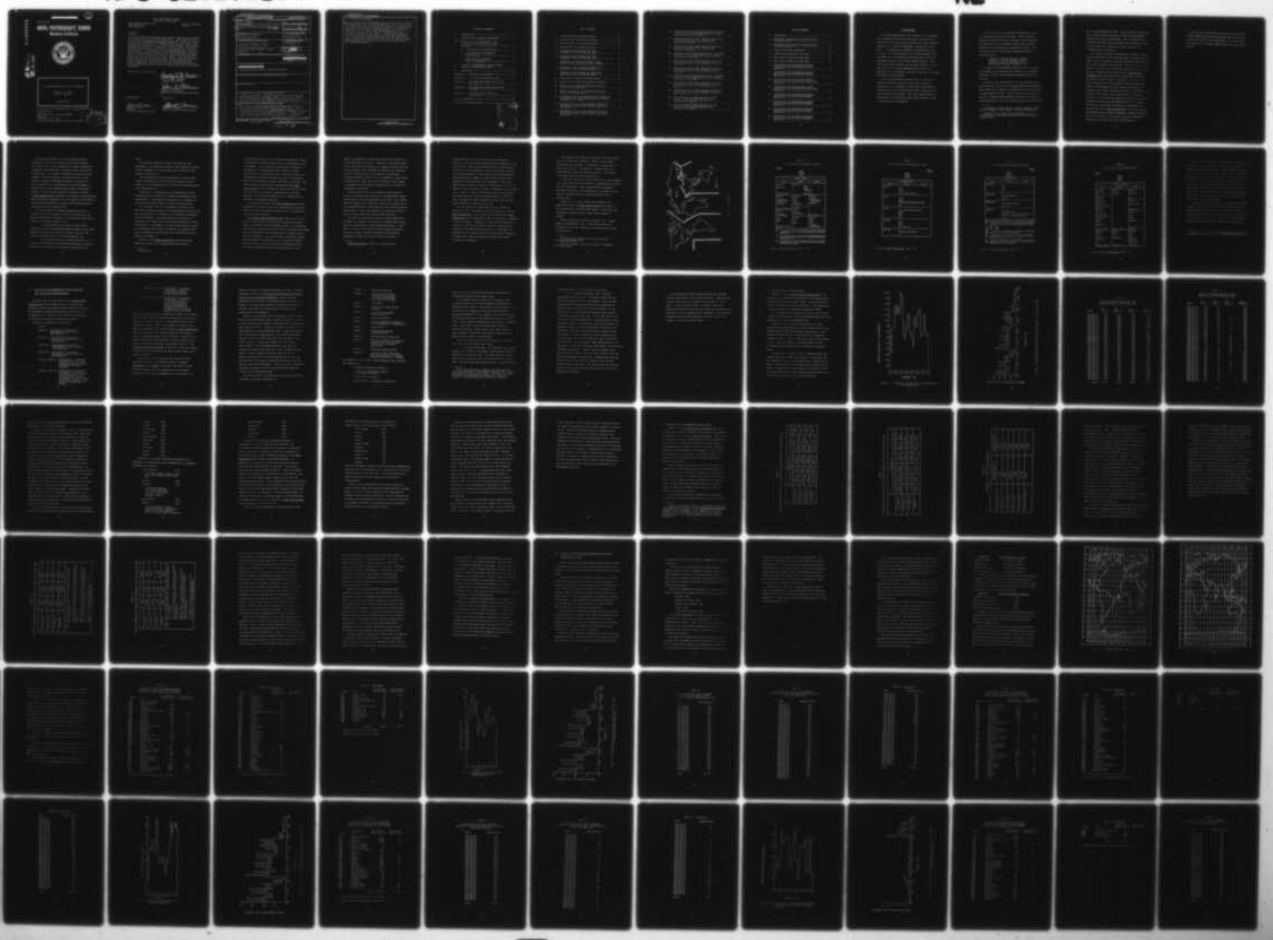
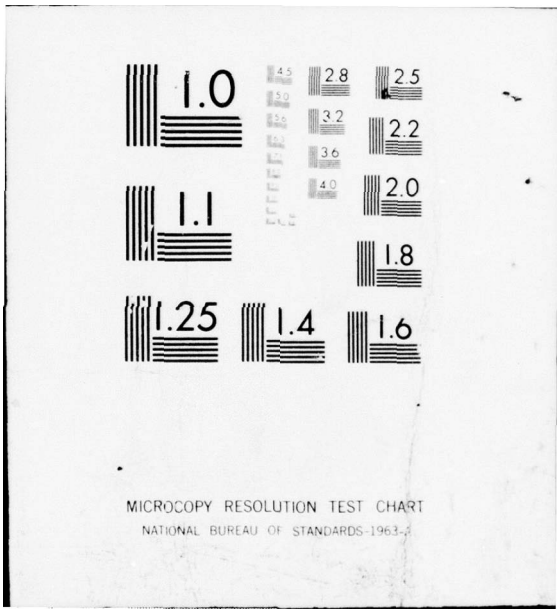
AD-A052 071 NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF F/G 17/2.1
ITU REGISTRATIONS AND NAVY UHF SATCOM.(U)
OCT 76 T D MENO, J E OHLSON
UNCLASSIFIED NPS-62OL76104 NL

1 OF 2
AD
A052 071




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A052071

AD No.
DDC FILE COPY

NPS-62OL76104

NAVAL POSTGRADUATE SCHOOL

Monterey, California



ITU REGISTRATIONS AND NAVY UHF SATCOM

Timothy D. B. Meno
John E. Ohlson

October 1976

A task under the Shipboard RFI in UHF SATCOM Project

Prepared for:

Naval Electronic Systems Command
PME 106
Washington, DC 20360

Approved for public release; distribution unlimited.

DDC
RECEIVED
APR 4 1978
D

NAVAL POSTGRADUATE SCHOOL
Monterey, California

Rear Admiral Isham Linder
Superintendent
15 October 1976

Jack R. Borsting
Provost

ABSTRACT

This report examines international frequency management as applied to the 225-400 and 500-890 MHz UHF bands. 40,647 registrations from the 1975 International Frequency List were analyzed in terms of four characteristics: frequency, location, power level, and maximum hours of operation. A relationship between registrations and national interest is suggested, and 10 countries are identified that account for 84.3 percent of registrations in the 225-400 MHz band. 10 countries are also identified that account for 96.4 percent of registrations in the 500-890 MHz band. Seventy percent of transmitters registered in the 225-400 MHz band have power levels of 100 watts or greater, while in the 500-890 MHz band, only 35 percent operate at this level. Intermittent operation dominates the 225-400 MHz band; registrations indicating 24-hour continuous operation dominate the 500-890 MHz band. These findings have implications in terms of potential interference between terrestrial users and current and future Navy SATCOM operations.

This report was prepared by:

TIMOTHY D. B. MENO
Lieutenant Commander
United States Navy

JOHN E. OHLSON
Associate Professor
Electrical Engineering Department

Approved by:

DONALD E. KIRK
Chairman
Electrical Engineering Dept.

Released by:

ROBERT R. FOSSUM
Dean of Research Administration

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NPS-62OL76104	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): ITU REGISTRATIONS AND NAVY UHF SATCOM.	5. TYPE OF REPORT & PERIOD COVERED: Technical Report.
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Timothy D. B. Meno John E. Ohlson	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School Monterey, California 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: N0003976WRT9053
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Electronic Systems Command PME 106 Washington, DC 20360	12. REPORT DATE: Oct[redacted]976 13. NUMBER OF PAGES: 174
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

[redacted]

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

frequency management, frequency registration, International Frequency Registration Board (IFRB), International Frequency List, International Telecommunications Union (ITU), Navy Satellite Communications (SATCOM), ultra-high frequency (UHF)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report examines international frequency management as applied to the 225-400 and 500-890 MHz UHF bands. 40,647 registrations from the 1975 International Frequency List were analyzed in terms of four characteristics: frequency, location, power level, and maximum hours of operation. A relationship between registrations and national interest is suggested,

(continued on reverse of this page)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

251 450

20. ABSTRACT (continued)

and 10 countries are identified that account for 84.3 percent of registrations in the 225-400 MHz band. Ten countries are also identified that account for 96.4 percent of registrations in the 500-890 MHz band. Seventy percent of transmitters registered in the 225-400 MHz band have power levels of 100 watts or greater, while in the 500-890 MHz band, only 35 percent operate at this level. Intermittent operation dominates the 225-400 MHz band; registrations indicating 24-hour continuous operation dominate the 500-890 MHz band. These findings have implications in terms of potential interference between terrestrial users and current and future Navy SATCOM operations.

TABLE OF CONTENTS

I. INTRODUCTION ---------- 9

II. INTERNATIONAL FREQUENCY MANAGEMENT ---------- 13

III. ANALYSIS OF REGISTRATIONS IN THE 225-400 MHz and 500-890 MHz BANDS WORLDWIDE ---------- 29

A. DISTRIBUTION OF REGISTRATIONS ---------- 36

B. DISTRIBUTION OF TRANSMITTER POWER LEVELS ---------- 49

C. DISTRIBUTION OF MAXIMUM HOURS OF OPERATION ---------- 55

IV. A VIEW OF INTERNATIONAL REGISTRATIONS FROM THE GEOSTATIONARY ORBIT ---------- 62

V. CONCLUSION ---------- 105

APPENDIX A - COUNTRIES OF THE WORLD ---------- 108

APPENDIX B - ITU SYMBOL TRANSLATION TABLE ---------- 117

APPENDIX C - REGISTRATIONS ACROSS THE 225-400 MHz BAND ---------- 120

APPENDIX D - REGISTRATIONS ACROSS THE 500-890 MHz BAND ---------- 144

APPENDIX E - GLOSSARY OF ITU TERMS AND DEFINITIONS ---------- 168

LIST OF REFERENCES ---------- 170

INITIAL DISTRIBUTION LIST ---------- 172

NTIS White Section
DDC Buff Section
UNANNOUNCED
JUSTIFICATION
BY
DISTRIBUTION/AVAILABILITY CODES
DIST. AVAIL. and/or SPECIAL
A

LIST OF TABLES

1. 174-235 MHz ITU Allocation Table..... 22

2. 235-335.4 MHz ITU Allocation Table..... 23

3. 335.4-401 MHz ITU Allocation Table..... 24

4. 470-942 MHz ITU Allocation Table..... 25

5. Worldwide Registrations Per 5 MHz Increment In The 225-400 MHz Band..... 39

6. Worldwide Registrations Per 5 MHz Increment In The 500-890 MHz Band..... 40

7. Comparison Of Registrations Per 5 MHz Across 225-400 MHz and 500-890 MHz Bands..... 42

8. Transmitter Power Levels Of Registered Stations In The 225-400 MHz Band..... 50

9. Transmitter Power Levels Of Registered Stations In The 500-890 MHz Band..... 51

10. Comparison Of Power Levels Worldwide..... 52

11. Comparison Of Hours Of Operation Worldwide..... 56

12. Hours Of Operation Of Registered Stations In The 225-400 MHz Band..... 57

13. Hours Of Operation Of Registered Stations In The 500-890 MHz Band..... 58

14. Geographic Areas With Registrations Indicating A Potential For Interference With An Atlantic Satellite At 23° West..... 72

15. Registrations Per 5 MHz Increment Across The 225-400 MHz Band For The Atlantic Satellite Look Area..... 77

16. Registrations Per 5 MHz Increment Across The 500-890 MHz Band For The Atlantic Satellite Look Area..... 78

17. Geographic Areas With Registrations Indicating A Potential For Interference With An Indian Ocean Satellite At 75° East 80

18. Registrations Per 5 MHz Increment Across The 225-400 MHz Band For The Indian Ocean Satellite Look Area 83

19. Registrations Per 5 MHz Increment Across The 500-890 MHz Band For The Indian Ocean Satellite Look Area 84

20. Geographic Areas With Registrations Indicating A Potential For Interference With A WESTPAC Satellite At 172° East 88

21. Registrations Per 5 MHz Increment Across The 225-400 MHz Band For The WESTPAC Satellite Look Area 89

22. Registrations Per 5 MHz Increment Across The 500-890 MHz Band For The EASTPAC Satellite Look Area 90

23. Geographic Areas With Registrations Indicating A Potential For Interference With An EASTPAC Satellite At 100° WEST 94

24. Registrations Per 5 MHz Increment Across The 225-400 MHz Band For The EASTPAC Satellite Look Area 96

25. Registrations Per 5 MHz Increment Across The 500-890 MHz Band For The EASTPAC Satellite Look Area 97

26. Average Number Of Registrations Per MHz Across The 225-400 MHz Band For Four Satellite Look Areas 102

27. Average Number Of Registrations Per MHz Across The 500-890 MHz Band For Four Satellite Look Areas 103

LIST OF FIGURES

1. ITU Regions 21

2. Worldwide Distribution Of Registrations, 225-400 MHz Band 37

3. Worldwide Distribution Of Registrations, 500-890 MHz Band 38

4. Atlantic Satellite Look Area 67

5. Indian Ocean Satellite Look Area 68

6. West Pacific Satellite Look Area 69

7. East Pacific Satellite Look Area 70

8. Distribution Of Registrations Across 225-400 MHz Band As Seen By Atlantic Satellite 75

9. Distribution Of Registrations Across 500-890 MHz Band As Seen By Atlantic Satellite 76

10. Distribution Of Registrations Across 225-400 MHz Band As Seen By Indian Ocean Satellite 86

11. Distribution Of Registrations Across 500-890 MHz Band As Seen By Indian Ocean Satellite 87

12. Distribution Of Registrations Across 225-400 MHz Band As Seen By WESTPAC Satellite 92

13. Distribution Of Registrations Across 500-890 MHz Band As Seen By WESTPAC Satellite 93

14. Distribution Of Registrations Across 225-400 MHz Band As Seen By EASTPAC Satellite 99

15. Distribution Of Registrations Across 500-890 MHz Band As Seen By EASTPAC Satellite 100

I. INTRODUCTION

A radio communications link consists of a transmitter which radiates energy into space and a receiver which intercepts the signal while rejecting all other unwanted signals (e.g., other intelligence, atmospheric noise, etc.). To establish an effective communications link by radio, the field strength of the desired signal must be greater by a technically specified amount than the combined strength of all other signals present. When two or more users radiate on the same frequency, at the same time, in the same geographic area, there is a potential for interference, and one or more or all signals may become unintelligible.

Since electromagnetic signals have no respect for national boundries, and since they are a resource available to all countries, there must be some mutual understanding on an international level concerning how the spectrum will be used. Once this understanding is established, countries can tailor their domestic usage to international allocations.

In 1903 the first international conference on wireless telegraphy was held in Berlin. Nine countries, including the United States, attended.[1] The purpose of the conference was to undertake preliminary studies regarding the international regulation of radio. One of the main points of Protocol resulting from the conference read:

> "Wireless telegraph stations should operate, as far as possible, in such a manner as not to interfere with the working of other stations." [2][2]

In spite of the elementary state of the use of radio at the time, this principle has remained a fundamental principle of radio communications regulation for over 70 years.

The operating frequencies for a radio communications system must be selected for optimum operating performance under constraints imposed by compatibility with the needs of other spectrum users. This is particularly true for satellite communications systems operating at line-of-sight frequencies since the satellite sees and can be seen

---

[1]Attendees included Austria, France, Germany, Great Britain, Hungary, Italy, Spain, and the United States.

[2]Codding's book traces the development of the International Telecommunications Union from its beginnings to 1952.

by a large geographical area. On the ground, frequencies may be used several times with sufficient geographical seperation without interference. But a satellite can interfere with and could be subject to interference from a large number of terrestrial systems which do not interfere with one another.

This thesis examines international frequency management as performed by the International Telecommunications Union (ITU) as applied to the 225-400 MHz and 500-890 MHz ultra-high frequency (UHF) bands. The main focus of the paper is an analysis of frequency registrations contained in the 1 February 1975 edition of the International Frequency List drawn up by the International Frequency Registration Board (IFRB), an agency of the ITU. [4] Four characteristics are examined: assigned frequency, country or geographical area in which the station is located, power level, and maximum hours of operation. The findings which result have implications in terms of potential for interference between terrestrial users and present and future Navy SATCOM operations, as well as in terms of developing and supporting strategies for changing the ITU's Radio Regulations [5] at the General World Administrative Radio Conference (GWARC) scheduled for 1979 in Geneva, Switzerland to provide expanded frequency allocations for Navy SATCOM service.

The outcome of GWARC 1979 will have a strong impact on Navy SATCOM operations during the 1980 to 2000 time period, for based on past experience, it is not likely that there will be another GWARC before the end of the century.

II. INTERNATIONAL FREQUENCY MANAGEMENT

International agreement with regard to the allocation and registration of radio frequencies comes about through the workings of the International Telecommunications Union (ITU). Created in 1865 with 20 nations, the ITU is now an organ of the United Nations and has 144 members.[3] [6] Each member has one vote in the ITU decision-making process. The major policy output of the ITU is Radio Regulations [5] which have treaty status and which, upon adoption by a country, becomes a part of the country's law. These rules and regulations apply to all radiations emanating from international areas, and radiations from within nations which extend beyond their territorial control. ITU headquarters is in Geneva, Switzerland, where a permanent Secretariat is supported by member nations.[4]

The ITU is composed of four permanent groups: the Secretariat, the International Telegraph and Telephone Consultive Committee, the International Radio Consultive

---

[3]Membership as of 31 March 1975. Appendix A lists the countries of the world and identifies ITU members.

[4]The headquarters address is: International Telecommunications Union, Place des Nations, CH-1211, Geneva 20, Switzerland.

Committee (CCIR), and the International Frequency Registration Board (IFRB). The CCIR and the IFRB are directly concerned with international radio frequency management.

The function of the International Radio Consultive Committee (CCIR) is to study technical and operational questions relating to the use of radio and to issue reports and recommendations on such studies. Its work is accomplished by 12 study groups [10], each of which deals with a specific phase of radio communications, such as spectrum utilization and monitoring, space research and radioastronomy services, fixed services below about 30 MHz, fixed services using satellites, propagation in non-ionized media, ionospheric propagation, standard frequency and time-signal services, mobile services, fixed services using radio-relay systems, sound broadcasting service, television broadcasting service, and coordination of matters of mutual concern to radio, telegraph, and telephone regulation.

Plenary Assemblies of the CCIR are held every three years to update, correlate, and ratify the work done during the intervening period by the individual study groups which, in turn, work through national committees and typically hold international interim meetings between CCIR Plenary Assemblies.

The published output of a CCIR Plenary Assembly represents its official opinion on any given subject at a given time. It may consist of a report supporting a specific recommendation, a partial report calling for further study, or a report introducing a specific study program. The CCIR plays a significant role in international frequency management because its output has great influence on the modification and development of regulations at World Administrative Radio Conferences (WARC's). An excellent approach to getting a change to Radio Regulations accepted at the General Administrative Radio Conference scheduled for 1979 would be to intrduce it through the United States national CCIR committees into international CCIR deliberations.

The International Frequency Registration Board (IFRB) of the ITU, created in 1947 at the Atlantic City General World Radio Conference, is an elected 5-man board which has two major concerns: [6]

a. Maintaining an up-to-date international register of station assignments made by member nations and approved by the Board, showing the date, purpose, and technical characteristics of each assignment; and

b. Furnishing advice to administrations with a view to the operation of the maximum practicable number of channels in the bands where harmful interferences may

occur.

The date of registration with the IFRB for any assignment is an important factor in the relative position of the assignment on the priority list in event of subsequent interference.

ITU regulations require notification if potentially harmful interference to the service of another nation exists or if the frequency is to be used for international radio communication.

Optionally, a frequency may be registered to obtain recognition and to establish a degree of pretection from interference. The degree of protection is a function of the level of service rights and time of registration.

The interface area for terrestrial services in the UHF band is limited (except for international services) and thus the incentive to register is a function of geography and other factors. Coordination may be achieved on a regional or bilateral basis without the necessity for ITU registration. For example, for the United States, bilateral coordination with Canada and Mexico is frequently all that is necessary for operation in the UHF band near the respective borders.

However, ITU's Radio Regulations require that the IFRB be notified of all planned satellite systems.[3]

---

[3]Article 9A.

Information supplied for the "advance information" phase is published in IFRB circulars and is distributed to all ITU members. Any country has the right to require coordination. A coordination cycle follows in which coordination is achieved with all effected nations, and assignments obtained from other nations, as necessary. When all assignemtns are made, the IFRB is notified. The IFRB checks notifications for compliance with Radio Regulations and for interference possibilities with other registrations in the Master International Frequency Register. Notifications found to be in compliance are recorded in the Master Register.

It should be noticed that Radio Regulations provides procedures for hostile nations to coordinate through the IFRB, and that satisfactory coordination is presumed for non-responsive countries.

The International Frequency List (IFL), which is produced from the Master International Frequency Register, does not represent actual worldwide usage. It represents only those frequencies which are used in international areas and frequencies whose use causes them to radiate across national boundries. The ITU can make allocations (designation of band of frequencies for a particular purpose, use, or service), but only countries (administrations) can make assignments (specific authorizations to use

specific frequencies within their territorial control or in international territory). However, it would be unfair to say that IFRB registrations are merely "protective" and do not represent use, because the IFRB has the responsibility to review entries in the Master International Frequency Register "with a view to amending or elimination, as appropriate, those which do not reflect actual usage, in agreement with the administrations which notified the assignments concerned.[4]

The division of the radio spectrum into bands for use by the several radio services is accomplished through administrative Radio Conferences of the ITU. Their decisions are based on the technical output of the CCIR and on the recommendations of individual national administrations with respect to what they consider an equitable distribution of space among the various radio services.

As might be anticipated, there are some undesirable features to a process of arriving at international agreements by conferences of 144 voting participants. One of these is the built-in inertia as the complex mechanism strives to update equipment standards and operating procedures to meet the current state-of-the-art. A

---

[4] Radio Regulations, Article 8, paragraph 2d.

second feature is the multiplicity and frequency of meetings. The CCIR holds regular Plenary Assemblies every three years. Special World Administrative Radio Conferences with limited agendas to deal with special problems are held periodically. And General World Administrative Radio Conferences (GWARC's), which deal with all radio regulation, and held even less frequently. Only five GWARC's have been held to date: in Washington in 1927, in Madrid in 1932, in Cairo in 1938, in Atlantic City in 1947, and in Geneva in 1959. Conferences with limited agendas reviewed space and radio astronomy matters in 1963 and 1971, aeronautical mobile matters in 1966, and maritime mobile matters in 1967 and 1974. [11]

The next major ITU conference will be a GWARC in Geneva in 1979. The purpose will be a complete review of Radio Regulations. As a result of the conference, Radio Regulations may be modified in part, or they may be changed in their entirety. Therefore, if the United States Navy intends to continue to operate satellite communication systems in the 1980-2000 time period, it must make its needs known and, working with the United States delegation to GWARC 1979, must be prepared to defend its future frequency requirements.

For purposes of spectrum allocation, the ITU divides the world into three regions. Figure 1 shows these divisions quite vividly. ITU Region 1 includes all of Europe and Africa. ITU Region 2 includes North and South America, plus the Northern Pacific. ITU Region 3 includes Asia and the South Pacific.

A typical service may be the same in all three regions, or it may vary among the regions in accordance with international agreement. Thus, communications equipment designed technically and functionally to operate in one area of the world may not be authorized for use in another area.

Tables 1, 2, 3, and 4 show those pages of the Allocation Table from Radio Regulations which apply to the 225-400 MHz and 500-890 MHz bands.[5] The tables are arranged by frequency band, usage, and priority of rights.

Usage is implied by service category (i.e., Fixed, Mobile, Broadcasting, etc.). When these terms are followed by the word, "Satellite," they may be provided by satellite.[6]

---

[5]The Allocation Tables are found in Article 5 of Radio Regulations. [5]

[6]Service category definitions appear in Appendix E of this paper.

