly band usage during the pre-inaugural period and on inauguration day exceeded the post-inaugural usage for all hours. Table 3-1 is a list of the statistics for daily band usage. Maximum and minimum values for hourly band usage given in the table are plotted in Figure 3-1.

TABLE 3-1

DAILY BAND USAGE STATISTICS FOR THE 138-150.8 MHZ BAND

	INAUGURAL PERIOD		
	BEFORE	DURING	AFTER
DAILY BAND USAGE	3.34%	3.79%	1.51%
MAXIMUM HOURLY BAND USAGE	4.11%	4.92%	2.03%
MINIMUM HOURLY BAND USAGE	2.12%	2.45%	1.24%

The 138-150.8 MHz inaugural data was analyzed further to determine if the higher hourly band usage for the before and during inaugural periods manifest in Figure 3-1 could be attributed to usage on DOD's inaugural channels. Table 3-2 shows the channel usage distributions for the 195 local and 105 inaugural channels.

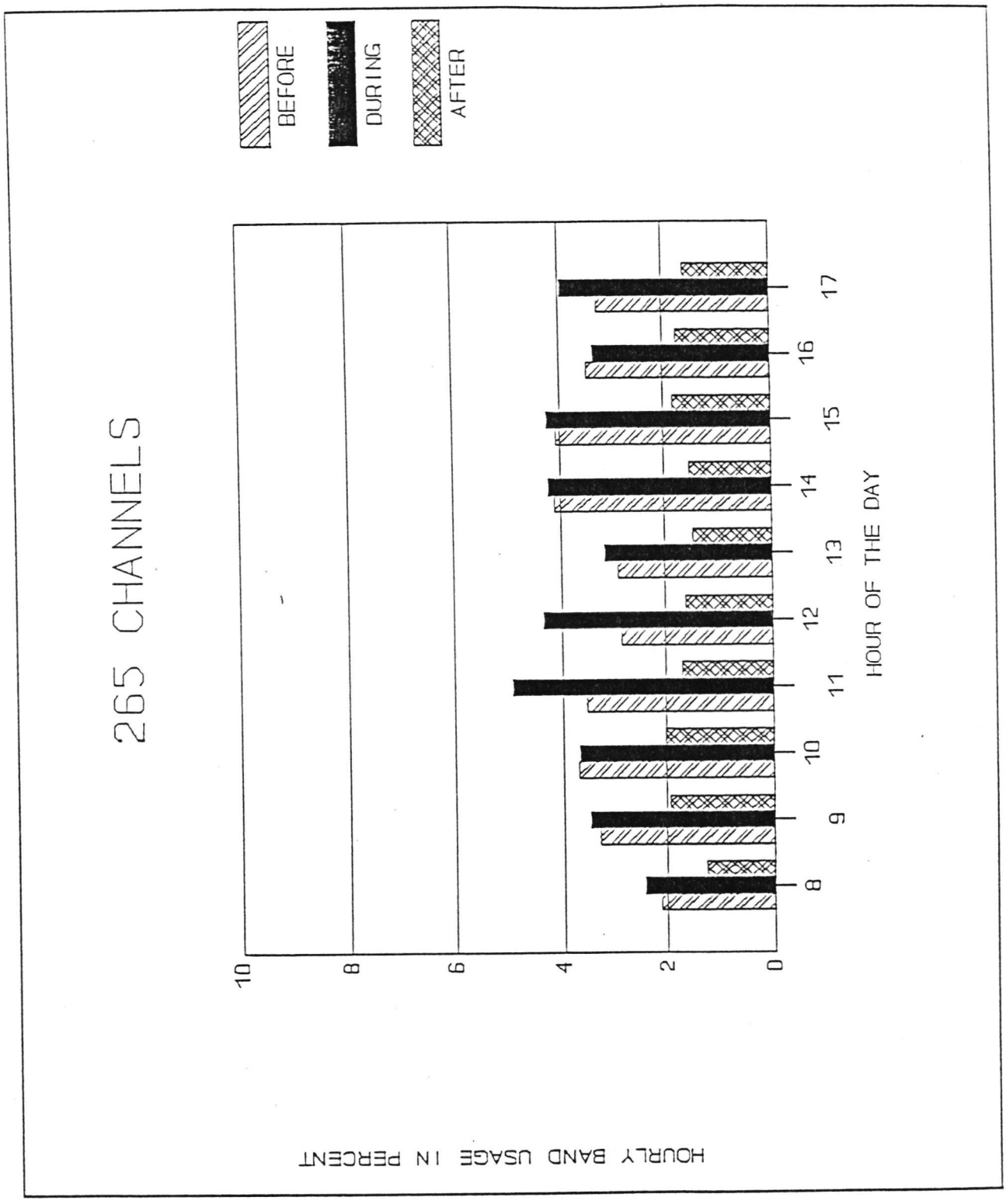

FIGURE 3-1. Hourly band usage of the 138-150.8 MHz band for 195 local plus 70 inaugural channels.

Table 3-2

CHANNEL USAGE DISTRIBUTIONS FOR THE 138-150.8 MHZ BAND

TIME PERIOD & TYPE OF CHANNELS	CHANNEL USAGE BINS				
	>=90%	>=20%	>=0.5%	0.5%-0.1%	<0.1%
PRE-INAUGURAL PERIOD					
195 CHANNELS LOCALLY ASSIGNED	0	9	120	69	6
105 INAUGURAL CHANNELS	0	7	74	30	1
INAUGURATION DAY					
195 CHANNELS LOCALLY ASSIGNED	0	5*	84#	50	61
105 INAUGURAL CHANNELS	0	10*	74#	21	10
POST-INAUGURAL PERIOD					
195 CHANNELS LOCALLY ASSIGNED	0	4	84	69	42
105 INAUGURAL CHANNELS	0	0	27	42	36

Comparing the inauguration day channel usage distributions in Table 3-2 for the 195 local channels and the 105 inaugural channels shows that twice as many inaugural channels are in the highest usage bin (marked by *) than local channels while the numbers in the adjacent lower bin (marked by #) differ by only 10 for the two sets of channels. Considering that 35 inaugural channels are included in the 195 local channels, it may be that 1 or more of the 5 high use local channels may be inaugural channels. The distributions for the post-inaugural period show a decline in high use local channels from 5 to 4, a 20% change, while there was a corresponding 100% decrease, from 10 to 0, in usage of the inaugural channels. The local channel usage remained at 84 in the adjacent lower bin, but for the inaugural channels there was a decrease of from 74 t0 27, a 64% change. From the above, it can be concluded that the increase in band usage on inauguration day was due to increased activity on the inaugural channels.

A similar comparison between the pre-inaugural and post inaugural periods indicate that increased band usage may also be due to usage of the inaugural channels, but the numbers do not show this to be the obvious conclusion.

As a matter of interest, distributions of hourly band usage and maximum hourly channel usage were developed for DOD's inaugural channels. The results are shown in Figures 3-2 and 3-3. The statistics for daily band usage on the 105 DOD inaugural channels are presented in Table 3-3.

TABLE 3-3

DAILY BAND USAGE STATISTICS FOR 105 DOD INAUGURAL CHANNELS

	INAUGURAL PERIOD		
	BEFORE	DURING	AFTER
DAILY BAND USAGE	4.34%	6.29%	0.56%
MAXIMUM HOURLY BAND USAGE	5.27%	9.3%	0.99%
MINIMUM HOURLY BAND USAGE	1.8%	4.18%	0.38%

Examination of Figure 3-2 and the corresponding values in Table 3-3 show a large decrease in the use of the 105 DOD inaugural channels after inauguration day. Of the three bands measured these results give the clearest indication of the increase in channel activity associated with the President's inauguration. Figure 3-3 shows that channel usage exceeded 40% at some time during 8 of 10 hourly periods before inauguration day and for 7 periods on inauguration day. The higher maximum channel usage during the pre-inaugural period is most likely due to testing the effectiveness of newly established communications links.

