NHB 2570.6
AUGUST 1989

NASA RADIO FREQUENCY SPECTRUM MANAGEMENT MANUAL

(NHB-2570.6) NASA RADIO FREQUENCY SPECTRUM MANAGEMENT MANUAL (NASA) 75 p

N94-70715

Unclas

Z9/32 0190963

NASA

WASHINGTON, D.C. 20546

NASA RADIO FREQUENCY (RF) SPECTRUM MANAGEMENT MANUAL

PREFACE

Effective Date: August 1989

The Radio Frequency (RF) Spectrum Management Manual sets forth procedures, and guidelines for the management requirements for controlling the use of radio frequencies by the National Aeronautics and Space Administration. It is applicable to NASA Headquarters and field installations.

NASA Management Instruction 1102.3 assigns the authority for management of radio frequencies for the National Aeronautics and Space Administration to the Associate Administrator for Space Operations, NASA Headquarters.

This Manual is issued in loose-leaf form and will be revised by page changes.

Comments, suggestions or questions concerning this Manual should be addressed to the NASA Spectrum Management Program Manager, Communications and Data Systems Division, Code TS, NASA Headquarters, Washington, DC 20546.

Charles T. Force
Associate Administrator for Space Operations

DISTRIBUTION:
SDL 1(SIQ)

PAGE ______ INTENTIONALLY BLANK

CHANGES CHECK LIST

This check list is provided for recording receipt of changes, date of change, name of poster and date of posting.

CHANGE		POSTING		CHANGE		POSTING	
No.	Date	Initials	Date	No.	Date	Initial	Date
1.				16.			
2.				17.			
3.				18.			
4.				19.			
5.				20.			
6.				21.			
7.				22.			
8.				23.			
9.				24.			
10.				25.			
11.				26.			
12.				27.			
13.				28.			
14.				29.			
15.				30.			

PAGE ______ INTENTIONALLY BLANK

TABLE OF CONTENTS

PARAGRAPH **PAGE**

PRECEDING PAGE BLANK NOT FILMED

TABLE OF CONTENTS (Contd)

PARAGRAPH **PAGE**

APPENDICES

PAGE ______ INTENTIONALLY BLANK

TABLE OF ACRONYMS

AA/OSO	Associate Administrator for Space Operations
AFETR	Air Force Eastern Test Range
ATDRSS	Advanced Tracking and Data Relay Satellite System
CCIR	International Consultative Committee For Radio
CCITT	International Consultative Committee for Telephone and Telegraph
DOD	Department of Defense
DRS	Data Relay Satellite
EMC	Electromagnetic Compatibility
ESA	European Space Agency
FAR	Federal Acquisition Regulation
FAS	Frequency Assignment Subcommittee
FCC	Federal Communications Commission
FISMG	Field Installation Spectrum Managers' Group
FMLG	Frequency Management Liaison Group
IFRB	International Frequency Registration Board
IRAC	Interdepartment Radio Advisory Committee
ITU	International Telecommunication Union
JPL	Jet Propulsion Laboratory
NASDA	National Space Development Agency of Japan
NIB	Non-Interference Basis
NMI	NASA Management Instruction
NRL	Naval Research Laboratory
NTIA	National Telecommunications and Information Administration

TABLE OF ACRONYMS (CONTD)

OCP	Office of Commercial Programs
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OSO	Office of Space Operations
OSSA	Office of Space Science and Applications
RF	Radio Frequency
RFA	Radio Frequency Assignment
RFI	Radio Frequency Interference
SFCG	Space Frequency Coordination Group
SPS	Spectrum Planning Subcommittee
SSG	Space Systems Group
TDRSS	Tracking and Data Relay Satellite System
STS	Space Transportation System
TSC	Technical Subcommittee
WARC	World Administrative Radio Conference

CHAPTER 1: INTRODUCTION

1.1 PURPOSE

a. This Manual provides guidance in the use of the radio frequency spectrum for agency communications links. Procedures relating to radio frequency interference (RFI) are also presented and requirements are defined for the support of potential future NASA flight programs which may require long lead time spectrum management initiatives. Responsibilities of concerned NASA personnel are defined in Chapter 2.

b. Appendices A through K present ancillary spectrum management information.

c. For the purpose of this Manual, radio frequency (RF) spectrum is defined as the set of radio frequencies below, arbitrarily, about 3000 GHz. Also several terms used frequently have very specific, technical connotations for those familiar with the RF spectrum management discipline. A glossary of these terms, with their definitions, is provided in Appendix J.

1.2 REGULATORY STRUCTURE

a. Internationally, the RF spectrum is allocated by the International Telecommunication Union (ITU) to various classes of service according to different regions of the world (see Figure 1-1). Within the United States and its Possessions, the RF spectrum is further allocated to non-Government and Government users. The Federal Communications Commission (FCC), acting under the authority of Congress, is responsible for the allocation and assignment of frequencies to non-Government users. The National Telecommunications and Information Administration (NTIA) is responsible for the allocation and assignment of frequencies to departments and agencies of the U.S. Government. Descriptions of international and national spectrum management structures are contained in Appendices A and B.

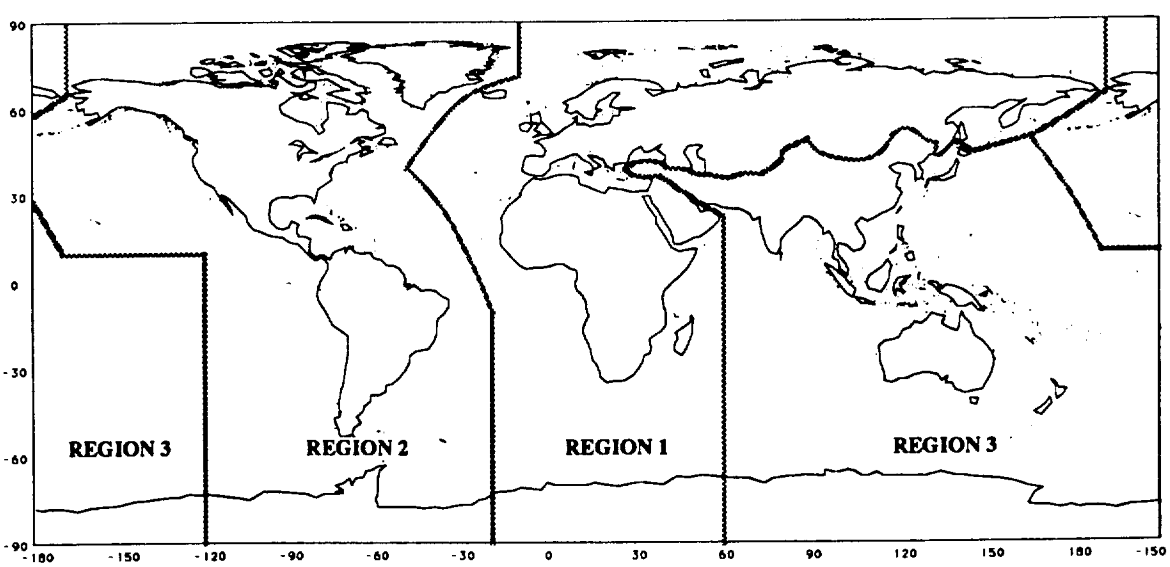


FIGURE 1-1. GEOGRAPHIC REGIONS FOR FREQUENCY ALLOCATION OF THE SPECTRUM

b. NTIA performs its functions through the assistance of the Interdepartment Radio Advisory Committee (IRAC)[1] which is also responsible for maintaining the National Table of Frequency Allocations. Coordination between non-Government and Government users of the RF spectrum is accomplished by joint meetings of the FCC and the NTIA.

c. Within NASA, the responsibility for acquiring frequency allocations and providing assignment of frequencies is designated to the Associate Administrator for Space Operations (AA/OSO). Normally, all allocations and assignments are made through the AA/OSO, and are issued to NASA RF spectrum users through NASA Field Installation Spectrum Managers.

1.3 AUTHORITY

a. Communications Act of 1934, as amended.

b. Radio Regulations, International Telecommunication Union (ITU).

c. Office of Management and Budget (OMB) Circular A-11, Section 13.2.

d. Rules and Regulations, Federal Communications Commission, Washington, DC 20554.

e. Manual of Regulations and Procedures for Federal Radio Frequency Management, National Telecommunications and Information Administration.

1.4 U.S. POLICY

The U.S. policy with regard to the use of properly authorized frequency bands is stated in the Communications Act of 1934, as amended. In order to assure compliance with the provisions of the Communications Act, OMB Circular No. A-11, section 13.2, states that:

> "Estimates for the development or procurement of major communications-electronics systems (including all systems employing satellite (space) techniques) will be submitted only after certification by NTIA that the space in the radio frequency spectrum required for such systems is available."

1.5 NASA POLICY OVERVIEW

a. To assure compliance with national RF spectrum policy, the NASA Administrator has delegated authority for the management of the agency's use of the RF spectrum to the Associate Administrator for Space Operations.

b. In order to discharge this responsibility, the AA/OSO has established the following policies to be adhered to by all agency RF spectrum users.

(1) All NASA RF spectrum usage must be pursuant to specific assignments approved by the Associate Administrator for Space Operations.

[1]The IRAC has been in constant session since 1922, NASA has been an active member since 1958.

(2) To the maximum extent possible, all RF spectrum selections for the satisfaction of NASA requirements must be consistent with the National Table of Frequency Allocations.

(3) Pending assurance of the availability of the appropriate RF spectrum support, no funds will be obligated by NASA for the research, development or acquisition of components; for modification of major communications and electronic equipment or systems; or for the selection, procurement and deployment of space or terrestrial radio stations and facilities when such items require RF spectrum support. Approved RF requirements must be made a part of the specifications included with the procurement request or requisition. Exceptions to this policy include, conceptual studies, feasibility studies, development of components for the commercial communications satellite industry and laboratory research which does not lead directly to components or systems to be flown on agency spacecraft.

(4) All space vehicles and spacecraft under cognizance of NASA must be equipped with the ability to control emissions on and off by telecommand.

(5) No NASA space assignments will be made to transmitting devices in radio frequency bands allocated either nationally or internationally to the Radio Astronomy Service.

1.6 REFERENCE DOCUMENTS

a. NMI 1102.3, Role and Responsibilities-Associate Administration for Space Operations.

b. NMI 2570.5, Radio Frequency Spectrum Management.

c. NASA/ESA Frequency Coordination Manual.

d. NASA/NASDA Frequency Coordination Manual.

e. NASA FAR Supplement 18-23.71, Frequency Authorization.

f. The spectrum management program documentation tree is shown in Figure 1-2. One initial copy of each document marked with an asterisk(*) will be provided to each Field Installation Spectrum Manager by the Spectrum Management Program Manager. Updates to these documents will also be provided as necessary.

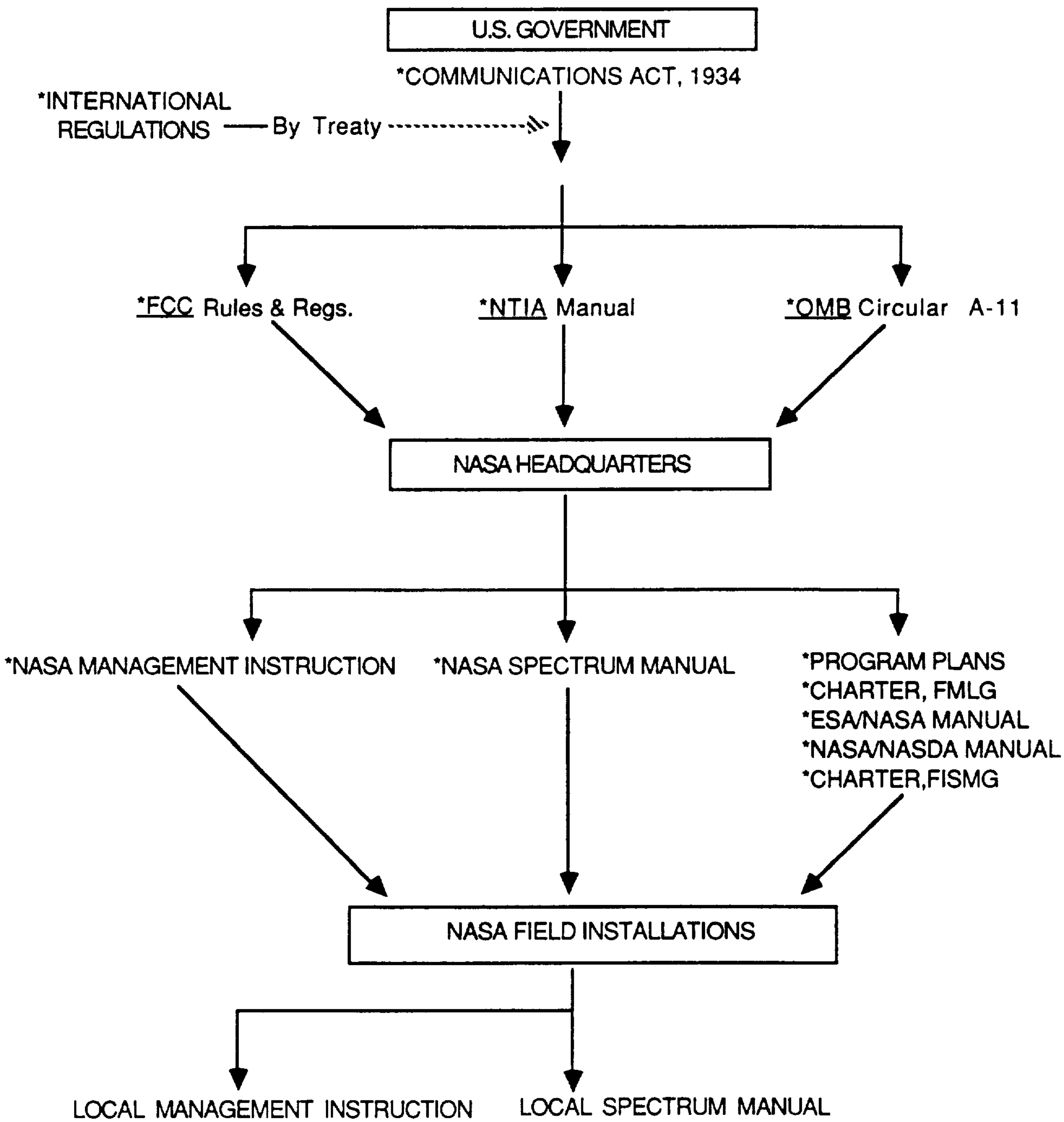


FIGURE 1.2 DOCUMENTATION TREE, SPECTRUM MANAGEMENT PROGRAM

CHAPTER 2: ROLES AND RESPONSIBILITIES

2.1 NASA SPECTRUM MANAGEMENT PROGRAM

a. The Associate Administrator for Space Operations (AA/OSO) is designated the NASA Spectrum Manager and is responsible for assuring compliance with pertinent international and national rules and regulations of all NASA RF spectrum users. Additionally, the AA/OSO nominates the Chairperson of the U.S. Study Group 2 of the International Consultative Committee for Radio (CCIR).

b. The Communications and Data Systems Division, Code TS, is responsible for the overall planning, policy and administration of the NASA Spectrum Management Program. This Division is also responsible for agency implementation of the policies and applicable procedures outlined in this Manual.

c. The NASA Spectrum Management Program Manager implements necessary procedures to:

(1) Obtain adequate frequency spectrum to support agency programs.