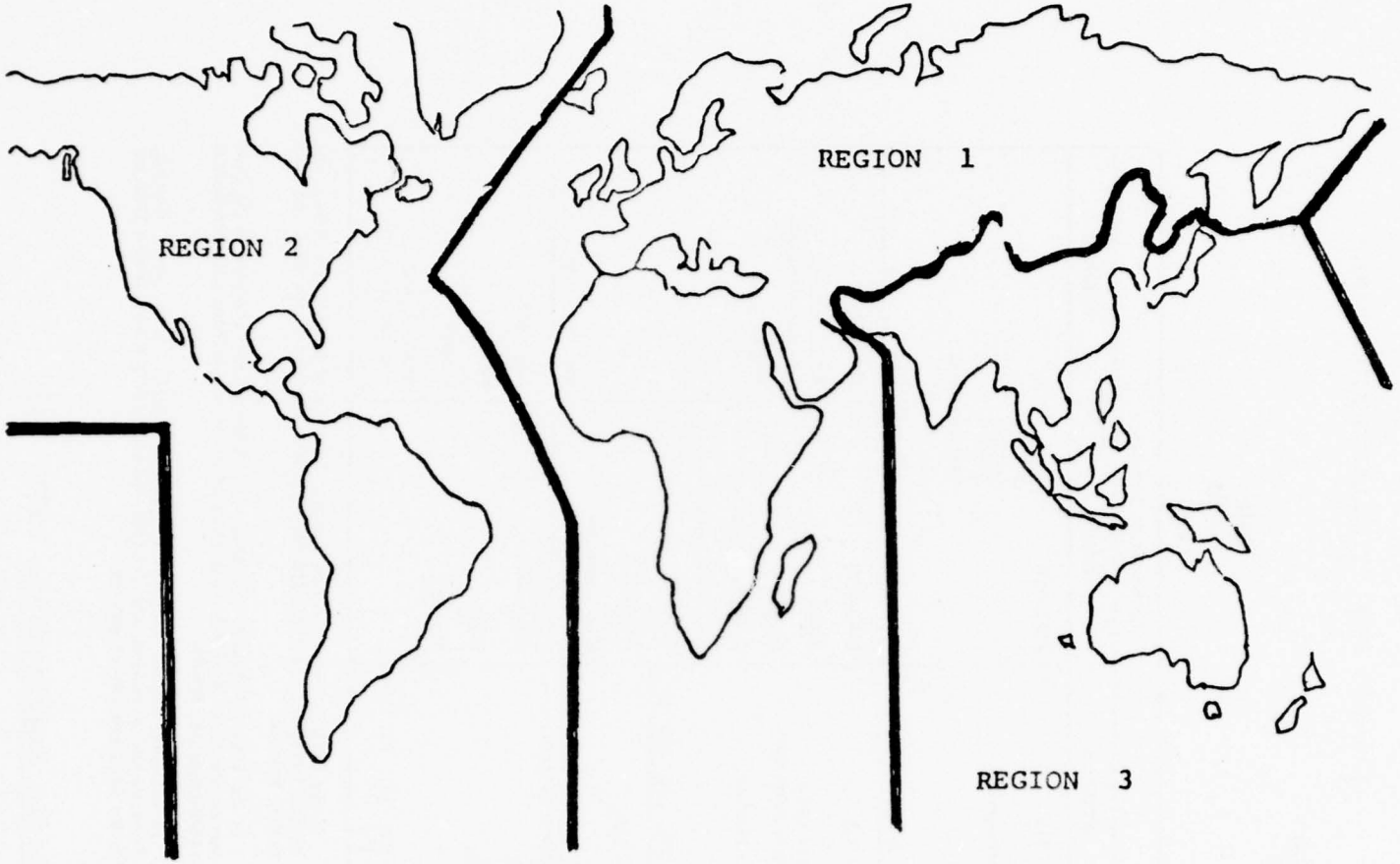


Figure 1 - ITU REGIONS

TABLE 1

174-235 MHz ITU ALLOCATION TABLE

RR5-54
(1971)

MHz
174 — 235
(Spa)

Allocation to Services		
Region 1	Region 2	Region 3
174 — 216 BROADCASTING 291 292 293 294	**174 — 216** FIXED MOBILE BROADCASTING 294 295 296	
216 — 223 AERONAUTICAL RADIONAVIGATION BROADCASTING 297 298 299 300 301	**216 — 220** FIXED MOBILE RADIOLOCATION	**216 — 225** AERONAUTICAL RADIONAVIGATION *Radiolocation*
223 — 235 AERONAUTICAL RADIONAVIGATION *Fixed* *Mobile* 299 300 301 302 303 304 305	**220 — 225** AMATEUR RADIOLOCATION	306 307 308
	225 — 235 FIXED MOBILE	**225 — 235** FIXED MOBILE AERONAUTICAL RADIONAVIGATION

291 In the Union of South Africa and the Territory of South West Africa, the bands 174-181 Mc/s and 213-216 Mc/s are also allocated to the fixed and land mobile services.

292 In the United Kingdom, the band 174-184 Mc/s is also allocated to the fixed service; the band 211-216 Mc/s is allocated to the broadcasting and aeronautical radionavigation services.

293 In Ethiopia, Kenya, Tanganyika, Uganda, Nigeria, Sierra Leone, Gambia, Rhodesia and Nyasaland, and Zanzibar, the band 174-216 Mc/s is also allocated to the fixed and mobile services.

Source: Radio Regulations, 1971. [5]

TABLE 2

235-335.4 MHz ITU ALLOCATION TABLE

RR5-57
(1971)

MHz
235— 335·4
(Spa2)

Allocation to Services		
Region 1	Region 2	Region 3
235 - 267	FIXED MOBILE 201A 305 305A 308A 309	
267 - 272	FIXED MOBILE *Space operation* (Telemetering) 309A 309B 308A	
272 - 273	SPACE OPERATION (Telemetering) 309A FIXED MOBILE 308A	
273 - 328·6	FIXED MOBILE 308A 310 310A	
328·6 - 335·4	AERONAUTICAL RADIONAVIGATION 311	

Source: Radio Regulations, 1971. [5]

TABLE 3

335.4-401 MHz ITU ALLOCATION TABLE

RR5-59
(1971)

MHz

335·4–401

(Spa2)

Allocation to Services		
Region 1	Region 2	Region 3
335·4 – 399·9	FIXED MOBILE 308A	
399·9 – 400·05	RADIONAVIGATION-SATELLITE 285C 311A	
400·05 – 400·15	STANDARD FREQUENCY-SATELLITE 312B 313 314	
400·15 – 401	METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (Maintenance telemetering) SPACE RESEARCH (Telemetering and tracking) 313 314	

311A Spa2 In Bulgaria, Cuba, Greece, Hungary, Indonesia, Iran, Kuwait, Lebanon, the United Arab Republic, Syria and Yugoslavia, the band 399·9 – 400·05 MHz is also allocated to the fixed and mobile services (see Recommendation No. Spa 8).

312 SUP (Spa)

312A SUP (Spa2)

312B Spa2 In this band the standard frequency is 400·1 MHz. Emissions shall be confined in a band of ± 25 kHz about this frequency.

313 Spa In Albania, Bulgaria, Greece, Hungary, Poland, the United Arab Republic, Yugoslavia, Roumania, Czechoslovakia and the U.S.S.R., the band 400·05-401 Mc/s, is also allocated to the fixed and mobile services.

314 Spa In the United Kingdom, the band 400·05-420 Mc/s is also allocated to the radiolocation service; however, between 400·05 and 410 Mc/s the allocation to the radiolocation service is on a secondary basis.

Source: Radio Regulations, 1971. [5]

TABLE 4

470-942 MHz ITU ALLOCATION TABLE

RR5-66
(1971)

MHz
470–942
(Spa2)

Allocation to Services		
Region 1	Region 2	Region 3
470– 582 BROADCASTING	**470 — 890** BROADCASTING	**470 — 585** BROADCASTING 335
582 — 606 BROADCASTING RADIONAVIGATION 325 327 328 329		**585 — 610** RADIONAVIGATION 330B 336 337
606 — 790 BROADCASTING 329 330 330A 331 332 332A		**610 — 890** FIXED MOBILE BROADCASTING 330B 332 332A 338 339
790 — 890 FIXED BROADCASTING 329 331 333 334	329A 332 332A	
890 — 942 FIXED BROADCASTING *Radiolocation* 329 331 333 339A	**890 — 942** FIXED RADIOLOCATION 339A 340	**890 — 942** FIXED MOBILE BROADCASTING *Radiolocation* 339 339A

Source: Radio Regulations, 1971. [5]

With regard to the 225-400 MHz and 500-890 MHz bands, there are primary, secondary, and footnote rights.[7] Higher rights always dominate. Lower rights to service must insure that unacceptable interference is not caused to higher right services. Higher right services have no obligation to insure that they do not interfere with lower right services. When two or more services have equal rights, the date of registration governs whose service will take precedence. The burden for insuring that interference does not occur is the responsibility of the most recent registration.

Tables 1, 2, and 3 show that in the 225-400 MHz band primary service rights are currently allocated to the Fixed and Mobile services (i.e., terrestrial radio communications) across most of the band. The 240.0 to 328.6 and 335.4 to 339.9 MHz bands may also be used by the Mobile Satellite service subject to agreement by

---

[7]Section II of Article 5 of Radio Regulations [5] discusses catagories of service, allocations, and rights.

countries concerned or effected. The authority for such use is Footnote 308A.[8]

Thus, the burden of insuring compatibility with existing systems resides with the Mobile Satellite service. Even if a terrestrial system is not registered with the ITU, a country could object through the ITU if it receives interference from a satellite system since terrestrial services have higher rights. The burden of clearing the interference is clearly with the Mobile Satellite service, unless prior coordination and agreement have been effected.

In the United States these portions of the UHF band are allocated to the federal government, and by Office of Telecommunications Policy (OTP) footnote they are further allocated on a primary basis to military use. [10][9]

---

[8]Footnote 308A reads:

"The bands 240-328.6 MHz and 335.4-399.9 MHz may be used by the Mobile Satellite service. The use and development of this service shall be subject to agreement between the administrations concerned and those having services operating in accordance with the Table, which may be affected." [5]

[9]Pages 4-44, 4-45, and 4-81 (Footnote G30) of the OTP Manual [10] are useful in comparing U.S. national and international allocations in the 240-500 MHz band.

In April 1976, the United States Navy defined its requirements for use of the electromagnetic spectrum for the 1980-2000 time period. [9] The statement was in support of the preparation of preliminary United States National Views for the General World Administrative Radio Conference to be held in Geneva, Switzerland in 1979.

The Navy has proposed that the frequencies between 500 and 890 MHz be opened for use by maritime mobile, land mobile, and fixed and mobile satellite services, sharing with shipboard radio location systems. The reason given for this proposal was that the opening of this band would be "especially useful due to intermod problems and excessive congestion which will force operations in other than the 225-400 MHz band for fleet satellite communications operations."

No changes in allocation were recommended for the 225-400 MHz band.

III. ANALYSIS OF REGISTRATIONS IN THE 225-400 MHz AND 500-890 MHz BANDS WORLDWIDE

The data base for this study is the International Frequency List (IFL) drawn up by the International Frequency Registration Board (IFRB) based on the status of the Master International Frequency Register as of 1 February 1975. The IFL is an "offset" reproduction of information printed by electronic computer.

The IFL is published in nine parts:

Preface

Volume I - particulars of frequency assignments between 10 kHz and 4063 kHz

Volume II - particulars of frequency assignments between 4063 kHz and 7000 kHz

Volume III - particulars of frequency assignments between 7000 kHz and 11700 kHz

Volume IV - particulars of frequency assignments between 11700 kHz and 28000 kHz

Volume V, Part a - particulars of frequency assignments in the bands between 28 MHz and 50 MHz, excluding broadcasting stations

Volume V, Part b - particulars of frequency assignments in Region 1 in the bands between 50 MHz and 40000 MHz, and of assignments to broadcasting stations in Region 1 in the bands between 28 MHz and 50 MHz

Volume V, Part c - particulars of frequency assignments in Region 2 in the bands between 50 MHz and 40,000 MHz

Volume V, Part d - particulars of frequency assignments in Region 3 in the bands between 50 MHz and 40,000 MHz and of assignments to broadcasting stations in Region 3 in the bands between 28 MHz and 50 MHz

The list is printed from information recorded in the Master International Frequency Register maintained by the IFRB in accordance with Resolution 1 of the Administrative Radio Conference, Geneva, 1959, and is kept up to date by the IFRB in accordance with the provisions of Radio Regulations. Data is presented in the manner prescribed in Appendix 9 to the Radio Regulations, and the Preface (a separate 153 page book) provides explanations of format, abbreviations, codes, and symbols necessary to interpret the IFL. The International Frequency List is kept up to date by quarterly recapitulative supplements, and new editions appear about every two years.

Three documents are essential for analyzing IFRB registration data: the effective edition of Radio Regulations, the Preface to the IFL, and those volumes of the IFL which list the frequencies to be studied. Should any one of these documents not be available, the

analyst is forced to consider secondary sources. A prime secondary source is the Manual Of Regulations And Procedures For Radio Frequency Management (latest edition) published by the Office of Telecommunications Policy. [10] Chapter 3 (International Matters) discusses the role of the ITU, the IFRB, and international allocation and registration of frequencies.

Since this study deals with frequencies in the 225-400 MHz and 500-890 MHz UHF bands, Volume V, Parts b, c, and d of the IFL were used. Region 1 (Europe-Africa) registrations were found in Part b. Pages 619 through 707 lists 13,912 registrations in the 225-400 MHz band. Pages 792 through 1053 lists 10,391 registrations in the 500-890 MHz band. Region 2 (North and South America) registrations were found in Part c. Pages 281 through 341 list 9,186 registrations in the 225-400 MHz band, and pages 376 through 382 contain 583 listings in the 500-890 MHz band. Region 3 (Asia) registrations were found in Part d Pages 63 through 102 list 6442 registrations in the 225-400 Mhz band, and pages 107 through 109 contain 118 listings in the 500-890 MHz band. A total of 40,632 registrations were examined, 29,540 in the 225-400 MHz band and 11,092 in the 500-890 MHz band.

The IFL provides 13 columns for recording information regarding a specific registration:

Column 1	Assigned frequency
Column 2	Dates of registration, notification, putting into use, and receipt of notice by the IFRB
Column 3	Call Sign
Column 4	Location of Transmitting Station
Column 5	Location of Intended Receiving Area
Column 6	Nature of Service
Column 7	Class of Emission, Bandwidth, and Description of Transmission
Column 8	Power Level
Column 9	Transmitting Antenna Characteristics
Column 10	Maximum Hours of Operation
Column 11	MHz Order of Other Frequencies Normally Used for the Same Circuit Over the Whole Solar Year
Column 12	Operating Administration
Column 13	Results of IFRB Examination and Investigation of Findings Regarding Restration. Remarks.

For purposes of this study, four parameters were selected for examination:

* Assigned Frequency (Column 1)
* Country or Area Where Station Is Located (Column 4)
* Power Level (Column 8)
* Maximum Hours of Operation (Column 10)

Data from other columns was used only for purposes of clarifying parameter date under study.

In secondary source of data was a listing of ITU records provided by the Electromagnetic Compatibility Analysis Center (ECAC), a DOD facility specializing in the collection and analysis of data for radio frequency spectrum management.[10] The computer listing contained all ITU records contained in the ECAC data base as of 17 May 1976. Data elements included: state or country, frequency (MHz), power (kW), type of primary power reported, emission bandwidth, antenna gain, call sign, operating area, latitude, longitude, and security classification. ECAC's ITU File data is unclassified.

ECAC's ITU File did not equate exactly to the IFRB's IFL. Two key differences were noted:

a. A Time Difference. The IFRB data was compiled based on the status of the Master International Frequency Register on 1 February 1975. The ECAC data was compiled based on all ITU data received and entered as of 16 May 1976. The ECAC data base maintains only a current listing

---

[10]For Navy activities, requests for ECAC services should be addressed to Navy Deputy Director (ACY), ECAC North Severn, Annapolis, MD 21402. The Center publishes a booklet, "Electromagnetic Compatibility Analysis Center," which describes their services in detail.

of registrations; no historical file is kept.

b. A Format Difference. ECAC "records" from IFRB "registrations." The ECAC listing for the 225-400 MHz band lists 47,216 records. These records indicate 43,045 transmitters and 4,171 receivers of which 23,687 are fixed and 23,529 are mobile. Of the 47,216 total, 47,154 records indicate communications use and 62 indicate radar use. On the other hand, the IFL lists 29,540 registrations. How could such a large difference exist? An example of how this difference is created is seen in the United States' registration of 249.9 MHz. The IFL, Column 4b listing indicates USA, the Column 5a listing (Area with which communications is established) lists ARIZ (Arizona), CAL (California), FLA (Florida), LA (Louisiana), MASS (Massachusetts), NY (New York), SC (South Carolina), TEX (Texas), VA (Virginia), and WASH (Washington). ECAC's ITU File repeats this registration 10 times, since its file tallies state use plus United States national use. Unfortunately similar data is not provided for any country other than the United States. Therefore, the IFL was used as the data base for this study, and the ECAC data was only used to clarify IFL listings.

The difference between IFRB registrations and ECAC records illustrates a very important point. Registrations (and for that matter, records) DO NOT equate to total usage. At the national level, worldwide, there are numerous assignments that are not registered internationally. Therefore, as this example also illustrates, the frequency registrations analyzed represent only the "tip of the iceberg" in terms of actual usage.

A. DISTRIBUTION OF REGISTRATIONS

Column 1 of the International Frequency List (IFL) contains all frequencies registered by the International Frequency Registration Board (IFRB). Registrations are listed in numerical order by frequency. All frequencies in the UHF range are expressed in Megahertz (MHz).

The 1 February 1975 edition of the IFL lists 29,540 frequency registrations in the 225-400 MHz band and 11,092 registrations in the 500-890 MHz band.

Figures 2 and 3 show the distribution of these registrations graphically in 5 MHz increments across the 225-400 MHz and 500-890 MHz bands respectively. Both graphs were plotted to the same scale for comparative purposes. Tables 5 and 6, which were used to plot Figures 2 and 3, show the number of registrations per 5 MHz increment both worldwide and by ITU region in numeric terms.

A comparison of Figures 2 and 3 indicates that the 225-400 MHz band is much more heavily "registered" than the 500-890 MHz band. This observation is supported by Table 7 which shows registrations per MHz across the two bands. A comparison of these indices reveals that there are almost six times as many registrations per MHz in the 225-400 MHz band than in the 500-890 MHz band.

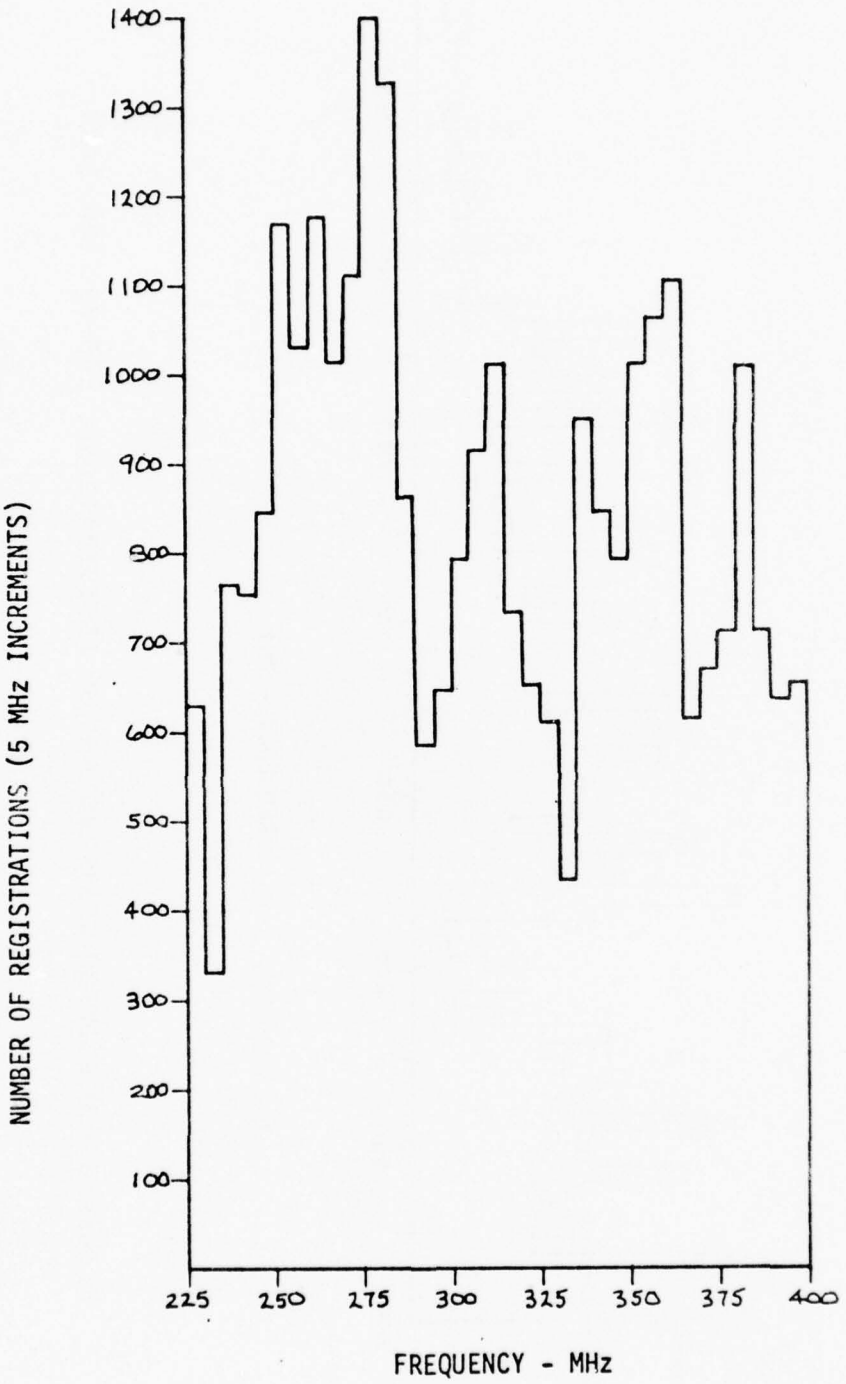


Figure 2 - WORLDWIDE DISTRIBUTION OF REGISTRATIONS, 225-400 MHz BAND

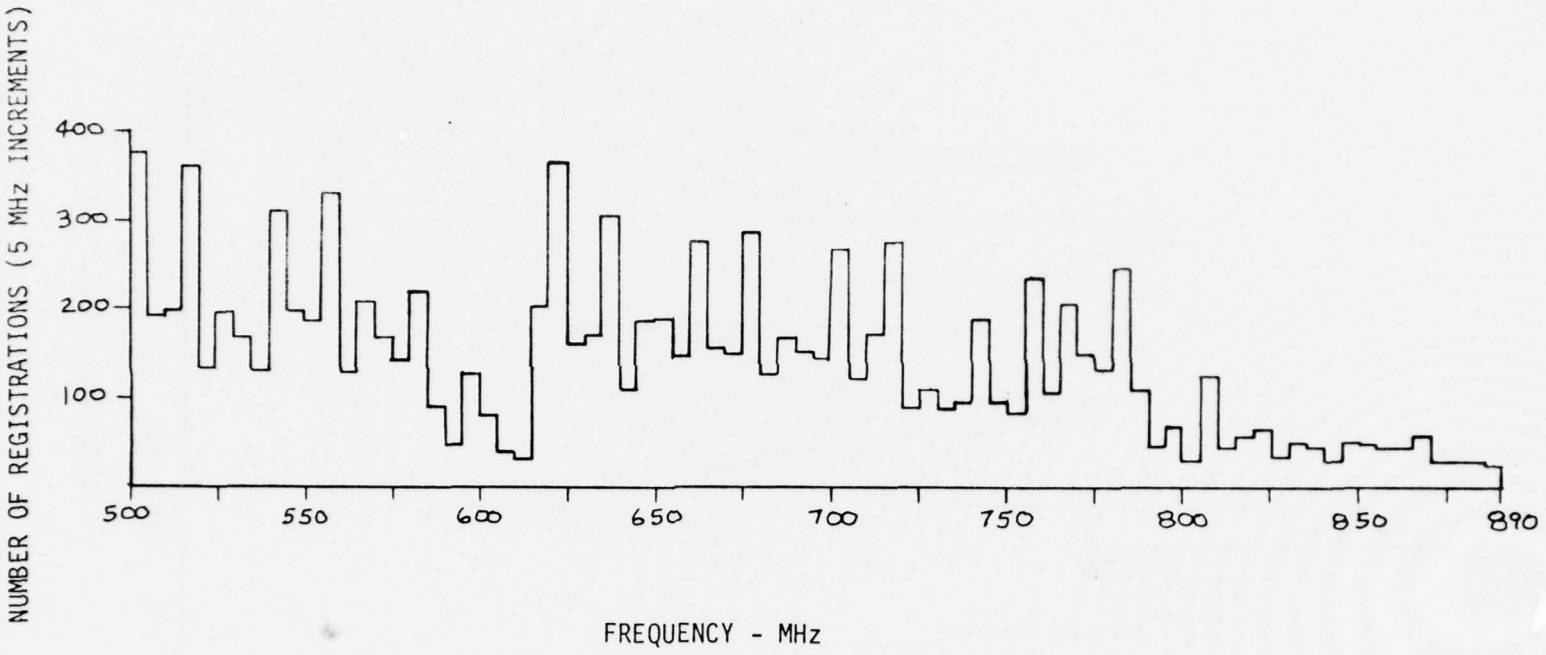


Figure 3 - WORLDWIDE DISTRIBUTION OF REGISTRATIONS, 500-890 MHz BAND

TABLE 5

WORLDWIDE REGISTRATIONS PER 5 MHz
INCREMENT IN THE 225-400 MHz BAND

Band	ITU Region 1	ITU Region 2	ITU Region 3	Total Worldwide
225-229.99	375	133	121	629
230-234.99	100	109	125	334
235-239.99	357	204	202	763
240-244.99	464	118	173	755
245-249.99	428	274	145	847
250-254.99	505	438	227	1170
255-259.99	545	316	174	1035
260-265.99	490	477	212	1179
265-269.99	366	427	224	1017
270-274.99	385	513	208	1091
275-279.99	478	421	501	1400
280-284.99	512	457	359	1328
285-289.99	505	192	164	861
290-294.99	319	116	146	581
295-299.99	317	173	152	642
300-304.99	294	310	189	793
305-309.99	292	425	198	915
310-314.99	297	459	255	1011
315-319.99	316	234	183	733
320-324.99	321	182	145	648
325-329.99	237	217	157	611
330-334.99	130	208	99	437
335-339.99	336	425	182	943
340-344.99	318	371	152	841
345-349.99	304	320	169	793
350-354.99	500	341	170	1011
355-359.99	494	372	195	1061
360-364.99	549	357	196	1102
365-369.99	448	18	148	614
370-374.99	492	45	134	671
375-379.99	518	56	139	713
380-384.99	479	333	196	1008
385-389.99	477	93	145	715
390-394.99	478	28	131	637
395-399.99	501	24	126	651
Totals	13912	9186	6442	29540

TABLE 6

WORLDWIDE REGISTRATIONS PER 5 MHz
INCREMENT IN THE 500-890 MHz BAND

Band	ITU Region 1	ITU Region 2	ITU Region 3	Total Worldwide
500-504.99	360	16		376
505-509.99	174	15		189
510-514.99	194			194
515-519.99	345	14		359
520-524.99	119	10		129
525-529.99	189	9		198
530-534.99	148	13	5	166
535-539.99	122	12	2	136
540-544.99	312			312
545-549.99	190	8		198
550-554.99	175	8	2	185
555-559.99	329	8	1	338
560-564.99	123	9	2	134
565-569.99	195	11		206
570-574.99	164			164
575-579.99	133	6	2	141
580-584.99	211	7	1	219
585-589.99	77	8	3	88
590-594.99	31	7	5	43
595-599.99	110	6	7	123
600-604.99	78		2	80
605-609.99	19	7	9	35
610-614.99	13	9	5	27
615-619.99	190	4	8	202
620-624.99	347	6	10	363
625-629.99	154	8	1	163
630-634.99	173			173
635-639.99	294	6	3	303
640-644.99	103	7		110
645-649.99	181	4	1	186
650-654.99	177	4	6	187
655-659.99	141	1	1	143
660-664.99	275		3	278
665-669.99	154	4		158
670-674.99	143	3	3	149
675-679.99	282	2		284
680-684.99	130	4		134
685-689.99	163	4		167
690-694.99	153	1		154
695-699.99	142	1	1	144

TABLE 6 – Continued

Band	ITU Region 1	ITU Region 2	ITU Region 3	Total Worldwide
700-704.99	263	2		265
705-709.99	118	4		122
710-714.99	169	4	1	174
715-719.99	273	1		274
720-724.99	85		2	87
725-729.99	105	5	1	111
730-734.99	82	2		84
735-739.99	88	1		89
740-744.99	185	3	6	194
745-749.99	97			97
750-754.99	80		2	82
755-759.99	236	2	1	239
760-764.99	101	5		106
765-769.99	207	1		208
770-774.99	150	2	1	153
775-779.99	134	1		135
780-784.99	243			243
785-789.99	112		1	113
790-794.99	39	2	1	42
795-799.99	66	1		67
800-804.99	24	4	3	31
805-809.99	74	48		122
810-814.99	41		5	46
815-819.99	36	23	1	60
820-824.99	38	25	2	65
825-829.99	20	17		37
830-834.99	22	26	1	49
835-839.99	27	19		46
840-844.99	28	1	1	30
845-849.99	30	25		55
850-854.99	31	22	1	54
855-859.99	25	21		46
860-864.99	26	19	1	46
865-869.99	28	30	1	59
870-874.99	26	5	1	32
875-879.99	23	9		32
880-884.99	25	6	1	32
885-889.99	21	5	1	27
Totals	10391	583	118	11092

TABLE 7

COMPARISON OF REGISTRATIONS PER MHz ACROSS
THE 225-400 AND 500-890 MHz BANDS

Band (MHz)	Bandwidth (MHz)	Number Of Registrations	Registrations Per MHz *
225-400	175	29,540	168.9
500-890	390	11,092	28.4

* NOTE: Registrations Per MHz was calculated by dividing the total number of registrations across the band by the bandwidth in MHz.

six times as many registrations per MHz in the 225-400 MHz band than in the 500-890 MHz band.