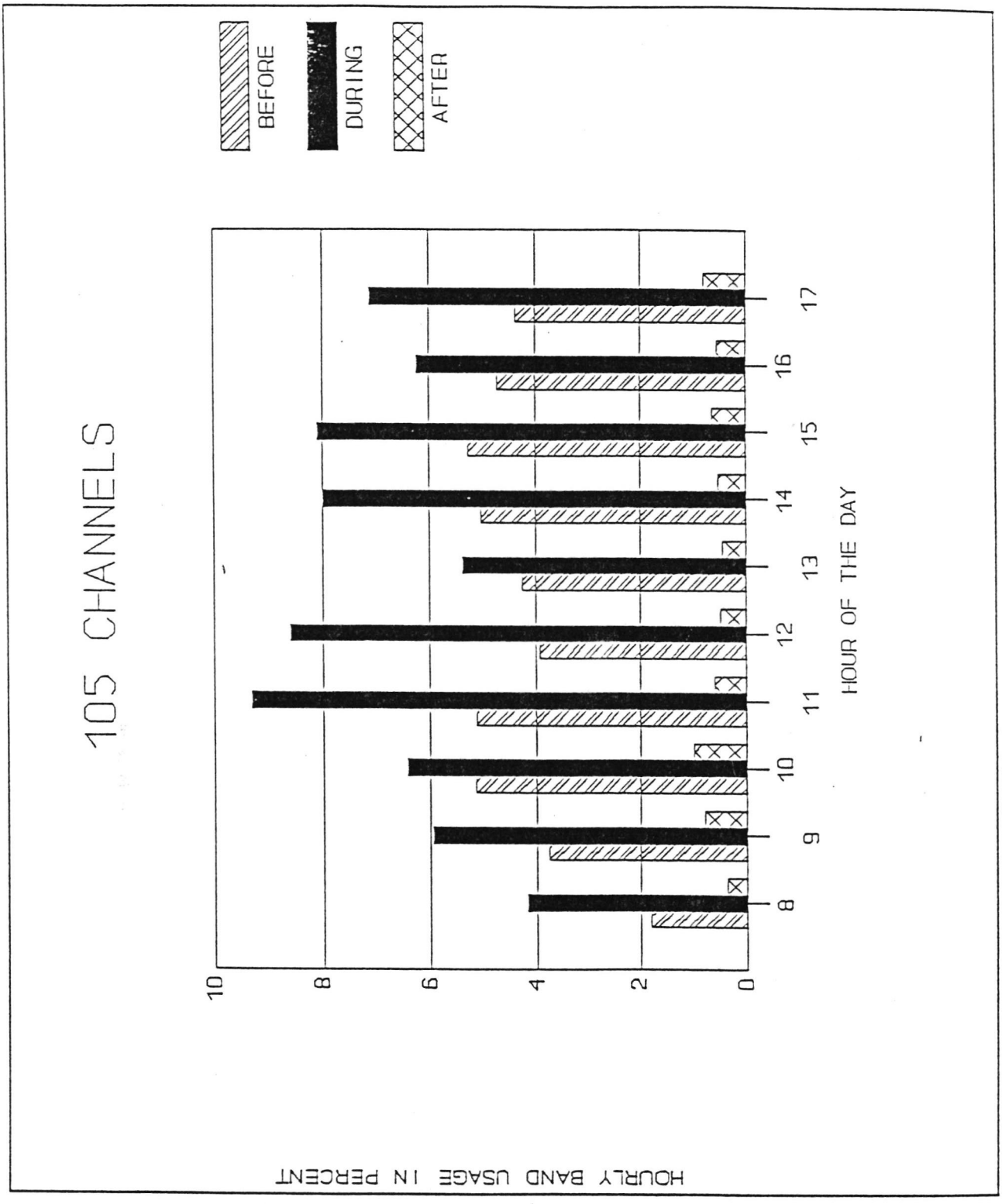

FIGURE 3-2. Hourly band usage on DOD's 105 inaugural channels measured during the 1989 Presidential inaugural period.

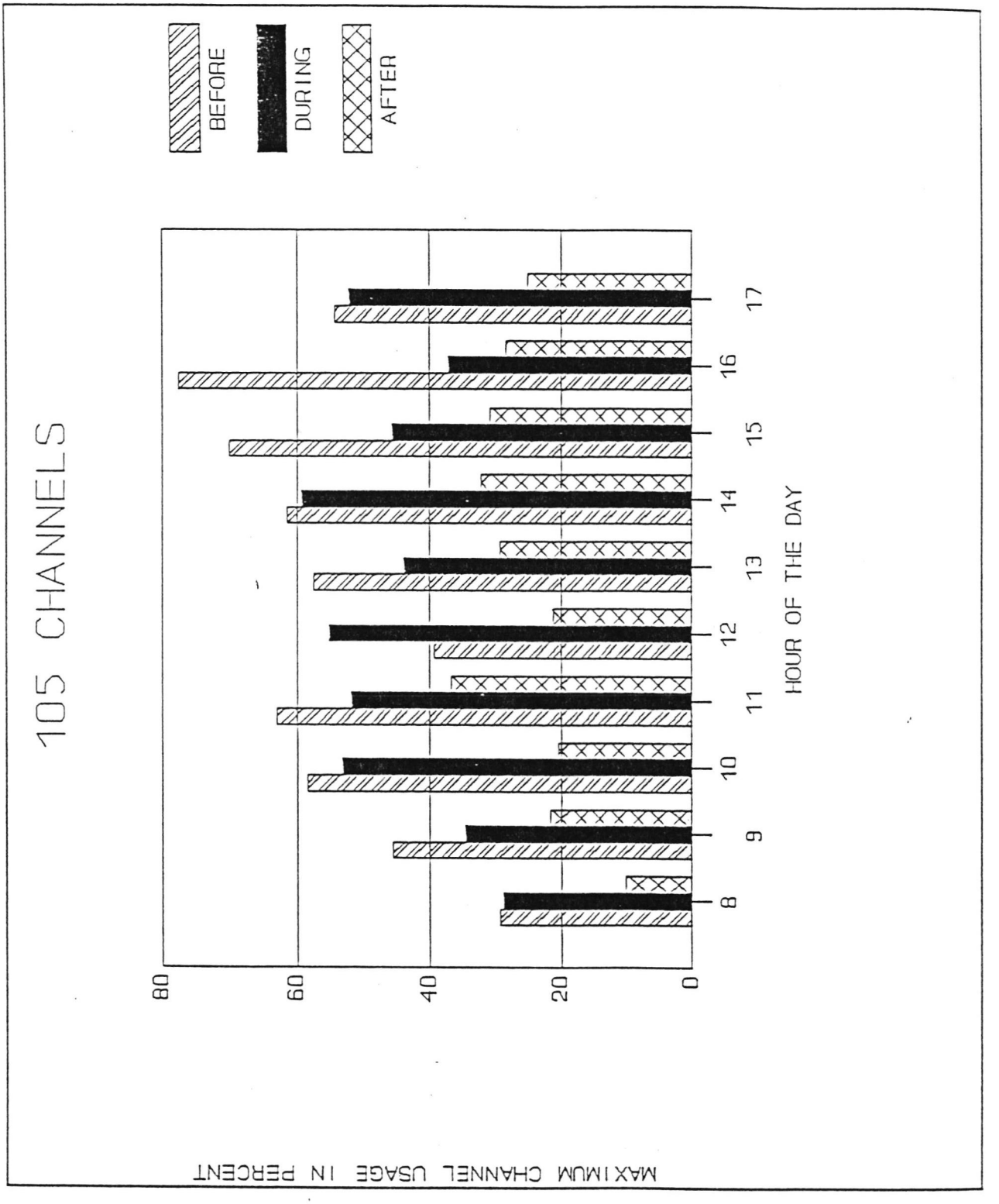

Figure 3-3. The maximum usage observed on a single DOD inaugural channel for each hour.

162.0125-174 MHz Band

A total of 330 channels was used to calculate band usage of the 162.0125-174 MHz band. The 20 mile radius select of the GMF identified 326 locally assigned channels, 16 of which were contained in the list of 20 inaugural channels provided by Justice and Treasury. The 4 channels not included in the GMF select were added to the 326, bringing the total to 330 channels. The composition of the channel set is: 310 (94%) are local channels assigned to the D.C. area, 16 (5%) are local channels designated for inaugural use, and 4 (1%) are area wide assignments that were designated for use during the inaugural period.

Figure 3-4 shows the hourly band usage for the three inaugural periods. In comparison to the post-inaugural period, the bar charts indicate greater usage for all hours during the pre-inaugural period and for 9 hours on inauguration day. The statistics for daily band usage are presented in Table in Table 3-4.

TABLE 3-4

DAILY BAND USAGE STATISTICS FOR THE 162.0125-174 MHZ BAND

INAUGURAL PERIOD

	BEFORE	DURING	AFTER
DAILY BAND USAGE	4.18%	3.81%	3.03%
MAXIMUM HOURLY BAND USAGE	5.47%	4.77%	3.43%
MINIMUM HOURLY BAND USAGE	2.6%	3.24%	2.34%

Although the analysis results indicate increased band usage during the pre-inaugural period and on inauguration day, it was unlikely that usage on the 20 inaugural channels were the sole cause since they comprised only 6% of the data base of 330 channels. In order to verify this, Table 3-5 was developed to show the distributions of channel usage for the three inaugural periods.

It is obvious from the distributions shown in Table 3-5 that increased daily band usage was not due to inaugural channel usage. For the pre-inaugural period, usage on the inaugural channels did not exceed 20%. On inauguration day, there was increased activity on the inaugural channels, but here again usage on the local channels was far greater in both the number of channels in use and the magnitude of the usage. For example, 11 of the local channels had measured usage of 20% or greater with 2 exceeding or equaling 90% usage.