(2) Ensure agency compliance with national and international rules and regulations pertaining to the use of radio frequencies.

(3) Ensure the timely processing of spectrum allocation and frequency assignment requests for agency programs.

(4) Ensure timely dissemination of technical and regulatory changes, which have a bearing on field installation activities, to the Field Installation Spectrum Manager for evaluation and implementation.

(5) Provide the means for Program Offices to provide guidance to project managers so that programs requiring the use of electromagnetic radiating devices are coordinated at the conceptual stage with the appropriate Spectrum Manager.

(6) Ensure identification and mitigation of any RFI which might be caused by or suffered by agency operational programs.

(7) Provide planning and implementation of actions required to obtain new allocations or enhanced radio regulations through national or international organizations.

d. The structure of the NASA Spectrum Management Program is shown in Figure 2-1. NASA and its relationship to the national spectrum management structure is presented in Figure 2-2.

e. Appendix C identifies the addresses for agencywide spectrum management.

2.2 PROGRAM AND OTHER HEADQUARTERS OFFICES

a. NASA Program and other Headquarters Offices are responsible for coordinating spectrum requirements with the NASA Spectrum Management Program Manager. The Office of Space Science and Applications (OSSA) has an unique role within the agency which is authorized under the Comsat Act of 1962, as amended. This role is to provide technical advocacy to U.S. Industry in the research and development of advanced technology applied to communications satellites. Additionally, the Office of Commercial Programs (OCP) may, at times, be required to transfer to entities of U.S. Industry, existing communications technology. To ensure adequate spectrum support for the programs sponsored by these two offices, Office of Space Operations (OSO) must provide adequate coordination and representation to the Federal Communications Commission.

b. The Frequency Management Liaison Group (FMLG) is organized to provide a forum for the exchange of information on RF spectrum management requirements, policies and issues between the Headquarters Offices. Appendix D presents a description of the FMLG.

2.3 FIELD INSTALLATIONS

a. The responsibility at each field installation for implementing the policies and applicable procedures is delegated to each Field Installation Director, whose role is to publish appropriate Field Installation Management Instructions and a Manual of Procedures in support of the installation spectrum management function. Additionally, the Field Installation Director will designate a Spectrum Manager. It is essential that the Spectrum Manager be included in the installation procurement process for all RF equipment, in order to properly discharge the responsibilities outlined below.

b. Each Field Installation Spectrum Manager is responsible for:

(1) Coordinating all the RF spectrum requirements pertaining to activities and projects involving that installation with the NASA Spectrum Management Program Manager in accordance with the procedures outlined in Chapter 3 of this Manual.

(2) Maintaining accurate records of all frequency assignments in use at the site. Each record shall include, as a minimum, all of the information required to complete NASA Form 566, Application for Authorization of Radio Frequency Assignment. The complete set of such records shall provide an accurate reflection of the RF environment at the site. All frequency assignment records must be reviewed at least every 5 years from the date of original assignment.

(3) Maintaining the electromagnetic integrity of the site by means of proper selection of RF equipment location and electromagnetic compatibility (EMC) testing, prior to issuance of RFA.

(4) Assuring the day-to-day interference-free operations at the site, and RFI incident reporting, in accordance with the procedures outlined in Chapter 4 of this Manual.

(5) Assuring that communications and RF spectrum requirements for future missions are identified as early as possible and reported to the NASA Spectrum Management Program Manager for inclusion in NASA long range spectrum forecasts.

(6) Participation in local or national frequency management coordination groups, as appropriate, to provide representation and cognizance of the field installation's communications requirements.

(7) Coordinating the development of Field Installation Management Instructions for Spectrum Management and a Field Installation Manual of Procedures for Spectrum Management with the Spectrum Management Program Manager at NASA Headquarters, to ensure agencywide program consistency. When published, a copy of each of these documents will be provided to every Field Installation Spectrum Manager. Additionally, the Spectrum Manager will maintain the documents provided by the Spectrum Management Program Manager, denoted by an asterisk(*) in Figure 1-2.

c. The NASA Field Installation Spectrum Managers' Group (FISMG) is organized to provide a forum for the exchange of information on radio frequency spectrum management requirements, actions and issues among all NASA Field Installation Spectrum Managers.

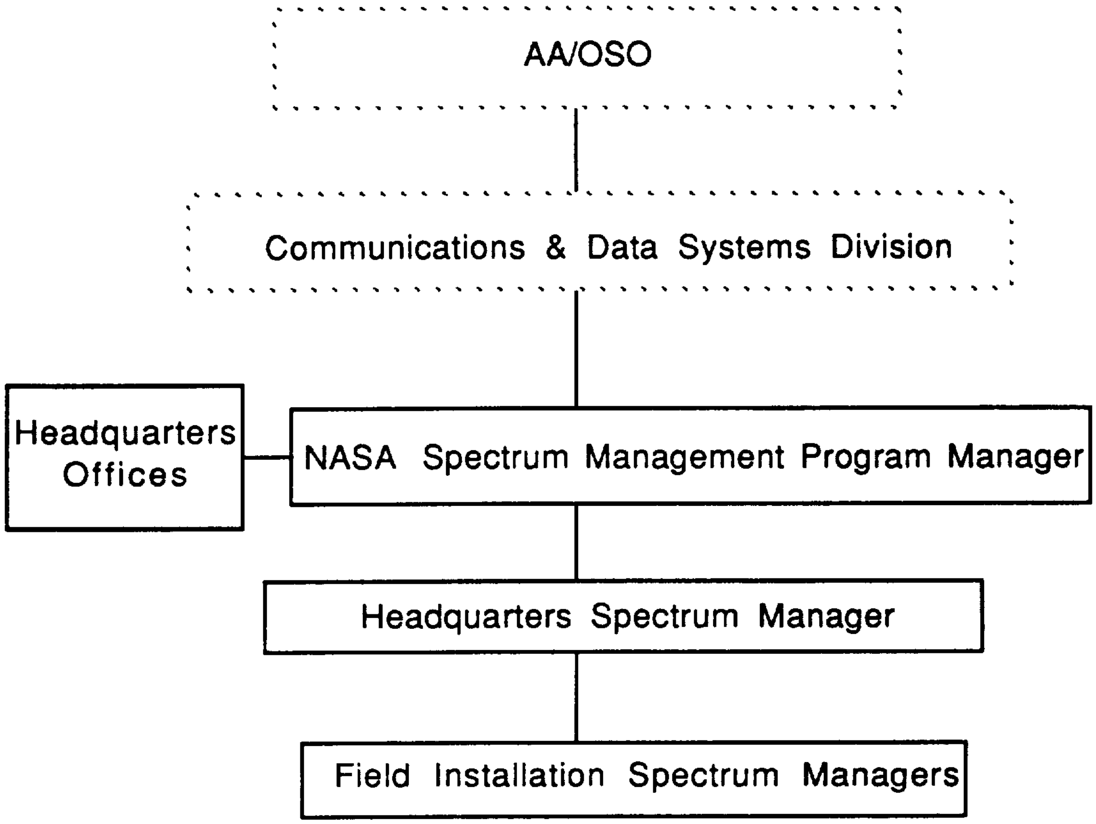
d. The group provides for each field installation to input the communications requirements of all current and future projects undertaken by that center to the NASA Spectrum Management Program Manager, Code TS, in a timely manner, to ensure that spectrum support is available as required by each project. Appendix E presents a description of the FISMG.

2.4 JET PROPULSION LABORATORY

The Jet Propulsion Laboratory (JPL) is not a NASA field installation. Under the terms of NASA prime contract, NAS 7-918, JPL performs a number of communications functions including, for example, management of the Deep Space Network. These functions require access to and the use of the RF spectrum. To ensure proper and adequate RF spectrum availability, the JPL Spectrum Manager provides support to the NASA Spectrum Management Program in accordance with the procedures outlined in this Manual.

2.5 LONG RANGE REQUIREMENTS

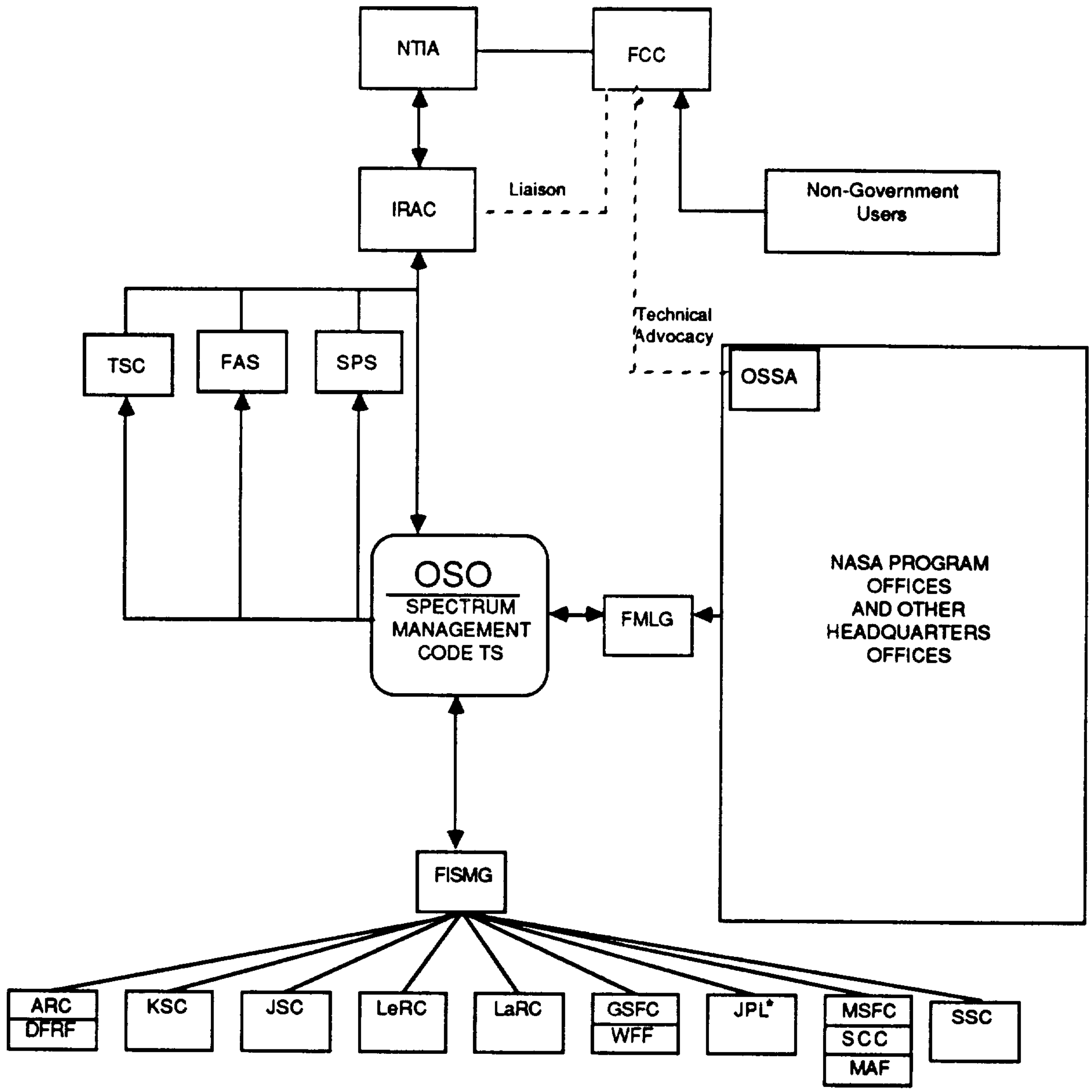
It is the responsibility of each Headquarters office and field installation through its cognizant spectrum manager to identify, document and provide to the NASA Spectrum Management Program Manager, early in the stages of conceptual development, RF spectrum support needs which may not be accommodated under current spectrum allocations. Identification of these needs should be done in consultation with the NASA Spectrum Management Program Manager in order that appropriate action can be effected in a timely manner. This need for early identification of conceptual communications and spectrum requirements is necessary to permit the agency to continue to operate in compliance with paragraphs 1.4 and 1.5 of this Manual.



ARC - Ames Research Center
DFRF - Dryden Flight Research Facility
GSFC - Goddard Space Flight Center
WFF - Wallops Flight Facility
MSFC - Marshall Space Flight Center
JSC - Johnson Space Center
KSC - Kennedy Space Center
LaRC - Langley Research Center
LeRC - Lewis Research Center
SSC - Stennis Space Center
SCC - Slidell Computer Center
MAF - Michoud Assembly Facility

NOTE: With respect to the Jet Propulsion Laboratory see paragraph 2.4.

FIGURE 2-1. NASA RF SPECTRUM MANAGEMENT STRUCTURE



FCC - FEDERAL COMMUNICATIONS COMMISSION
IRAC - INTERDEPARTMENT RADIO ADVISORY COMMITTEE
TSC - TECHNICAL SUBCOMMITTEE
FAS - FREQUENCY ASSIGNMENT SUBCOMMITTEE
SPS - SPECTRUM PLANNING SUBCOMMITTEE
NTIA - NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION
FMLG - FREQUENCY MANAGEMENT LIAISON GROUP
FISMG - FIELD INSTALLATION SPECTRUM MANAGERS GROUP

*With respect to the JPL see paragraph 2.4.

FIGURE 2-2. NASA/NATIONAL SPECTRUM MANAGEMENT STRUCTURE

PAGE ________ INTENTIONALLY BLANK

CHAPTER 3: RF ALLOCATIONS AND ASSIGNMENTS

3.1 GENERAL

a. In order that national and international spectrum management policy is effectively implemented, NASA has adopted procedures for requesting frequency assignments and for obtaining new frequency allocations.These procedures allow for a coordinated process starting with identification of flight project needs and ending with national and international recognition of actual band usage.

b. For the purpose of this Manual, the following definitions are adopted:

(1) Frequency Allocation. A particular portion of the RF spectrum which is set aside or reserved for a particular type of use or for a particular ITU or national radio service (e.g., fixed, mobile, mobile satellite, space research). Current allocations are specified in the National and International Radio Regulations.