As shown graphically in Figures 2 and 3 , registrations are not distributed evenly across either band. The peaks and valleys of the graphs can be understood in greater depth by referring to Tables 5 and 6 . These tables show the contribution of each ITU Region to worldwide totals for each 5 MHz increment. It is clear, that within each increment, each region does not contribute equally. Nor do all the countries in a particular region contribute equally to regional totals. For example, in Region 1, in the 225-400 MHz band, Austria has registered 3,865 assignments, while Spain has only 23 registrations. To see how each country's registrations are distributed across the two bands, Appendix C and Appendix D can be consulted. Appendix C lists the number of registrations, in 5 MHz increments, of each country with registrations in the 225-400 MHz band. Countries are arranged according to the total number of registrations held. Categories include: over 1000 registrations, 100-999 registrations, 10-99 registrations, and less than 10 registrations. Appendix D contains similar information for countries with registrations in the 500-890 MHz band.

In the 225-400 MHz band, the following 10 geographical areas accounted for almost 63 percent of 1975 registrations:

Austria	3865
Alaska	1968
New Zealand	1860
France	1827
West Germany	1715
Australia	1689
Norway	1589
Argentina	1402
Britain	1316
Mexico	1311

Viewed from a slightly different perspective, if countries are grouped with their dependencies, a somewhat different list results:

United States	6717
(including Alaska, Hawaii, Canal Zone, Guam, Midway, and Puerto Rico)	
Austria	3865
Britian	2935
(including Bermuda, Br.Indian Ocean Terr., Gibraltar, Hong Kong, and U.K. Terr. in Regions 1 and 3)	
New Zealand	1860
France	1836
(including Afars & Issas, French Polynesia, Guadeloupe, Martinique, New Caledonia, Reunion, and S.Pierre & Miquelon)	

West Germany	1715
Australia	1689
Norway	1589
Argentina	1402
Mexico	1311

In this more politically oriented grouping of "aggregated interest" in the 225-400 MHz band, the 10 countries listed represent 84.3 percent of registrations. These are the countries that can be expected to have the greatest concern regarding changes to the Radio Regulations which effect the 225-400 MHz band. In addition to the "Big 10," there are 80 other countries who also have registrations in the band. They should also be considered interested parties. Other ITU members may also be interested in the band, but from another viewpoint. All ITU members have a single vote in the ITU decision-making process. Thus, members without registrations in the band are likely to be interested in the band not for future use, but for what those most interested in the band might be willing to negotiate. It can be anticipated, in view of the increasing political nature of ITU conferences in recent years [1], that all aspects of Radio Regulations will be subject to review in 1979.

A similar interest analysis of registrations in the

500-890 MHz band reveals that the following 10 countries have a strong interest in this band:

West Germany	5676
France	1853
Britain	825
Italy	625
United States	524
Austria	400
Switzerland	302
Sweden	263
Soviet Union	119
Denmark	107

These 10 ITU member countries (including their dependencies) accounted for 96.4 percent of all registrations in the 500-890 MHz band as of the 1975 IFL. Thirty-six additional members accounted for the remaining 3.6 percent of registrations.

What are the implications of this data relative to future United States Navy satellite communications systems? First, in terms of total numbers of ITU registrations, dominant users have been identified. These countries also represent those geographical areas of the world which have the greatest potential to interfere with Navy satellite systems operating in the bands analyzed.

Second, the distribution of registrations across the 225-400 MHz band reveals that the Navy SATCOM frequencies, approximately 250 to 270 MHz (downlink) and 290 to 315 MHz (uplink), are likely to be effected to different degrees in terms of numbers of potential interferers. For example, using data from Table 6, it was calculated that the average number of registrations per 5 MHz increment in the 250-269.99 MHz range was 1100.3 (or 220.1 per MHz across the band). The range of registrations per 5 MHz increment varied from a low of 1017 to a high of 1179. In the 290-314.99 MHz range, the average number of registrations per 5 MHz increment was 788.4 (or 157.7 per MHz across the band). The range of registrations per 5 MHz increment varied from 581 to 1011. A Registrations Per MHz comparison indicates that Navy SATCOM downlink frequencies occupy a portion of the 225-400 MHz band where registrations per MHz are 30.3 percent higher than the average across band. Navy SATCOM uplink frequencies occupy a portion of the spectrum where registrations per MHz are 6.6 percent lower than the average across the entire 225-400 MHz band.

Third, should the 500-890 MHz band be opened for use by the Mobile Satellite service at GWARC 1979, satellite users would find fewer interferers than in the 225-400 MHz band. Worldwide, the average number of registrations per

5 MHz increment is 142.3 (28.4 per MHz) across the band. The range of registrations per 5 MHz increment is from 27 to 376. Should future Navy satellite communications systems elect to operate on different channels from different positions in the geostationary orbit, satellites located over ITU Region 2 (the Americas) and particularly ITU Region 3 (Asia) would encounter even fewer interferers, as the bulk (93.7 percent) of registrations in the 500-890 MHz band occur in ITU Region 1 (particularly Europe). Chapter IV presents a detailed view of the distribution of 1975 registrations as seen from the four locations on the geostationary orbit which will be occupied by the FLTSATCOM satellites.

B. DISTRIBUTION OF TRANSMITTER POWER LEVELS

Column 8 of the International Frequency List (IFL) provides the value in kilowatts (kW) specified in Appendix 1, or Appendix 1A, to the ITU Radio Regulations. Power level is considered a basic characteristic to be furnished with notification. It must be stipulated for each class of emission shown in Column 7 (Class of emission, necessary bandwidth, and description of transmission) of the IFL. For purposes of this analysis, the highest power level shown for each registration was recorded regardless of class of emission.[11]

Table 8 shows the distribution of power levels of transmitters registered across the 225-400 MHz band as of 1 February 1975, and Table 9 shows the distribution of power levels across the 500-890 MHz band as of the same date. Actual numbers as well as percentages of registrations are tabulated both worldwide and by ITU region. Table 10 shows the worldwide distributions of the two bands for comparative purposes.

In the 225-400 MHz band, transmitters with powers in the 100 to 900 watt range account for over 66 percent

---

[11]Great care must be taken in interpreting power level data contained in Column 8 of the International Frequency List because values given, in all cases, are not given in kilowatts (kW). Therefore, it is important to review Article 17 of the Preface of the IFL to insure correct interpretation (i.e., that milliwatts are not read as megawatts).

TABLE 8

TRANSMITTER POWER LEVELS OF REGISTERED STATIONS IN THE 225-400 MHz BAND

	Power (kW)					
	< .01	.01-.09	0.1-0.9	1 - 9	10-99	≥ 100
ITU Region 1	304 (2.2%)	4724 (33.9%)	8834 (63.4%)	55 (0.4%)	9 (<0.1%)	None
ITU Region 2	278 (3.0%)	2587 (28.2%)	5665 (61.7%)	643 (7.0%)	14 (0.1%)	None
ITU Region 3	83 (1.3%)	1096 (17.0%)	5094 (79.1%)	169 (2.6%)	None	None
WORLDWIDE	665 (2.3%)	8407 (28.4%)	19593 (66.3%)	867 (2.9%)	23 (<0.1%)	None

TABLE 9

TRANSMITTER POWER LEVELS OF REGISTERED STATIONS IN THE 500-890 MHz BAND

	Power (kW)					
	<.01	.01-.09	0.1-0.9	1 - 9	10-99	≥ 100
ITU Region 1	3434 (33.1%)	3682 (35.4%)	1399 (13.5%)	560 (5.4%)	591 (5.7%)	716 (5.9%)
ITU Region 2	7 (1.1%)	74 (12.9%)	153 (26.7%)	86 (15.0%)	63 (11.0%)	191 (33.3%)
ITU Region 3	2 (1.8%)	18 (15.8%)	None	34 (29.8%)	27 (23.7%)	33 (28.9%)
WORLDWIDE	3443 (31.1%)	3774 (34.1%)	1552 (14.0%)	680 (6.1%)	681 (6.2%)	940 (8.5%)

TABLE 10

COMPARISON OF POWER LEVELS WORLDWIDE

	225-400 MHz Band Registrations	500-890 MHz Band Registrations
Less than 10 W	665 (2.3%)	3443 (31.1%)
10 W - 99 W	8407 (28.4%)	3774 (34.1%)
100 W - 999 W	19593 (66.3%)	1552 (14.0%)
1 kW - 9 kW	869 (2.9%)	680 (6.1%)
10 kW - 99 kW	23 (<0.1%)	681 (6.2%)
100 kW or Greater	None	940 (8.5%)

of registrations. Most of these emitters operate at the 100 and 200 watt level. Almost 70 percent of the registrations have a power level of 100 watts or greater. The largest number (8898) occur in ITU Region 1 (Europe-Africa), closely followed by ITU Region 2 (the Americas) with 6322 and ITU Region 3 (Asia) with 5263 registrations.

In the 500-890 MHz band, only about 35 percent of registrations indicate transmitter operation at a power level of 100 watts or greater. However, it should be noted that 8.5 percent (940 registrations) of the world-wide total operate at 100 kilowatts or greater. A number of these high power transmitters are in the megawatt range. From a regional perspective, the bulk (93.8 percent) of registrations in the 500-890 MHz band (10382) occur in Region 1 (Europe-Africa); the remainder are found in Region 2 (the Americas) and Region 3 (Asia). Eighty-one percent of registrations with a power level of 100 watts or greater (1867) occur in Region 1, especially in Europe. An examination of the IFL indicates that the majority of these stations are broadband, high power UHF television stations.

In terms of potential interference with a United States Navy satellite communications system, a power level of 100 watts is significant. It is significant because it represents the maximum usable power level of the Navy's

Satellite Communications Set, AN/WSC-3, when transmitting digital data. [8] Any station with a power level equal to or greater than Navy satellite communications transmitters has the potential to interfere with an uplink signal.

What are the implications of the IFL power level data for future Navy satellite communications systems operating in either the 225-400 or 500-890 MHz bands? First, it indicates that in the 225-400 MHz band, which is the band the Navy's current satellite communications sets will utilize [8], there are a large number of users distributed worldwide with equipment equal or greater in power than Navy equipment. Therefore, a high potential for interference exists. Second, although there are far fewer users at or above the 100 watt level in the 500-890 MHz band, there are a larger number of very high power users. Should the Navy plan to operate future satellite systems in this band, assuming the band is opened for Mobile Satellite service at the GWARC in 1979, the need for considerable coordination can be anticipated, particularly with France and West Germany.

C. DISTRIBUTION OF MAXIMUM HOURS OF OPERATION

Column 10 of the International Frequency List (IFL) provides information regarding the maximum hours of operation of each registered circuit to different localities or areas in Greenwich Mean Time (G.M.T.). Symbols composed of one or two letters plus one or two numbers are used in this column. The symbols are defined in Appendix 10 to the Radio Regulations. These hours of operation represent circuit operation; additional information regarding frequency hours of operation can often be found in Column 13c (Remarks). Access to Table 7 of the Preface to the IFL is necessary to interpret the coding in the "remarks" column as it is the key to the code.

Table 11 of this paper summarizes and compares maximum hours of operation across the 225-400 and 500-890 MHz bands Table 12 gives a more detailed picture of the 225-400 MHz band, while Table 13 provides more detail regarding the 500-890 MHz band. An examination of the tables shows that the bands have some distinctly different characteristics, as well as some similarities. In both bands, the most frequently found maximum hours of operation were represented by ITU symbols H24 and HX. H24 indicates continuous circuit operation throughout each 24 hour period; and HX indicates intermittent operation through-

TABLE 11

COMPARISON OF HOURS OF OPERATION WORLDWIDE

	225-400 MHz Band Registrations	500-890 MHz Band Registrations
24 Hour Continuous Operation	5054 (17.1%)	9152 (82.5%)
Specific Period Less Than 24 Hours	278 (0.9%)	979 (8.8%)
Intermittent Operation	24213 (82.0%)	961 (8.7%)

TABLE 12

HOURS OF OPERATION OF REGISTERED STATIONS IN THE 225-400 MHz BAND

	H24	HX	OTHER
ITU Region 1	944 (6.8%)	12763 (91.7)	212 (1.5%)
ITU Region 2	2969 (32.3%)	6155 (67.0%)	58 (0.7%)
ITU Region 3	1141 (17.7%)	5295 (82.2%)	6 (0.1%)
WORLDWIDE	5054 (17.1%)	24213 (82.0%)	276 (0.9%)

NOTE: H24 is the ITU symbol for "Continuous throughout the 24 hours."

HX is the ITU symbol for "Intermittent throughout the 24 hours, or station having no specific working hours."

OTHER refers to all ITU categories except H24 and HX. Such categories specify hours of operation less than 24 hours but greater than intermittent.

ITU Hours of Operation symbols are found in Appendix 10 of Radio Regulations.

TABLE 13

HOURS OF OPERATION OF REGISTERED STATIONS IN THE 500-890 MHz BAND

	H24	HX	OTHER
ITU Region 1	8558 (82.4%)	926 (8.9%)	907 (8.7%)
ITU Region 2	574 (98.5%)	9 (1.5%)	None
ITU Region 3	20 (17.0%)	26 (22.0%)	72 (61.0%)
WORLDWIDE	9152 (82.5%)	961 (8.7%)	979 (8.8%)

NOTE: H24 is the ITU symbol for "Continuous throughout the 24 hours."

HX is the ITU symbol for "Intermittent throughout the 24 hours, or station having no specific working hours."

OTHER refers to all ITU categories except H24 and HX. Such categories specify hours of operation less than 24 hours but greater than intermittent.

ITU Hours of Operation symbols are found in Appendix 10 of Radio Regulations.

out each 24 hour period, or stations having no specific working hours. The 225-400 MHz band, on the one hand, is dominated by HX-type operation. In this band 82 percent of registered stations (24213 of 29543) claim this type of operation. On the other hand, in the 500-890 MHz band, 82.5 percent of registered stations (9152 of 11092) claim H24-type operation. Less than one percent of stations in the 225-400 MHz band (276 of 29543) and 8.8 percent of stations in the 500-890 MHz band (979 of 11092) claim specific hours of operation less than 24 hours out of every 24 hour period. Most frequenty reported maximum hours of operation in this category were "day services," 19 hours, 17 hours, 16 hours, 5 hours, and 3 hours of each 24 hour period. By far, the majority user of frequencies in the 500-890 MHz band were UHF television stations. The majority of these stations were registered for 24 hour operation.

What are the implications of the IFL Maximum Hours of Operation data for future Navy satellite communications systems? First, in the current FLTSATCOM operating band, the most frequently claimed maximum hours of operation are unspecified (intermittant). Thus, it will be difficult to predict or track down stations which will interfere with satellite uplink channels. On the other hand, under current ITU allocations, any interference with terrestrial users

resulting from Navy communications satellite systems can be expected to be reported quickly. In either case, the responsibility to resolve cases of interference rests with the Mobile Satellite service user. FLTSATCOM will have to adjust accordingly. A possible exception would be interference from another communications satellite, and the likelihood of such interference will grow as more and more countries begin to use Mobile Satellite service.

Second, in the band proposed for expanded Navy satellite communications use, the 500-890 MHz band, the most frequently claimed minimum is 24 of every 24 hours. This seems an unusually high maximum considering the majority of users are UHF television stations, which probably only broadcast a maximum of 18 to 20 hours per day. The overall effort to open the 500-890 MHz band for Mobile Satellite service should include action aimed at requiring the submission of more accurate maximum hours of operation. Such action would seem particularly appropriate should the Navy advocate frequency sharing for more effective spectrum use at some future date.

A large number of consecutive frequencies are required to transmit large volumes of data. Channel bandwidth varies from service to service depending on the type of data and mode of transmission. Television signals occupy

large bandwidths. United States broadcast television registrations in the 500-890 MHz band typically show a six megahertz bandwidth requirement. As the needs of new services, such as Mobile Satellite, emerge, the use of UHF spectrum for broadcast television may increasingly represent poor spectrum use. It will simply be found to take up too much space for the benefit derived. It will be too limiting in terms of the number of available frequencies that could otherwise be used in a given frequency range. This view may well represent the future with regard to the 500-890 MHz band.

The matter deserves further study. For example, a finding that currently available UHF television channels are under-utilized would support alternate allocation of the 500-890 MHz band to other services. A finding that there is limited likelihood of intensive growth of UHF television would also support alternative allocation. Perhaps, UHF can be more efficiently delivered by cable. Should these suggestions prove true and ITU allocations be modified accordingly, more UHF spectrum would be available for such services as Mobile Satellite service whose existence depend on radiated signals.

IV. A VIEW OF INTERNATIONAL REGISTRATIONS FROM THE GEOSTATIONARY ORBIT

Future United States Navy communications plans include a continuing requirement for global communications using satellites on the geostationary orbit operating in the UHF range.

Current equipment is designed to operate in the 240-320 MHz range and allows the use of low antenna gain shipboard terminals. These antennas have little directivity. Thus, the system will have little immunity to adjacent channel interference from sources within the radio horizon. Current equipment is designed to operate at 100 watts. Large numbers of transmitters operate in the 225-400 MHz band with 100 watts or greater power. They are potential sources of interference.

Current Navy UHF satellite systems are characterized by satellites with transmit and receive antennas that see nearly hemispherical areas of the earth. Thus, Navy communications satellites can interfere with or be interfered with by a large number of terresterial systems which do not interfere with one another.

The Navy's UHF satellite communication system provides worldwide service. The satellites act as relay facilities for two-way communication traffic between appropriately

equipped surface ships, aircraft, submarines, and shore stations.

In 1975, the Naval Electronic Systems Command commissioned a study to determine optimum slotting of Navy SATCOM satellites on the geostationary orbit. [7] The resulting analysis was based on placing the satellites where they could best be seen by various combinations of Navy earth terminals.

Major Navy SATCOM earth terminals are being built at Naval Communications Stations at the following locations:

Naples, Italy

Norfolk, Virginia, USA

Wahiwa, Oahu, Hawaii, USA

Agana, Guam

Stockton, California, USA

One system requirement is that at least two of these sites must be visible to any one spacecraft in the communications system. Thus, in case of an equipment failure at any single Naval Communications Station, each spacecraft would still be able to operate through the second earth terminal.

The Navy's UHF satellite system will also distribute one-way Fleet Broadcast traffic. Traffic will be beamed to the satellite by either of the major earth terminals in the footprint of the satellite and will be relayed by

the satellite to all units in the same footprint. To facilitate transmission of the Fleet Broadcast to ships not equipped to receive satellite transmission directly and ships which cannot be accessed from the geostationary orbit, satellite signals will be received and retransmitted by twelve HF "rekey" sites. A second constraint of the slotting study [7] was that each rekey site must be in view of at least one satellite.

Additionally, there are several additional ground points of importance to the United States Navy which must also be within the 5° elevation footprint of at least one spacecraft. These stations were also accounted for in the slotting analysis. [7]

Two satellites could cover all major communications stations, but two satellite coverage would leave significant gaps in coverage of worldwide Navy operational areas. Coverage of major communications stations, plus rekey stations and other operationally significant sites and areas requires three satellites.

Four satellites would give complete global coverage between 70°N and 70°S. Four satellites would also allow many important ground points to see satellites at higher elevation angles and provide an in-orbit spare should a satellite fail thus necessitating fallback to a three satellite system.

For purposes of this study, it has been assumed that future Navy Satellite communications systems will be four-satellite systems. As with a three-satellite system, one satellite each will be placed for Atlantic, Pacific, and Indian Ocean coverage. The fourth satellite will share Pacific area duties. Located in the Eastern Pacific, it will provide better ocean coverage and will permit areas surrounding the United States and Cape Horn common communication access via a single satellite.

National Scientific Laboratories' 1975 study of geostationary orbit slotting [7], indicated that the following orbital arcs yield best worldwide coverage considering constraints imposed:

Satellite	Geostationary Arc Limits
Atlantic Ocean	3.44°W to 57.73°W
Indian Ocean	85.90°E to 68.80°E
West Pacific Ocean	139.30°W to 164188°E
East Pacific Ocean	82.70°W to 149.06°w

In fact, the information supplied to the International Frequency Registration Board of the International Telecommunications Union [3] by the Department of State indicates that the FLTSATCOM satellites will be located within these arcs at the following locations:

Satellite	Nominal Geographic Longitude
Atlantic Ocean Service	23°W
Indian Ocean Service	75°E
West Pacific Ocean Service	172°E
East Pacific Ocean Service	100°W

Figures 4, 5, 6, and 7 show the Navy SATCOM satellite receiving and transmitting antenna service areas for the Atlantic, Indian Ocean, West Pacific, and East Pacific satellites respectively.