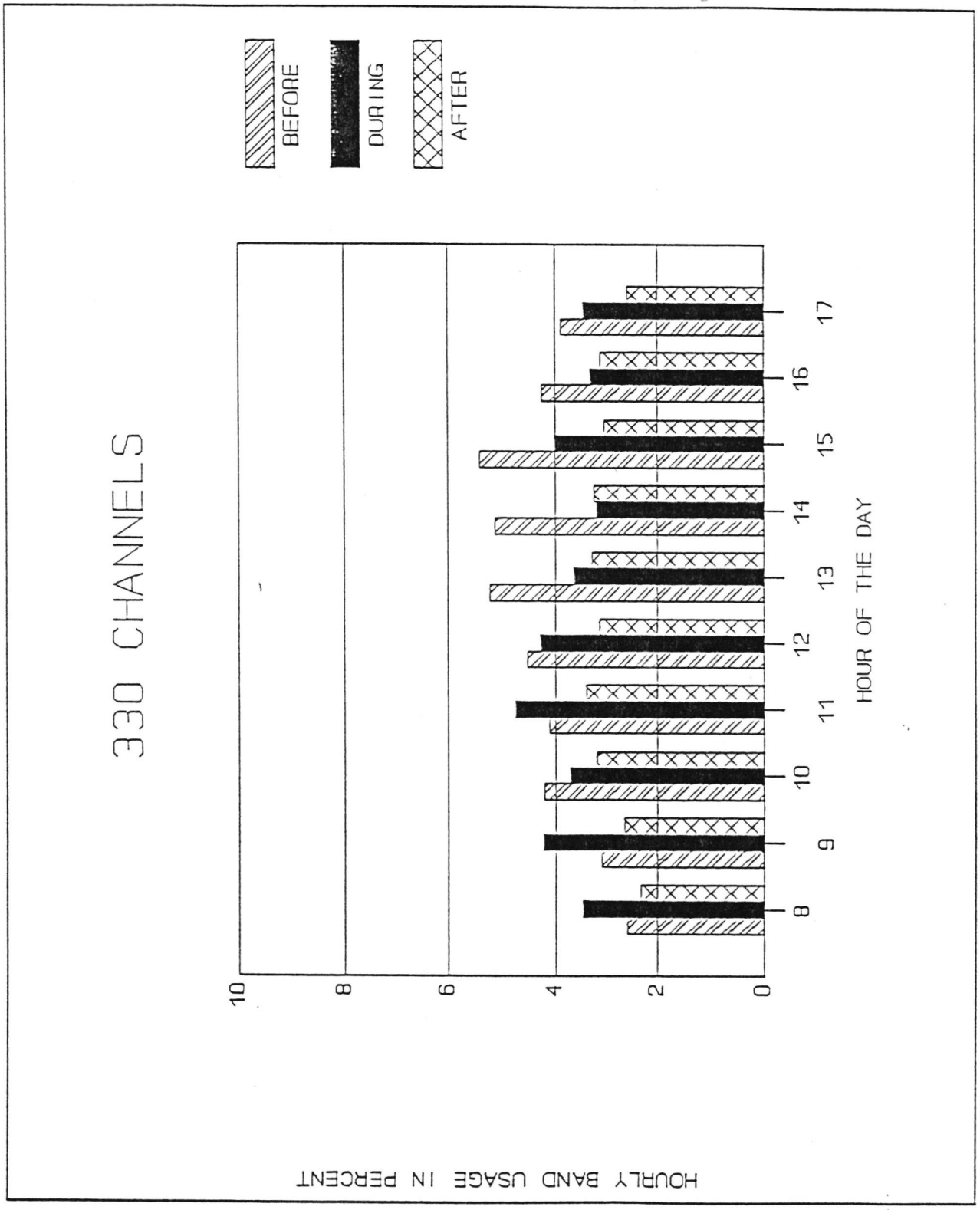

Figure 3-4. Hourly band usage of the 162.0125-174 MHz band on 326 local channels plus 4 inaugural channels.

Table 3-5

CHANNEL USAGE DISTRIBUTIONS FOR THE 162.0125-174 MHZ BAND

TIME PERIOD & TYPE OF CHANNELS	CHANNEL USAGE BINS				
	>=90%	>=20%	>=0.5%	0.5-0.1%	<0.1%
PRE-INAUGURAL PERIOD					
326 CHANNELS LOCALLY ASSIGNED	2	11	230	78	18
20 INAUGURAL CHANNELS	0	0	18	2	0
INAUGURATION DAY					
326 CHANNELS LOCALLY ASSIGNED	2	13	174	48	104
20 INAUGURAL CHANNELS	0	2	17	1	2
POST-INAUGURAL PERIOD					
326 CHANNELS LOCALLY ASSIGNED	2	7	193	70	63
20 INAUGURAL CHANNELS	0	0	16	3	1

Figures 3-5 and 3-6 show the distributions of hourly band usage due exclusively to activity on the 9 Justice and 11 Treasury inaugural channels. The statistics for these distributions are given in Table 3-6.

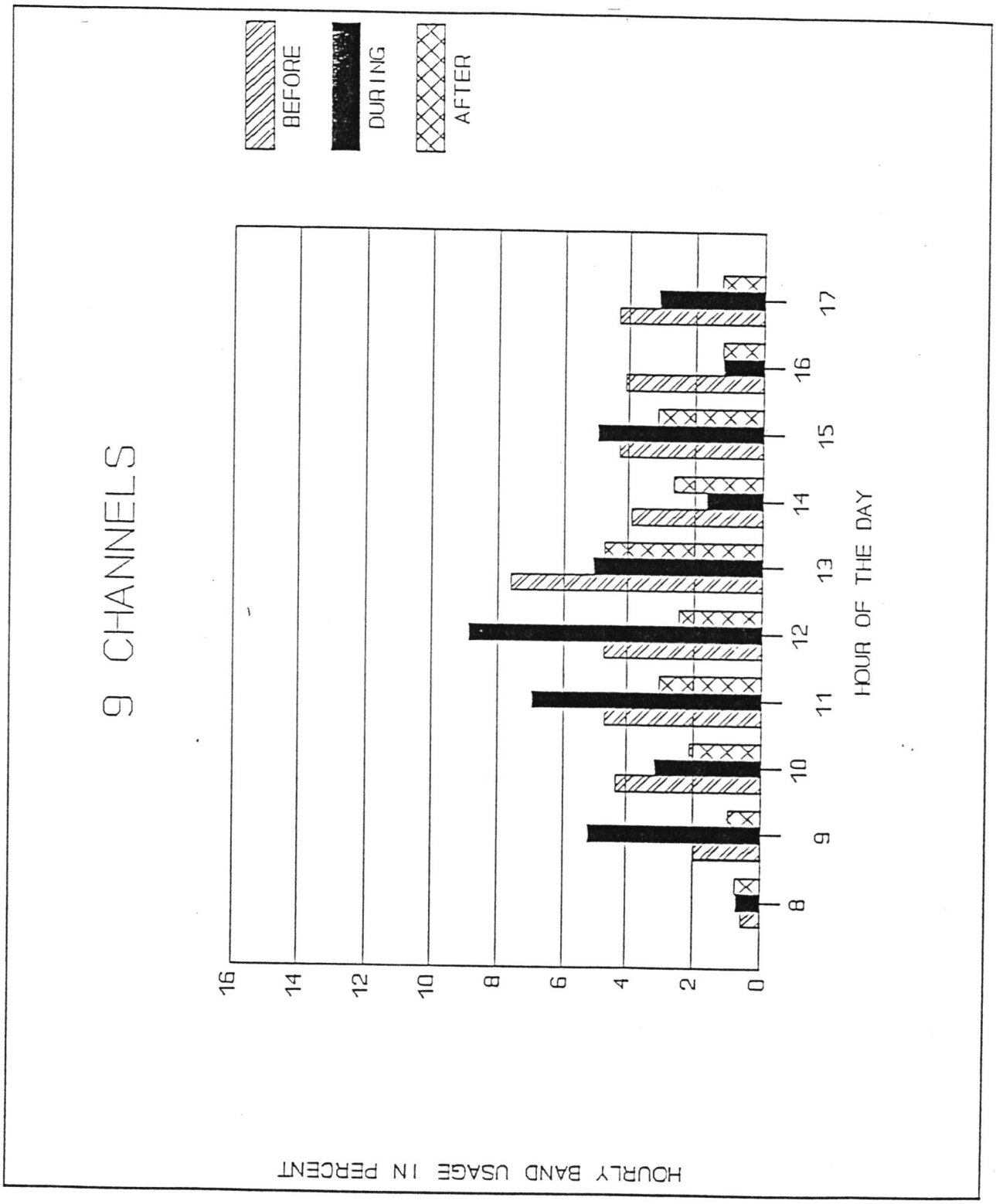

FIGURE 3-5. Hourly band usage of the 162.0125-174 MHz band on Justice's inaugural channels.