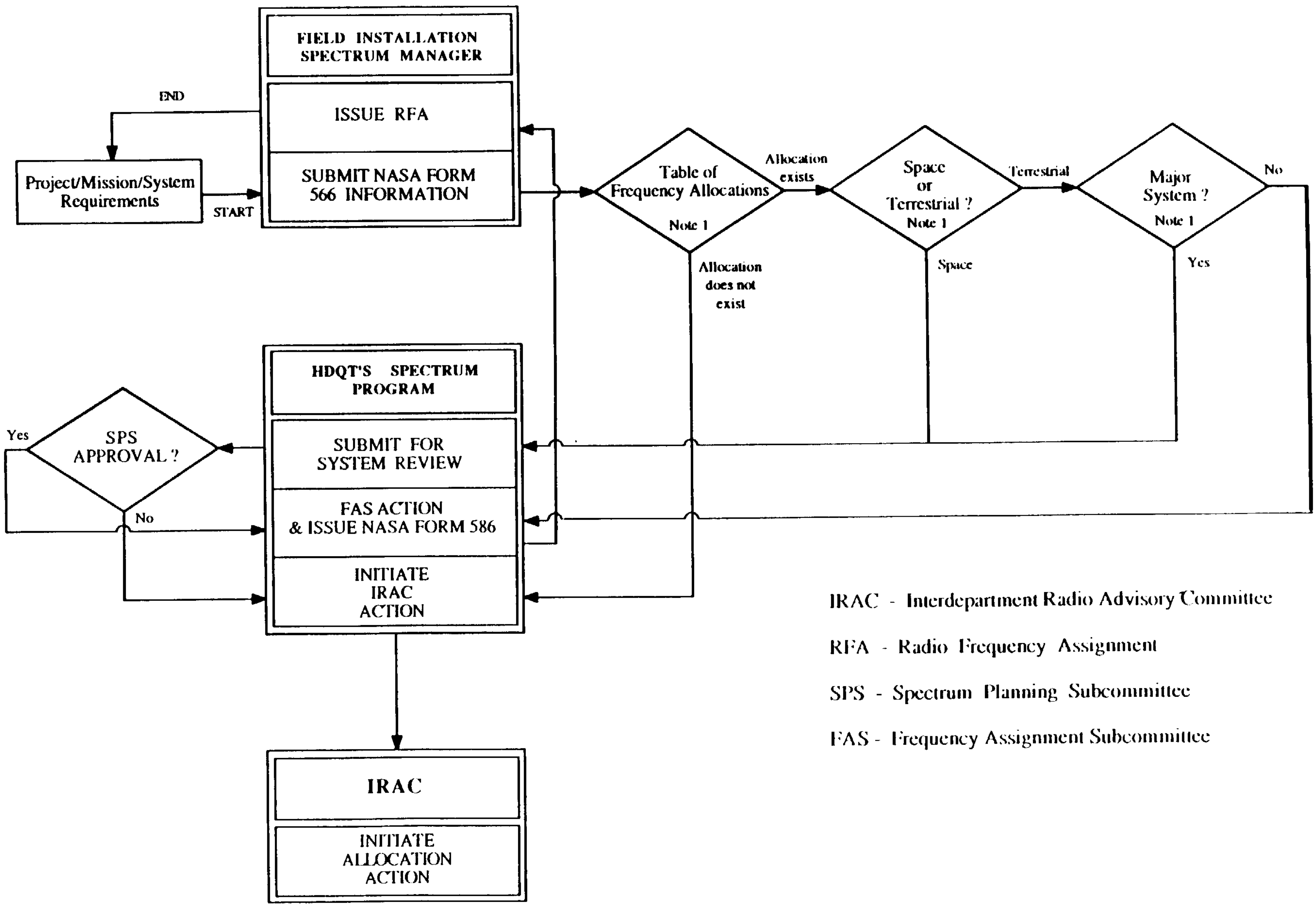
(2) Frequency Assignment. The authorization for the use of a particular frequency or band of frequencies within an allocation for either Government or non-Government operations. When assigned, it is the license to a station to use the specific frequencies.

c. In general, the frequency assignment process takes the form outlined in Figure 3-1 and is initiated at the user field installation and ends with issuance of a Radio Frequency Assignment (RFA). If use is not for a major terrestrial program or is not for frequencies to be used for transmissions to and from space, the frequency assignment process is fairly simple as described in paragraph 3.3.b(2).

d. However, for major new programs or for programs involving spacecraft, which have the potential for international RFI, NTIA has established a review process by which the use is coordinated within the U.S. and internationally. This process is described in Appendix F.

3.2 FREQUENCY ALLOCATIONS

a. In most cases, identification of RF spectrum support for agency needs is focused on frequency bands currently allocated nationally and internationally for the particular radio service for which the agency requires support. This includes both terrestrial use (in fixed and mobile allocations) and space use (in space services which support the U.S. space programs). However, in some cases, particularly as new scientific, technological and commercial requirements emerge and bands lower in the RF spectrum become congested, it may be necessary to move agency communication operations elsewhere in the RF spectrum where appropriate allocations do not currently exist within which to operate. As shown in Figure 3-1, the identification of the need for a new allocation may be made by reference to the Table of Frequency Allocations or as a result of the Systems Review Process which includes a study of current frequency band occupancy.



IRAC - Interdepartment Radio Advisory Committee

RFA - Radio Frequency Assignment

SPS - Spectrum Planning Subcommittee

FAS - Frequency Assignment Subcommittee

Note 1: Actions conducted by the Field Installation Spectrum Manager and, if necessary, repeated by the Headquarters Spectrum Manager.

FIGURE 3-1. FREQUENCY AUTHORIZATION FLOW

b. In cases where new frequency allocations are deemed necessary, it is imperative that long lead times be allowed for the national and international processes which are required for new allocations to be made. Since ITU conferences which are competent to reallocate portions of the RF spectrum occur infrequently, at approximate 10-year intervals, NASA must be prepared to identify new requirements well in advance of these conferences so that supporting technical and regulatory arguments can be prepared and presented.

3.3 FREQUENCY ASSIGNMENTS

a. General. The specific procedures by which agency users may be authorized to operate on a particular frequency depend upon the following factors:

(1) Whether a frequency allocation exists or not;

(2) Whether the system is terrestrial or spaceborne; and

(3) Whether the system is considered major, e.g., high investment.

b. Terrestrial Assignments.

(1) Some terrestrial systems may be classified as major systems. These would be expected to include systems which, even though spectrum allocations currently exist, may be required to submit to NTIA Systems Review due, for example, to high bandwidth requirements, new modulation techniques, novel applications, et al. The Systems Review procedure is referred to in paragraph 3.3c and Appendix F of this Manual.

(2) NASA users requiring assignments for radio frequencies for non-major terrestrial use should prepare the information required to complete NASA Form 566, Application for Authorization of Radio Frequency Assignment (Figure 3-2). This information must be submitted for all frequency assignment actions (new, renewal, modifications, etc.) to the appropriate Field Installation Spectrum Manager for review and submission to the NASA Headquarters Spectrum Manager.

NASA
National Aeronautics and Space Administration

Application for Authorization of Radio Frequency Assignment

NOTE: For user compliance with NMI 5104.2, as revised. See Instructions on reverse before completion.

1. INSTALLATION/CODE

2. DATE OF PREPARATION

3. PROJECT

4. DATE AND LENGTH OF TIME REQUIRED

5. HRS. OF OPERATION *(Cont., frequent, infrequent)*

6. PURPOSE OF ASSIGNMENT AND METHOD OF OPERATION

TRANSMITTER DATA

7. NOMENCLATURE AND MANUFACTURER

8. LOCATION *(e.g., SPCE, State, city)*

9. TYPE MODULATION OF TRANSMITTED CARRIER AND FULL DESCRIPTION OF CARRIER SIGNAL OPERATIONAL CHARACTERISTICS *(Also, as applicable, indicate type data, data rate, phase or amplitude deviation of carrier by each subcarrier, composite modulation index, and whether encryption is used. Continue on separate sheets, if necessary)*

SAMPLE

10. COORDINATES

11. ELEVATION ABOVE MSL

12. FREQ. OR BAND REQUIRED

13. TUNING RANGE

14. EMISSION BANDWIDTH OF TRANSMITTED SIGNAL

a. −3dB | b. −20dB | c. −40dB | d. −60dB

15. POWER

a. CARRIER | b. MEAN | c. PEAK

16. FILTER USED

☐ a. LOW PASS ☐ b. HIGH PASS
☐ c. BAND PASS ☐ d. NONE

17. FREQ. CONTROL METHOD

18. SPURIOUS EMISSION LEVEL *(Referenced to carrier (dBc))*

19. FREQUENCY TOLERANCE

20. HARMONIC LEVEL *(dBc)*

a. 2ND | b. 3RD | c. 4TH

21. ANTENNA

a. TYPE | b. POLARIZATION | c. GAIN *(dB)* | d. BEAM WIDTH *(Degrees)* (1) Az (2) El

RECEIVER DATA *(i.e., receiver which will receive the above transmitted data)*

22. NOMENCLATURE AND MANUFACTURER

23. LOCATION *(e.g., SPCE, state, city)*

24. COORDINATES

25. ELEVATION ABOVE MSL

26. TUNING RANGE

27. FREQUENCY STABILITY

28. RF SELECTIVITY

a. −3dB | b. −20dB | c. −60dB

29. SENSITIVITY *(dBm)*

30. SYSTEM NOISE TEMPERATURE *(Spaceborne and earth stations)*

30. IF FREQUENCY

a. 1ST | 2ND

31. ANTENNA

a. TYPE | b. POLARIZATION | c. GAIN *(dB)* | d. BEAMWIDTH *(Degrees)* (1) Az (2) El

APPROVAL

32. TYPED NAME

33. SIGNATURE

NASA FORM 566 OCT 83 PREVIOUS EDITION IS OBSOLETE.

FIGURE 3-2. SAMPLE OF NASA FORM 566, APPLICATION FOR AUTHORIZATION OF RADIO FREQUENCY ASSIGNMENT

(3) The following procedures and notes will aid NASA spectrum users in the preparation of applications for frequency assignments, and facilitate the processing of the applications:

Step 1. From the operational requirements, determine the specific frequency or band of frequencies, together with alternate frequencies that would be acceptable if the desired frequencies are not available. Allow a lead time of at least 90 days (for frequencies above 30 MHz) or 180 days (for frequencies below 30 MHz) for the processing of the request after the request is received at NASA Headquarters.

Step 2. The Field Installation Spectrum Manager will ensure that the frequencies are available and in accordance with the National Table of Frequency Allocations. Do not request "out-of-band" frequency assignments or allocations unless absolutely necessary. In cases where out-of-band frequencies must be used, allow the maximum lead time possible.

Step 3. Refer to paragraph 3.4 to determine if coordination with others is required. The type and amount of coordination that might be required varies with the specific frequencies involved. When such coordination is extensive, the user (applicant) must provide funds for such coordination, including the preparation of coordination contour charts.

Step 4. For each frequency assignment action required, submit the information requested by NASA Form 566 to the Field Installation Spectrum Manager together with any other information that will aid in expediting the application. If necessary refer to Appendices G and H for procedures to determine bandwidth/emissions designations and call signs.

(4) Field Installation Spectrum Managers are responsible for processing the information contained in NASA Form 566 by coordinating directly with the NASA Headquarters Spectrum Manager.

(5) Submission of NASA Form 566 or acknowledged receipt of these forms does not constitute an assignment or authorization regardless of any verbal agreements or understandings between the applicant and NASA spectrum management personnel. Do not attempt to operate on the frequency requested or to purchase equipment requiring such frequency support until authorized by formal Radio Frequency Authorizations issued by the Field Installation Spectrum Manager.

c. Space Assignments.

(1) Section 8.3 of the NTIA Manual, "Procedure for the Review of Telecommunication Systems for Frequency Availability and Electromagnetic Compatibility (EMC)" states that for Government agencies the Systems Review is applicable to certain systems and subsystems. The Systems Review is intended for:

(a) New telecommunication systems or subsystems, and major modifications to existing systems or subsystems, involving the use of satellites or spacecraft.

(b) New major terrestrial systems or subsystems, and major modifications to existing systems or subsystems.

(c) Such systems or facilities as may be referred to the Spectrum Planning Subcommittee (SPS) on a case-by-case basis.

(2) The Systems Review is a procedure used by the SPS to develop recommendations on behalf of the Interdepartment Radio Advisory Committee (IRAC) for the Deputy Associate Administrator, Office of Spectrum Management of NTIA, regarding certification of spectrum support for telecommunication systems or subsystems. This review provides an early awareness in the regulatory community and allows for either early support or early identification of potential problems in the future. A system can be reviewed at four stages as it matures into an operational status. These are:

Stage 1	Conceptual.
Stage 2	Experimental.
Stage 3	Developmental.
Stage 4	Operational.

(3) Determination of agency systems which require Systems Review will be determined by the Field Installation Spectrum Manager and the NASA Spectrum Management Program Manager. For those systems so designated, the Field Installation Spectrum Manager will be required to coordinate with the NASA Spectrum Management Program Manager throughout the review process.

(4) Details of the Systems Review procedure can be found in Appendix F.

3.4 U.S. COORDINATION REQUIREMENTS

a. NASA Components as Tenants at Other Government Installations. NASA installations having tenant status at other Government installations will coordinate frequency requirements with the Government installation as required. Applications are then forwarded to NASA Headquarters reflecting the recommendations of the installation under whose jurisdiction the operation is proposed.

b. Joint Radio Frequency Coordination for National Test Ranges.

(1) The Department of Defense (DOD) has established a system of military interservice frequency coordination to minimize interference and to avoid conflict with or among radio and electronic operations at the DOD National Test Ranges. This system requires that certain frequencies must be coordinated with DOD Area Frequency Coordinators prior to assignments. In the interest of economy and compatibility of operations, this system of coordination is used by NASA, in accordance with the joint DOD-NASA Agreement.

(2) The areas in which Military Interservice Frequency Coordination is required are shown in Figure 3-3 and further defined in Table 3-1. Table 3-1 also lists the DOD Area Frequency Coordinators responsible for coordination within each area.

(3) DOD Area Frequency Coordinators maintain current records of frequencies that have been coordinated with them for use in their area of cognizance. Upon request for frequency coordination, they supply technical comments on the probability of harmful interference being caused or received by the proposed operations.