However, there is potential for interference between satellite and terrestrial service beyond the service area ovals due to the broad area coverage of the space station receiving and transmitting antennas. Basically, this area of potential interference extends to (and perhaps a bit beyond) the hemispherical horizon of the earth viewed by

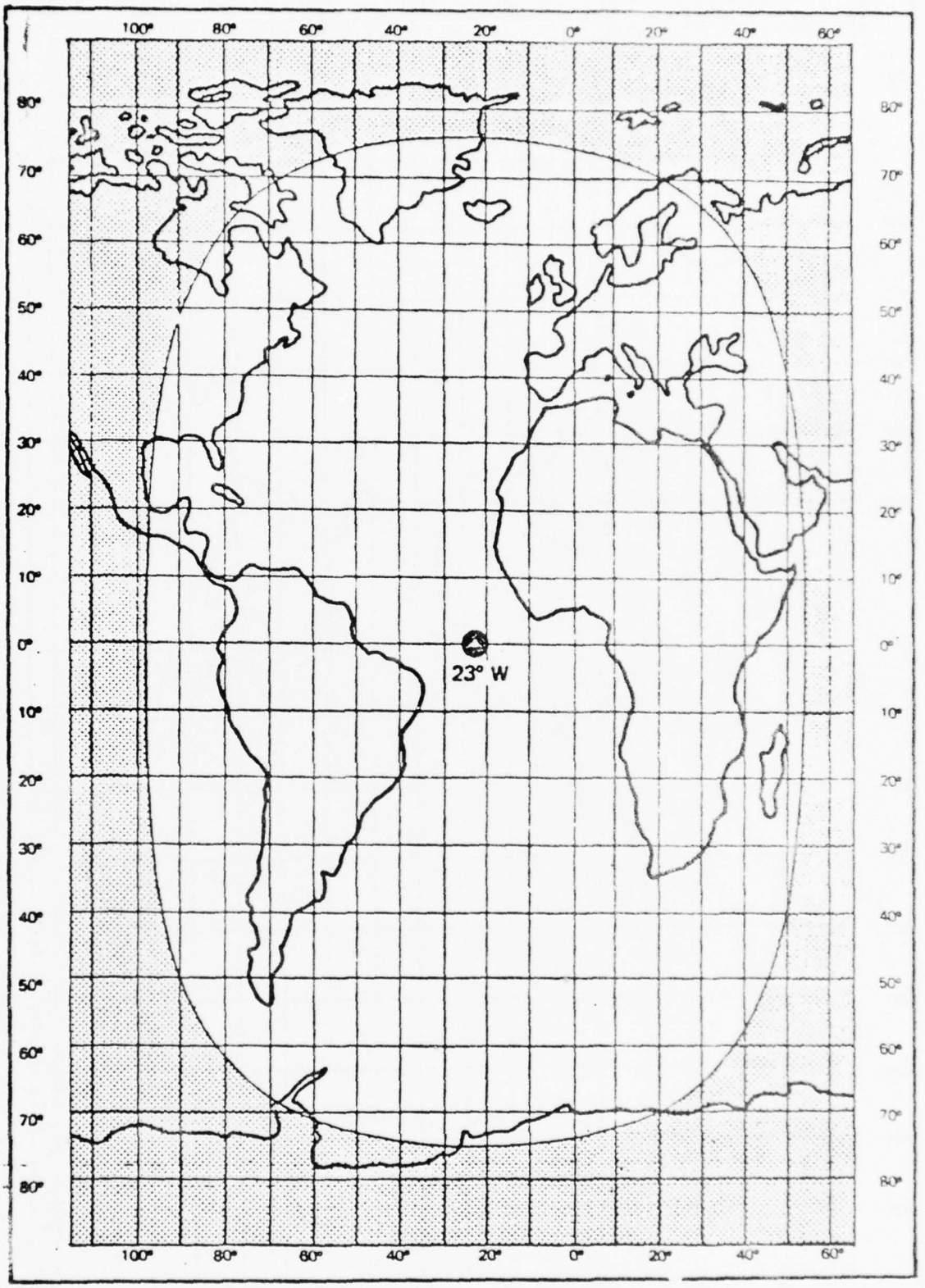


Figure 4 - ATLANTIC SATELLITE LOOK AREA

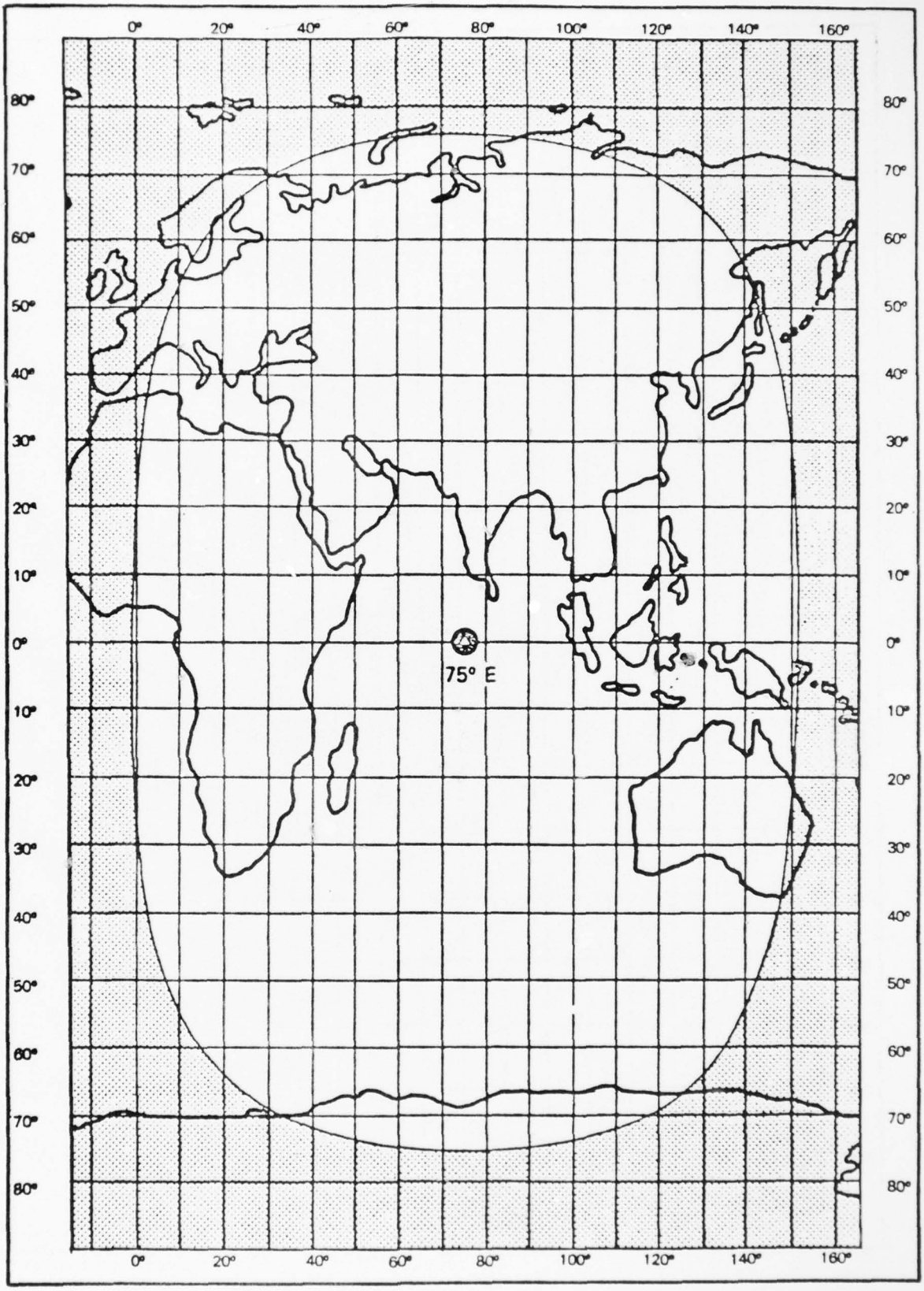


Figure 5 - INDIAN OCEAN SATELLITE LOOK AREA

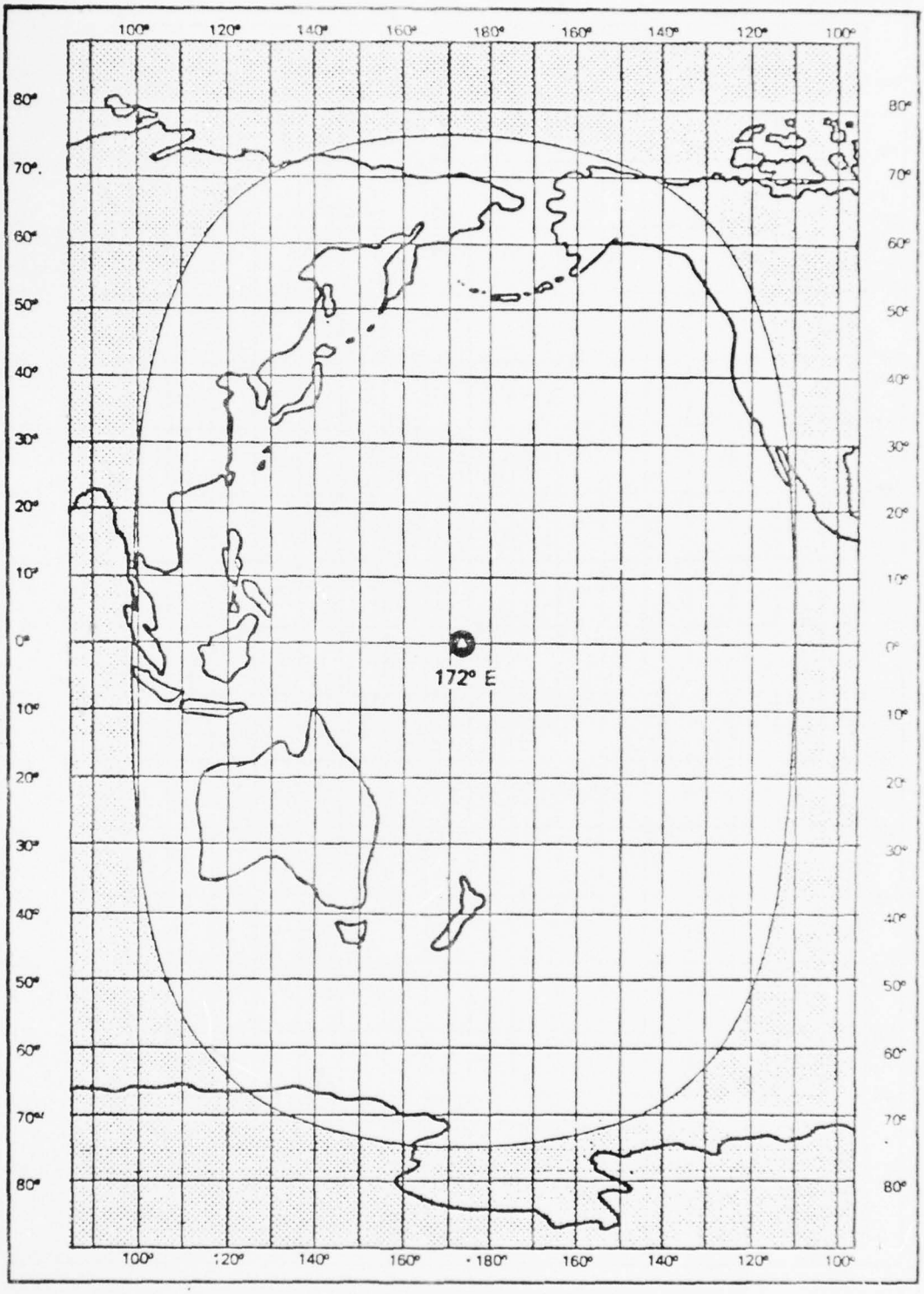


Figure 6 - WEST PACIFIC SATELLITE LOOK AREA

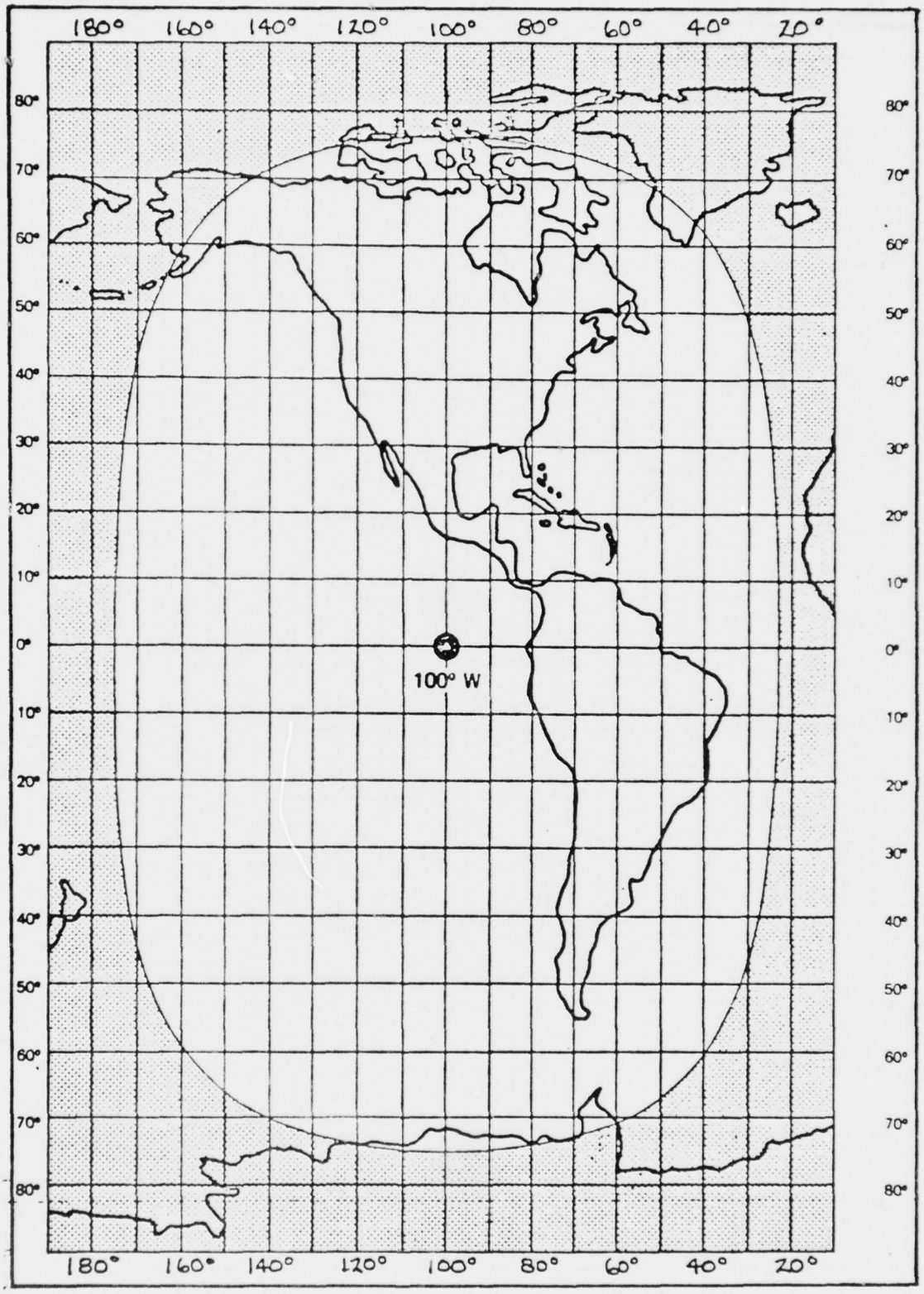


Figure 7 - EAST PACIFIC SATELLITE LOOK AREA

a particular satellite. Thus, transformed into mercator projections, the shaded areas in Figures 4,5,6, and 7 are also of interest.

Table 14 lists the countries of the world which have registered frequencies with a potential to interfere with Atlantic Ocean Navy SATCOM service. The number of frequencies that each country has listed in the 225-400 and 500-890 MHz bands are tabulated. The distribution of the summation of registrations of all countries within the potential interference area is graphed in Figure 8 and 9 respectively, based on the data tabulated in Table 15 and 16 respectively.

Data with regard to Indian Ocean Navy SATCOM service is presented in Tables 17, 18, and 19 and in Figures 10 and 11.

Data regarding the West Pacific Navy SATCOM service can be found in Table 20, 21, and 22. Figure 12 graphs 225-400 MHz registrations, and Figure 13 graphs 500-890 MHz registrations.

Data regarding the East Pacific Navy SATCOM service is found in Table 23 through 25 and Figures 14 and 15.

TABLE 14

GEOGRAPHIC AREAS WITH REGISTRATIONS
INDICATING A POTENTIAL FOR INTERFERENCE
WITH AN ATLANTIC SATELLITE AT 23°WEST

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
AAA	Shared Worldwide	1	
AFI	Afars & Issas	1	
AFS	South Africa	490	
ALG	Algeria	2	
ARG	Argentina	1402	
ATN	Netherlands Antilles	2	
AUT	Austria	3865	400
AZR	Azores	1	1
B	Brazil	452	19
BAH	Bahamas	4	
BEL	Belgium	88	13
BER	Bermuda	2	
BHR	Bahrain	14	
BLR	Byelorussian SSR	25	12
BRB	Barbados		4
BUL	Bulgaria	6	
CAN	*Canada	24	17
CME	Cameroon		2
CNR	Canary Islands	10	
CLM	Columbia	100	
COM	Comorros	1	
CPV	Cape Verde Islands	1	
CTR	Costa Rica	2	
CUB	Cuba	13	2
CVA	Vatican City	2	
CYP	Cyprus		4
D	Fed. Rep. Germany	1715	5676
DDR	German Dem. Rep.	2	6
DNK	Denmark	249	107
E	Spain	23	10
EHB	Space Research	2	
EHR	Space Research	5	
ENA	Radionavigation	3	
ETH	Ethopia	4	
F	France	1827	1847
FNL	Finland	142	5
G	Great Britain (UK)	1316	822
GCA	UK Terr. Region 1	1285	
GDL	Guadeloupe	1	4

* Only stations located East of 113° West.

TABLE 14 - Continued

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
GIB	Gibraltar		2
GRC	Greece	2	2
GTM	Guatemala	2	
GUB	Guyana	1	8
HOL	Netherlands	494	39
HND	Honduras	2	
HVO	Upper Volta	1	
I	Italy	10	625
IOB	Grenada (Br. West Indies)	2	
IRL	Ireland	18	
IRN	Iran	15	
IRQ	Iraq	7	
ISL	Iceland	38	4
JMC	Jamica	6	
KEN	Kenya	2	
LBY	Libya	2	3
LUX	Luxembourg	1	
MEX	*Mexico	1152	
MLT	Malta	2	1
MOZ	Mozambique		4
MRC	Morocco	14	2
MRT	Martinique	1	
MTN	Mauritania	1	
MWI	Malawi	1	
NCG	Nicaragua	2	
NGR	Niger	1	
NIG	Nigeria	5	
NOR	Norway	1589	8
PAK	Pakistan	226	3
POL	Poland	44	10
POR	Portugal	2	2
PNZ	Canal Zone	36	
PTR	Puerto Rico	980	4
QAT	Qatar	3	
REU	Reunion	1	
RHS	Rhodesia	3	
S	Sweden	178	263
SDN	Sudan	1	
SEN	Senegal	1	
SEY	Seychelles	4	
SPM	S. Pierre & Miquelon	1	

* Only stations located East of 113° West.

TABLE 14 - Continued

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
SUI	Switzerland	42	302
TCD	Chad	1	
TCH	Czechoslovakia	55	6
TGK	Tanzania (Tanganyika)	2	3
TGO	Togo	1	
TUR	Turkey	10	34
UAE	United Arab Emirates	2	
UGA	Uganda	2	
UKR	Ukranian SSR	48	25
URG	Uruguay	100	
URS	*Soviet Union	68	80
USA	**United States	751	352
YUG	Yugoslavia	120	30
ZAI	Zaire		2
ZAM	Zambia	3	
	Totals	19138	10765

* Only stations West of 67° East.

** Only stations East of 113° West.

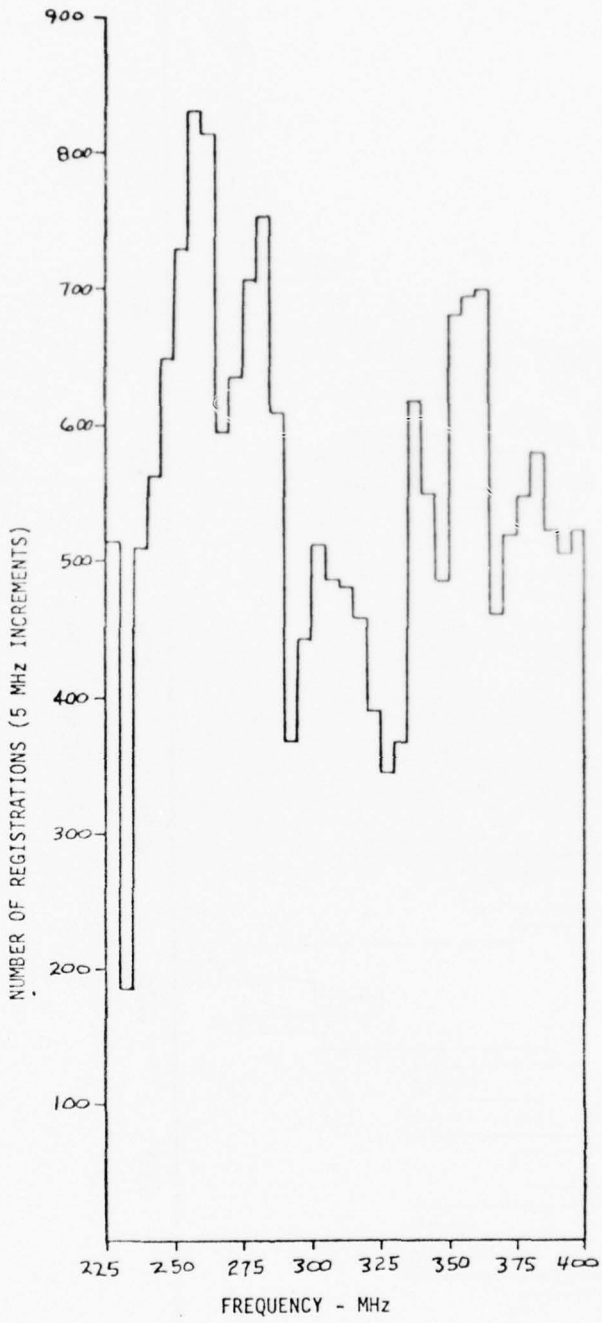


Figure 8 - DISTRIBUTION OF REGISTRATIONS ACROSS 225-400 MHz BAND AS SEEN BY ATLANTIC SATELLITE

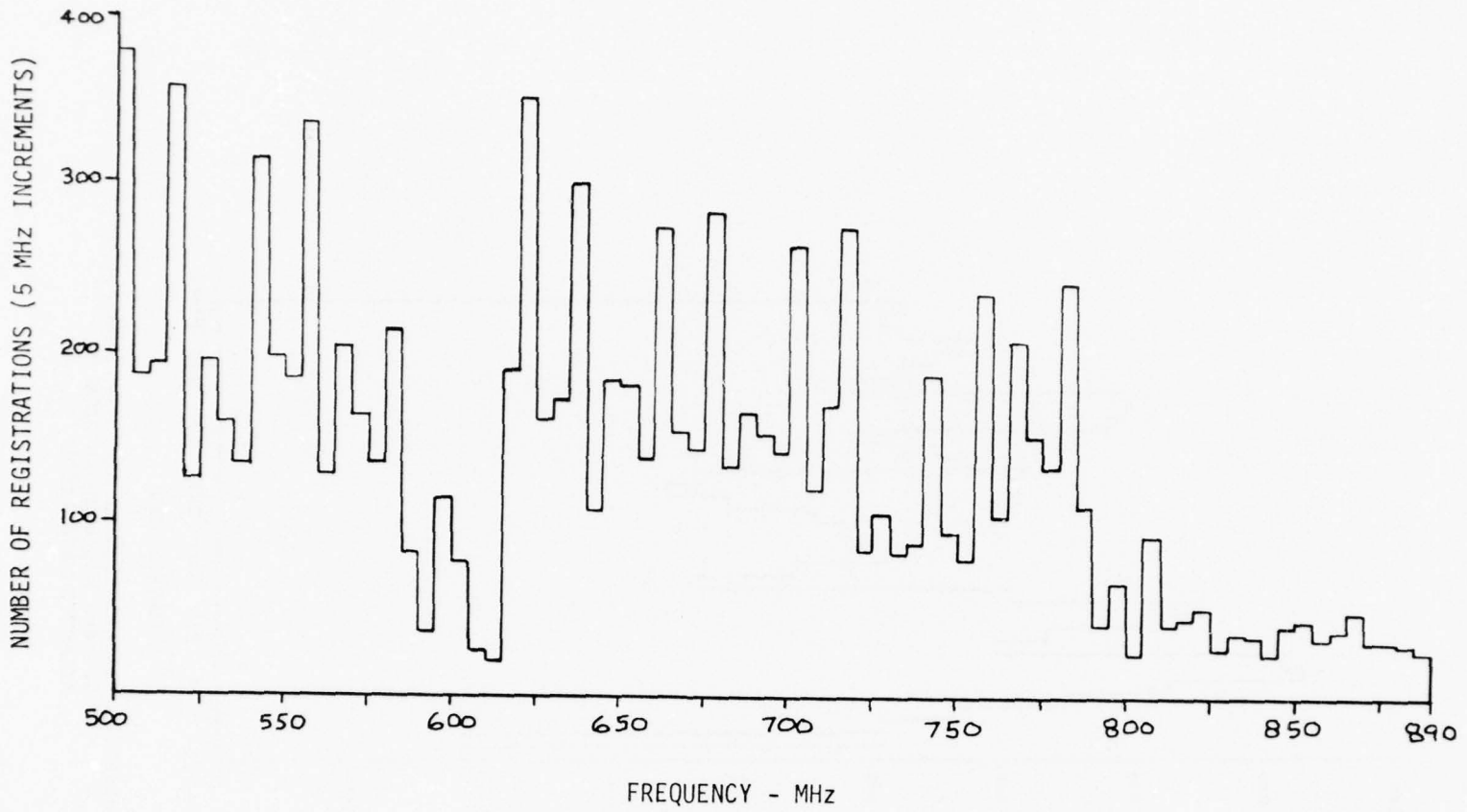


Figure 9 - DISTRIBUTION OF REGISTRATIONS ACROSS 500-890 MHz BAND AS SEEN BY ATLANTIC SATELLITE

TABLE 15

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 225-400 MHz BAND
FOR THE ATLANTIC SATELLITE LOOK AREA

Band	Registrations
225-229.99	514
230-234.99	188
235-239.99	510
240-244.99	564
245-249.99	649
250-254.99	731
255-259.99	720
260-264.99	815
265-269.99	596
270-274.99	636
275-279.99	707
280-284.99	753
285-289.99	608
290-294.99	378
295-299.99	442
300-304.99	412
305-309.99	485
310-314.99	481
315-319.99	458
320-324.99	390
325-329.99	345
330-334.99	368
335-339.99	618
340-344.99	550
345-349.99	485
350-354.99	681
355-359.99	695
360-364.99	700
365-369.99	462
370-374.99	520
375-379.99	547
380-384.99	580
385-389.99	522
390-394.99	505
395-399.99	522
Total	19,138