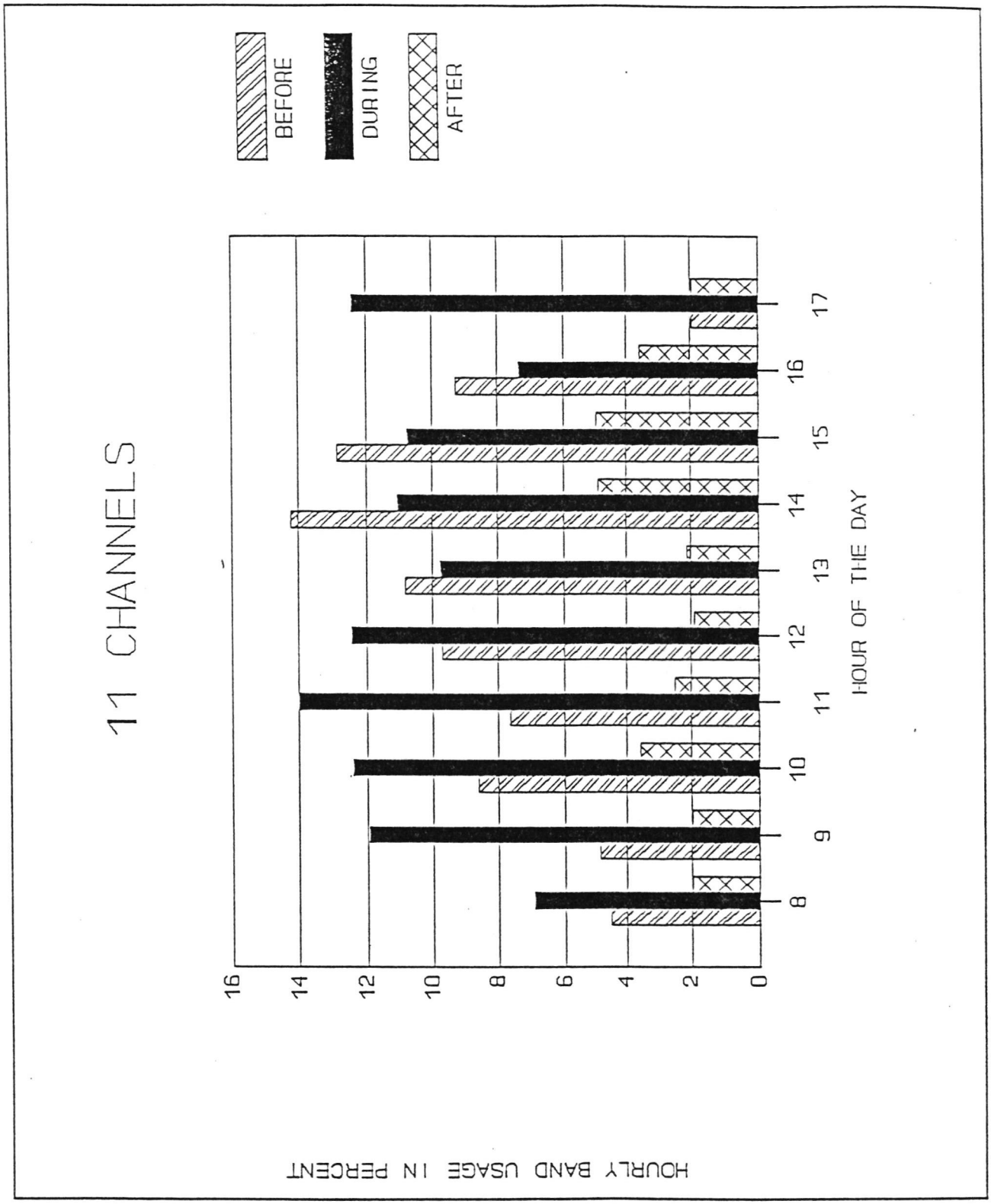

FIGURE 3-6. Hourly band usage of the 162.0125-174 MHz band on Treasury's inaugural channels.

TABLE 3-6

DAILY BAND USAGE STATISTICS FOR JUSTICE AND TREASURY CHANNELS

	9 JUSTICE CHANNELS			11 TREASURY CHANNELS		
	BEFORE	DURING	AFTER	BEFORE	DURING	AFTER
DAILY BAND USAGE	4.04%	4.09%	2.22%	8.44%	10.9%	2.94%
MAXIMUM HOURLY BAND USAGE	7.59%	8.87%	4.74%	14.24%	13.98%	4.97%
MINIMUM HOURLY BAND USAGE	0.54%	0.70%	0.72%	1.95%	6.93%	1.89%

The distribution in Figure 3-5 shows that Justice's use of their channels varied considerably for all three inaugural periods. This pattern of usage is also indicated in Table 3-6 by the large differences between the maximum and minimum usage measured during all three periods.

Treasury's usage distribution, Figure 3-6, is similar to Justice's, Figure 3-5, for the pre-inaugural period, although the magnitude of Treasury's usage is generally higher. In contrast, Treasury's usage distributions for inauguration day and the post-inaugural period are more uniform. Also, the change in usage on between the two periods is greater for Treasury. This is is evident in Table 3-6 which shows that Justice's daily band usage changed from 4.09% on inauguration day to 2.22% during the post-inaugural period. The corresponding change shown for Treasury in the Table 3-6 is from 10.9% to 2.94%

Distributions of maximum hourly channel usage were developed for Justice and Treasury. The results are presented in Figures 3-7 and 3-8 respectively. The maximum usage measured on a single Justice inaugural channel was 54% which occurred on inauguration day during the 12th hour. For Treasury, their maximum usage reached 68.3% which occurred also on inauguration day, but during the 17th hour.

The distributions for inaugural channel use on inauguration day by Justice and Treasury are given in Tables 3-7 and 3-8 respectively. The variability in Justice's channel use is evident in Table 3-7 by the number of zero entries. In contrast very few zero entries are contained in Table 3-8 which depicts Treasury's channel usage for inauguration day. Treasury's higher channel usage throughout the day is also evident in Table 3-8 by the magnitude of the entries. One conclusion that can be drawn from comparing the distributions in Tables 3-7 and 8 is that Treasury's role in protecting the President, Vice President and members of their families called for constant communications between agents of the Secret Service.