(4) All frequencies intended for use within the National Test Ranges (or within those areas delineated in Table 3-1) which are considered capable of causing harmful interference to operations at the specified test ranges, including any extended established "down-range" areas, are coordinated with the responsible DOD Area Frequency Coordinator. Area frequency coordination is accomplished by the Spectrum Manager of the NASA Field Installation in accordance with the following procedures:

Step 1. When NASA operations are to be conducted at sites under military cognizance, select the use of the frequencies required in coordination with the Area Frequency Coordinator of the range concerned. In the case of those military test facilities where there is no resident Area Frequency Coordinator coordinate NASA frequency usage with the local Military Frequency Manager who will, in turn, effect the necessary coordination with the cognizant Area Frequency Coordinator.

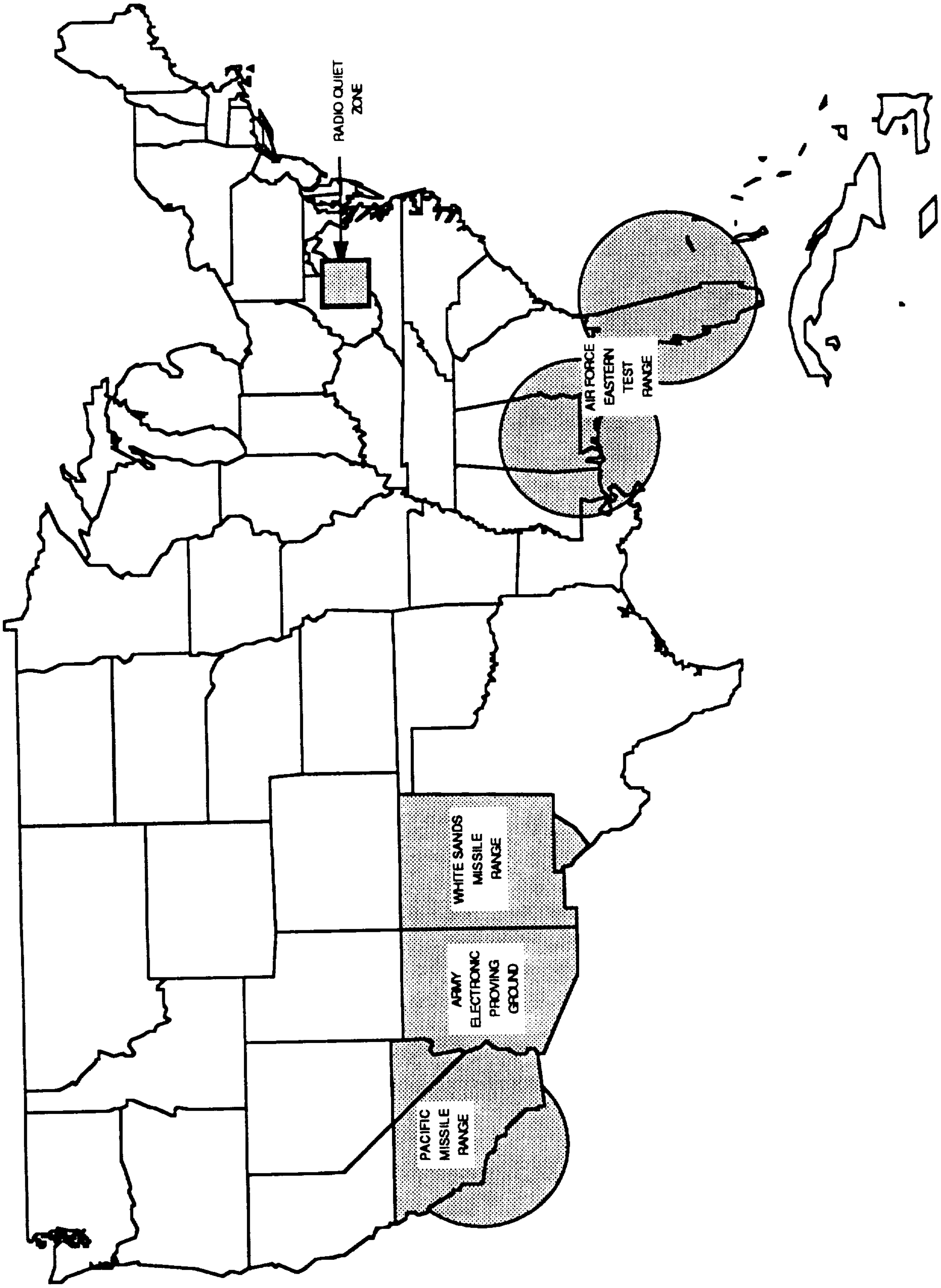


FIGURE 3-3. GEOGRAPHIC LOCATIONS OF NATIONAL RANGES AND RADIO QUIET ZONE

Table 3-1. Coordination Areas For National Test Ranges

Area	Responsibility
The entire State of Florida including Key West Area, as well as the area enclosed with a 200-mile radius of the Headquarters Building, Patrick Air Force Base, Florida; and the area enclosed within a 200-mile radius of Eglin Air Force Base, Florida.	Area Frequency Coordinator, Air Force Eastern Test Range (AFETR), Patrick Air Force Base, Florida.
The entire State of Arizona.	Area Frequency Coordinator, U.S. Army Electronic Proving Ground, Fort Huachuca, Arizona.
The entire State of New Mexico and other U.S. Territory within a 150-mile radius of the Headquarters Building, White Sands Missile Range, Las Cruces, New Mexico.	Area Frequency Coordinator, White Sands Missile Range, Las Cruces, New Mexico.
The area enclosed within a 200-mile radius of the Headquarters Building, Pacific Missile Range, Point Mugu, California, plus the area of Nevada and California that lies south of latitude 37° 30'N. This Area Frequency Coordinator will provide frequency coordination for the Naval Weapons Center, China Lake, California; and Edwards Air Force Base, California.	Area Frequency Coordinator, Pacific Missile Range, Point Mugu, California.

<u>Step 2.</u> Forward two action copies of NASA Form 566 or authorized DOD form to the Area Frequency Coordinator (or Local Military Frequency Manager) and one information copy of NASA Form 566 to NASA Headquarters Spectrum Manager. If the frequencies required are already assigned for use at the Range concerned, the Area Frequency Coordinator (or local Military Frequency Manager) will request assignment from the military department having cognizance of the Range. Such military department will be responsible for all necessary coordination and securing IRAC approval of the frequencies relating to the NASA project at the Range. No NASA assignments will be issued.

<u>Step 3.</u> Where NASA operations are to be conducted at sites not under military cognizance, but within are area defined in Table 3-1, coordinate the use with the

Area Frequency Coordinator of the Range concerned by providing an information copy of NASA Form 566 or authorized DOD form for this purpose. The Area Frequency Coordinator will comment with due regard to all military frequency usage within the area involved.

Step 4. Forward the information required in NASA Form 566 to NASA Headquarters for coordination with other users and IRAC, as appropriate. Include a memorandum stating that coordination has been effected with the Area Frequency Coordinator involved. NASA Headquarters will issue the assignments to cover these operations.

Step 5. Should a frequency conflict arise between DOD Area Frequency Coordinators and NASA Field Installation Spectrum Managers that cannot be resolved satisfactorily through measures acceptable to the NASA installation involved, forward a complete and detailed report to NASA Headquarters Spectrum Manager, Code TS.

c. Coordination Procedures for the National Radio Quiet Zone.

(1) The National Radio Quiet Zone is an area approximately 100 miles square set aside for radioastronomy observations. This area is bounded by 39°15'N on the North, 78°30'W on the East, 37°30'N on the South and 80°30'W on the West (Figure 3-3).

(2) To protect this zone from interference, the following criteria have been established for the maximum field strength limits:

50 MHz to 1 GHz	Less than 0.1 microvolt per meter
1 GHz to 10 GHz	Less than 1.0 microvolt per meter
10 GHz to 100 GHz	Less than 10.0 microvolt per meter

(Measured at 38°31' 16" N, 79°16' 36" W at 2292 feet above mean sea level.)

(3) All proposed frequency assignments to NASA radio stations within the National Radio Quiet Zone must be coordinated with the Naval Research Laboratory (NRL) Washington, DC 20332, prior to authorization.

3.5 NASA CONTRACTORS (NASA FAR SUP. 18-23.71 APPLIES)

a. Field Installation Spectrum Manager.

(1) The Field Installation Spectrum Manager shall request the contracting officer to insert the clause, Frequency Authorization, in any contract which calls for the development, construction or operation of a device for which a radio frequency authorization is required.

(2) The spectrum manager shall provide to the contracting officer such technical assistance as may be required to enable the issuance of a radio frequency assignment, including

the provision of NASA Form 566, Application for Authorization of a Radio Frequency Assignment (Figure 3-2).

b. NASA Contracting Officers. Commercial contractors, providing or operating RF equipment for NASA use, shall obtain RF spectrum authorization in accordance with the terms of the contract, through the NASA contracting officer.

3.6 FOREIGN FREQUENCY ASSIGNMENTS

Foreign frequency assignments will be obtained by the senior NASA official available at, or convenient to, the site of operations. Reports of all such actions will be made to the AA/OSO, National Aeronautics and Space Administration, Washington, DC 20546.

3.7 CONDITIONS OF ASSIGNMENT

a. All NASA field activities will be assigned frequencies by NASA Headquarters, Code TS, and will reflect full particulars of the assignment. The Headquarters Spectrum Manager will forward these assignments, using NASA Form 586, to the appropriate Field Installation Spectrum Manager upon completion of the frequency coordination process. Based on this authorization, Field Installation Spectrum Managers will issue Field Installation RFA's.

b. Annually, the NASA Headquarters Spectrum Manager will provide each Field Installation Spectrum Manager with a current list of all NASA frequency assignments that have been approved by IRAC. Additionally, a copy of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management will also be supplied to all Spectrum Managers. Supplements to the Manual will be furnished by Headquarters, when published by NTIA.

c. All NASA frequency assignments are issued subject to the following conditions:

(1) All frequencies assigned by NASA are issued subject to the conditions stated on the assignment.

(2) Radio transmitters must be operated by adequately trained and designated personnel, and in a manner conforming to established and accepted procedures.

(3) Transmitter operations must be conducted only on authorized frequencies.

(4) Power, emissions and conditions of assignments must be adhered to at all times.

(5) All radio transmissions must be identified by the use of the authorized radio call signs pursuant to the NTIA Manual of Regulations and Procedures for Radio Frequency Management (Appendix H).

(6) Transmitter operations must be held within the prescribed tolerances outlined in the NTIA Manual, unless otherwise authorized.

(7) A copy of the current frequency authorization for each radio station must be posted or retained in some manner at the principal control point of each station.

(8) Appropriate logs must be maintained at each radio station showing the dates and hours of use, and link parameters.

(9) A radio frequency evaluation must be conducted to determine the effects on human health, including interference with personnel operations such as maintenance procedures. Evaluations must be handled at a local level and must be coordinated with the Radio Frequency Spectrum Manager. Local procedures will vary at each site but should follow ANSI C95.1, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields."

d. Chapter 7 of the NTIA Manual outlines conditions under which specific frequency usage may be authorized without prior coordination with NASA Headquarters. Spectrum Managers may issue local Radio Frequency Assignment (RFA) without referral to NASA Headquarters Communications and Data Systems Division, Code TS, to cover those operations which meet the criteria established in this chapter of the NTIA Manual for the particular frequency usage involved.

3.8 EMERGENCY AND WARTIME PROCEDURES

a. Emergency Procedures. Under an emergency condition, Field Installation Spectrum Managers may use or assign to an operation under their direction, frequencies not otherwise authorized, provided that:

(1) The nature and duration of the requirement is such that the normal frequency assignment procedures are impractical.

(2) All reasonable measures must be taken before such frequencies are used to ensure that harmful interference will not be caused to other users.

b. Wartime Procedures.

(1) In wartime, all radio frequencies, both Government and non-Government will be under the centralized authority of NTIA. Normally, under such conditions, military operations will take precedence over non-military operation. However, all priorities are established by NTIA to take into account all aspects of the President's communications requirements for the national defense in time of war.

(2) NASA's role in providing support for these wartime procedures is established through NTIA by the NASA Spectrum Management Program Manager and will be implemented as required. The specific procedures are beyond the scope or intent of this Manual.

CHAPTER 4: RFI PROCEDURES

4.1 RADIO FREQUENCY INTERFERENCE REPORTING PROCEDURES

a. The probability of harmful radio frequency interference (RFI) increases as more and more demands for frequency assignments are placed on the RF spectrum. In an attempt to meet these demands and to optimize the use of the spectrum, the space between channels is minimized within the limitations imposed by the state-of-the-art development of electronic equipment; the same frequencies are often shared by frequency users separated geographically; or the same frequencies may be assigned to two or more users on a time-share basis. Because of this, some interference must be expected (and even tolerated) since, ordinarily, clear channels are not available within the overcrowded RF spectrum.

b. Occurrences of interference are to be investigated initially at the lowest possible echelon of NASA spectrum management. Requests for the assignment of replacement frequencies will be made only if the interference is prolonged and disruptive, and cannot be cleared through normal procedures.

4.2 RFI CONTROL PROCEDURES

a. Radio Frequency Users.

(1) Normally, the NASA frequency user will be the first to become aware of RFI, and a judgment must be made of how the observed RFI affects the operation.

(2) If the interference is such that it cannot be tolerated, proceed in the following manner:

Step 1. Thoroughly check the affected equipment to ensure that the RFI is not being generated internally or on-site and that the equipment is operating properly.

Step 2. If possible, identify by call sign (or other identification) the station causing the interference.

Step 3. Measure the frequency or band of frequencies causing the interference.

Step 4. Determine the type of emission and the type of traffic being transmitted.

Step 5. Measure the bandwidth of the interfering signal (highest and lowest frequencies) and note the type of equipment used for measurement.

Step 6. Measure the interference signal strength with a high quality field strength meter.

Step 7. Determine the nature or severity of the interference. Indicate the impact to operations including the severity of data loss or data degradation due to the interference.

Step 8. After the information in Steps 2 through 7 has been obtained, report this data to the Field Installation Spectrum Manager together with a formal request to clear the interference.

Step 9. Supply the Field Installation Spectrum Manager with any additional information that is necessary or may be useful in identifying and clearing the RFI (e.g., tape recordings or spectrum photographs).

b. Field Installation Spectrum Managers.

(1) The Field Installation Spectrum Manager will make every effort to clear the interference at the installation before requesting assistance from NASA Headquarters.

(2) Follow the appropriate procedures listed below to clear cases of interference to agency operations:

Step 1. Check the information supplied by the frequency user to ensure that it is as complete as possible. Request additional information from the user as required for filing the standard RFI report (See Step 6).