TABLE 16

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 500-890 MHz BAND FOR THE ATLANTIC
SATELLITE LOOK AREA

Band	Registrations
500-504.99	374
505-509.99	188
510-514.99	194
515-519.99	356
520-524.99	127
525-529.99	196
530-534.99	159
535-539.99	134
540-544.99	312
545-549.99	197
550-554.99	184
555-559.99	335
560-564.99	130
565-569.99	204
570-574.99	164
575-579.99	136
580-584.99	214
585-589.99	83
590-594.99	36
595-599.99	116
600-604.99	78
605-609.99	25
610-614.99	19
615-619.99	191
620-624.99	349
625-629.99	161
630-634.99	173
635-639.99	300
640-644.99	108
645-649.99	184
650-654.99	181
655-659.99	139
660-664.99	275
665-669.99	154
670-674.99	144
675-679.99	284
680-684.99	135
685-689.99	166
690-694.99	153
695-699.99	142

TABLE 16 - Continued

Band	Registrations
700-704.99	263
705-709.99	121
710-714.99	170
715-719.99	274
720-724.99	85
725-729.99	108
730-734.99	84
735-739.99	89
740-744.99	187
745-749.99	97
750-754.99	80
755-759.99	238
760-764.99	105
765-769.99	208
770-774.99	152
775-779.99	135
780-784.99	242
785-789.99	111
790-794.99	41
795-799.99	67
800-804.99	25
805-809.99	95
810-814.99	41
815-819.99	44
820-824.99	51
825-829.99	28
830-834.99	37
835-839.99	36
840-844.99	25
845-849.99	41.
850-854.99	43
855-859.99	36
860-864.99	39
865-869.99	49
870-874.99	31
875-879.99	31
880-884.99	30
885-889.99	26
Total	10,765

TABLE 17

GEOGRAPHIC AREAS WITH REGISTRATIONS
INDICATION A POTENTIAL FOR INTERFERENCE
WITH AN INDIAN OCEAN SATELLITE AT 75°EAST

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
AAA	Shared Worldwide	1	
AFI	Afars & Issas	1	
AFS	South Africa	490	
ALG	Algeria	2	
AUS	Australia	1689	6
AUT	Austria	3865	400
BEL	Belgium	88	13
BGD	Bangladesh	89	2
BHR	Bahrain	14	
BIO	Br. Indian Ocean Terr.	6	
BLR	Byelorussian SSR	25	12
BRM	Burma	2	
BUL	Bulgaria	6	
	China (Taiwan)	4	6
CLN	Ceylon (Sri Lanka)	8	
CVA	Vatican City	2	
CYP	Cyprus		4
D	Fed. Rep. Germany	1715	5676
DDR	German Dem. Rep.	2	6
DNK	Denmark	249	107
E	Spain	23	10
EHB	Space Research	2	
EHR	Space Research	5	
ENA	Radionavigation	3	
ETH	Ethopia	4	
F	France	1827	1847
FNL	Finland	142	5
G	Great Britain (UK)	1316	822
GCC	UK Terr. Region 3	325	
GIB	Gibraltar		2
GRC	Greece	2	2
GUM	Guam	982	
HKG	Hong Kong	1	1
HOL	Netherlands	494	39
HVO	Upper Volta	1	
I	Italy	10	625
IND	India	638	22
INS	Indonesia	32	14
IRL	Ireland	18	
IRN	Iran	15	
IRQ	Iraq	7	

TABLE 17 - Continued

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
ISL	*Iceland		
J	Japan	144	51
KEN	Kenya	2	
LBY	Libya	2	3
LUX	Luxembourg	1	
MLA	Malaysia	328	2
MLT	Malta	2	1
MOZ	Mozambique		4
MRC	Morocco	14	2
MTN	*Mauritania		
MWI	Malawi	1	
NCL	New Caledonia	1	
NGR	Niger	1	
NIG	Nigeria	5	
NOR	Norway	1589	8
PAK	Pakistan	226	3
PHL	Philippines	41	
PNG	Papua New Guinea	10	
POL	Poland	44	10
POR	Portugal	2	2
QAT	Qatar	3	
REU	Reunion	1	
RHS	Rhodesia	3	
RYU	Ryukyu Islands	21	2
S	Sweden	178	263
SDN	Sudan	1	
SEN	*Senegal		
SEY	Seychelles	4	
SNG	Singapore	2	2
SUI	Switzerland	42	302
TCD	Chad	1	
TCH	Czechoslovakia	55	6
TGK	Tanzania (Tanganyika)	2	3
TGO	Togo	1	
THA	Thailand	3	
TUR	Turkey	10	34
UAE	United Arab Emirates	2	
UGA	Uganda	2	
UKR	Ukrainian SSR	48	25
URS	**Soviet Union	117	119

* No Stations located East of 15° West.

** Includes only Soviet stations located East of 165° East.

TABLE 17 - Continued

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
VTN	Vietnam	1	
YUG	Yugoslavia	120	30
ZAI	Zaire		2
ZMB	Zambia	3	
	Totals	17138	10495

TABLE 18

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 225-400 MHz BAND
FOR THE INDIAN OCEAN SATELLITE LOOK AREA

Band	Registrations
225-229.99	440
230-234.99	169
235-239.99	471
240-244.99	550
245-249.99	505
250-254.99	635
255-259.99	621
260-264.99	610
265-269.99	494
270-274.99	479
275-279.99	888
280-284.99	777
285-289.99	570
290-294.99	368
295-299.99	351
300-304.99	381
305-309.99	384
310-314.99	453
315-319.99	394
320-324.99	362
325-329.99	314
330-334.99	224
335-339.99	413
340-344.99	367
345-349.99	368
350-354.99	568
355-359.99	586
360-364.99	849
365-369.99	692
370-374.99	787
375-379.99	799
380-384.99	837
385-389.99	786
390-394.99	821
395-399.99	775
Total	17,138

TABLE 19

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 500-890 MHz BAND
FOR THE INDIAN OCEAN SATELLITE LOOK AREA

Band	Registrations
500-504.99	360
505-509.99	174
510-514.99	194
515-519.99	345
520-524.99	119
525-529.99	189
530-534.99	153
535-539.99	124
540-544.99	312
545-549.99	190
550-554.99	177
555-559.99	330
560-564.99	125
565-569.99	195
570-574.99	164
575-579.99	135
580-584.99	212
585-589.99	79.
590-594.99	34
595-599.99	116
600-604.99	78
605-609.99	27
610-614.99	18
615-619.99	198
620-624.99	357
625-629.99	155
630-634.99	173
635-639.99	297
640-644.99	103
645-649.99	182
650-654.99	184
655-659.99	140
660-664.99	275
665-669.99	155
670-674.99	146
675-679.99	282
680-684.99	133
685-689.99	163
690-694.99	153
695-699.99	143

TABLE 19 - Continued

Band	Registrations
700-704.99	263
705-709.99	118
710-714.99	170
715-719.99	273
720-724.99	87
725-729.99	106
730-734.99	82
735-739.99	88
740-744.99	191
745-749.99	97
750-754.99	82
755-759.99	237
760-764.99	101
765-769.99	207
770-774.99	151
775-779.99	134
780-784.99	243
785-789.99	113
790-794.99	39
795-799.99	66
800-804.99	26
805-809.99	74
810-814.99	45
815-819.99	37
820-824.99	39
825-829.99	20
830-834.99	23
835-839.99	26
840-844.99	29
845-849.99	30
850-854.99	32
855-859.99	25
860-864.99	26
865-869.99	29
870-874.99	27
875-879.99	22
880-884.99	26
885-889.99	22
Total	10,495

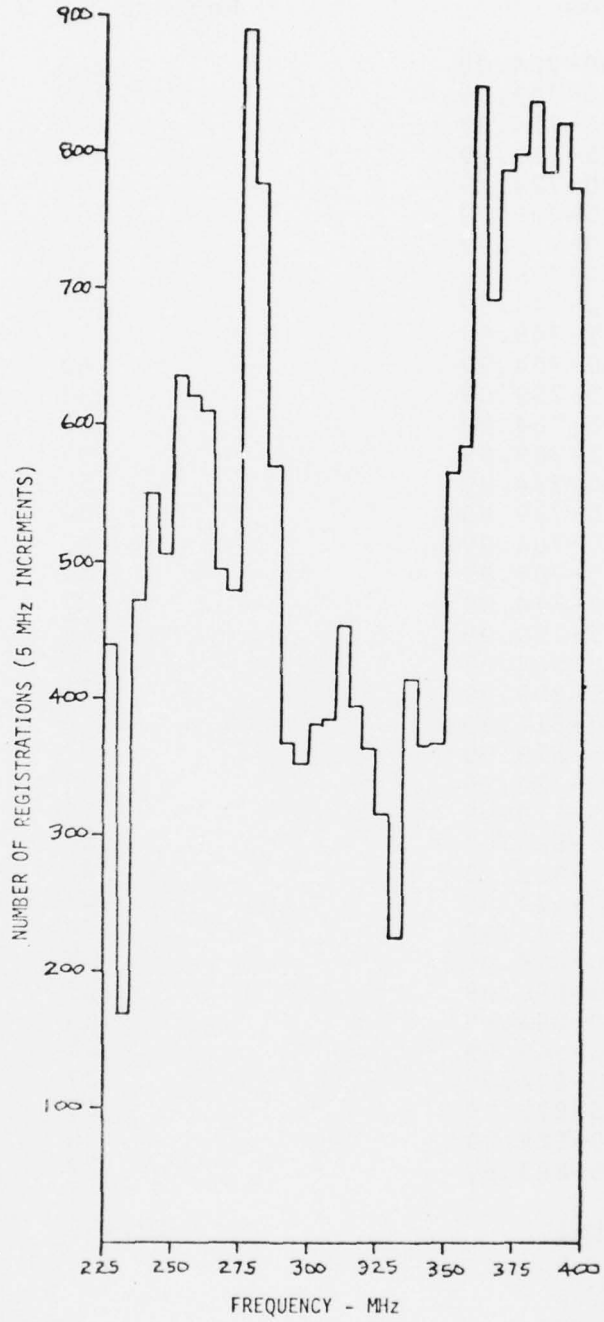


Figure 10 - DISTRIBUTION OF REGISTRATIONS ACROSS 225-400 MHz BAND AS SEEN BY INDIAN OCEAN SATELLITE

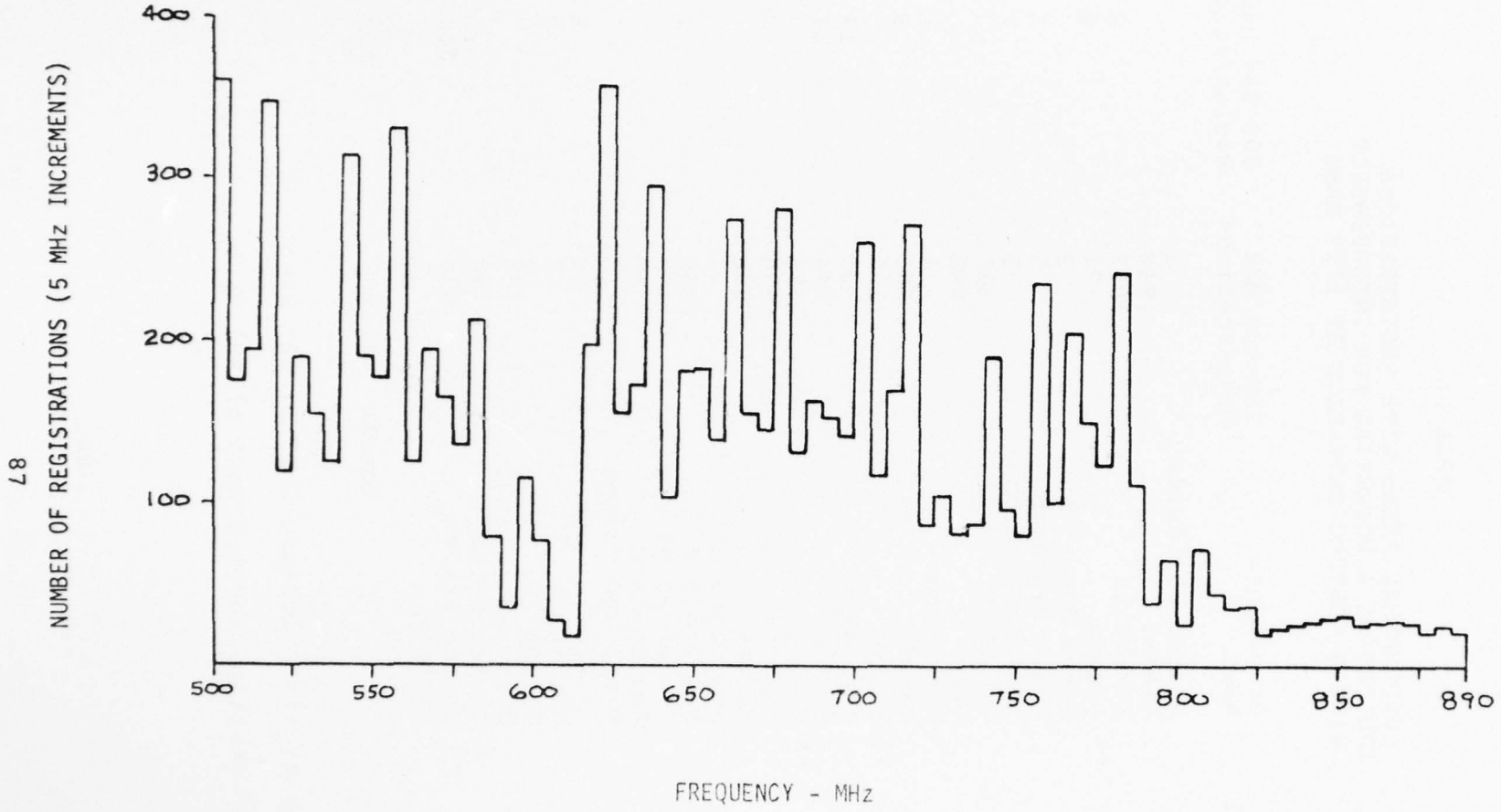


Figure 11 - DISTRIBUTION OF REGISTRATIONS ACROSS 500-890 MHz BAND AS SEEN BY INDIAN OCEAN SATELLITE

TABLE 20

GEOGRAPHIC AREAS WITH REGISTRATIONS
INDICATING A POTENTIAL FOR INTERFERENCE
WITH A WESTPAC SATELLITE AT 172° EAST

Symbol		Geographic Area	225-400 MHz Registrations	500-890 MHz Registrations
AAA		Shared Worldwide	1	
ALS		Alaska	1968	
AUS		Australia	1689	6
CAN	**	Canada	21	8
EHB		Space Research	2	
EHR		Space Research	5	
ENA		Radionavigation	3	
GCC		U.K. Terr. Region 3	325	
GUM		Guam	982	
HKG		Hong Kong	1	1
HWA		Hawaii	981	8
IND	*	India	157	5
INS		Indonesia	32	14
J		Japan	144	51
MEX	**	Mexico	1066	
MLA		Malaysia	328	2
MWD		Midway	980	
NCL		New Caledonia	1	
NZL		New Zealand	1860	7
OCE		French Polynesia	3	
PHL		Philippines	41	
PNG		Papua New Guinea	10	
RYU		Ryukyu Islands	21	2
SNG		Singapore	2	2
		Taiwan	4	6
THA		Thailand	3	
URS	*	Soviet Union	38	28
USA	**	United States	630	242
VTN		Vietnam	1	
		Totals	11,299	382

* Only stations located East of 82° East.

** Only stations located West of 98° West.

TABLE 21

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 225-400 MHz BAND FOR THE WESTPAC
SATELLITE LOOK AREA

Band	Registrations
225-229.99	148
230-234.99	157
235-239.99	238
240-244.99	201
245-249.99	305
250-254.99	530
255-259.99	415
260-264.99	440
265-269.99	436
270-274.99	485
275-279.99	487
280-284.99	470
285-289.99	266
290-294.99	205
295-299.99	203
300-304.99	405
305-309.99	460
310-314.99	557
315-319.99	287
320-324.99	268
325-329.99	278
330-334.99	99
335-339.99	383
340-344.99	400
345-349.99	385
350-354.99	410
355-359.99	437
360-364.99	461
365-369.99	157
370-374.99	170
375-379.99	186
380-384.99	469
385-389.99	212
390-394.99	153
395-399.99	136
Total	11,299

TABLE 22

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 500-890 MHz BAND FOR THE WESTPAC
SATELLITE LOOK AREA

Band	Registrations
500-504.99	2
505-509.99	1
510-514.99	
515-519.99	3
520-524.99	2
525-529.99	2
530-534.99	3
535-539.99	1
540-544.99	
545-549.99	1
550-554.99	
555-559.99	3
560-564.99	4
565-569.99	2
570-574.99	
575-579.99	5
580-584.99	4
585-589.99	5
590-594.99	8
595-599.99	7
600-604.99	2
605-609.99	10
610-614.99	7
615-619.99	10
620-624.99	14
625-629.99	2
630-634.99	
635-639.99	4
640-644.99	2
645-649.99	2
650-654.99	3
655-659.99	
660-664.99	
665-669.99	4
670-674.99	5
675-679.99	
680-684.99	2
685-689.99	1
690-694.99	1
695-699.99	2

TABLE 22 - Continued

Band	Registrations
700-704.99	1
705-709.99	1
710-714.99	4
715-719.99	
720-724.99	2
725-729.99	3
730-734.99	
735-739.99	
740-744.99	3
745-749.99	
750-754.99	2
755-759.99	1
760-764.99	1
765-769.99	
770-774.99	1
775-779.99	
780-784.99	1
785-789.99	2
790-794.99	1
795-799.99	
800-804.99	6
805-809.99	44
810-814.99	1
815-819.99	21
820-824.99	25
825-829.99	12
830-834.99	21
835-839.99	13
840-844.99	3
845-849.99	21
850-854.99	17
855-859.99	15
860-864.99	8
865-869.99	19
870-874.99	1
875-879.99	1
880-884.99	4
885-889.99	3
Total	382

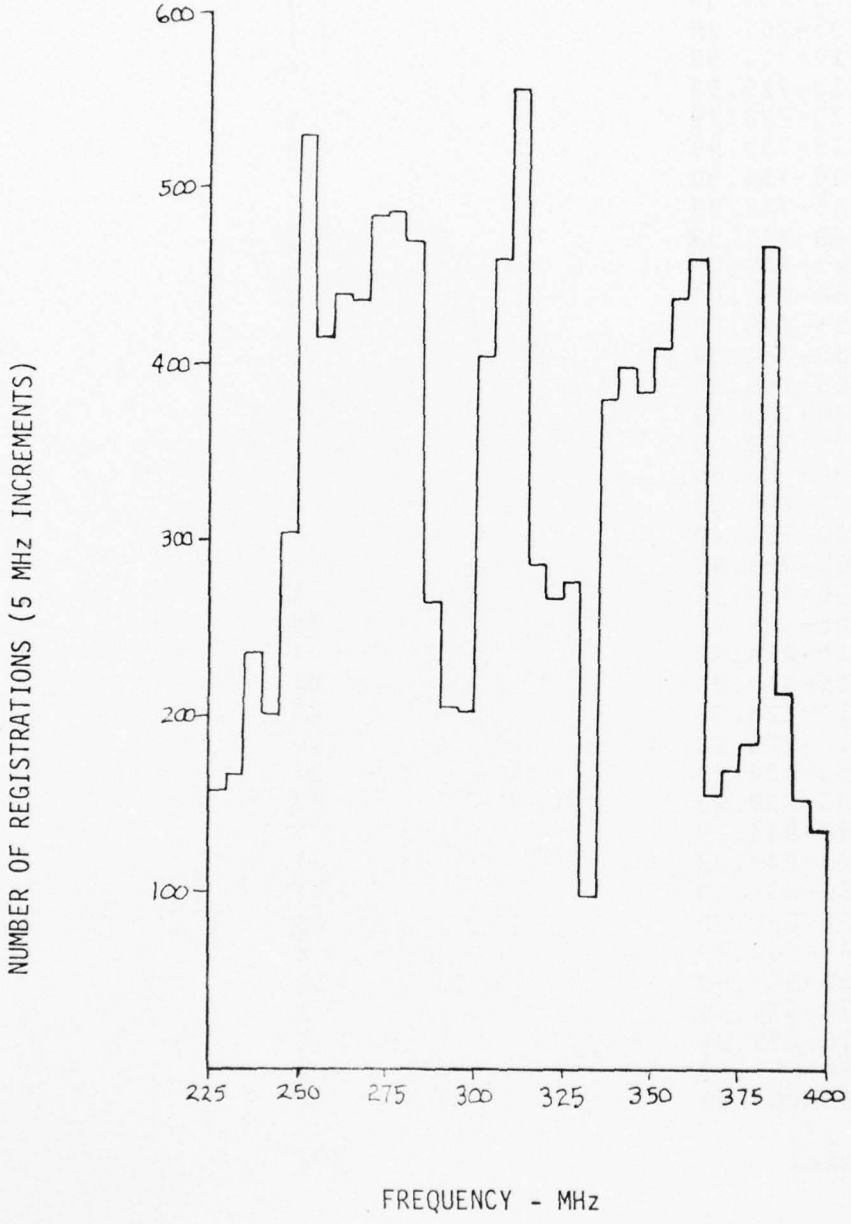


Figure 12 - DISTRIBUTION OF REGISTRATIONS ACROSS 225-400 MHz BAND AS SEEN BY WESPAC SATELLITE

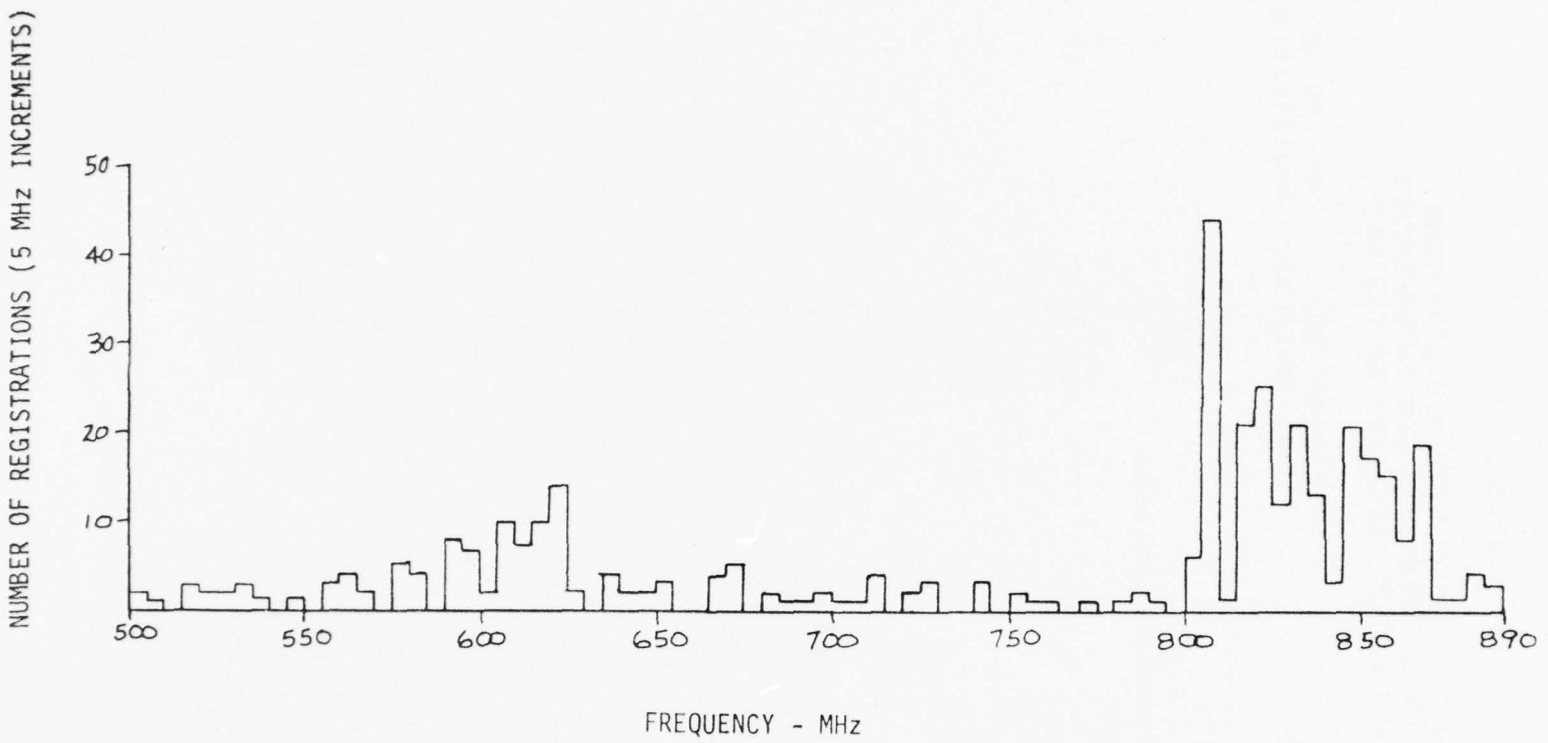


Figure 13 - DISTRIBUTION OF REGISTRATIONS ACROSS 500-890 MHz BAND
AS SEEN BY WESTPAC SATELLITE

TABLE 23

GEOGRAPHIC AREAS WITH REGISTRATIONS
INDICATING A POTENTIAL FOR INTERFERENCE
WITH AN EASTPAC SATELLITE AT 100°WEST

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
AAA	Shared Worldwide	1	
ALS	Alaska	1968	
ARG	Argentina	1402	
ATN	Netherlands Antilles	2	
AZR	Azores	1	1
B	Brazil	452	19
BAH	Bahamas	4	
BER	Bermuda	2	
BRB	Barbados		4
CAN	Canada	34	24
CLM	Columbia	100	
CPV	Cape Verde Islands	1	
CTR	Costa Rica	2	
CUB	Cuba	13	2
EHB	Space Research	2	
EHR	Space Research	5	
ENA	Radionavigation	3	
GCC	UK Terr. Region 3	325	
GDL	Guadeloupe	1	4
GTM	Guatemala	2	
GUB	Guyana	1	8
HND	Honduras	2	
HWA	Hawaii	981	8
IOB	Br. West Indies	2	
ISL	Iceland	38	4
JMC	Jamica	6	
MEX	Mexico	1311	
MRT	Martinique	1	2
MTN	Mauritania	1	
MWD	Midway	980	
NCG	Nicaragua	2	
NZL	New Zealand	1860	7
OCE	French Polynesia	3	
PNZ	Canal Zone	36	
PTR	Puerto Rico	980	4
SEN	Senegal	1	

TABLE 23 - Continued

Symbol	Area	225-400 MHz Registrations	500-890 MHz Registrations
SPM	S. Pierre & Miquelon	1	
URG	Uruguay	100	
URS	*Soviet Union	118	
USA	United States	790	508
	Totals	11534	595

* Soviet Union stations located West of 170° East.