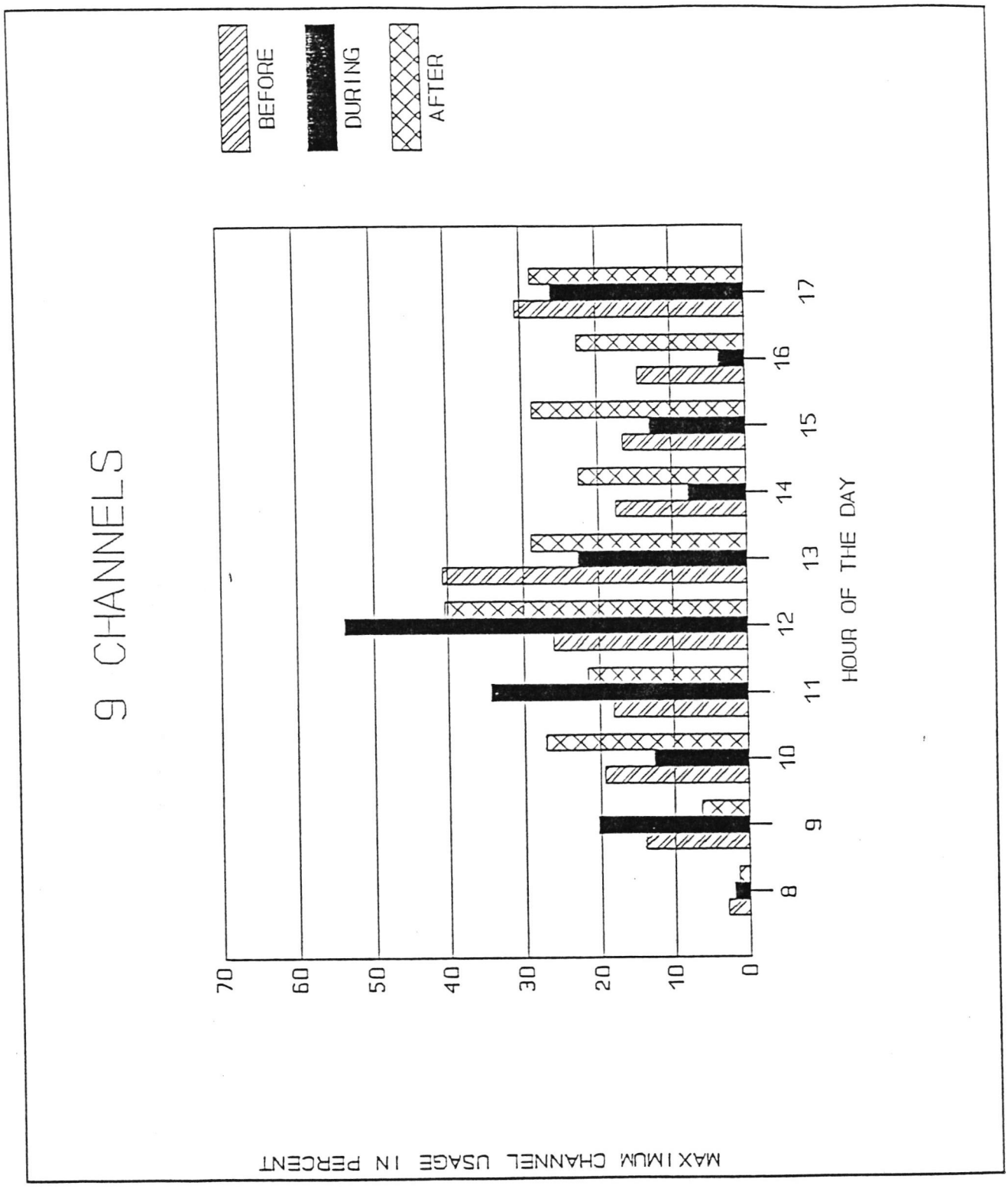

FIGURE 3-7. The maximum usage observed on a single Justice inaugural channel for each hour in the 162.0125-174 MHz band.

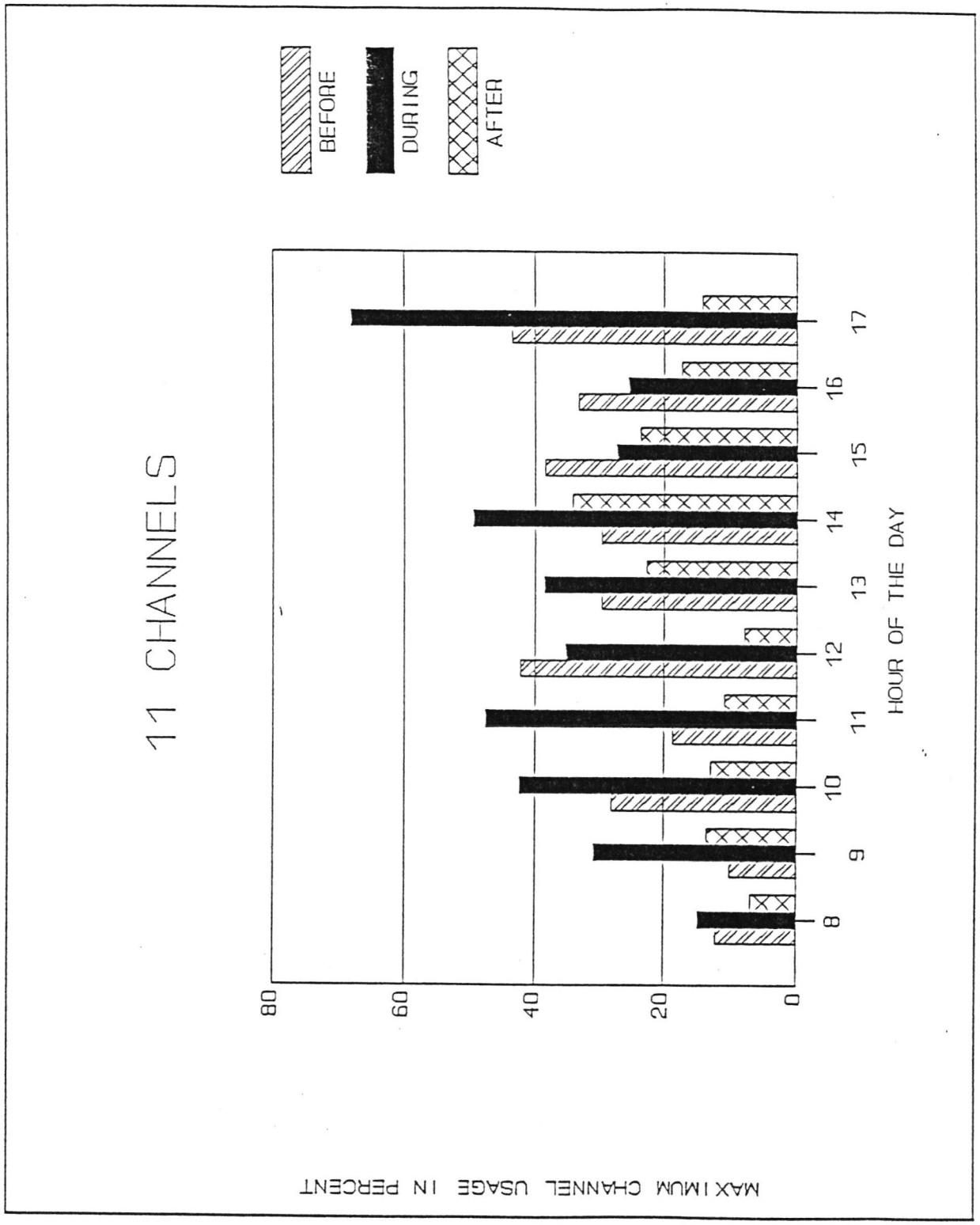

Figure 3-8. Maximum usage observed on a single Treasury inaugural channel for each hour in the 162.0125-174 MHz band.

TABLE 3-7

CHANNEL USAGE BY JUSTICE ON INAUGURATION DAY

	HOUR OF THE DAY										STATISTICS		
CHANNEL	8	9	10	11	12	13	14	15	16	17	MEAN	MAX	MIN
1	2.10	2.80	8.50	16.40	54.00	22.90	7.90	12.90	1.40	26.10	15.50	54.00	1.40
2	0.00	0.70	0.00	0.00	1.40	2.10	0.00	0.00	0.00	0.00	0.42	2.10	0.00
3	0.00	20.40	12.70	0.00	0.00	7.10	0.00	8.60	3.50	0.00	5.23	20.40	0.00
4	0.00	11.30	0.00	34.30	3.60	0.70	5.70	4.30	0.00	0.00	5.99	34.30	0.00
5	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.07	0.70	0.00
6	1.40	2.10	5.60	0.00	0.70	6.40	0.00	8.60	2.10	0.00	2.69	8.60	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	10.00	19.40	5.70	2.10	9.40	0.70	2.10	4.94	19.40	0.00
9	0.00	9.80	1.40	2.10	0.70	0.00	0.00	0.70	2.80	0.00	1.75	9.80	0.00
MEAN	0.39	5.23	3.13	6.98	8.87	5.07	1.74	4.94	1.17	3.13			
MAX	2.10	20.40	12.70	34.30	54.00	22.90	7.90	12.90	3.50	26.10			
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			

TABLE 3-8

CHANNEL USAGE BY TREASURY ON INAUGURATION DAY

	HOUR OF THE DAY										STATISTICS		
CHANNEL	8	9	10	11	12	13	14	15	16	17	MEAN	MAX	MIN
1	13.30	28.20	21.10	22.10	20.10	9.30	16.40	12.90	25.40	19.60	18.84	28.20	9.30
2	7.00	8.50	11.30	16.40	5.00	2.10	8.60	15.10	7.70	0.70	8.24	16.40	0.70
3	3.50	1.40	2.80	8.60	9.30	8.60	1.40	2.20	3.50	7.00	4.83	9.30	1.40
4	14.70	30.90	24.60	23.60	15.10	19.30	15.80	15.20	3.50	10.50	17.32	30.90	3.50
5	10.50	25.50	7.00	6.50	9.40	4.30	7.10	7.20	8.50	7.00	9.30	25.50	4.30
6	7.70	4.90	6.30	22.90	35.30	38.60	49.30	27.30	19.00	9.80	22.11	49.30	4.90
7	2.10	19.60	42.30	47.50	22.30	10.70	8.60	23.70	4.20	13.30	19.43	47.50	2.10
8	2.10	3.50	0.00	0.00	2.20	0.70	2.10	0.00	0.70	0.00	1.13	3.50	0.00
9	0.00	0.00	0.00	0.00	8.60	9.30	3.60	5.80	0.70	0.00	2.80	9.30	0.00
10	10.50	3.50	14.80	7.10	4.30	4.30	2.10	8.00	6.30	68.30	12.92	68.30	2.10
11	4.20	4.90	4.90	1.40	6.50	0.00	6.40	0.70	1.40	0.70	3.11	6.50	0.00
MEAN	6.87	11.90	12.28	14.19	12.55	9.75	11.04	10.74	7.35	12.45			
MAX	14.70	30.90	42.30	47.50	35.30	38.60	49.30	27.30	25.40	68.30			
MIN	0.00	0.00	0.00	0.00	2.20	0.00	1.40	0.00	0.70	0.00			

406.1-420 MHz Band

A total of 273 channels was used in calculating band usage of the 406.1-420 MHz band. The 20 mile radius select of the GMF identified the 273 channels which included all 3 of the inaugural channels for this band. The composition of the channel set for this band consists of 323 (99%) local channels and 3 (1%) local channels designated for inaugural use.