Step 2. If the station can be identified, contact the interfering station directly, and attempt to clear the interference through coordination with the station manager. If the interference originates from a foreign (non-U.S.) source, contact the NASA Headquarters Spectrum Manager for further assistance (see paragraph 4.2 e (2) and (3)).

Step 3. If direct contact with the interfering station is unsuccessful and the interference appears to be from a non-Government station, request assistance from the nearest FCC monitoring station as required, to coordinate efforts to clear the interference.

Step 4. If the interference is encountered on or from a DOD Test Range, report the RFI to the Area Frequency Coordinator (see Table 3-1) in accordance with appropriate range communications instructions.

Step 5. If all attempts to clear the interference through local coordination fail, report the RFI to the NASA Headquarters Spectrum Manager in accordance with Steps 6 and 7.

Step 6. Forward a message (telegraphic report) directly to the NASA Headquarters Spectrum Manager. Use the standard RFI reporting format shown in Figure 4-1 for listing the particulars of the interference.

REPORT OF HARMFUL INTERFERENCE

- Particulars Concerning the Station Causing the Interference:

  A. Name or call sign and category of station ....
  B. Frequency measured ....
  C. Class of emission ....
  D. Bandwidth ....
  E. Field strength ....
  F. Nature of interference ....

- Particulars Concerning the Transmitting Station Interfered With:

  G. Name or call sign and category of station ....
  H. Frequency assigned ....
  I. Frequency measured ....
  J. Class of emission ....
  K. Bandwidth ....
  L. Field strength ....

- Particulars Furnished by the Receiving Station Experiencing the Interference:

  M. Name of station ....
  N. Geographic location of station ....
  O. Dates and times of occurrence of harmful interference ....
  P. Other particulars ....
  Q. Requested action ....

NOTE: For convenience and brevity, prepare telegraphic reports in the format above, using the letters in the order listed in lieu of the explanatory titles, and an "X" after any such letter if no information on this particular item is reported.

FIGURE 4-1. STANDARD RFI REPORTING FORMAT

Step 7. As soon as practical, forward a followup letter to the NASA Headquarters Spectrum Manager. Reference the message by number and date/time group, and include the same information as the message together with a detailed report of local action taken to eliminate the interference.

(3) The Field Installation Spectrum Manager should cooperate fully with non-NASA spectrum users in resolving RFI which may be caused by emissions from within the local Field Installation.

c. NASA Headquarters Spectrum Manager.

(1) When an RFI problem cannot be resolved at the field installation, the NASA Headquarters Spectrum Manager must clear the interference through direct coordination with other agencies if the problem is a national one, or indirectly with the assistance of the FCC or the NTIA if the problem is international.

(2) Follow the steps given below as they apply to the particular situation:

Step 1. If the RFI is caused by a non-government station operating in the United States and its Possessions, notify the Federal Communication Commission directly, and provide such information and assistance required to enable the FCC to clear the interference.

Step 2. If the RFI is caused by a station operated by another agency or department of the U.S. Government, refer the matter to the Interdepartment Radio Advisory Committee, including a full report of the interference and a request for action or assistance as required.

Step 3. If the RFI is caused by a station of another nation operating outside the United States and its Possessions, refer the matter to IRAC or to NTIA as appropriate. NTIA or the FCC will assume the coordination necessary to resolve the problem at the international level through the ITU, if required.

(3) The NASA Headquarters Spectrum Manager should cooperate fully with non-NASA spectrum users in resolving RFI which may be caused by emissions from within the local field installation.

d. STS RFI Management. Procedures for RFI Management for the Space Transportation System (STS) are defined in NASA Publication STDN No. 912 dated May 1988 and titled Space Transportation System Radio Frequency Interference Management Manual (Rev 2).

e. Interference From Foreign (Non-U.S.) Sources.

(1) All other NASA flight projects shall follow the procedures outlined earlier in this paragraph for the management of RFI situations, except when the interference originates from a foreign (non-U.S.) source.

(2) In the case of interference from a foreign (non-U.S.) source, the NASA Headquarters Spectrum Manager shall use the information supplied in the standard RFI report to apprise appropriate spectrum administration offices (e.g., NTIA, FCC, Department of State), of the interference, its nature, source and the need for cessation.

(3) In the case where interference from a foreign (non-U.S.) source is jeopardizing the return of unique scientific data or the survival of a spacecraft (e.g., spacecraft emergency), the NASA Spectrum Management Program Manager shall contact appropriate Space Frequency Coordination Group members to try to secure cessation of the interfering transmission. This action is to be followed up via a formal report to the appropriate spectrum administration office (e.g., NTIA, FCC or Department of State).

f. NASA/ESA/NASDA RFI Coordination Procedures. Coordination of spectrum use between NASA, the European Space Agency (ESA) and the National Space Development Agency of Japan (NASDA) shall conform to the procedures outlined in the appropriate coordination manual.

g. Space Frequency Coordination Group (SFCG).

(1) The SFCG was established in order to provide a less formal and more flexible environment, as compared with the formal structure of the International Telecommunications Union (ITU), for the solution of frequency management problems encountered by member space agencies. The Terms of Reference for SFCG are given in Appendix K.

(2) The SFCG is concerned with the effective use and management of those radio frequency bands as allocated in the Radio Regulations of the ITU for radio services within the scope of CCIR Study Group 2. In particular, the services of interest to the SFCG include space research, earth exploration satellites, meteorological satellites, space operations, data relay satellites and radio astronomy (including radar astronomy) to the extent that they are relevant to spacecraft missions. Within the formal framework of the Radio Regulations, there is the need and opportunity for international informal agreement among participating space agencies concerning assignment of specific frequencies, and related technical issues.

(3) The principal result of SFCG meetings is the adoption of resolutions and recommendations which express technical and administrative agreements. These agreements may be used by space agencies to make best use of allocated bands and to avoid interference.

PAGE ______ INTENTIONALLY BLANK

CHAPTER 5: NASA LONG RANGE SPECTRUM PLANNING

5.1 BACKGROUND

a. NASA Communications and Data Systems Division, Code TS, is responsible for long term international and national spectrum management initiatives aimed at improving the spectrum management environment within which the agency must operate. Initiatives, however, may require many years to accomplish. For instance, in cases where new frequency allocations or changes to the National and International Radio Regulations are required, lead times of more than a decade may be necessary since international (ITU) meetings which are held to make such changes are few and far between. For this reason, and to permit the agency to continue to operate in compliance with paragraphs 1.4 and 1.5 of this Manual, the NASA Spectrum Management Program Manager must be aware of new concepts which may require spectrum support with sufficient time available to accomplish changes.

b. Considering typical design and construction periods, it is essential that appropriate spectrum be allocated a minimum of 5 years prior to anticipated launch dates for all agency missions. Since new allocations may take as much as 10 years to realize, it is essential that the NASA Spectrum Management Program Manager be informed of new mission concepts as early as possible so that appropriate allocation initiatives may be identified.

5.2 LONG RANGE PLANNING

a. General. In light of potential long lead time requirements for some new mission concepts, the NASA Spectrum Management Program Manager maintains a long range spectrum forecast in order to identify needed spectrum management initiatives in a timely manner. Appendix I presents this forecast identifying current mission concepts and dates at which new requirements must be identified so that appropriate spectrum management action can be initiated. All dates are driven, primarily, by the anticipated dates of World Administrative Radio Conferences (WARC's) and projected launch dates of particular missions. It is expected that many mission RF spectrum needs will be satisfied by existing allocations. However, for some missions, changes in international and national regulations may be required to support new and entirely unique operations in the future (such as operations on or in the vicinity of the far side of the Moon or for radio links between a Transatmospheric Vehicle and the Earth). To this end, the long range spectrum forecast attempts to identify dates at which consideration of these matters needs to be completed if NASA is to operate in an interference free environment.

b. Program Office Responsibilities.

(1) For future agency missions it is the responsibility of each NASA Program Office to provide the latest conceptual communications requirements to the NASA Spectrum Management Program Manager in respect of programs and future mission concepts over which they may have cognizance. This information should be provided from the inception of the conceptual mission and updated as the program evolves.

(2) The NASA Spectrum Management Program Manager will provide an assessment of the spectrum requirements in consultation with the concerned Program Office with sufficient lead time to allow appropriate regulatory action.

(3) Each Headquarters Office should review the long range spectrum forecast, as contained in Appendix I with the goal of providing updated mission concepts and new anticipated launch dates to the NASA Spectrum Management Program Manager via consultation with that office or via the FMLG.

c. Field Installation Responsibilities.

(1) For future agency missions, it is the responsibility of each Field Installation Spectrum Manager to provide the latest conceptual communications requirements to the Spectrum Management Program Manager in respect of projects and future mission concepts over which the installation may have cognizance. This information should be provided from the inception of the conceptual mission and updated as the project evolves.

(2) The NASA Spectrum Management Program Manager will provide an assessment of the spectrum requirements in consultation with the installation with sufficient lead time to permit appropriate regulatory action.

(3) Each field installation should review the long range spectrum forecast, as contained in Appendix I, with the goal of providing updated mission concepts and new anticipated launch dates to the NASA Spectrum Management Program Manager via consultation with that office and/or via the FISMG.

APPENDIX A

INTERNATIONAL SPECTRUM MANAGEMENT STRUCTURE

The International Telecommunication Union (ITU) is recognized by the United States as the agency for international telecommunications policy and regulations. Figure A-1 presents the general ITU structure with its components of the Administrative Council, the International Frequency Registration Board (IFRB), the International Consultative Committee for Telephone and Telegraph (CCITT) and the International Consultative Committee for Radio (CCIR).

The authority of the ITU is derived from its member nations and is contained in the ITU Convention, the Radio Regulations, the Telephone Regulations and the Telegraph Regulations each of which holds treaty status.

A.1 PLENIPOTENTIARY

The Plenipotentiary meets once in approximately every 7 years to determine the operational framework of the Union including:

- Election of Secretary-General.
- Election of Administrative Council Members (41).
- Election of CCIR and CCITT Directors and IFRB Members.
- Authorizing any World or Regional Administrative Radio Conferences.
- Approving any changes to the Radio Regulations.
- Determining budget for the Union.
- Publishing the new convention (enabling treaty document).

A.2 ADMINISTRATIVE COUNCIL

The Administrative Council meets annually and is comprised of 41 members elected by the Plenipotentiary to serve until the next Plenipotentiary. The functions served by the Administrative Council are:

- Determines agenda and actual dates for upcoming conferences.
- Manages Union resources between Plenipotentiary meetings.
- Guides, by means of questions and study programs, the work of study groups of the CCIR and CCITT.

A.3 INTERNATIONAL CONSULTATIVE COMMITTEE FOR RADIO (CCIR)

The International Consultative Committee for Radio (CCIR) is a permanent, technical organ of the ITU. The following is a summary list of what the committee does and how:

- Establishes technical standards, interservice operability criteria and parameters for all radio communications services (including space services).
- Work is performed by study groups which are independent specialist groups representing different technical areas.
- CCIR plenary assemblies are held once every 4 years, at the end of each plenary cycle to approve the work done by the CCIR.
- Each study group meets once in interim session (no final papers published) and then, 2 years later, in final session to produce a final report of the group's work during this plenary cycle, for submission to the plenary assembly.

A.4 CCIR STUDY GROUPS

The study groups of the CCIR are responsible for specific areas of technical interest as follows:

Study Group	• 1	Spectrum utilization & monitoring
	• 2	Space research and radioastronomy
	• 3	Fixed service below 30 MHz
	• 4	Fixed satellite service
	• 5	Propagation in non-ionized media
	• 6	Propagation in ionized media
	• 7	Standard frequencies and time signals
	• 8	Mobile services
	• 9	Fixed service using radio relay systems
	• 10/11	Broadcasting services (sound & television)