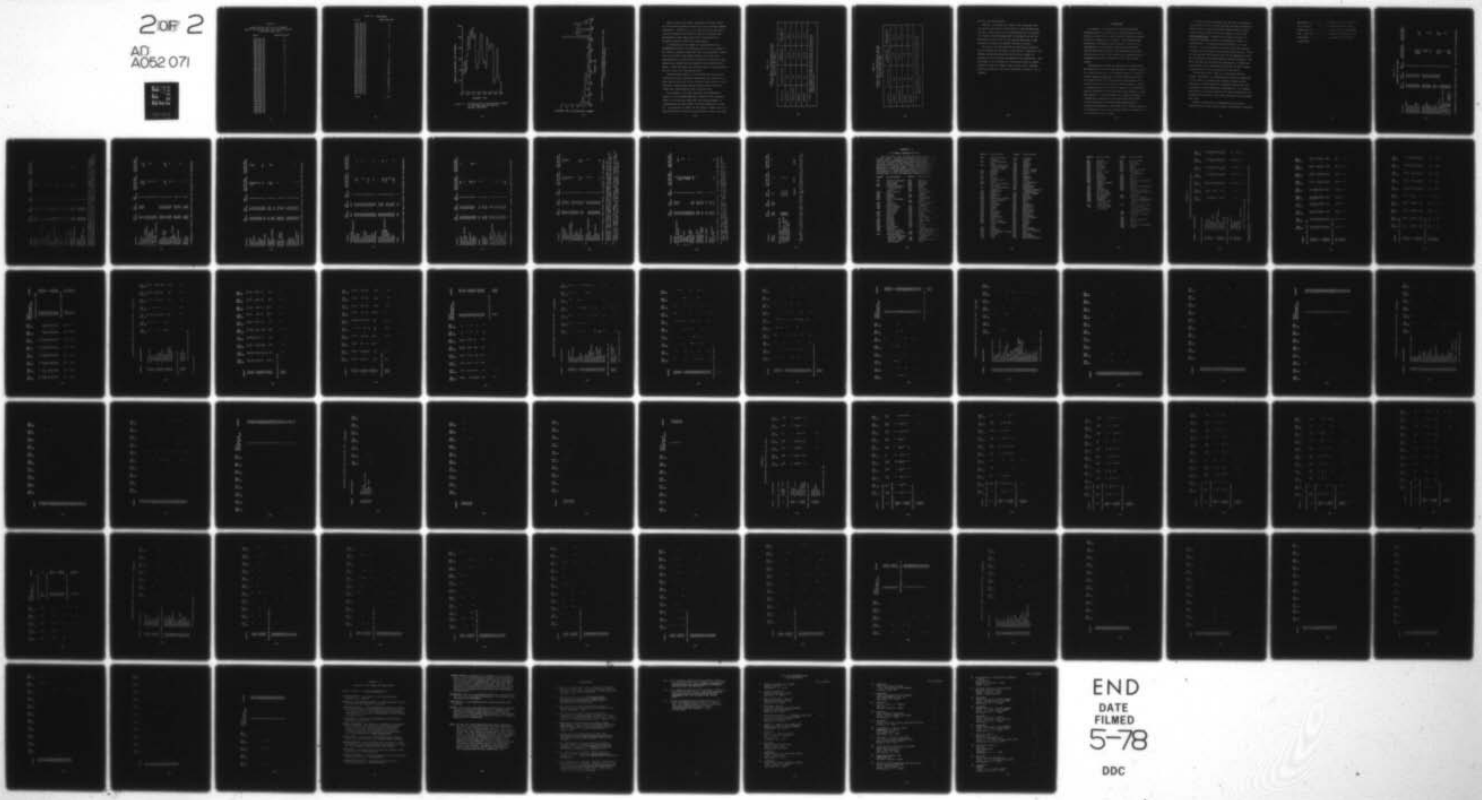
TABLE 24

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 225-400 MHz BAND FOR THE EASTPAC
SATELLITE LOOK AREA

Band	Registrations
225-229.99	196
230-234.99	165
235-239.99	280
240-244.99	188
245-249.99	334
250-254.99	509
255-259.99	389
260-264.99	557
265-269.99	498
270-274.99	587
275-279.99	487
280-284.99	526
285-289.99	264
290-294.99	208
295-299.99	262
300-304.99	379
305-309.99	495
310-314.99	529
315-319.99	302
320-324.99	259
325-329.99	281
330-334.99	212
335-339.99	493
340-344.99	436
345-349.99	385
350-354.99	404
355-359.99	438
360-364.99	423
365-369.99	81
370-374.99	110
375-379.99	126
380-384.99	396
385-389.99	156
390-394.99	93
395-399.99	86
Total	11,534

AD-A052 071 NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF F/G 17/2.1
ITU REGISTRATIONS AND NAVY UHF SATCOM.(U)
OCT 76 T D MENO, J E OHLSON
UNCLASSIFIED NPS-62OL76104 NL

2 OF 2
AD
A052 071



END
DATE
FILMED
5-78
DDC

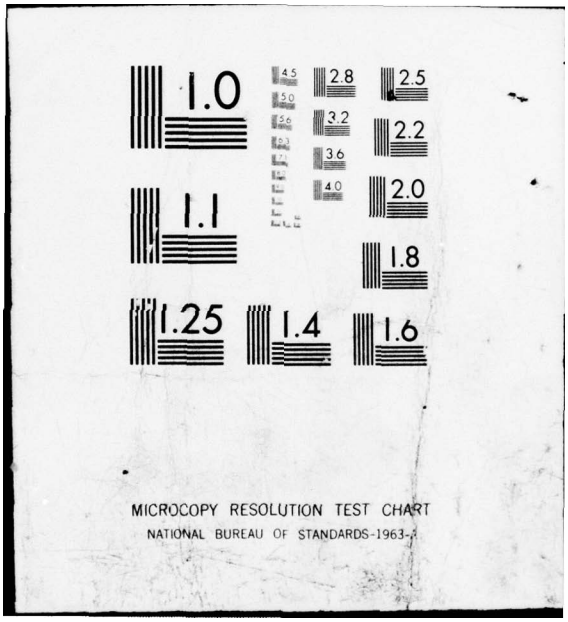

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 25

REGISTRATIONS PER 5 MHz INCREMENT
ACROSS THE 500-890 MHz BAND FOR THE EASTPAC
SATELLITE LOOK AREA

Band	Registrations
500-504.99	16
505-509.99	15
510-514.99	
515-519.99	14
520-524.99	10
525-529.99	9
530-534.99	13
535-539.99	12
540-544.99	
545-549.99	8
550-554.99	8
555-559.99	8
560-564.99	9
565-569.99	11
570-574.99	
575-579.99	6
580-584.99	7
585-589.99	9
590-594.99	9
595-599.99	7
600-604.99	2
605-609.99	8
610-614.99	9
615-619.99	4
620-624.99	6
625-629.99	8
630-634.99	
635-639.99	6
640-644.99	7
645-649.99	4
650-654.99	4
655-659.99	1
660-664.99	
665-669.99	4
670-674.99	3
675-679.99	2
680-684.99	4
685-689.99	4
690-694.99	1
695-699.99	1

TABLE 25 - Continued

Band	Registrations
700-704.99	2
705-709.99	4
710-714.99	4
715-719.99	1
720-724.99	
725-729.99	5
730-734.99	2
735-739.99	1
740-744.99	3
745-749.99	
750-754.99	
755-759.99	2
760-764.99	5
765-769.99	1
770-774.99	2
775-779.99	1
780-784.99	
785-789.99	
790-794.99	3
795-799.99	1
800-804.99	5
805-809.99	48
810-814.99	1
815-819.99	23
820-824.99	26
825-829.99	17
830-834.99	26
835-839.99	20
840-844.99	1
845-849.99	25
850-854.99	22
855-859.99	21
860-864.99	19
865-869.99	30
870-874.99	5
875-879.99	9
880-884.99	6
885-889.99	5
Total	595

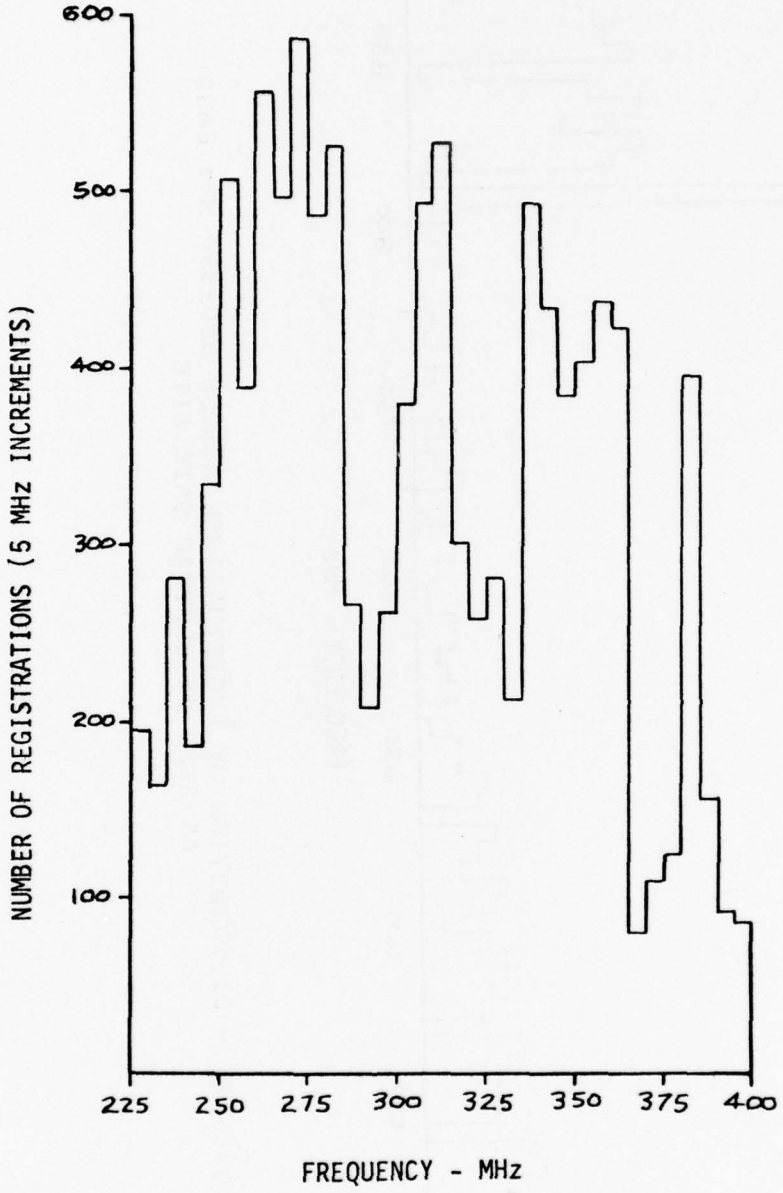


Figure 14 - DISTRIBUTION OF REGISTRATIONS ACROSS 225-400 MHz BAND AS SEEN BY EASTPAC SATELLITE

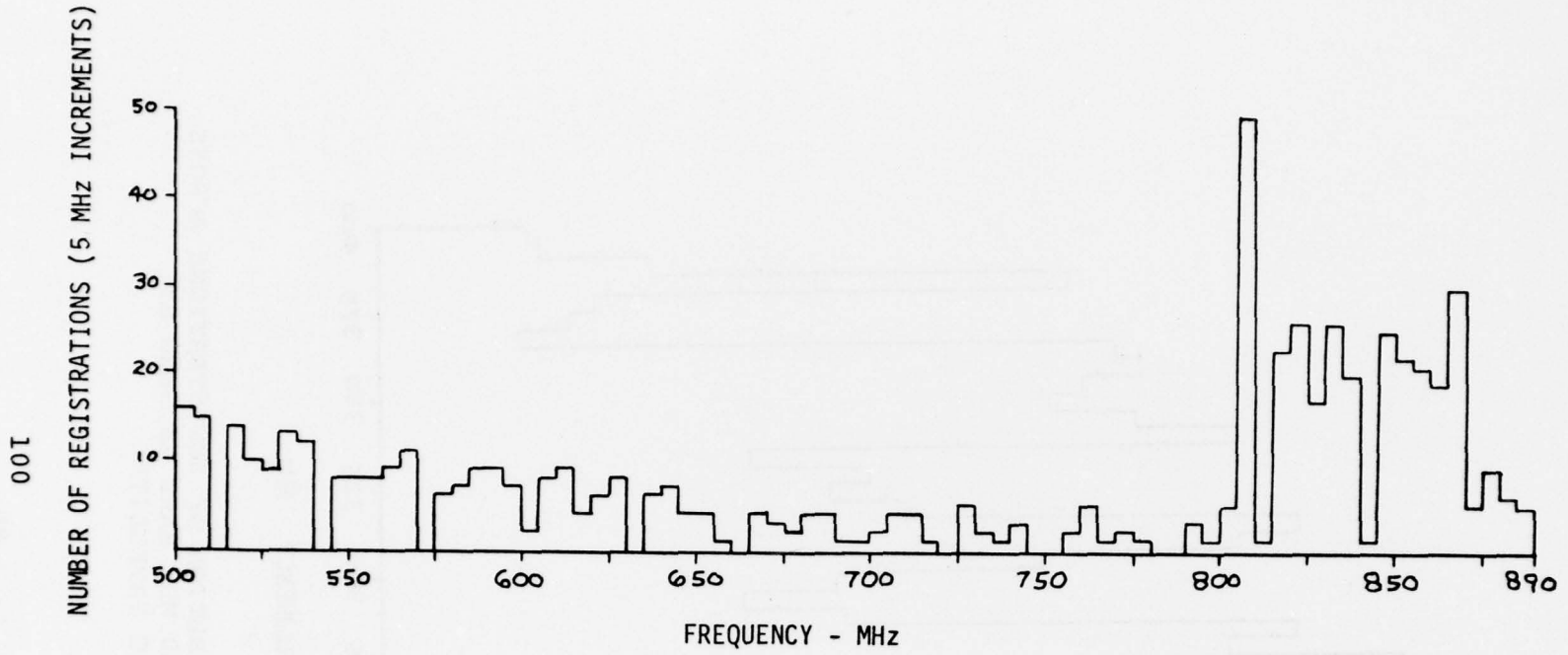


Figure 15 - DISTRIBUTION OF REGISTRATIONS ACROSS 500-890 MHz BAND
AS SEEN BY EASTPAC SATELLITE

These figures and tables represent potential levels of interference between terrestrial users and Navy SATCOM operations. Tables 14, 17, 20, and 23 are of particular interest because they identify specific countries and geographical areas where potential interference may originate based on 1975 IFL registrations.

A comparison of the number of registrations each FLTSATCOM satellite will probably see with its transmit and receive antennas indicates that the satellites located over the Atlantic and Indian Oceans will likely see approximately 59 percent more registered frequencies than satellites located over the Eastern and Western Pacific Ocean. Table 26 shows the average number of registrations per MHz across the 225-400 MHz band.

Should channel space in the 500-890 MHz band become available for Navy satellite communications system use at some future date, use of the new band could result in less potential interference because future satellites would likely see significantly fewer registrations.

For example, if it were possible for FLTSATCOM to operate in the 500-890 MHz band, based on 1975 registrations, its satellites would see the average number of registrations per MHz across the band indicated in Table 27. A comparison of Table 26 and Table 27 shows that all 500-890 MHz band indices are significantly less than those

TABLE 26

AVERAGE NUMBER OF REGISTRATIONS PER MHz
ACROSS THE 225-400 MHz BAND FOR FOUR
SATELLITE LOOK AREAS

Satellite	Bandwidth (MHz)	Number Of Registrations	Registrations Per MHz *
Atlantic	175	19,138	109.4
Indian Ocean	175	17,138	97.9
WESTPAC	175	11,299	64.6
EASTPAC	175	11,534	65.9

* NOTE: Registrations Per MHz was calculated by dividing the total number of registrations across the band by the bandwidth in MHz.

TABLE 27

AVERAGE NUMBER OF REGISTRATIONS PER MHz
ACROSS THE 500-890 MHz BAND FOR FOUR
SATELLITE LOOK AREAS

Satellite	Bandwidth (MHz)	Number Of Registrations	Registrations Per MHz *
Atlantic	390	10,765	27.6
Indian Ocean	390	10,495	26.9
WESTPAC	390	382	1.0
EASTPAC	390	595	1.5

* NOTE: Registrations Per MHz was calculated by dividing the total number of registrations across the band by the bandwidth in MHz.

for the 225-400 MHz band.

However, one should not jump to the conclusion that the United States Navy should shift to 500-890 MHz band use now. This could not be accomplished for two reasons: (1) current FLTSATCOM equipment is designed for 225-400 MHz band use only, and (2) the 500-890 MHz band is not currently allocated for Mobile Satellite service.

The use of the UHF spectrum by developing countries can be expected to increase in the future. Therefore, the indices calculated using the 1975 IFL are likely to increase as more and more frequencies are registered. The IFL needs to be analyzed on a continuing basis to detect changes in level of usage, users, power level, maximum hours of operation, and other parameters listed in its 13 columns.

V. CONCLUSION

In summary, this analysis of ITU registrations indicates that the potential for serious mutual interference exists between communications satellite systems and other communications systems. Interference from terrestrial assignments seems likely in view of the distribution of frequencies across the 225-400 and 500-890 MHz bands, and the large percentage of transmitters with a power level equal to or greater than the equipment which will be used with the Navy SATCOM system.

Registrations per MHz are much less in the 500-890 MHz band than in the 225-400 MHz band. Although this band is currently dedicated to Broadcast service, a change to current Radio Regulations permitting Mobile Satellite use would provide the United States Navy greater flexibility in frequency choice for future systems. However, it should be noted that current usage in the 500-890 MHz band is dominated by UHF television with powerful, broad band signals. Although there is a larger percentage of transmitters operating in the band which have power levels less than the current Navy communications satellite transmitters, there are also a larger percentage of transmitters with power levels 100 kW or greater (some in the multi-megawatt range).

In terms of both coverage area and area of potential interference the use of UHF spectrum for Mobile Satellite service poses a quite different problem from the traditional line-of-sight use on the surface of the earth. Radio Regulations currently give little priority to satellite systems in terms of allocations, rights, or registration. The Mobile Satellite service is a new service. It has only been in recent years that rapidly accelerating technology has permitted such service. Thus, in the general reallocation that can be expected in 1979 at the General World Administrative Radio Conference, the Navy, through the United States delegation to GWARC and the national CCIR committees should work to gain greater recognition for this new service in the future.

At the same time, there is a continued need for further refinement of communications satellite technology in the areas of narrower band channels and/or spread spectrum, a higher degree of frequency flexibility, and a minimum of fixed frequency relationships. For example, narrow beam, steerable antennas for both transmission and reception would reduce broad area coverage to Fleet Broadcast only.

Greater registration of frequencies by national administrations would permit better international frequency

management and planning. The Mobile Satellite service is an excellent example of how normally short range communications assets have been put to very long range use. Such use was probably not even considered at the 1959 GWARC. Radio Regulations needs to be adjusted accordingly.

APPENDIX A

COUNTRIES OF THE WORLD

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Afghanistan	AFG	Yes	3		
Albania	ALB	Yes	1		
Algeria	ALG	Yes	1	2	
Andorra	AND	No	1		
Angola	AGL	No	1		
Argentina	ARG	Yes	2	1402	
Australia	AUS	Yes	3	1689	6
Austria	AUT	Yes	1	3865	400
Bahamas	BAH	Yes	2	4	
Bahrain	BHR	Yes	1	14	
Bangladesh	BGD	Yes	3	89	2
Barbados	BRB	Yes	2		4
Belgium	BEL	Yes	1	88	13
Bhutan		No	3		
Bolivia	BOL	Yes	2		
Botswana	BOT	Yes	1		
Brazil	B	Yes	2	452	19
Britain (U.K.)	G	Yes	1	1316	822
* Bermuda	BER		2	2	
* Br.Indian Ocean Terr.	BIO		3	6	
* Gibraltar	GIB		1		2
* Hong Kong	HKG		3	1	1
* U.K. Terr. Region 1	GCA		1	1285	
* U.K. Terr. Region 3	GCC		3	325	

* Dependency of country under which listed. Not eligible for ITU membership.

	Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
	Bulgaria	BUL	Yes	1	6	
	Burma	BRM	Yes	3	2	
	Burundi	BDI	Yes	1		
	Cambodia (Khmer Rep.)	CBG	Yes	3		
	Cameroon	CME	Yes	1		2
	Canada	CAN	Yes	2	34	24
	Cape Verde	CPV	No	1	1	
	Central Africa	CAF	Yes	1		
	Chad	TCD	Yes	1	1	
	Chile	CHL	Yes	2		
*	China (People's Rep.)	CHN	Yes	3		
	Columbia	CLM	Yes	2	100	
	Comoros	COM	No	1	1	
	Congo	COG	Yes	1		
	Costa Rica	CTR	Yes	2	2	
	Cuba	CUB	Yes	2	13	2
	Cyprus	CYP	Yes	1		4
	Czechoslovakia	TCH	Yes	1	55	6
	Dahomey (Benin)	DAH	Yes	1		
	Denmark	DNK	Yes	1	249	107
	Dominican Republic	DOM	Yes	2		
	Equador	EQA	Yes	2		
	Egypt	EGY	Yes	1		
	El Salvador	SLV	Yes	2		
	Equitorial Guinea	GNE	Yes	1		
	Ethopia	ETH	Yes	1		

* The People's Republic of China has officially become a member of the ITU, and a condition of membership was that Taiwan no longer be a member (since the People's Republic claims Taiwan as a province). However, all CHN registrations in the 225-400 and 500-890 MHz bands are located in Taiwan and appear under Taiwan in this list.

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Fiji	FJI	Yes	3		
Finland	FNL	Yes	1	142	5
France	F	Yes	1	1827	1847
* Afars & Issas	AFI		1	1	
* French Polynesia	OCE		3	3	
* Guadeloupe	GDL		2	1	4
* Martinique	MRT		2	1	2
* New Caledonia	NCL		3	1	
* Reunion	REU		1	1	
* S.Pierre & Miquelon	SPM		2	1	
Gabon	GAB	Yes	1		
Gambia	GMB	Yes	1		
Germany, East	DDR	Yes	1	2	6
Germany, West	D	Yes	1	1715	5676
Ghana	GHA	Yes	1		
Greece	GRC	Yes	1	2	2
Grenada (Br.West Indies)	IOB	No	2	2	
Guatemala	GTM	Yes	2	2	
Guinea	GUI	Yes	1		
Guinea-Bissau	GNP	No	1		
Guyana	GUB	Yes	2	1	8
Haiti	HTI	Yes	2		
Honduras	HND	Yes	2	2	
Hungary	HNG	Yes	1		

* Dependency of country under which listed. Not eligible for ITU membership.

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Iceland	ISL	Yes	1	38	4
India	IND	Yes	3	638	22
Indonesia	INS	Yes	3	32	14
Iran	IRN	Yes	3	15	
Iraq	IRQ	Yes	1	7	
Ireland	IRL	Yes	1	18	
Israel	ISR	Yes	1		
Italy	I	Yes	1	10	625
Ivory Coast	CTI	Yes	1		
Jamaica	JMC	Yes	2	6	
Japan	J	Yes	3	144	51
* Ryukyu Islands	RYU		3	21	2
Jordan	JOR	Yes	1		
Kenya	KEN	Yes	1	2	
Korea, North	KRE	No	3		
Korea, South	KOR	Yes	3		
Kuwait	KWT	Yes	1		
Laos	LAO	Yes	3		
Lebanon	LBN	Yes	1		
Lesotho	LSO	Yes	1		
Liberia	LBR	Yes	1		
Libya	LBY	Yes	1	2	3
Liechtenstein	LIE	Yes	1		
Luxembourg	LUX	Yes	1	1	

* Dependency of country under which listed. Not eligible for ITU membership.