Figure 3-9 shows the hourly band usage for the 3 inaugural periods. The statistics for daily band usage statistics are presented in Table 3-9.

TABLE 3-9

DAILY BAND USAGE STATISTICS FOR THE 406.1-420 MHZ BAND

	INAUGURAL PERIOD		
	BEFORE	DURING	AFTER
DAILY BAND USAGE	2.67%	2.45%	2.40%
MAXIMUM HOURLY BAND USAGE	3.15%	3.11%	2.70%
MINIMUM HOURLY BAND USAGE	2.29%	1.9%	2.03%

Examination of Figure 3-9 and Table 3-9 shows that usage of the 406.1-420 MHz band remained fairly constant for the three inaugural periods. Table 3-11 was developed to see if usage on Treasury's inaugural had any impact daily band usage. It is clear from examining the distributions in the table that heavy usage on locally assigned channels completely masked Treasury's usage on their 3 inaugural channels.

TABLE 3-10

DAILY BAND USAGE STATISTICS FOR 3 TREASURY INAUGURAL CHANNELS

	INAUGURAL PERIOD		
	BEFORE	DURING	AFTER
DAILY BAND USAGE	2.51%	5.11%	3.40%
MAXIMUM HOURLY BAND USAGE	3.29%	8.29%	5.38%
MINIMUM HOURLY BAND USAGE	1.7%	1.81%	1.75%

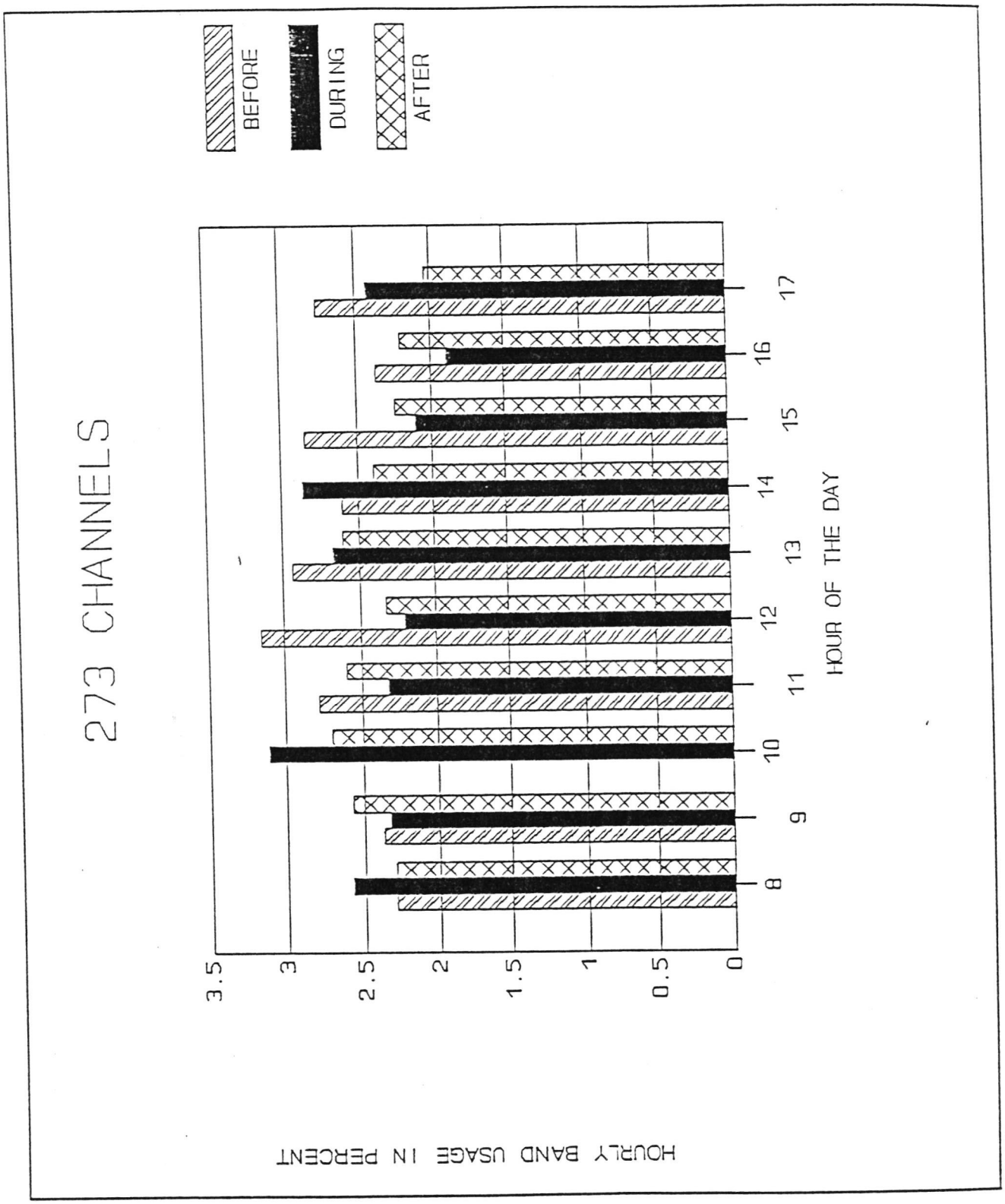

Figure 3-9. Hourly band usage of the 406.1-420 MHz band on 273 local channels.

TABLE 3-11

CHANNEL USAGE DISTRIBUTIONS FOR THE 406.1-420 MHZ BAND

TIME PERIOD & TYPE OF CHANNELS	CHANNEL USAGE BINS				
	>=90%	>=20%	>=0.5%	0.5-0.1%	<0.1%
PRE-INAUGURAL PERIOD					
273 CHANNELS LOCALLY ASSIGNED	2	6	108	148	17
3 INAUGURAL CHANNELS	0	0	2	1	0
INAUGURATION DAY					
273 CHANNELS LOCALLY ASSIGNED	2	7	82	28	163
3 INAUGURAL CHANNELS	0	0	1	2	0
POST-INAUGURAL PERIOD					
273 CHANNELS LOCALLY ASSIGNED	2	6	90	41	142
3 INAUGURAL CHANNELS	0	0	1	1	1

Hourly band usage based on Treasury's 3 inaugural channels is shown in Figure 3-10. Usage on inauguration day was greatest for 7 of the 10 hours for which data is plotted. The maximum usage observed on a single inaugural channel during each hour is shown for the 3 inaugural periods in Figure 3-11. Maximum usage occurred during the 12th hour.