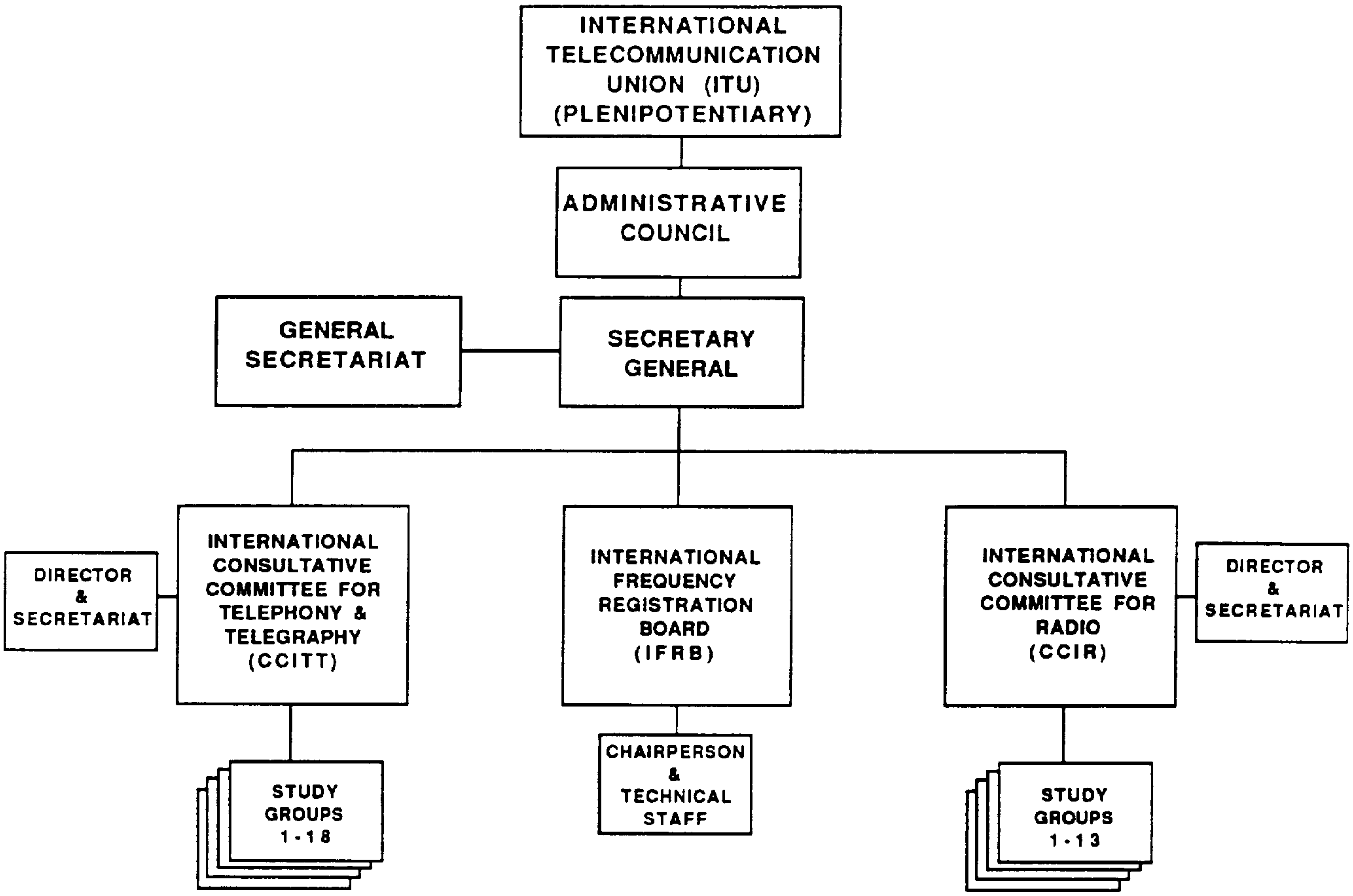


FIGURE A-1. ITU STRUCTURE

PAGE ________ INTENTIONALLY BLANK

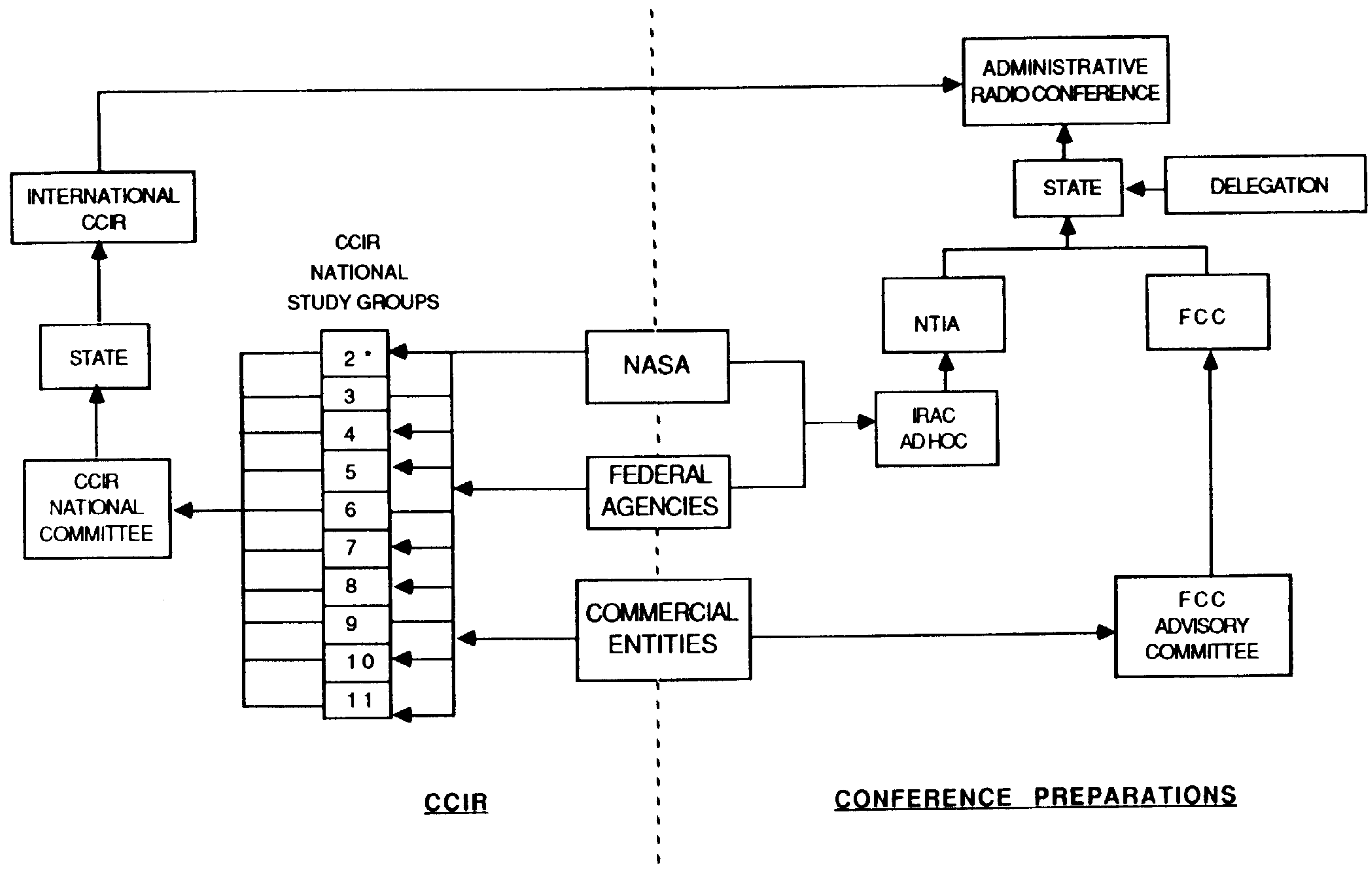
APPENDIX B

NATIONAL/INTERNATIONAL SPECTRUM INTERFACES

The relationship between the U.S. and international spectrum management structures is shown as Figure B-1. The figure depicts two paths. One is the CCIR path where technical studies of radio matters are conducted; the other depicts the preparations within the U.S. leading to an Administrative Radio Conference.

Conference preparation follows the flow as shown in Figure B-1. NASA, as well as other Federal agencies, inputs proposals to the IRAC Ad Hoc working groups, after which they are submitted to NTIA and finally, through the Department of State, to the conferences.

NASA's technical interests are in the CCIR Study Groups concerned with the space services which support U.S. civil and commercial space programs. In general, technical studies of current interest are supplied to the National Study Group by member agencies. When approved by the National Study Group, they are forwarded to the CCIR National Committee for national policy review prior to being submitted to the International CCIR Study Group. The results of CCIR studies provide the technical bases for Administrative Radio Conferences.



* Chaired by NASA

FIGURE B-1. NATIONAL/INTERNATIONAL SPECTRUM INTERFACES

008A

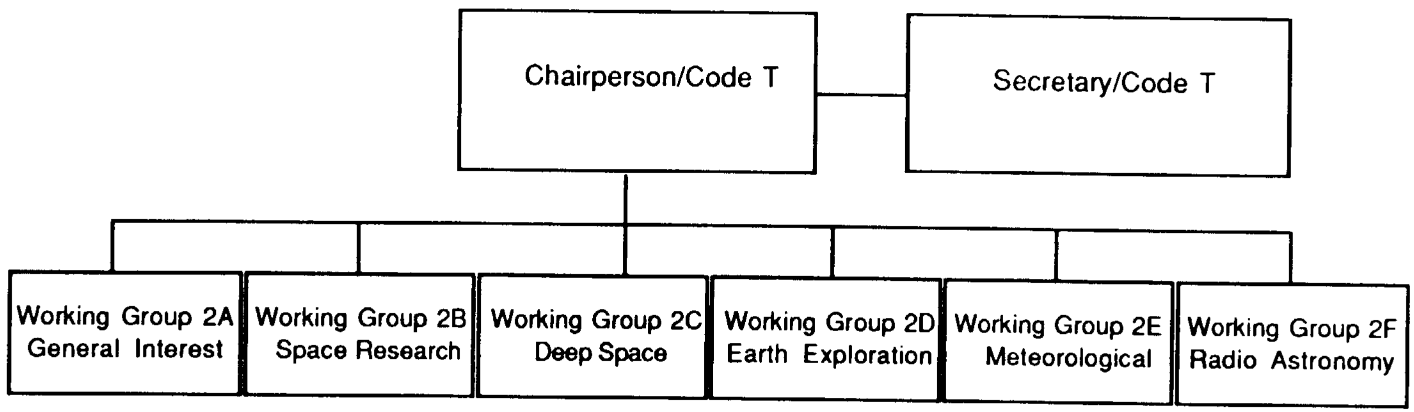


FIGURE B-2. NATIONAL CCIR STUDY GROUP 2 STRUCTURE

PAGE ______ INTENTIONALLY BLANK

APPENDIX C

CURRENT NASA SPECTRUM MANAGEMENT ADDRESSES

Location	Address
Office of Space Operations (OSO)	NASA Headquarters, Code T Washington, DC 20546 Tel: (202) 453-2019
Communications & Data Systems Division	NASA Headquarters, Code TS Washington, DC 20546 Tel: (202) 453-2000
Code TS	Manager, Spectrum Management Program NASA Headquarters, Code TS Washington, DC 20546 Tel: (202) 453-1998
Code TS	Headquarters Spectrum Manager NASA Headquarters, Code TS Washington, DC 20546 Tel: (202) 453-2008
Ames Research Center	Spectrum Manager NASA, Ames Research Center Mail Stop 233-18 Moffett Field, CA 94035
Ames/Dryden Flight Research Facility	Spectrum Manager NASA, Ames/Dryden Flight Research Facility Mail Stop OFI P.O. Box 273 Edwards, CA 93523
Goddard Space Flight Center	Spectrum Manager NASA, Goddard Space Flight Center Code 502 Greenbelt Road Greenbelt, MD 20771
Goddard/Wallops Flight Facility	Spectrum Manager NASA, Goddard/Wallops Flight Facility Wallops Island, VA 23337
Jet Propulsion Laboratory	Spectrum Manager Jet Propulsion Laboratory Mail Stop 303-404 4800 Oak Grove Drive Pasadena, CA 91109

Johnson Space Center	Spectrum Manager NASA, Johnson Space Center Code EE 8 Houston, TX 77058
Kennedy Space Center	Spectrum Manager NASA, Kennedy Space Center Mail Stop TE-CID-2A Kennedy Space Center, FL 32899
Langley Research Center	Spectrum Manager NASA, Langley Research Center Mail Stop 488 Hampton, VA 23665
Lewis Research Center	Spectrum Manager NASA, Lewis Research Center Mail Stop 501-10 21000 Brookpark Road Cleveland, OH 44135
Marshall Space Flight Center	Spectrum Manager NASA, Marshall Space Flight Center Code AI52 Marshall Space Flight Center, AL 35812
Stennis Space Center	Spectrum Manager NASA, Stennis Space Center Code GA20 Stennis Space Center, MS 39529
Michoud Assembly Facility	Facility Spectrum Coordinator Martin Marietta, Dept. 350 P.O. Box 29300 NASA/Michoud Assembly Facility New Orleans, LA 70189

N.B. A current listing of assigned personnel, including names, alternates, and telephone numbers will be published annually with the minutes of the NASA Field Installation Spectrum Managers meeting.

APPENDIX D

FREQUENCY MANAGEMENT LIAISON GROUP (FMLG)

The Frequency Management Liaison Group (FMLG) is organized to provide a forum for the exchange of information on radio frequency spectrum management requirements, policies, and issues between all Program Offices of the agency.

D.1 PURPOSE

The group is established to provide the means by which the Associate Administrator for Space Operations assures other Headquarters Offices of the agency's compliance with Office of Management and Budget (OMB) Circular A-11, Section 13.2.

The group also provides the means of assuring spectrum compatibility between the different communications systems requirements, in support of the different Program Office mission goals.

D.2 OBJECTIVES

The group provides a medium for each Program Office to input the communications requirements of all current and future programs sponsored by that office to the NASA Spectrum Management Program Manager, Code TS, in a timely manner, to ensure that spectrum support is available, as and when required by each program.

The group also provides the means for Headquarters Offices to review and comment on the status and progress of frequency spectrum support issues and activities in the national and international frequency spectrum arenas.

Additionally, the group provides assurance of intra-NASA compatibility by reviewing, for coordination purposes, spectrum support submissions prior to frequency assignment application.

D.3 ORGANIZATION

The group is co-chaired by the Director, Communications and Data Systems Division (Code TS), and the Director, Communications and Information Systems Division (Code EC) on behalf of the Associate Administrator for Space Operations (Code T), who is responsible for overall agency frequency spectrum policy.

Each Program Office provides to the group one representative, knowledgeable in the communications requirements of all current and future programs sponsored by that office.

Meetings of the group are convened by the Chairpersons, as necessary, but not more than 90 days should elapse between meetings.

The work of the group will be recorded by means of three documents:

1. Meeting Minutes, published after each meeting.

2. Action Item List, reviewed and updated at each meeting.

3. Calendar of Events for 1 year, updated monthly.

These documents, published by the Chairperson, will be distributed to all members. Additionally, all three documents are available in current status on the electronic bulletin board, FMLGBB, available to all NASAMAIL users.

APPENDIX E

FIELD INSTALLATION SPECTRUM MANAGERS' GROUP (FISMG)

The NASA Field Installation Spectrum Managers' Group (FISMG) is organized to provide a forum for the exchange of information on radio frequency spectrum management requirements, actions and issues among all NASA Field Installation Spectrum Managers.

E.1 PURPOSE

The group provides the assurance to the Spectrum Management Program of the field installations' compliance with NASA policy.

E.2 OBJECTIVES

The group provides a medium for each field installation to input the communications requirements of all current and future projects undertaken by that installation to the NASA Spectrum Management Program Manager, Code TS, in a timely manner, to ensure that spectrum support is available, as and when required by each project.

The group also provides a means for Field Installation Spectrum Managers to be kept informed on the status and progress of frequency spectrum support issues in the national and international frequency spectrum arenas.

Additionally, the group's meetings provide the opportunity for field installations to comment on proposed agency and interagency frequency spectrum issues.

E.3 ORGANIZATION

The group is chaired by the NASA Spectrum Management Program Manager, Code TS, on behalf of the Associate Administrator for Space Operations, who is responsible for overall NASA frequency spectrum policy.

Each Field Installation Spectrum Manager provides to the group one representative knowledgeable in the communications requirements of all current and future project activities in which the installation is involved.

Meetings of the group are convened annually by the Chairperson. Meeting locations will vary to provide each field installation the opportunity to host.

The work of the group is recorded by means of three documents:

1. Meeting Minutes, published after each meeting.

2. Action Item List, reviewed and updated at each meeting.

3. Calendar of Events for 1 year, updated monthly.

These documents, published by the Chairperson, are distributed to all members, in hard copy format.

APPENDIX F

NTIA SYSTEMS REVIEW

Details of the NTIA Systems Review can be found in the NTIA Manual. In summary, the procedure consists of a four-stage review described below.

Stage 1 Conceptual

The initial planning effort has been completed, including proposed frequency bands and other available characteristics.

The Space Systems Group (SSG) of the Spectrum Planning Subcommittee (SPS) will review the information provided by the agency. The Stage 1 Systems Review addresses the certification of spectrum support for telecommunication systems or subsystems and provides guidance on the feasibility of obtaining certification of spectrum support at subsequent stages. Those systems or subsystems that have a major impact on spectrum usage as defined by user agencies, IRAC, or NTIA, especially those that use new technological concepts or use existing technology in significant new ways, should be submitted. The guidance provided will indicate any modification, including more suitable frequency bands, necessary to assure conformance with the Tables of Frequency Allocations and the provisions of Chapter 5 of the NTIA Manual.