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Madagascar (Malagasy Republic)	MDG	Yes	1		
Malawi	MWI	Yes	1	1	
Malaysia	MLA	Yes	3	328	2
Maldives	MLD	Yes	3		
Mali	MLI	Yes	1		
Malta	MLT	Yes	1	2	1
Mauritania	MTN	Yes	1	1	
Mauritius	MAU	Yes	1		
Mexico	MEX	Yes	2	1311	
Monaco	MCO	Yes	1		
Mongolia	MNG	Yes	1		
Morocco	MRC	Yes	1	14	2
Mozambique	MOZ	No	1		
Nauru	NRU	Yes	3		
Nepal	NPL	Yes	3		
Netherlands	HOL	Yes	1	494	39
* Netherlands Antilles	ATN		2	2	
New Zealand	NZL	Yes	3	1860	7
Nicaragua	NCG	Yes	2	2	
Niger	NGR	Yes	1	1	
Nigeria	NIG	Yes	1	5	
Norway	NOR	Yes	1	1589	8
Oman	OMA	Yes	1		

* Dependency of country under which listed. Not eligible for ITU membership.

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Pakistan	PAK	Yes	3	226	3
Panama	PNR	Yes	2		
Papua New Guinea	PNG	Yes	3	10	
Paraguay	PRG	Yes	2		
Peru	PRU	Yes	2		
Philippines	PHL	Yes	3	41	
Poland	POL	Yes	1	44	10
Portugal	POR	Yes	1	2	2
* Azores	AZR		1	1	1
Qatar	QAT	Yes	1	3	
Rhodesia	RHS	No	1	3	
Romania	ROU	Yes	1		
Rwanda	RRW	Yes	1		
San Marino	SMR	No	1		
Sao Tome & Principe	STP	No	1		
Saudi.Arabia	ARS	Yes	1		
Senegal	SEN	Yes	1	1	
Seychelles	SEY	No	1	4	
Sierra Leone	SRL	Yes	1		
Singapore	SNG	Yes	3	2	2
Somalia	SOM	Yes	1		
South Africa	AFS	Yes	1	490	

* Dependency of country under which listed. Not eligible for ITU membership.

	Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
**	Soviet Union	URS	Yes	1	121	119
	Belorussia	BLR	Yes	1	25	12
	Ukraine	UKR	Yes	1	48	25
	Spain	E	Yes	1	23	10
*	Canary Islands	CNR		1	10	
	Sri Lanka (Ceylon)	CLN	Yes	3	8	
	Sudan	SDN	Yes	1	1	
	Surinam	SUR	No	2		
	Swaziland	SWZ	Yes	1		
	Sweden	S	Yes	1	178	263
	Switzerland	SUI	Yes	1	42	302
	Syria	SYR	Yes	1		
***	Taiwan		No	3	4	6
	Tanzania (Tanganyika)	TGK	Yes	1	2	3
	Thailand	THA	Yes	3	3	
	Togo	TGO	Yes	1	1	
	Tonga	TON	Yes	3		
	Trinidad-Tobago	TRD	Yes	2		
	Tunisia	TUN	Yes	1		
	Turkey	TUR	Yes	1	10	34

* Dependency of country under which listed. Not eligible for ITU membership.

** The Soviet Union (Union of Soviet Socialist Republics) includes 15 Soviet republics. Two of these republics have independent membership status in the ITU: Belorussia (Byelorussian SSR) or White Russia, and the Ukraine (Ukrainian SSR).

*** Taiwan is no longer an ITU member. Officially, the People's Republic of China has registration rights, but all stations are located in Taiwan. In the IFL, registrations are listed CHN (which is now the People's Republic (Red China)).

	Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
	Uganda	UGA	Yes	1	2	
	United Arab Emirates	UAE	Yes	1	2	
**	United States	USA	Yes	2	790	508
	Alaska	ALS		2	1968	
	Hawaii	HWA		2	981	8
*	Canal Zone	PNZ		2	36	4
*	Guam	GUM		3	982	
*	Midway	MWD		2	980	
*	Puerto Rico	PTR		2	980	4
	Upper Volta	HVO	Yes	1	1	
	Uruguay	URG	Yes	2	100	
	Vatican City	CVA	Yes	1	2	
	Venezuela	VEN	Yes	2		
	Vietnam, North		No	3		
	Vietnam, South	VTN	Yes	1		
	Western Samoa	SMO	No	3		
	Yemen	YEM	Yes	1		
	Yemen, Southern	YMS	Yes	1		
	Yugoslavia	YUG	Yes	1	120	30

* Dependency of country under which listed. Not eligible for ITU membership.

** The United States includes 50 states. The 48 contiguous states are listed under USA. Alaska (ALS) and Hawaii (HWI) are listed separately in the ITU's International Frequency List. The United States has only one membership in the ITU.

Country	ITU Symbol	ITU Member	ITU Region	225-400 MHz Registrations	500-890 MHz Registrations
Zaire	ZAI	Yes	1		2
Zambia	ZMB	Yes	1	3	
Special Usage Worldwide					
* Lifesaving	AAA		1,2,3	3	
* Space Research, Sweden	EHB		1,2,3	6	
* Space Research, USA	EHR		1,2,3	15	
* Space Station Radio Navigation, USA	ENA		1,2,3	9	
			Totals	29540	**11092**

* The number of registrations shown accounts for one registration in each region However, it should be noted that it is the same frequency registered three times.

APPENDIX B

ITU SYMBOL TRANSLATION TABLE

This appendix lists the 185 ITU symbols which appear in this paper. Listing is alphabetic by symbol. ITU symbols have geographical or usage significance. Table 1 of the Preface to the International Frequency List contains symbols for 269 countries, geographical areas, and special worldwide uses. These symbols provide meaning to Column 4b (Country, area, or special use identifier of transmitting station) as well as Column 5a (Locality or area with which communication is established) of the International Frequency List.

Symbol	Country/Area
AAA	Shared throughout the world
AFG	Afganistan
AFI	French Territory of Afars and Issas
AFS	South Africa
AGH	Angola
ALB	Albania
ALG	Algeria
ALS	State of Alaska, USA
AND	Andorra
ARG	Argentina
ARS	Saudi Arabia
ATN	Netherlands Antilles
AUS	Australia
AUT	Austria
AZR	Azores
B	Brazil
BAH	Bahamas
BDI	Burundi
BEL	Belgium
BER	Bermuda
BGD	Bangladesh
BHR	Bahrain
BIO	British Indian Ocean Territory
BLR	Byelorussian Soviet Socialist Republic (White Russia), also Belorussia
BOL	Bolivia
BOT	Botswana
BRB	Barbados
BRM	Burma
BRU	Brunei
BUL	Bulgaria
CAF	Central African Republic
CAN	Canada
CBG	Khmer Republic (Cambodia)
CHL	Chile
CHN	China (People's Republic)
CLM	Columbia
CLN	Sri Lanka (Ceylon)
CME	Cameroon
CNR	Canary Islands
COG	Congo
COM	Comoros
CPV	Cape Verde Islands
CTI	Ivory Coast
CTR	Costa Rica
CUB	Cuba
CVA	Vatican City State
CYP	Cyprus
D	Germany, West (Federal Republic)
DAH	Benin (Dahomey)
DDR	Germany, East (Democratic Republic)
DNK	Denmark
DOM	Dominican Republic
E	Spain

Symbol	Country/Area	Symbol	Country/Area
EHB	Space Research, Sweden	ISL	Iceland
EHR	Space Research, USA	ISR	Israel
ENA	Radionavigation-Satellite Space Station, USA	J	Japan
		JMC	Jamaica
		JOR	Jordan
		KEN	Kenya
		KOR	Korea, South
EQA	Equador	KRE	Korea, North
ETH	Ethopia	KWT	Kuwait
F	France	LAO	Laos
FJI	Fiji	LBN	Lebanon
FNL	Finland	LBR	Liberia
G	Britain (U.K.)	LBY	Libya
GAB	Gabon	LIE	Liechtenstein
GCA	U.K. Territories, Region 1	LSO	Lesotho
		LUX	Luxembourg
GCC	U.K. Territories, Region 3	MAU	Mauritius
		MDG	Malagasy Republic (Madagascar)
GDL	Guadeloupe		
GHA	Ghana	MDW	Midway Islands
GIB	Gibraltar	MEX	Mexico
GMB	Gambia	MLA	Malaysia
GNE	Equitorial Guinea	MLD	Maldives
GNP	Guinea-Bissau	MLI	Mali
GRC	Greece	MLT	Malta
GTM	Guatemala	MNG	Mongolia
GUB	Guyana	MOZ	Mozambique
GUI	Guinea	MRC	Morocco
GUM	Guam	MRT	Martinique
HKG	Hong Kong	MTN	Mauritania
HND	Honduras	MWI	Malawi
HNG	Hungary	NCG	Nicaragua
HOL	Netherlands	NCL	New Caledonia
HTI	Haiti	NGR	Niger
HVO	Upper Volta	NIG	Nigeria
HWA	State of Hawaii, USA	NOR	Norway
		NPL	Nepal
I	Italy	NRU	Nauru
IND	India	NZL	New Zealand
INS	Indonesia	OCE	French Polynesia
IOB	British West Indies	OMA	Oman
IRL	Ireland	PAK	Pakistan
IRN	Iran	PHL	Philippines
IRQ	Iraq	PNG	Papua New Guinea

Symbol	Country/Area
PNR	Panama
PNZ	Canal Zone
POL	Poland
POR	Portugal
PRG	Paraguay
PRU	Peru
PTR	Puerto Rico
QAT	Qatar
REU	Reunion
RHS	Rhodesia
ROU	Roumania
RRW	Rwanda
RYU	Ryukyu Islands
S	Sweden
SDN	Sudan
SEN	Senegal
SEY	Seychelles
SLV	El Salvador
SMO	Western Samoa
SMR	San Marino
SNG	Singapore
SOM	Somalia
SPM	S.Pierre and Miquelon
SRL	Sierra Leone
STP	Sao Tome and Principe
SUI	Switzerland
SUR	Surinam
SWZ	Swaziland
SYR	Syria
TCD	Chad
TCH	Czechoslovakia
TGK	Tanzania (Tanganyika)
TGO	Togo
THA	Thailand
TON	Tonga
TRD	Trinidad and Tobago
TUN	Tunisia
TUR	Turkey
UAE	United Arab Emirates
UGA	Uganda
UKR	Ukrainian Soviet Socialist Republic (Ukraine)
URG	Uruguay
URS	Union of Soviet Socialist Republics (Soviet Union or USSR)
USA	United States (the 48 contiguous states, excluding Alaska and Hawaii)
VEN	Venezuela
VTN	Vietnam (Vietnam, South)
YEM	Yemen
YMS	Yemen, Southern
YUG	Yugoslavia
ZAI	Zaire
ZAN	Tanzania (Zanzibar)
ZMB	Zambia

APPENDIX C

REGISTRATION ACROSS THE 225-400 MHz BAND

Symbol	Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
Registrations over 1000								
ALS	* Alaska		13	28		8	97	56
ARG	Argentina	60	28	95	34	61	37	20
AUS	* Australia	50	50	50	50	50	50	50
AUT	Austria	26		79	200	200	200	200
D	* Germany, West	132	4	53	50	51	55	55
F	* France	51	56	58	49	56	60	74
G	* Britain (U.K.)	4	5	34	27	13	39	39
GCA	* U.K. Terr. Region 1			33	27	13	39	39
MEX	Mexico	38	8	16	68	177	107	130
NOR	* Norway	6	5	39	49	50	50	50
NZL	* New Zealand	56	56	55	55	55	55	55
Registrations of 100-999								
AFS	* South Africa			16	11	9	16	19
B	Brazil	3	4	2	2	3	5	
CLM	Columbia			5	4	5	14	6
DNK	* Denmark	2	5	6	5	9	5	14
FNL	* Finland				1		1	
GCC	* U.K. Terr. Region 3			11	6	4	11	14

(List continues on page 124)

* Areas which have registered all or most of the even 100 kHz intervals across the band.

Symbol	260-264.99	265-269.99	270-274.99	275-279.99	280-284.99	285-289.99	290-294.99	295-299.99	300-304.99	305-309.99
Registrations over 1000										
ALS	64	96	124	96	108	44	24	20	96	116
ARG	170	83	112	102	109	13	1	92	26	74
AUS	50	50	50	50	50	50	50	50	50	50
AUT	200	80	79	200	200	200				
D	53	50	50	55	56	54	50	50	50	50
F	50	52	50	51	56	52	52	51	52	52
G	37	39	39	36	36	41	41	44	47	47
GCA	37	39	39	36	36	41	41	44	47	47
MEX	114	25				2	3	2		
NOR	50	50	50	49	50	50	50	50	50	49
NZL	55	55	55	55	55	55	55	55	55	55
Registrations of 100-999										
AFS	17	20	20	16	16	21	19	21	19	18
B	2	3	46	43	40	45	38	14	16	27
CLM	9	6	9	8	9	4	6	6	1	
DNK	8	9	6	9	14	11	9	7	9	7
FNL		1		1			1			
GCC	12	15	15	11	11	16	14	16	14	13

Symbol	310-314.99	315-319.99	320-324.99	325-329.99	330-334.99	335-339.99	340-344.99	345-349.99	350-354.99	355-359.99
Registrations over 1000										
ALS	153	56	52	60	2	71	68	72	84	92
ARG		24	1	25	5	111	51	24	27	
AUS	50	50	50	39	5	46	50	50	50	50
AUT					4	1			200	200
D	50	50	50	38	22	46	50	50	50	50
F	54	53	57	44	16	49	56	54	50	50
G	48	49	48	35	16	43	47	47	46	45
GCA	48	49	48	32		42	47	47	46	45
MEX						45	130	90	80	116
NOR	50	50	51	36	4	52	50	50	50	50
NZL	55	55	55	45	1	54	55	55	55	55
Registrations of 100-999										
AFS	19	17	12	9	5	13	11	12	12	14
B	31	50	36	19		1		2		
CLM					1					
DNK	4	8	7	7	9	15	6	1	8	4
FNL			1		13	5	10	10	10	9
GCC	14	12	7	4		8	6	7	7	9

360-364.99	365-369.99	370-374.99	375-379.99	380-384.99	385-389.99	390-394.99	395-399.99	Total Registrations 225-400 MHz Band	Symbol
								Registrations over 1000	
104	4	8	12	116	24			1968	ALS
3		3	2	1	8			1402	ARG
50	50	50	50	50	50	50	49	1689	AUS
200	200	200	200	200	200	200	196	3865	AUT
40		50	50	50	52	50	49	1715	D
52	56	55	54	53	50	51	51	1827	F
47	45	41	39	33	38	35	46	1316	G
47	45	41	39	33	38	35	45	1285	GCA
57	5	18	20	10	14	22	14	1311	MEX
50	50	50	50	50	50	50	49	1589	NOR
55	55	55	55	55	55	55	53	1860	NZL
								Registrations of 100-999	
14	13	13	15	13	13	13	14	490	AFS
1	2	1	5	1	4	2	4	452	B
					1	3	3	100	CLM
10	8	5	7	2	5	4	4	249	DNK
10	10	10	10	10	10	10	9	142	FNL
9	8	8	10	8	8	8	9	325	GCC

REGISTRATION ACROSS THE 225-400 MHz BAND - Continued

Symbol		Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
GUM	*	Guam		8	14		4	48	28
HOL	*	Netherlands	10	7	17	19	16	24	15
HWA	*	Hawaii		6	14		4	48	28
IND		India	1		30	30	1		
J		Japan		3	3	5	2	40	7
MWD	*	Midway		6	14		4	48	28
MLA		Malaysia	1		11	6	4	11	14
PAK		Pakistan	2		9	7	11	4	1
PTR	*	Puerto Rico		6	14		4	48	28
S		Sweden	2	1	1	1			18
URG		Uruguay	30	28					
URS		Soviet Union	7		10	5	1	2	2
USA		United States	2	5	9		4	25	16
YUG		Yugoslavia			1	2	1	2	2

Registrations of 10-99

BEL		Belgium	3	3	2	4		4	7
BGD		Bangladesh	1		9	7	11	4	1
BHR		Bahrain							

(List continues on page 128)

* across the band.

Symbol	260-264.99	265-269.99	270-274.99	275-279.99	280-284.99	285-289.99	290-294.99	295-299.99	300-304.99	305-309.99
GUM	32	48	62	48	54	22	12	10	48	58
HOL	16	14	16	21	17	16	13	17	9	13
HWA	32	48	62	48	54	22	12	10	48	58
IND	29	30		321	177			1		
J	2	5	4	2		2			5	6
MWD	32	48	62	48	54	22	12	10	48	58
MLA	12	15	15	11	11	16	14	16	14	13
PAK	5	1	2							
PTR	32	48	62	48	54	22	12	10	48	58
S		1	10		18					
URG		40								
URS	13						22	19		
USA	19	24	33	26	29	13	6	5	24	31
YUG	1	2	2	1	2	2	1	2	2	1
Registrations of 10-99										
BEL		3			3	4	4	2	6	2
BGD	5	1	2							
BHR			1	1	2				1	

Symbol	310-314.99	315-319.99	320-324.99	325-329.99	330-334.99	335-339.99	340-344.99	345-349.99	350-354.99	355-359.99
GUM	76	28	26	30		34	34	36	42	46
HOL	14	12	16	9	5	14	13	12	15	14
HWA	76	28	26	30	1	34	34	36	42	46
IND				1	2	15				
J	1	2			1	2		2		2
MWD	76	28	26	30		34	34	36	42	46
MLA	14	12	7	4	2	8	6	7	7	9
PAK	33	20		21	57	7		8	8	16
PTR	76	32	26	30		34	34	36	42	46
S		18			12	7				
URG							1			
URS			16	13		1	3			
USA	42	14	13	21	186	84	19	18	23	25
YUG	2	2	1	1			6	6	10	6

Registrations of 10-99

BEL	4	7		1	3	5	4	6		
BGD	12	2		4	18	2		2	1	4
BHR			1	1		1		2	2	2

360-364.99	365-369.99	370-374.99	375-379.99	380-384.99	385-389.99	390-394.99	395-399.99	Total Registrations 225-400 MHz Band	Symbol
52	2	4	6	58	12			982	GUM
16	9	11	16	18	12	11	17	494	HOL
52	2	4	6	58	12			981	HWA
								638	IND
	11	8	7	6	4	9	3	144	J
52	2	4	6	58	12			980	MWD
9	8	8	10	8	8	8	9	328	MLA
10	4							226	PAK
52	2	4	2	58	12			980	PTR
41	5	3	25	5		5	5	178	S
1								100	URG
		2	5					121	URS
31	1	2	3	31	6			790	USA
6	6	9	8	7	8	10	8	120	YUG
								Registrations of 10-99	
8				2			1	88	BEL
2	1							89	BGD
								14	BHR

REGISTRATION ACROSS THE 225-400 MHz BAND - Continued

Symbol	Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
BLR	Byelorussia		2	2		1	1	1
CAN	Canada		1	2	3	3	1	1
CNR	Canary Islands							2
CUB	Cuba		3				3	
E	Spain							1
I	Italy	3	1			1		
INS	Indonesia		2	1	1	2		1
IRL	Ireland				8			
IRN	Iran	8	4		1			1
ISL	Iceland				4		3	2
MRC	Morocco						2	4
PHL	Philippines			3	1		2	2
PNG	Papua New Guinea							
PNZ	Canal Zone			1	2			1
POL	Poland	13						
RYU	Ryukyu Islands			4	2			
SUI	Switzerland	42						
TCH	Czechoslovakia	54						
TUR	Turkey							
UKR	Ukraine	2	1	2	1	2		1

Registrations of less than 10

AAA	Shared worldwide				1			
AFI	Afars & Issas							
ALG	Algeria	2						

(List continues on page 132)

Symbol	260-264.99	265-269.99	270-274.99	275-279.99	280-284.99	285-289.99	290-294.99	295-299.99	300-304.99	305-309.99
BLR	2						7	2		
CAN		1				1	2	1		
CNR						2				2
CUB				1						
E						4				2
I			1		1				1	
INS	4	2				3		2	1	
IRL					1					
IRN										
ISL		1	4		3	1	1	1		2
MRC			2	2		2				
PHL	2			2						
PNG										
PNZ	2	4	2	1		2		3	2	3
POL										
RYU	2		2	1	1			1		1
SUI										
TCH										
TUR		4				4				
UKR	5						8	7		

Registrations of less than 10

AAA
AFI
ALG

Symbol	310-314.99	315-319.99	320-324.99	325-329.99	330-334.99	335-339.99	340-344.99	345-349.99	350-354.99	355-359.99
BLR			3	2				1		
CAN				2	12	4				
CNR					1	3				
CUB	3					3				
E					9	5				
I			1							
INS		1		2			1	2		
IRL					2	1				
IRN										
ISL	1	1		2		1	1	3	1	2
MRC	2									
PHL				2		2				
PNG					8	2				
PNZ	2	2	2			1		6		
POL				1		18	11			
RYU		1		3		1				1
SUI										
TCH						1				
TUR						2				
UKR			9	6			2	1		

Registrations of less than 10

AAA	
AFI	1
ALG	

Symbol	Total Registrations 225-400 MHz Band	395-399.99	390-394.99	385-389.99	380-384.99	375-379.99	370-374.99	365-369.99	360-364.99
BLR	25			1					
CAN	34								
CNR	10								
CUB	13								
E	23				2				
I	10						1		
INS	32		1		5		1		
IRL	18	1	1		1		1	1	1
IRN	15								1
ISL	38		2						2
MRC	14								
PHL	41			6	6	1		9	3
PNG	10								
PNZ	36								
POL	44	1							
RYU	21			1					
SUI	42								
TCH	55								
TUR	10								
UKR	48		1						

Registrations of less than 10

AAA	1
AFI	1
ALG	2

REGISTRATION ACROSS THE 225-400 MHz BAND - Continued

Symbol	Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
ATN	Netherlands Antilles							
AZR	Azores							
BAH	Bahamas			1	1		1	1
BER	Bermuda							
BIO	Br. Indian Ocean Terr.							
BRM	Burma	1	1					
BUL	Bulgaria	6						
CHN	China (Taiwan)	1		1	1			
CLN	Sri Lanka (Ceylon)			1		1	2	
COM	Comoros							
CPV	Cape Verde							
CTR	Costa Rica				1		1	
CVA	Vatican City					1	1	
DDR	Germany, East							
EHB	Space Research, Sweden							
EHR	Space Research, USA							
ENA	Space Station Radio							
ETH	Ethopia		1				1	
GDL	Guadeloupe							
GRC	Greece							
GTM	Guatemala			1			1	
GUB	Guyana							
HKG	Hong Kong							
HND	Honduras				1		1	
HVO	Upper Volta							

(List continues on page 136)

Symbol	305-309.99	300-304.99	295-299.99	290-294.99	285-289.99	280-284.99	275-279.99	270-274.99	265-269.99	260-264.99
ATN										
AZR										
BAH										
BER					1					
BIO										1
BRM										
BUL										
CHN										
CLN	1			1					1	1
COM										
CPV										
CTR										
CVA										
DDR									1	
EHB								1		
EHR										
ENA										
ETH										1
GDL										
GRC										
GTM										
GUB										
HKG										
HND										
HVO										

Symbol	355-359.99	350-354.99	345-349.99	340-344.99	335-339.99	330-334.99	325-329.99	320-324.99	315-319.99	310-314.99
ATN										
AZR					1					
BAH										
BER		1								
BIO	2						2			
BRM										
BUL										
CHN					1					
CLN						1				
COM										
CPV						1				
CTR										
CVA					1					
DDR										
EHB										
EHR	1									
ENA										
ETH									1	
GDL					1					
GRC										
GTM										
GUB					1					
HKG						1				
HND										
HVO						1				

Symbol	Total Registrations 225-400 MHz Band	395-399.99	390-394.99	385-389.99	380-384.99	375-379.99	370-374.99	365-369.99	360-364.99
ATN	2		1						
AZR	1								
BAH	4								
BER	2								
BIO	6			1					
BRM	2								
BUL	6								1
CHN	4								
CLN	8								
COM	1								
CPV	1								
CTR	2								
CVA	2								
DDR	2								
EHB	2								
EHR	5	3							4
ENA	3								
ETH	4								
GDL	1								
GRC	2	2							
GTM	2								
GUB	1								
HKG	1								
HND	2								
HVO	1								

REGISTRATION ACROSS THE 225-400 MHz BAND - Continued

Symbol	Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
IOB	Grenada (Br. West Indies)		1	1				
IRQ	Iraq		1	3		3		
JMC	Jamica			1	1			1
KEN	Kenya		1					
LBY	Libya	2						
LUX	Luxembourg							
MLT	Malta							
MRT	Martinique							
MTN	Mauritania							
MWI	Malawi	1						
NCG	Nicaragua					1	1	
NCL	New Caledonia							
NGR	Niger							
NIG	Nigeria	3	2					
OCE	French Polynesia							
POR	Portugal							
QAT	Qatar			1		1		
REU	Reunion							
RHS	Rhodesia	2	1					
SDN	Sudan		1					
SEN	Senegal							
SEY	Seychelles							
SNG	Singapore		1					
SPM	S. Pierre & Miquelon							
TCD	Chad							
TGK	Tanzania (Tanganyika)		1					

(List continues on page 140)

Symbol	IOB	IRQ	JMC	KEN	LBY	LUX	MLT	MRT	MTN	MWI	NCG	NCL	NGR	NIG	OCE	POR	QAT	REU	RHS	SDN	SEN	SEY	SNG	SPM	TCD	TGK
305-309.99																										
300-304.99			1				1																			
295-299.99																										
290-294.99																										
285-289.99			1																							
280-284.99																										
275-279.99																										
270-274.99																										
265-269.99																										
260-264.99			1																							

Symbol	355-359.99	350-354.99	345-349.99	340-344.99	335-339.99	330-334.99	325-329.99	320-324.99	315-319.99	310-314.99
IOB										
IRQ										
JMC										
KEN					1					
LBY										
LUX					1					
MLT			1							
MRT						1				
MTN					1					
MWI										
NCG										
NCL						1				
NGR						1				
NIG										
OCE					1	2				
POR						2				
QAT	1									
REU					1					
RHS										
SDN										
SEN					1					
SEY	1		1	1		1				
SNG										
SPM					1					
TCD						1				
TGK					1					