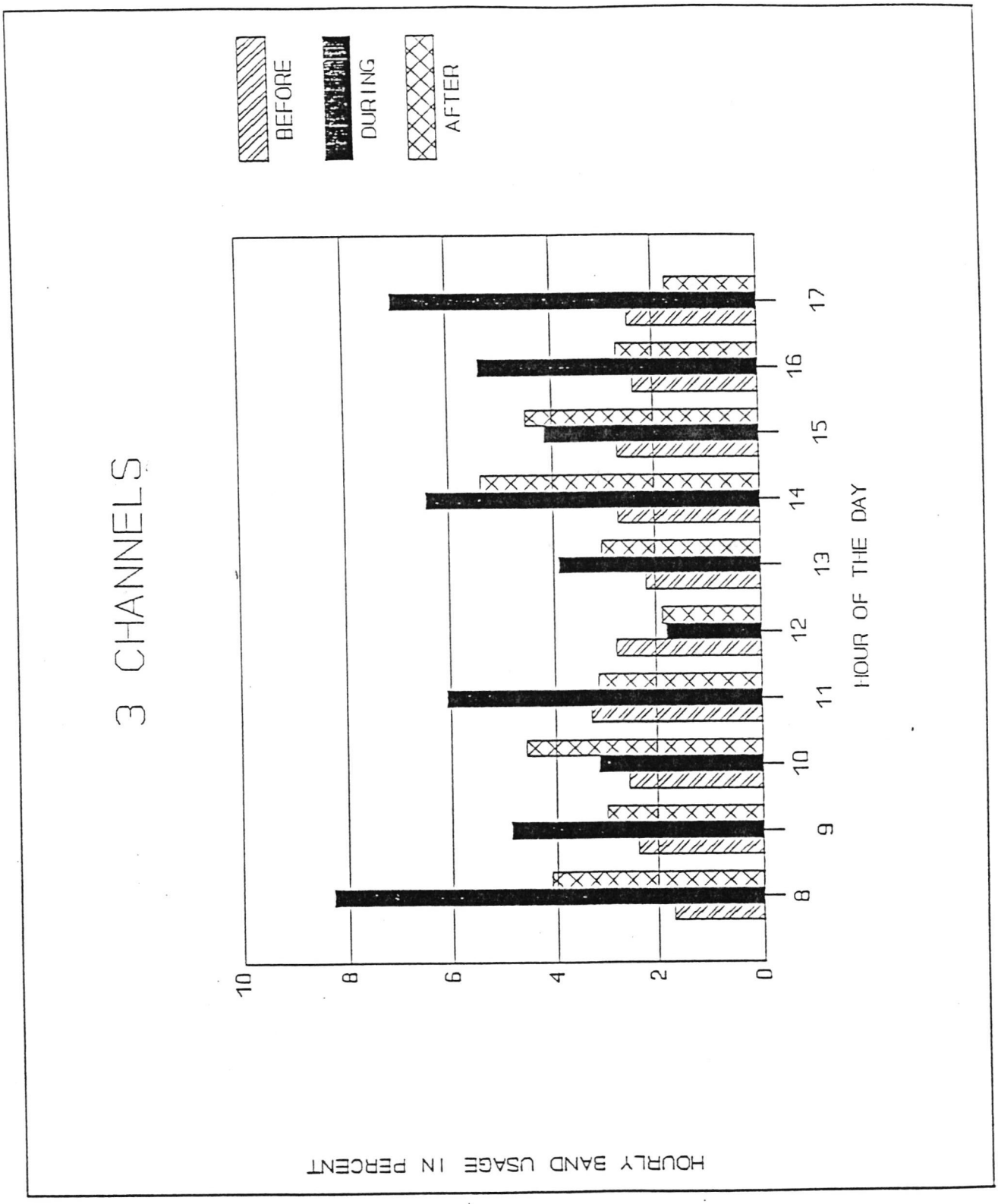

FIGURE 3-11 Hourly band usage of the 406.1-420 MHz band on Treasury's inaugural channels.

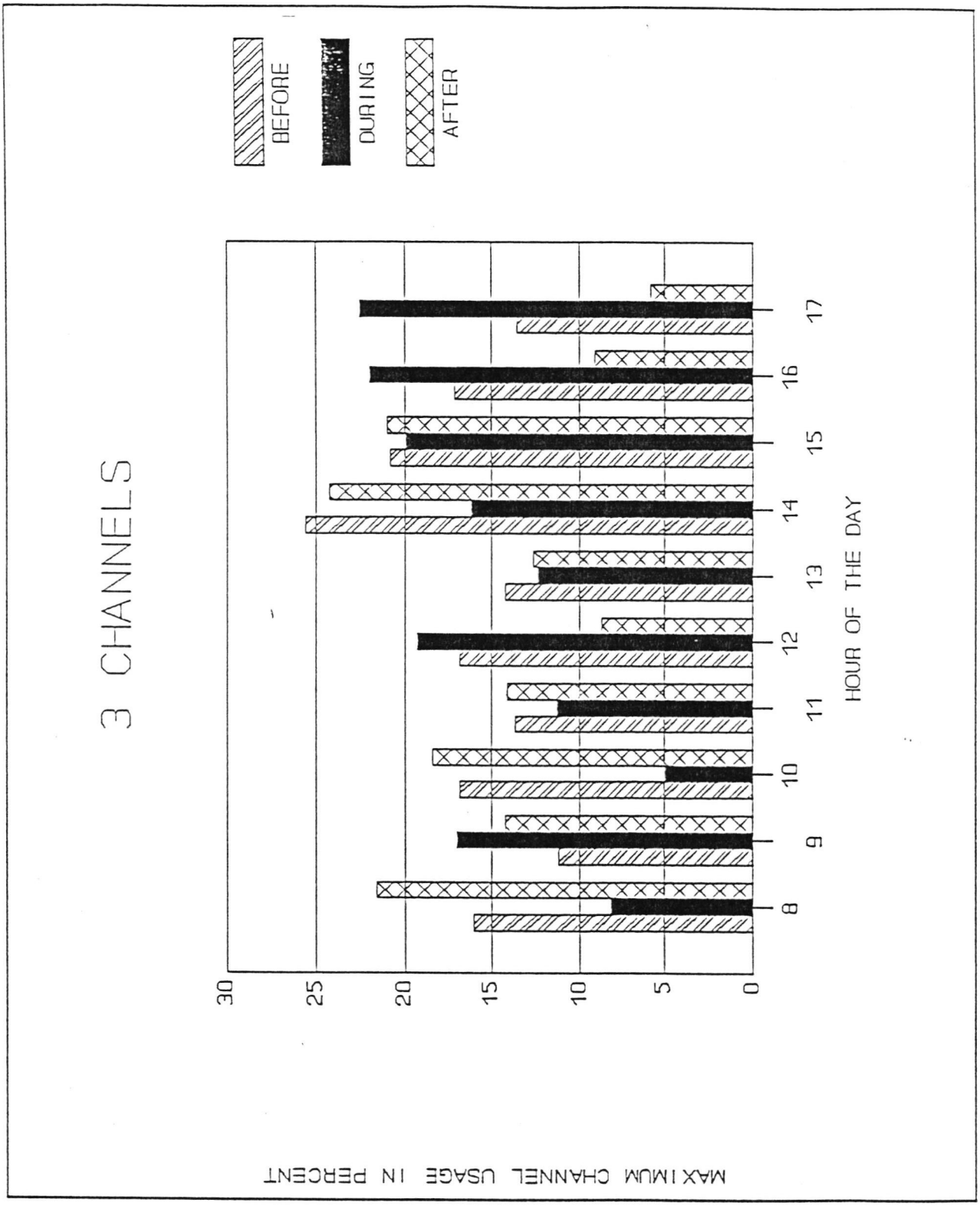

FIGURE 3-11. The maximum usage observed on a single Treasury channel in the 406.1-420 MHz band for each hour.

Verification of Band Usage Baseline

As mentioned earlier, the post-inaugural period was used as being representative of routine band usage in the Washington D.C. area. This period was chosen based on the assumption that all communications associated with the President's inauguration would have been terminated and routine band usage would be resumed.

The 162.0125-174 band was measured in 1986 with the RSMS Van located at the same site as for the inaugural measurements. A comparison was made of the 1986 distribution of hourly band usage with the distribution for the post-inaugural period. Band usage obtained using both the 1986 and 1989 data are shown in Figure 3-12. Table 3-11 lists the data and statistics for the two periods.

The correlation coefficient for the two data sets was calculated to obtain an estimate of the degree of association. The procedure used is described below.[1]

$$r_{xy} = \frac{\Sigma^{n}(X_i-\overline{X})(Y_i-\overline{Y})}{n\, S_x\, S_y}$$

r_{xy} = correlation coefficient

X_i, Y_i = corresponding data points in sets X & Y

$\overline{X}, \overline{Y}$ = Means of X & Y data sets

S_x, S_y = Standard deviations for data sets X & Y

n = Number of data points

The correlation coefficient ranges from -1 to +1, with 0 meaning the two distributions are independent of each other. The degree of association of two distributions is indicated by the magnitude of the correlation coefficient. If a distribution were correlated with itself, it is easily shown that the correlation coefficient would be equal to 1. A negative value for the coefficient means that the two distributions are inversely related such as student IQ with wrong answers on an exam.

The computation using the values for the 1986 and the inaugural band usage data is as follows.

$$r_{xy} = 0.87/10(0.36)(0.3)$$
$$= 0.81$$

The value of .81 indicates a high degree of association between the 1986 and inaugural band usage distribution. This result supports the selection of the post-inaugural measurements to represent routine operations, at least for the 162-174 MHz band.