Because much of the system data will be estimated, in analyses performed by the SPS leading to certification of spectrum support, only gross calculations may be achievable for a general evaluation of spectrum impact and will be subject to adjustment during later stages. The system will be reviewed in conformance to International and National Allocation Tables. In addition, checks will be made against existing standards and sharing criteria, comparison will be made with known similar systems, and spectrum efficiency will be considered.

Stage 2 Experimental

The preliminary design has been completed, and radiation, using test equipment or preliminary models, may be required.

Information identified in the Stage 1 Systems Review should be enhanced to make it current. Along with this, information required by Appendix 4 of the ITU Radio Regulations shall be furnished to the SSG in accordance with the instructions in the current Manual of Instructions and Procedures for Notifying US Radio Frequency Assignment Data to the International Frequency Registration Board. This data may be used in lieu of the data required for Stage 1 or 2 Systems Review request. The Appendix 4 data shall be provided to the SSG at the same time as the request for Stage 2 Systems Review and shall not normally be transmitted to the IFRB for advance publication until Stage 2 Certification of Spectrum Support has been granted.

The Advance Publication Information should be submitted not earlier than 6 years and preferably not later than 2 years before bringing the frequency assignments into use. There is no minimum time period but as a practical matter if coordination and/or agreement is required the information should be submitted at least 2 years before bringing the frequency assignments into use.

The Radio Regulations require information for each "satellite network", e.g., a satellite "system" or part thereof consisting of "only one satellite and the co-operating earth station(s)" or in the case of inter-satellite links, "the associated satellite network". The information on a multi-satellite system should, where possible, be furnished to the IFRB in separate parts, each corresponding to a satellite network.

In the case of a geostationary satellite system, there is no difficulty in singling out each network.

In the case of a nongeostationary satellite system, an operator may find it difficult to single out one satellite (and its cooperating earth stations) from the system in order to assign an identity to the network. One system may be composed of two satellites, one of which is working while the other is idle. Another system may be composed of a large number of satellites operating simultaneously. Thus, according to the type of nongeostationary satellite system involved, it may be difficult or even impossible to draw a distinction between network and system. In order to distinguish between the different networks of such a nongeostationary satellite system, it is often necessary to specify factors such as the satellite's orbit, the nature of the service to be provided, the coverage area on the Earth's surface, the daily hours of operation, etc., which would lead to unwarranted complications.

Unless the agency can easily break down the satellite system into separate networks, the identity of the entire nongeostationary satellite system should be entered and information on the whole system should be furnished.

Certification of spectrum support for telecommunication systems or subsystems at Stage 2 is a prerequisite for NTIA authorization of radiation in support of experimentation for space systems. It also provides guidance for assuring certification of spectrum support at subsequent stages. Certification at Stage 2 may be requested for test equipment, modified operational equipment or initial design models that can be used to determine which of several frequency bands or which of several proposed equipment configurations should be selected for continued investigation.

In the review leading to certification of spectrum support at Stage 2, an evaluation of the system conformance to NTIA Manual Chapter 5 specifications is performed along with an assessment of the system usage for war emergencies and verification that Appendix 4 of the ITU Radio Regulations is satisfied. A general analysis will be applied by the Spectrum Planning Subcommittee, where appropriate, with more specific Electromagnetic Compatibility (EMC) analysis, against a typical environment, being added where experimental testing of technically defined equipments is involved. Recommendations for changes to equipment characteristics and contemplated operational employment/deployment will be provided, when appropriate. Calculations required in connection with national and international space coordination procedure s in accordance with the methods of Appendices 28 and 29 of the ITU Radio Regulations will be performed to the extent practicable. After the SPS review is complete and approved, the agency may forward a request to the Frequency Assignment Subcommittee to obtain the necessary frequency assignment. At this stage the frequency request should be for a trial assignment for the location at which the system will be tested. The procedure for a Frequency Assignment is contained in paragraph 3.3 of this Manual.

Stage 3 Developmental

The major design has been completed and radiation may be required during testing.

For the Stage 3 Systems Review, the agency must update the information already provided and include as a minimum:

(1) For each earth station transmitter and receiver site:

(a) Frequencies or frequency bands and satellites to be accessed.

(b) Coordinates.

(c) Emission designator for each frequency or frequency band.

(d) Maximum spectral power density and output power for each frequency or frequency band.

(e) Lowest equivalent satellite link noise temperature and associated value of transmission gain for each frequency or frequency band (geostationary satellites with simple frequency changing transponders only).

(f) Antenna gain and beamwidth.

(g) Minimum elevation angle of antenna main beam.

(h) Range of azimuth angles.

(i) Lowest total receiver noise temperature (when (e) is not appropriate).

(2) For each space station transmitter and receiver:

(a) Frequency or frequency bands and cooperating earth stations.

(b) Satellite orbital information.

(c) Emission designator for each frequency or frequency band.

(d) Peak power and spectral power density for each frequency or frequency band for transmitters.

(e) Receiver noise temperature.

(f) Transmitter antenna pattern (only if power flux density limits are exceeded).

The format for providing this data is left to the discretion of the agency. However, for unclassified space systems which have not been waived from the requirements of international registration, similar information must be prepared in specific formats and submitted to the SSG in accordance with instructions in the Manual of Instructions and Procedures for Notifying US Radio Frequency Assignment Data to the International Frequency Registration Board. These data, required by the SSG to satisfy the specifications in Appendix 3 of the ITU Radio Regulations, shall be submitted at the same time as the Stage 3 Systems Review requests and may be used in lieu of the data required for Stage 3 and 4 Systems Review requests.

Following receipt of these data, the SPS/SSG will initiate the Stage 3 Systems Review. Certification of spectrum support for telecommunication systems or subsystems at Stage 3 is a prerequisite for NTIA authorization of radiation in support of developmental testing for systems that are subject to these procedures. It also provides guidelines for assuring certification of spectrum support at Stage 4. At this point, the intended frequency band will normally have been determined and certification at Stage 3 will be required for testing of proposed operational hardware and potential equipment configurations.

In analyses leading to certification of spectrum support at Stage 3, an evaluation of the required submission of information according to Appendix 3 of the ITU Radio Regulations will be performed. Detailed EMC analyses will be performed using test data and considering specific sites of equipment. A radiation hazard evaluation will be performed using Occupational Safety and Health Administration (OSHA), Operation of Exposure Limits ANSI-C95.1-1982 as the standard. Appropriate recommendations as to equipment characteristics or operational deployment will be developed. Calculations in connection with national and international space system coordination procedures will be performed or updated as appropriate.

After the Stage 3 approval, the agency, through the IRAC representative, should apply for a temporary frequency assignment.

Stage 4 Operational

Development has been essentially completed, and final operating constraints or restrictions required to assure compatibility need to be identified.

When submitting for Stage 4 Systems Review, NASA must update all previous information provided.

Certification of spectrum support for telecommunication systems or subsystems at Stage 4 is a prerequisite for NTIA authorization of radiation from a station with an operational station class (i.e., other than experimental) for systems that are subject to these procedures. It provides restrictions on the operation of the system or subsystems as may be necessary to prevent harmful interference.

In analyses leading to certification of spectrum support at Stage 4, detailed EMC analyses will be updated, as required, to include consideration of frequency assignments for specific system deployment. Appropriate recommendations as to equipment characteristics and/or operational limitations will be provided. Having completed the SPS review process, application can be made for an operational frequency assignment.

APPENDIX G

DETERMINATION OF EMISSIONS AND BANDWIDTHS

G.1 FULL DESIGNATION OF EMISSION

The full designation of an emission consists of alphanumeric symbols for the classification of the emission preceded by a number indicating the necessary bandwidth in kilohertz. The classification symbols are described in paragraph G.2 and the procedure for calculating the necessary bandwidth is given in paragraph G.3.

G.2 CLASSIFICATION OF EMISSIONS

Emissions are classified by alphanumeric symbols that represents the type of modulation of the carrier, type of transmission, and supplementary characteristics of the transmitting system. The basic emission designator consists of three symbols, and if desired, two optional additional symbols, as derived from Tables G-1 to G-5.

Table G-1. First Symbol-designates the type of modulation of the main carrier

Symbol	Type of Emission
	UNMODULATED
N	Emission of an unmodulated carrier.
	AMPLITUDE-MODULATED
	Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated):
A	Double-sideband
B	Independent sidebands
C	Vestigial sideband
H	Single-sideband, full carrier
J	Single-sideband, suppressed carrier
R	Single-sideband, reduced or variable level carrier
	ANGLE-MODULATED
	Emission in which the main carrier is angle-modulated.
F	Frequency modulation
G	Phase modulation
	AMPLITUDE-MODULATED AND ANGLE-MODULATED
D	Emission in which the main carrier is amplitude-modulated and angle-modulated either simultaneously or in a preestablished sequence.
	PULSE
	Emission of pulses:
	(Emissions, where the main carrier is directly modulated by a signal which has been coded into quantized form (e.g., pulse code modulation), shall be designated as either an emission in which the main carrier is amplitude-modulated, or an emission in which the main carrier is angle-modulated).
P	Sequence of unmodulated pulses.
	A sequence of pulses:
K	Modulated in amplitude
L	Modulated in width or duration
M	Modulated in position or phase
Q	Carrier is angle-modulated during the period of the pulse
V	A combination of the foregoing or produced by other means
	COMBINATION
W	Cases not covered above, in which an emission consists of the main carrier modulated, either simultaneously or in a combination of two or more of the following modes: amplitude, angle, pulse.
X [1]	Cases not otherwise covered.

[1] A full explanation for the selection of the letter X shall be provided in the Supplementary Details (SUP) unless the application is for a non-directional beacon in the band 190–415 kHz.

Table G-2. Second Symbol-designates the nature of signal(s) modulating the main carrier

Symbol	Type of Emission
0	No modulating signal.
1	A single channel* containing quantized or digital signals without the use of a modulating subcarrier. (This excludes time-division multiplex.)
2	A single channel* containing a quantized or a digital signal with the use of modulating subcarrier.
3	A single channel* containing an analogue signal.
7	Two or more channels* containing quantized or digital signals.
8	Two or more channels* containing analogue signals.
9	A composite system with one or more channels* containing quantized or digital signals, *together with* one or more channels containing analogue signals.
X [1]	Cases not otherwise covered.

*In this context, the word "Channel(s)" refers to the radio frequency (RF) channel.

[1] A full explanation for the selection of the letter X shall be provided in the Supplementary Details (SUP) unless the application is for a non-directional beacon in the band 190–415 kHz.

Table G-3. Third Symbol--designates the type of information to be transmitted (In this context the word "information" does not include information of a constant, unvarying nature such as provided by standard frequency emissions, continuous wave and pulse radars, etc.)

Symbol	Type of Emission
N	No information transmitted.
A	Telegraphy—for aural reception.
B	Telegraphy—for automatic reception.
C	Facsimile.
D	Data transmission, telemetry, telecommand; (the symbol D indicates that data, telemetry, or telecommand information is being transmitted individually *or*, that any combination of the three are being transmitted *simultaneously*. If any combination *is* being transmitted *simultaneously*, one of the multi-channel symbols, 7, 8, or 9, *must* be used for the second symbol.)
E	Telephony (including sound broadcasting).
F	Television (video).
W	Combination of the above. (Use *only* for multi-channel systems having the *capability* of transmitting all information *simultaneously*).
X [1]	Cases not otherwise covered.

[1] A full explanation for the selection of the letter X shall be provided in the Supplementary Details (SUP) unless the application is for a non-directional beacon in the band 190–415 kHz.

Table G-4. Fourth Symbol--designates the details of signal(s)

Symbol	Type of Emission
A	Two-condition code with elements of differing numbers and/or durations.
B	Two-condition code with elements of the same number and duration without error-correction.
C	Two-condition code with elements of the same number and duration with error-correction.
D	Four-condition code in which each condition represents a signal element (of one or more bits).
E	Multi-condition code in which each condition represents a signal element (of one or more bits).
F	Multi-condition code in which each condition or combination of conditions represents a character.
G	Sound of broadcasting quality (monophonic).
H	Sound of broadcasting quality (stereophonic or quadraphonic).
J	Sound of commercial quality (excluding categories defined for symbols K and L below).
K	Sound of commercial quality with the use of frequency inversion or band-splitting.
L	Sound of commercial quality with separate frequency-modulated signals to control the level of demodulated signal.
M	Monochrome.
N	Color.
W	Combination of the above.
X	Cases not otherwise covered.

Table G-5. Fifth Symbol--designates the nature of multiplexing

Symbol	*Type of Emission*
N	None.
C	Code-division multiplex (This includes bandwidth expansion techniques.)
F	Frequency-division multiplex.
T	Time-division multiplex.
W	Combination of frequency-division multiplex and time-division multiplex.
X	Other types of multiplexing.

Examples:

Designator	*Type of Emission*
HN0N	Continuous wave.
1K24F1B	1.24 kHz necessary bandwidth for frequency modulated single channel telegraphy.
16KF3EJN	16 kHz necessary bandwidth for commercial telephony.

G.3 DETERMINATION OF NECESSARY BANDWIDTH

1. The necessary bandwidth is the minimum value of bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed. Emissions needed for satisfactory functioning of the receiving equipment (such as the carrier in reduced-carrier systems, or a vestigial sideband but not the effect of doppler) are included in the necessary bandwidths.

2. When the full designation of an emission is required, the symbol for that emission (as given in paragraph G.2) is preceded by the number of hertz, kilohertz or megahertz (see examples) required for the necessary bandwidths. Bandwidths are generally expressed to a maximum of three significant digits with the third digit usually being a multiple of five.

3. To calculate the necessary bandwidths, the formulas set forth in Table G-6 can be used. (This table also gives examples of the calculation of necessary bandwidths and full designation of corresponding emissions.) The necessary bandwidths can also be computed in accordance with CCIR Recommendation 328-1. In cases in which computation is not practical, the necessary bandwidth can be obtained by measurement.

4. The value of necessary bandwidth determined by calculation or measurement should be used in designating the full emission. The necessary bandwidths so determined is not the only characteristic of an emission to be considered in evaluating the interference caused by that emission.

5. The terms used in the formulas set forth in Table G-6 are defined as follows:

B_n = Necessary bandwidth .

B = Digital symbol rate for telegraphy (i.e., baud).

N = Maximum possible number of black plus white elements to be transmitted per second, in facsimile.

M = Maximum modulation frequency.

C = Sub-carrier frequency.

D = Peak deviation, i.e., half the difference between the maximum and minimum values of the instantaneous frequency.

t = Pulse duration in seconds at half-amplitude.