Total Registrations 225-400 MHz Band	Symbol	395-399.99	390-394.99	385-389.99	380-384.99	375-379.99	370-374.99	365-369.99	360-364.99
2	IOB								
7	IRQ								
6	JMC								
2	KEN								
2	LBY								
1	LUX								
2	MLT								
1	MRT								
1	MTN								
1	MWI								
2	NCG								
1	NCL								
1	NGR								
5	NIG								
3	OCE								
2	POR								
3	QAT								
1	REU								
3	RHS								
1	SDN								
1	SEN								
4	SEY							1	
2	SNG								
1	SPM								
1	TCD								
2	TGK								

REGISTRATION ACROSS THE 225-400 MHz BAND - Continued

Symbol	Country/Area	225-229.99	230-234.99	235-239.99	240-244.99	245-249.99	250-254.99	255-259.99
TGO	Togo							
THA	Thailand							
UAE	United Arab Emirates							
UGA	Uganda		1					
VTN	Vietnam, South							
ZMB	Zambia	2	1					

305-309.99					1	
300-304.99					2	
295-299.99				1		
290-294.99						
285-289.99						
280-284.99			1			
275-279.99						
270-274.99						
265-269.99						
260-264.99						
Symbol	TGO	THA	UAE	UGA	VTN	ZMB

355-359.99						
350-354.99						
345-349.99						
340-344.99						
335-339.99				1		
330-334.99		1	1			
325-329.99						
320-324.99						
315-319.99						
310-314.99						

Symbol	TGO	THA	UAE	UGA	VTN	ZMB

Total Registrations 225-400 MHz Band	Symbol
	TGO
1	THA
3	UAE
2	UGA
2	VTN
1	ZMB
3	

395-
399.99

390-
394.99

385-
389.99

380-
384.99

375-
379.99

370-
374.99

365-
369.99

360-
364.99

APPENDIX D

REGISTRATION ACROSS THE 500-890 MHz BAND

Symbol	Country/Area	500-504.99	505-509.99	510-514.99	515-519.99	520-524.99	525-529.99	530-534.99
Registrations over 1000								
D	Germany, West	181	91	117	185	68	75	75
F	France	40	22	12	30		32	14
Registrations of 100-999								
AUT	Austria	17	6	2	7	5	6	6
DNK	Denmark							
G	Britain (U.K.)	43	19	16	39		43	20
I	Italy	58	24	24	53	29	25	25
S	Sweden	12	5	10	19	9	6	6
SUI	Switzerland	6	4	3	5	2	1	1
URS	Soviet Union		1	4	4	2		
USA	United States	15	14		13	7	9	13
Registrations of 10-99								
B	Brazil							
BEL	Belgium							
BLR	Byelorussia			2		1		
CAN	Canada	1			1	2		
E	Spain							

(List continues on page 152)

Symbol	535-539.99	540-544.99	545-549.99	550-554.99	555-559.99	560-564.99	565-569.99	570-574.99	575-579.99	580-584.99	585-589.99
Registrations over 1000											
D	68	151	83	84	171	87	80	80	59	103	45
F	21	73	52	38	68		55	25	35	48	14
Registrations of 100-999											
AUT	2	7	5		10	10	8	8	2	2	
DNK				1	1						
G	1	2	1	11	11		16	16	1	3	2
I	20	60	40	26	44	18	24	24	21	30	9
S	5	8	3	5	11	6	5	5	6	8	2
SUI	4	9	5	5	6	1	2	2	5	6	1
URS									4	3	2
USA	11		8	8	8	8	10		6	7	8
Registrations of 10-99											
B											
BEL										1	1
BLR										2	
CAN	1					1					
E											

Symbol	590-594.99	595-599.99	600-604.99	605-609.99	610-614.99	615-619.99	620-624.99	625-629.99	630-634.99	635-639.99	640-644.99
Registrations over 1000											
D		36	36	1	1	97	184	87	91	172	81
F	9	23	1	16	1	51	93	42	43	58	
Registrations of 100-999											
AUT		4	4			15	18	3	13	21	8
DNK	1	3									
G	10	8	9		4	11	25	14	12	14	
I	1	16	15			1		1	1	2	
S	2	7	5			3	4	1	5	8	3
SUI		8	8			4	7	3	7	18	11
URS	3	3			2	6	11				
USA	7	6		7	7	4	6	8		6	7
Registrations of 10-99											
B											
BEL	1	1			1						
BLR											
CAN					1						
E											

Symbol	645-649.99	650-654.99	655-659.99	660-664.99	665-669.99	670-674.99	675-679.99	680-684.99	685-689.99	690-694.99	695-699.99
Registrations over 1000											
D	104	104	74	170	96	104	218	114	79	79	78
F	37	22	23	40	17	11	22		66	55	44
Registrations of 100-999											
AUT	11	11	4	10	6	4	12	8	5	5	1
DNK											
G	18	16	13	28	15	13	14		2	1	12
I		6	1			1					
S	5	5	1	6	5	3	7	4	2	2	3
SUI	5	5	8	17	9	5	8	3	5	5	1
URS			7		4	2			2	2	
USA	4	4	1		4	3	2	4	4		1
Registrations of 10-99											
B											
BEL		1		1							1
BLR		1	3								
CAN											
E											

Symbol	700-704.99	705-709.99	710-714.99	715-719.99	720-724.99	725-729.99	730-734.99	735-739.99	740-744.99	745-749.99	750-754.99
Registrations over 1000											
D	151	73	106	182	76	60	60	66	123	57	54
F	77	33	19	39		31	11	10	25	15	11
Registrations of 100-999											
AUT	6	5	12	14	2	1	1	4	8	4	2
DNK											
G	13	1	12	15		3			14	14	2
I											
S	5	2	4	7	3	2	2	1	3	2	4
SUI	4	3	6	8	2	6	6	5	8	3	5
URS	3		3	4							
USA	2	4	4			4	2	1	1		
Registrations of 10-99											
B											
BEL	1			1	1						
BLR			2								
CAN				1					1		
E											

Symbol	755-759.99	760-764.99	765-769.99	770-774.99	775-779.99	780-784.99	785-789.99	790-794.99	795-799.99	800-804.99	805-809.99
Registrations over 1000											
D	123	83	90	90	77	136	59	9	10	10	10
F	38		79	40	32	48	16	7	16		14
Registrations of 100-999											
AUT	32	4	5	5	6	13	7		1	1	
DNK								5	5	5	5
G	20		31	13	13	30	17	13	28		33
I									2		1
S	5	1	1	1	4	4					
SUI	14	9				7	7	1	1		1
URS						2	6			6	8
USA	1	5		2				1	1	2	46
Registrations of 10-99											
B											
BEL	1	1									
BLR		1									
CAN	1		1		1			1		1	
E					1	2		1			

Symbol	810-814.99	815-819.99	820-824.99	825-829.99	830-834.99	835-839.99	840-844.99	845-849.99	850-854.99	855-859.99	860-864.99
Registrations over 1000											
D	10	10	10	10	10	10	10	10	10	10	11
F	5	4	7	3		1		2	1		
Registrations of 100-999											
AUT									1		
DNK	5	5	5	5	5	5	5	5	5	5	5
G	18	13	13		4	5		2	2	2	2
I					1		3	2		2	3
S											
SUI	1										
URS		2					8	6	7	2	
USA		23	24	17	23	18		23	17	17	12
Registrations of 10-99											
B											3
BEL											
BLR											
CAN			1						2	1	2
E									1		2

865-869.99	870-874.99	875-879.99	880-884.99	885-889.99	Total Registrations 500-890 MHz Band	Symbol
					Registrations over 1000	
10	10	11	10	10	5676	D
3	2	1	3	1	1847	F
					Registrations of 100-999	
					400	AUT
5	6	5	5	5	107	DNK
2	2		2		822	G
3	3	3		3	625	I
					263	S
					302	SUI
					119	URS
23		2	2	1	508	USA
					Registrations of 10-99	
5	3	3	3	2	19	B
					13	BEL
					12	BLR
		1	1	2	24	CAN
	1		2		10	E

REGISTRATION ACROSS THE 500-890 MHz BAND - Continued

Symbol	Country/Area	500-504.99	505-509.99	510-514.99	515-519.99	520-524.99	525-529.99	530-534.99
HOL	Netherlands				1	1		5
IND	India							
INS	Indonesia							
J	Japan	1	1					
POL	Poland			4				
TUR	Turkey				1	1	1	1
UKR	Ukraine							
YUG	Yugoslavia							

Registrations of less than 10

AUS	Australia							
AZR	Azores							
BGD	Bangladesh							
BRB	Barbados							
CHN	China (Taiwan)							
CME	Cameroon							
CUB	Cuba							
CYP	Cyprus							
DDR	Germany, East				1	1		
FNL	Finland	1						
GDL	Guadeloupe							
GIB	Gibralter							
GRC	Greece							
GUB	Guyana							

(List continues on page 160)

Symbol	535-539.99	540-544.99	545-549.99	550-554.99	555-559.99	560-564.99	565-569.99	570-574.99	575-579.99	580-584.99	585-589.99
HOL	1	1		1	2	1	2	2			
IND											
INS									2	1	2
J					1	2					
POL		1	1		1		2	1			
TUR										4	
UKR				1	1						
YUG											

Registrations of less than 10

AUS											
AZR											
BGD	1			1							
BRB											
CHN											
CME											
CUB										1	1
CYP				2	2						
DDR							1	1			
FNL											
GDL											
GIB											
GRC											
GUB											

Symbol	590-594.99	595-599.99	600-604.99	605-609.99	610-614.99	615-619.99	620-624.99	625-629.99	630-634.99	635-639.99	640-644.99
HOL					2	1	1				
IND					1						
INS							1			1	
J	3	6		8	3	8	8	1		1	
POL							1	1			
TUR											
UKR	2										
YUG						1	2	1	1	1	
Registrations of less than 10											
AUS					1						
AZR											
BGD											
BRB											
CHN											
CME											
CUB											
CYP				1	1						
DDR											
FNL							1	1			
GDL											
GIB											
GRC											
GUB											

Symbol	645-649.99	650-654.99	655-659.99	660-664.99	665-669.99	670-674.99	675-679.99	680-684.99	685-689.99	690-694.99	695-699.99
HOL				1	1		1	1			2
IND		5									
INS		1			1			1			1
J	1					3		1			
POL									1	3	
TUR		6	5								
UKR		1	1	2	1				1	1	
YUG	1										

Registrations of less than 10

AUS
AZR
BGD
BRB
CHN
CME
CUB
CYP
DDR
FNL
GDL
GIB
GRC
GUB

Symbol	700-704.99	705-709.99	710-714.99	715-719.99	720-724.99	725-729.99	730-734.99	735-739.99	740-744.99	745-749.99	750-754.99
HOL	3	1	1	1							1
IND						2	2	2	2		
INS			1			1			5		
J									1		
POL			1	2	1						
TUR			3						2	2	1
UKR											
YUG											

Registrations of less than 10

AUS 2
AZR
BGD
BRB
CHN
CME
CUB 1
CYP
DDR
FNL
GDL
GIB
GRC
GUB

Symbol	755-759.99	760-764.99	765-769.99	770-774.99	775-779.99	780-784.99	785-789.99	790-794.99	795-799.99	800-804.99	805-809.99
HOL	1										
IND											
INS	1			1			1				
J											
POL			1	1				2	1	1	1
TUR		1									
UKR					1	1					
YUG	2	1									
Registration of less than 10											
AUS											
AZR											
BGD											
BRB											
CHN								1		1	
CME											
CUB											
CYP											
DDR											
FNL											
GDL											
GIB											
GRC											
GUB											

Symbol	860-864.99	855-859.99	850-854.99	845-849.99	840-844.99	835-839.99	830-834.99	825-829.99	820-824.99	815-819.99	810-814.99
HOL									1		
IND	1										5
INS										1	
J											
POL				1	2	1	1	2		1	
TUR		2	2								
UKR		1									
YUG											
Registrations of less than 10											
AUS						1					
AZR											
BGD											
BRB	2										
CHN			1		1		1		1		
CME	1										
CUB						1					
CYP				1		1					
DDR											
FNL				1							
GDL		1			1		1				
GIB			1						1		
GRC			2		1		1				
GUB		1									

Total Registrations 500-890 MHz Band	Symbol	865-869.99	870-874.99	875-879.99	880-884.99	885-889.99
39	HOL					
22	IND					
14	INS					
51	J					
10	POL					
34	TUR	3	2			1
25	UKR					
30	YUG					
Registrations of less than 10						
6	AUS	1	1		1	
1	AZR					
2	BGD					
4	BRB		2			
6	CHN			1		
2	CME					
2	CUB					
4	CYP					
6	DDR					
5	FNL	1				
4	GDL					
2	GIB					
	GRC					
	GUB	1		2		

REGISTRATIONS ACROSS THE 500-890 MHz BAND - Continued

Symbol	Country/Area	500-504.99	505-509.99	510-514.99	515-519.99	520-524.99	525-529.99	530-534.99
HKG	Hong Kong							
HWA	Hawaii							
ISL	Iceland							
LBY	Libya							
MLA	Malaysia							
MLT	Malta							
MOZ	Mozambique							
MRC	Morocco							
MRT	Martinique							
NOR	Norway							
NZL	New Zealand							
PAK	Pakistan							
POR	Portugal	1	1					
PTR	Puerto Rico		1			1		
RYU	Ryukyu Islands							
SNG	Singapore							
TCH	Czechoslavakia							
TGK	Tanzania (Tanganyika)							
ZAI	Zaire							

585-589.99													1						
580-584.99																			
575-579.99																			
570-574.99																			
565-569.99														1					
560-564.99																			
555-559.99																	1	1	
550-554.99												1					1		
545-549.99																			
540-544.99																			
535-539.99												1							
Symbol	HKG	HWA	ISL	LBY	MLA	MLT	MOZ	MRC	MRT	NOR	NZL	PAK	POR	PTR	RYU	SNG	TCH	TGK	ZAI

Symbol	640-644.99	635-639.99	630-634.99	625-629.99	620-624.99	615-619.99	610-614.99	605-609.99	600-604.99	595-599.99	590-594.99
HKG											
HWA											
ISL											
LBY											
MLA											1
MLT											
MOZ											
MRC											
MRT											
NOR									2	1	2
NZL								1			
PAK											
POR											
PTR							1				
RYU		1			1						
SNG								1			1
TCH							1			1	
TGK											
ZAI											

695-
699.99

690-
694.99

685-
689.99

680-
684.99

675-
679.99

670-
674.99

665-
669.99

660-
664.99

655-
659.99

650-
654.99

645-
649.99

1

Symbol	
HKG	
HWA	
ISL	
LBY	
MLA	
MLT	
MOZ	
MRC	
MRT	
NOR	
NZL	
PAK	
POR	
PTR	
RYU	
SNG	
TCH	
TGK	
ZAI	

750-754.99															2			
745-749.99																		
740-744.99																		
735-739.99																		
730-734.99																		
725-729.99											1							
720-724.99																		
715-719.99																		
710-714.99																		
705-709.99																		
700-704.99																		
Symbol	HKG	HWA	ISL	LBY	MLA	MLT	MOZ	MRC	MRT	NOR	NZL	PAK	POR	PTR	RYU	SNG	TCH	TGK	ZAI

805-809.99			2			1													
800-804.99			1		1			1											
795-799.99										1						1			
790-794.99				1															
785-789.99																			
780-784.99																			
775-779.99																			
770-774.99																			
765-769.99																			
760-764.99																			
755-759.99																			

Symbol

HKG
HWA
ISL
LBY
MLA
MLT
MOZ
MRC
MRT
NOR
NZL
PAK
POR
PTR
RYU
SNG
TCH
TGK
ZAI

Symbol	860-864.99	855-859.99	850-854.99	845-849.99	840-844.99	835-839.99	830-834.99	825-829.99	820-824.99	815-819.99	810-814.99
HKG											
HWA		1		1			2				
ISL									1		1
LBY				1							
MLA									1		
MLT			1			1					
MOZ	1										
MRC			1								
MRT	1					2					
NOR							1				
NZL		1									
PAK										1	1
POR											
PTR											
RYU											
SNG											
TCH											
TGK											
ZAI											

Symbol	Total Registrations 500-890 MHz Band	885-889.99	880-884.99	875-879.99	870-874.99	865-869.99
HKG	1	1				
HWA	8					
ISL	4	1				
LBY	3					
MLA	2					
MLT	1			1		1
MOZ	4		1			
MRC	2			1		
MRT	2		2	1		1
NOR	8					
NZL	7					
PAK	3					
POR	2					
PTR	4					
RYU	2					
SNG	2					
TCH	6					
TGK	3					
ZAI	2					

APPENDIX E

GLOSSARY OF ITU TERMS AND DEFINITIONS

Source: Chapter I of Radio Regulations [5]

ASSIGNED FREQUENCY: The center of the frequency band assigned to a station.

AERONAUTICAL RADIONAVIGATION SERVICE: A radionavigation service intended for the benefit of aircraft.

BROADCASTING SERVICE: A radiocommunication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other types of transmissions.

FIXED SERVICE: A service of radiocommunication between specified fixed points.

HARMFUL INTERFERENCE: Any emission, radiation or induction which endangers the functing of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with these Regulations (Radio Regulations).

MOBILE SERVICE: A service of radiocommunication between mobile and land stations, or between mobile stations.

RADIODETERMINATION: The determination of position, or the obtaining of information relating to position, by means of the propagation properties of radio waves.

RADIOLOCATION: Radiodetermination used for purposes other than those of radionavigation.

RADIOLOCATION SERVICE: A radiodetermination service involving involving the use of radiolocation.

RADIONAVIGATION SERVICE: A radiodetermination service involving the use of radionavigation.

SPURIOUS EMISSION: Emmission on a frequency or frequencies which are outside the necessary band, and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emmissions include harmonic emissions, parasitic emissions and intermodulation products, but exclude emissions in the immediate vicinity of the necessary band, which are a result of the modulation process for the transmission of information.

TELEMETERING: The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument.

SPACE SERVICE: A radiocommunication service between space stations.

STATION: One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service. Each station shall be classified by the service in which it operates permanently or temporarily.

NOTE: At the 1971 World Administrative Radio Conference For Space Telecommunications, the term SATELLITE was added to service definitions, but in a unique way. The notion was accepted that the basic radio services remain the same, and that satellite is only a technique. Only the technique allowing the establishment of links evolves. Consequently, the terms adopted were constituted by retaining the name of the existing terrestrial service (e.g., Mobile) and adding the word SATELLITE, instead of choosing a new name which might suggest that a new basic radio service had evolved. Adding the word SATELLITE merely indicates the use of space techniques by the existing radio service concerned. [12]

BIBLIOGRAPHY

1. Boyes, J.L. and Frisbie, F.L., "Another Problem Of Resource Allocation - The Radio Frequency Spectrum Shortage," U.S. Naval Institute, v. 101, pp.94-95, December 1975.

2. Codding, George A., Jr., The International Telecommunications Union: An Experiment In International Cooperation, p. 86, Leiden, Netherlands: E.J. Brill, 1952.

3. International Frequency Registration Board, Circular 11-89, International Telecommunications Union, 28 October 1975.

4. International Frequency Registration Board, International Frequency List, Preface and Volume V (Parts b, c, and d), Geneva, Switzerland: International Telecommunications Union, 1 February 1975.

5. International Telecommunications Union, Radio Regulations, 1968, including Amendments Resulting from Decisions Made by the World Administrative Radio Conference for Space Communications, Geneva, 1971.

6. International Telecommunication Union, The International Telecommunications Union: What It Is...What It Does...How It Works, Geneva: ITU, undated.

7. U.S., Department of the Navy, Naval Electronic Systems Command, Geostationary Orbit Slotting Analysis, v. I and v. II, prepared by National Scientific Laboratories, 1 December 1975.

8. U.S., Department of the Navy, Naval Electronic Systems Command, Satellite Communications Set, AN/WSC-3, v. 1, table 1-2, NAVELEX 0967-LP-545-4050, 15 May 1975.

9. U.S., Department of the Navy, Office of the Chief of Naval Operations, Director, Command, Control, and Communications, Department of Navy Electromagnetic Spectrum Requirement, prepared by Electronics Systems Division of Tracor, Inc., 1 April 1976. (FOR OFFICIAL USE ONLY document)

10. U.S., Executive Office of the President, Office of Telecommunications Policy, Manual of Regulations and Procedures for Radio Frequency Management, including May 1976 Revisions.

11. U.S., Executive Office of the President, Office of Telecommunications Policy, The Radio Frequency Frequency Spectrum: United States Use and Management, pp. C-14 through C-24, August 1975.

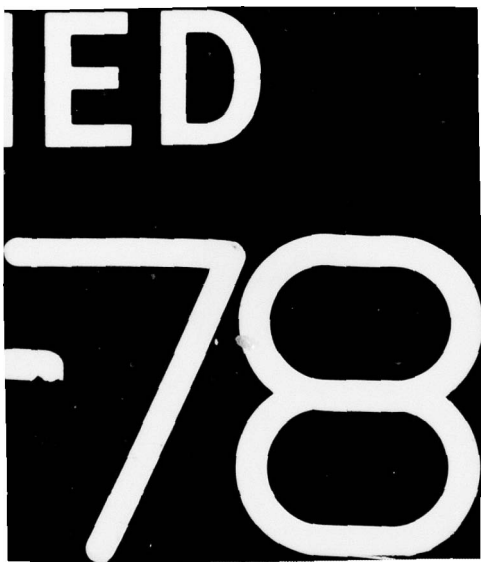
12. "The World Administrative Radio Conference For Space Telecommunications, Geneva, 7 June-17 July 1971 Summary Record By The International Frequency Registration Board (IFRB)," TELECOMMUNICATIONS JOURNAL, v. 38-X, p. 677, 1971.

INITIAL DISTRIBUTION LIST
(NPS-62OL76104)

		No. of Copies
1.	Defense Documentation Center Cameron Station Alexandria, VA 22314	2
2.	Library, Code 0212 Naval Postgraduate School Monterey, CA 93940	2
3.	Dean of Research, Code 023 Naval Postgraduate School Monterey, CA 93940	1
4.	Chairman, Code 62 Electrical Engineering Department Naval Postgraduate School Monterey, CA 93940	1
5.	Associate Professor J. E. Ohlson, Code 62OL Electrical Engineering Department Naval Postgraduate School Monterey, CA 93940	20
6.	LCDR C. J. Waylan, Code PME 106-IT Naval Electronic Systems Command Washington, DC 20360	6
7.	Director (Attn: Dr. Steve Bernstein) M.I.T. Lincoln Laboratory P.O. Box 73 Lexington, MA 02173	1
8.	Director Naval Research Laboratory (Attn: Code 5400) Washington, DC 20375	1
9.	Commander Naval Electronics Laboratory Center (Attn: Code 1410) San Diego, CA 92152	1
10.	Commander Naval Electronics Laboratory Center (Attn: Ralph D. Jensen) San Diego, CA 92152	1

		No. of Copies
11.	Commander Naval Electronic Systems Test and Evaluation Detachment Patuxent River, MD	1
12.	Commander Naval Telecommunications Command 4401 Massachusetts Ave. NW Washington, DC 20390	1
13.	NAVSEEACT (Attn: LCDR G. A. Burman) Box 194 FPO San Francisco 96630	1
14.	Director Naval Research Laboratory (Attn: Paul Crepeau, Code 5481) Washington, DC 20375	1
15.	Commander Naval Electronic Systems Engineering Center Vallejo, CA 94592	1
16.	LT Richard F. Carlson, USCG COMMANDANT (G-OTM-3) U.S. Coast Guard Washington, DC 20590	1
17.	CDR John T. Vinson, Code 62VN Electrical Engineering Department Naval Postgraduate School Monterey, CA 93940	1
18.	Chief of Naval Operations (OP-941F) Department of the Navy Attn: CAPT Madigan Washington, DC 20350	1
19.	LCDR Timothy Meno, USN COMCARGRU FIVE FPO San Francisco 96601	5
20.	Director, Electromagnetic Spectrum Center Naval Communications Unit (Attn: Bill Wojanis) Washington, D. C. 20390	1

		No. of Copies
21.	Electromagnetic Capatibility Analysis Center North Severn Annapolis, Maryland 21402 (Attn: ACY)	1
22.	National Scientific Laboratories Westgate Research Park McLean, Virginia 22102 (Attn: James Hufford)	1
23.	Commander Naval Electronic Systems Command (Attn: Mortum Runey, ELEX 952) Washington, D. C. 20360	1
24.	Commander Naval Electronic Systems Command (Attn: S. Caine, ELEX 51024) Washington, D. C. 20360	1
25.	Commander Naval Sea Systems Command (Attn: CRD R.R. Grove, SEA 06%) Washington, D. C. 20360	1
26.	Commander Naval Electronic System Command (Attn: H. J. Buhl, ELEX 51013) Washington, D. C. 20360	1
27.	Security Officer Motorola, Inc. GED 8201 East McDowell Road (Attn: C. D. McBiles, Mail Drop 1306) Scottsdale, Arizona 85252	1
28.	LCDR S. M. Skjei, Jr. OP-941E2 Navy Department Pentagon Washington, D. C. 20390	1
29.	Director Naval Research Laboratory (Attn: D. H. Townsend, Code 5435) Washington, D. C. 20375	1
30.	Commander NESTED (Attn: R. S. Trible, 0252) Patuxent River, MD 20670	1


ED
78