---

[1] Minimum, Edward W., "Statistical Reasoning in Psychology and Education",Second edition,1978, John Wiley & Sons, New York

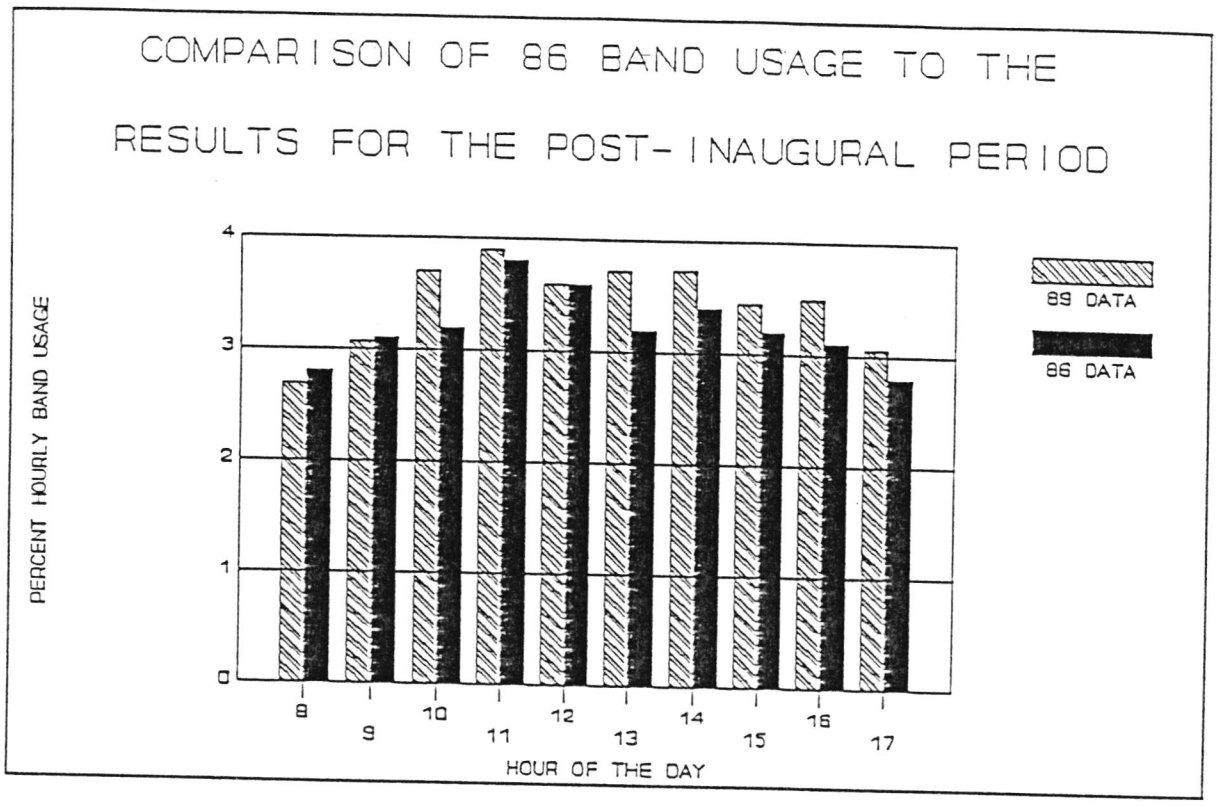

Figure 3-12 Band usage of the 162.0125-174 MHz band measured in 1986 and after the 1989 Presidential inauguration.

TABLE 3-11

DATA AND STATISTICS FOR USAGE COMPARISON OF THE 162.0125-174 MHZ BAND

HOUR	1989 USAGE IN PERCENT	1986 USAGE IN PERCENT
8	2.69	2.81
9	3.07	3.1
10	3.7	3.2
11	3.9	3.8
12	3.6	3.6
13	3.72	3.2
14	3.73	3.4
15	3.45	3.2
16	3.49	3.1
17	3.06	2.8
MEAN	3.44	3.22
STANDARD DEVIATION	0.36	0.3

Government Channel Assignments

In order to satisfy their inaugural period communications requirements, DOD and Justice relied in part on area wide frequency assignments. NTIA's LMR Notebooks were examined to see if a greater reliance on these types of assignments would have been required if a special event occurred in another location where band usage was measured using the RSMS. This was accomplished by noting the number of government channels assignments within each of the other areas. The results are presented in Table 3-13.

TABLE 3-13

GOVERNMENT CHANNELS ASSIGNED AT RSMS MEASURED SITES

BAND(MHz)	SITE	YEAR	NUMBER OF CHANNELS ASSIGNED IN AREA
162.0125-172	New York, NY	1985	262
	Long Island, NY	1985	289
	Patuxent NATC, MD	1986	56
	Washington, D.C.	1986	392
	Sandiego, CA	1986	157
	Los Angeles, CA	1987	264
	San Francisco, CA	1987	263
	Atlanta, GA	1988	173
	Washington, D.C.	1989	378
138-150.8	Patuxent NATC, MD	1986	172
	San Francisco, CA	1987	172
	Atlanta, GA	1988	54
	Seattle, WA	1988	196
	Washington, D.C.	1988	265
406.1-420	New York, NY	1985	166
	Long Island, NY	1985	163
	Patuxent NATC, MD	1986	68

Table 3-12 (continued)

406.1-420	Washington, D.C.	1986	347
	San Diego, CA	1986	94
	Los Angeles, CA	1986	196
	San Francisco,CA	1988	215
	Atlanta, GA	1988	92
	Seattle, WA	1988	149
	Washington, D.C.	1989	351

While the results given in Table 3-12 do not answer the question, they do show that the Washington D.C. has the highest concentration of assigned Government channels compared to other sites visited by the RSMS. Another consideration is that most of these other sites are near major metropolitan areas. The disparity between the D.C. area with respect to the availability of federal government channels may be greater for more rural locations.

SECTION 4

SUMMARY

INTRODUCTION

The purpose of this section is to present a summary of the findings observed in performing the analyses of the RSMS data collected during the Presidential inaugural period. The contents differ from the conclusions given in Section 2 in that a certain amount of conjecture is introduced which requires some extrapolation beyond what is directly supported by the analyses results. Consequently most of the material presented here expands on statements made elsewhere in the report.

FINDINGS

The data collected during over the period of January 18, 1989 to January 26, 1989 provides NTIA with information concerning band usage by federal agencies during a special event which was not previously available. However the President's inauguration was carried out as planned with no disruptions that required extraordinary actions by personnel overseeing the activities associated with the inauguration ceremony. It is highly likely that band usage would have increased considerably if a disturbance had occurred. Consequently, the inaugural period measurements should considered as the initial phase in the development of a data base that depicts communication requirements for other events of national importance or national emergencies.

There were 105 channels designated for inaugural use within the 138-150.8 MHz band, 70 of which were not assigned for use within the 20 mile radius used as the basis for determining the number of local channels to be used in calculating band usage. As a consequence, DOD's communications requirements were satisfied in part by using 70 channels that are authorized for nationwide use. There probably would have been a greater reliance on these types of assignments if similar communications requirements were needed in other areas of the United States. For example, in an area with no local assignments, the channel requirements would have been met via nationwide assignments since equipment for these channels is probably available and the problems associated with special authorization can be avoided.

Table 3-12 is a list of the number of government locally assigned channels at the various locations that have been measured with the RSMS. The area used for RSMS measurements is that contained within a 50 mile radius of the RSMS site rather than the 20 miles used in the inaugural data analysis. The numbers of channel assignments shown in Table 3-12 for inaugural period (listed in the Table as Washington DC, 1989) are also based on a 50 mile radius. The fact that 265 channels shown for the 138-150.8 MHz band equals the total of local plus inaugural channels for the 20 mile radius is just a coincidence. For all three bands, Washington DC has the highest concentration of channel assignments.

One other point to consider with respect to Table 3-12 is that all the areas visited by the RSMS van, with the exception of Patuxent NATC, MD, are either major metropolitan centers or in proximity to one.

In the 162.0125-174 MHz band, the patterns of channel usage by Justice and Treasury were significantly different. Justice's varied throughout inauguration day indicating differing requirements as the inauguration ceremony progressed. On the other hand,Treasury's usage was more consistent which is attributable to the Secret Service's responsibility for protecting the President, Vice President, members of their families and other dignitaries. These responsibilities require that agents must maintain constant contact with each other. In addition, their duties remain essentially the same whenever the President or other persons under the protection of the Secret Service are exposed to the public. Another difference was that the reduction in usage on Treasury's inaugural channels during the post-inaugural period was greater than that on Justice's. Table 3-6 shows that usage by Justice went from 4.09% during to 2.22% after. Treasury's usage went from 10.9% during to 2.94% after. This is probably due to Treasury's use of these channels mostly for a single purpose.

Examination of the channel usage distributions for the 162.0125-174 Mhz band,Table 3-5, shows that there was a significant amount of activity on other channels within this band that were not inaugural channels. It is not known whether or not this increased usage was related to the President's inauguration ceremony.

Usage on Treasury's inaugural channels in the 406-420 MHz band had no measurable effect on hourly band usage because they represented only 1.0% of the total number of locally assigned channels. Hourly band usage based on just the 3 inaugural channels, Figure 3-11, shows that for 7 of the 10 hours, usage was greater on inauguration day than during the post-inaugural period. Maximum usage. Figure 3-12, observed on a single channel was greater than 25% which occurred during the 14th hour during the pre-inaugural period.

It was possible to conduct the inaugural period measurements using the RSMS because there was adequate lead time to drive the van from Boulder to DC. In the case of an unplanned event , such as the Mount ST Helen's volcanic eruption or the forrest fire at Yellowstone Park, this would probably not have been feasible. For one, the van is a large vehicle which is not quickly deployable to distant locations. It requires accessible roads and considerable setup time. It is doubtful that rapid re-deployment of the van would be possible such as is sometimes required when forest fires change course due to a shift in wind direction. A portable version of the RSMS is required if NTIA is to obtain data during a period of a national emergency. With the advances today in miniaturization of equipment, development of a man portable equivalent of the RSMS LMR system should be feasible.