K = An overall numerical factor which varies according to the emission and which depends upon the allowable signal distortion.

N_c = Number of baseband channels in radio systems employing multichannel multiplexing.

fp = Continuity pilot subcarrier frequency (continuous signal utilized to verify performance of frequency-division multiplex systems).

R = Digital information rate.

S = Number of equivalent non-redundant signaling states.

6. Further, more detailed, information on the method of calculation of necessary bandwidth is available in Annex J of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (current edition).

Table G-6. Typical Necessary Bandwidth Calculations

I. NO MODULATING SIGNAL

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Continuous wave emission	—	—	NON

II. AMPLITUDE MODULATION

1. Signal with Quantized or Digital Information

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Continuous wave telegraphy, Morse code	$B_n = BK$, $K = 5$ for fading circuits, $K = 3$ for non-fading circuits	25 words per minute; $B = 20$, $K = 5$ $B_n = 100$ Hz	100H00A1AAN
Telegraphy by on-off keying of a tone modulated carrier, Morse code	$B_n = BK + 2M$, $K = 5$ for fading circuits, $K = 3$ for non-fading circuits	25 words per minute, $B = 20$, $M = 1\ 000$, $K = 5$ $B_n = 2\ 100$ Hz $= 2.1$ kHz	2K10A2AAN
Selective calling signal using sequential single frequency code, single-sideband full carrier	$B_n = M$	Maximum code frequency is: 2 110 Hz, $M = 2\ 110$ $B_n = 2\ 110$ Hz $= 2.11$ kHz	2K11H2BFN
Direct printing telegraphy using a frequency shifted modulating sub-carrier, with error-correction, single-sideband, suppressed carrier (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$	$B = 50$, $D = 35$ Hz (70 Hz shift), $K = 1.2$ $B_n = 134$ Hz	134H00J2BCN
Telegraphy, multi-channel with voice frequency, error-correction, some channels are time-division multiplexed, single-sideband, reduced carrier	$B_n =$ highest central frequency $+ M + DK$ $M = \frac{B}{2}$	15 channels; highest central frequency is 2 805 Hz, $B = 100$, $D = 42.5$ Hz (85 Hz shift), $K = 0.7$ $B_n = 2\ 885$ Hz $= 2.885$ kHz	2K89R7BCW

2. Telephony (Commercial Quality)

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Telephony, double-sideband (single channel)	$B_n = 2M$	$M = 3\ 000$ $B_n = 6\ 000$ Hz $= 6$ kHz	6K00A3EJN
Telephony, single-sideband, full carrier (single channel)	$B_n = M$	$M = 3\ 000$ $B_n = 3\ 000$ Hz $= 3$ kHz	3K00H3EJN
Telephony, single-sideband, suppressed carrier (single channel)	$B_n = M -$ lowest modulation frequency	$M = 3\ 000$, lowest modulation frequency is 300 Hz $B_n = 2\ 700$ Hz $= 2.7$ kHz	2K70J3EJN
Telephony with separate frequency modulated signal to control the level of de-modulated speech signal, single-sideband, reduced carrier (Lincompex) (single channel)	$B_n = M$	Maximum control frequency is 2 990 Hz $M = 2\ 990$ $B_n = 2\ 990$ Hz $= 2.99$ kHz	2K99R3ELN
Telephony with privacy, single-sideband, suppressed carrier (two or more channels)	$B_n = N_c M -$ lowest modulation frequency in the lowest channel	$N_c = 2$, $M = 3\ 000$, lowest modulation frequency is 250 Hz $B_n = 5\ 750$ Hz $= 5.75$ kHz	5K75J8EKF
Telephony independent sideband (two or more channels.)	$B_n =$ sum of M for each sideband	Two channels, $M = 3\ 000$ $B_n = 6\ 000$ Hz $= 6$ kHz	6K00B8EJN

Table G-6. Typical Necessary Bandwidth Calculations (Cont'd)

5. Composite Emissions [4]—Continued

Description of Emission	*Necessary Bandwidth*		*Designation of Emission*
	Formula	*Sample Calculation*	
Radio-relay system: frequency division multiplex	$B_n = 2M + 2DK$, $K = 1$ (typically)	960 data channels that operate at a uniform power level of -15dBmO occupying baseband between 60 kHz and 4 028 kHz; rms per channel deviation: 200 kHz; continuity pilot at 4 715 kHz produces 140 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 5.5 = 4.13 \times 10^6$ Hz; $M = 4.028 \times 10^6$ $f_p = 4.715 \times 10^6$, $(2M = 2DK) > 2f_p$ $B_n = 16.32 \times 10^6$ Hz $= 16.32$ MHz	16M30F87D
Stereophonic sound broadcasting with multiplexed subsidiary telephony sub-carrier	$B_n = 2M + 2DK$, $K = 1$ (typically)	Pilot tone system; $M = 75\,000$, $D = 75\,000$ Hz $B_n = 300\,000$, Hz $= 300$ kHz	300K00F8EHF
TV microwave relay system	$B_n = 2M + 2DK$ $K = 1$	Aural program on 7.5 MHz, aural subcarrier deviation ± 150 kHz; continuity pilot at 8.5 MHz produces 140 kHz rms deviation of main carrier; $D = 3.7 \times 10^6$ Hz (visual) plus 0.3×10^6 Hz (aural) Computation of B_n: $M = (7.5 + 0.15) \times 10^6$ Hz; $P = 8.5 \times 10^6$ Hz; $D = (3.7 + 0.3) \times 10^6$ Hz; $(2M + 2DK) > 2P$ $B_n = 23.3 \times 10^6$ Hz	23M00F3WJF
TV microwave relay system	$B_n = 2P$	Aural program on 6.9 MHz subcarrier; aural subcarrier deviation ± 150 kHz; continuity pilot at 8.5 MHz produces 50 kHz rms deviation of main carrier; $D = 2 \times 10^6$ Hz; (visual) plus 0.2×10^6 Hz (aural) Computation of B_n: $M = (2.0 + 0.2) \times 10^6$ Hz; $M = 6.15 \times 10^6$ Hz; $K = 1$; $P = 8.5 \times 10^6$ Hz; $(2M + 2DK) < 2P$ $B_n = 17 \times 10^6$ Hz	17M00F3WJF
Binary Frequency Shift Keying [5]	$(0.03 < \frac{2D}{R} < 1.0)$: $B_n = 3.86D + 0.27R$ $(1.0 < \frac{2D}{R} < 20)$: $B_n = 2.4D + 1.0\,R$	Digital modulation used to send 1 megabit per second by frequency shift keying with 2 signaling states and 0.75 MHz peak deviation of the carrier. $R = 1 \times 10^6$ bits per second; $D = 0.75 \times 10^6$ Hz; $B_n = 2.8$ MHz	2M80F1DBC
Multilevel Frequency Shift Keying	$B_n = (R/Log_2 S) + 2DK$	Digital modulation used to send 10 megabits per second by use of frequency shift keying with four signaling states and 2 MHz peak deviation of the main carrier. $R = 10 \times 10^6$ bits per second; $D = 2$ MHz; $K = 1$; $S = 4$; $B_n = 9$ MHz	9M00F7DDT
Phase Shift Keying	$B_n = 2RK/\mathrm{Log}_2 S$	Digital modulation used to send 10 megabits per second by use of phase shift keying with 4 signaling states. $R = 10 \times 10^6$ bits per second; $K = 1$; $S = 4$; $B_n = 10$ MHz [6]	10M0G7DDT
Quadrature Amplitude Modulation (QAM)	$B_n = \frac{2R}{\log_2 S}$	64 QAM is used to send 135 Mbps has the same necessary bandwidth [7] as 64-PSK used to send 135 Mbps; $R = 135 \times 10^6$bps, $S = 64$, $B_n = 45$ MHz	45M0WXD
Minimum Shift Keying [8]	2-ary: $B_n = R\,(1.18)$ 4-ary: $B_n = \mathrm{R}\,(2.340)$	Digital modulation used to send 2 megabits per second using 2-ary minimum shift keying; $B_n = 2.36 \times 10^6$Hz	2M36G1DBN

Table G-6. Typical Necessary Bandwidth Calculations (Cont'd)

6. Composite Emissions—Continued

Description of Emission	*Necessary Bandwidth*		*Designation of Emission*
	Formula	*Sample Calculation*	
Double-sideband emission of VOR with voice (VOR = VHF omnidirectional radio range)	$B_n = 2C_{max} + 2M + 2DK$, $K = 1$ (typically)	The main carrier is modulated by: —a 30 Hz sub-carrier —a carrier resulting from a 9 960 Hz tone frequency modulated by a 30 Hz tone —a telephone channel —a 1 020 Hz keyed tone for continual Morse identification $C_{max} = 9\,960$, $M = 30$, $D = 480$ Hz $B_n = 20\,940$ Hz $= 20.94$ kHz	20K90A9WWF
Independent sidebands: several telegraph channels with error-correction together with several telephone channels with privacy; frequency division multiplex	B_n = sum of M for each sideband	Normally composite systems are operated in accordance with standardized channel arrangements (e.g. CCIR/Rec. 348-2). 3 telephone channels and 15 telegraphy channels require the bandwidth 12 000 Hz = 12 kHz	12K00B9WWF

III. FREQUENCY MODULATION

1. Signal with Quantized or Digital Information

Description of Emission	*Necessary Bandwidth*		*Designation of Emission*
	Formula	*Sample Calculation*	
Telegraphy without error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$, $D = 85$ Hz (170 Hz shift) $B_n = 304$ Hz	304H00F1BBN
Telegraphy, narrow-band direct-printing with error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$, $D = 85$ Hz (170 Hz shift) $B_n = 304$ Hz	304H00F1BCN
Selective calling signal	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	$B = 100$, $D = 85$ Hz (170 Hz shift) $B_n = 304$ Hz	304H00F1BCN
Four-frequency duplex telegraphy	$B_n = 2M + 2DK$. B = Modulation rate in bauds of the faster channel. If the channels are synchronized: $M = \frac{B}{2}$ (otherwise $M = 2B$). $K = 1.1$ (typically)	Spacing between adjacent frequencies = 400 Hz; Synchronized channels $B = 100$, $M = 50$, $D = 600$ Hz $B_n = 1\,420$ Hz $= 1.42$ kHz	1K42F7BDX

2. Telephony (Commercial Quality)

Description of Emission	*Necessary Bandwidth*		*Designation of Emission*
	Formula	*Sample Calculation*	
Commercial telephony	$B_n = 2M + 2DK$. $K = 1$ (typically, but under certain conditions a higher value may be necessary)	For an average case of commercial telephony, $D = 5\,000$ Hz, $M = 3\,000$ $B_n = 16\,000$ Hz $= 16$ kHz	16K00F3EJN

Table G-6. Typical Necessary Bandwidth Calculations (Cont'd)

IV. PULSE MODULATION

1. Composite Emissions

Description of Emission	*Necessary Bandwidth*		*Designation of Emission*
	Formula	*Sample Calculation*	
Radio-relay system	$B_n = \frac{2K}{t}$ $K = 1.6$	Pulse position modulated by 36 voice channel baseband: pulse width at half amplitude = 0.4 μs. $B_n = 8 \times 10^6$ Hz = 8 MHz (Bandwidth independent of the number of voice channels)	8M00M7EJT
Composite transmission digital modulation using DSB-AM (Microwave radio relay system)	$B_n = 2RK/\log_2 S$	Digital modulation used to send 5 megabits per second by use of amplitude modulation of the main carrier with 4 signaling states $R = 5 \times 10^6$ bits per second $K = 1$ $S = 4$ $B_n = 5$ MHz	5M00K7DD

008A

APPENDIX H

CALL SIGNS

H.1 CALL SIGNS ALLOCATED TO NASA FIELD INSTALLATIONS AND THE JET PROPULSION LABORATORY (JPL)*

Blocks of call signs are allocated to NASA field installations and JPL for assignment by the Field Installation or JPL Spectrum Manager. The Spectrum Manager assigns these call signs, as required, to all frequency users at the installation or JPL, including commercial contractors. The call signs allocated to each NASA field installation and JPL are shown in Table H-1.

Table H-1. Allocation of Call Signs

Lewis Research Center	NA2XAA through NA2XGZ
Dryden Flight Research Facility	NA2XHA through NA2XOZ
Langley Research Center	NA2XPA through NA2XZZ
Ames Research Center	NA3XAA through NA3XGZ
Goddard Space Flight Center	NA3XHA through NA3X0Z
NASA Headquarters	NA3XPA through NA3XRZ
Jet Propulsion Laboratory*	NA3XSA through NA3XZZ
Marshall Space Flight Center	NA4XAA through NA4XEZ
Stennis Space Center	NA4XFA through NA4XJZ
Wallops Flight Facility	NA4XKA through NA4XUZ
Kennedy Space Center	NA4XVA through NA4XZZ
Johnson Space Center	NA5XAA through NA5XGZ

H.2 RESPONSIBILITY FOR ASSIGNMENT

The NASA Field Installation Spectrum Manager is responsible for the assignment of one or more of the call signs allocated to the installation to each specific operation requiring such an identifier.

*NOTE: With respect to the Jet Propulsion Laboratory see paragraph 2.4.

H.3 ASSIGNMENT PROCEDURE

1. The Field Installation or JPL Spectrum Manager exercises complete control of the assigned block of call signs and reserves the right to cancel or make changes as appropriate. The Spectrum Manager must maintain a complete and accurate record of all call sign assignments. Additional call signs may be made available by NASA Headquarters upon receipt of a request supplemented by documentary proof that the call sign allocation cannot satisfy existing call sign requirements.

2. One or more call signs may be assigned by the Field Installation or JPL Spectrum Manager to any operation remotely located from the installation where the spectrum manager exercises responsibility for the NASA radio frequency assignment specifically issued to NASA representatives of commercial contractors, research institutes, colleges and universities under contractual jurisdiction of the activity.

3. Upon receipt of a NASA radio frequency assignment, the Field Installation or JPL Spectrum Manager will make all call sign assignments required by operations on such radio frequencies from the call sign block allocated to the installation or JPL, regardless of the organization or commercial activity conducting the operation.

4. Prior to the assignment of an initial radio call sign, the Field Installation or JPL Spectrum Manager must first determine that a valid requirement exists and that no previous assignment of an experimental call sign has been made to this operation.

5. Upon receipt of a request for an additional call sign, the Field Installation or JPL Spectrum Manager will review the requirement to determine the feasibility of expanding the initial call sign assignment in lieu of the assignment of an additional identifier.

6. Duplicate assignment of the same call sign to different operations is not authorized.

H.4 EXPANSION OF NASA CALL SIGNS

In consideration of special requirements or the shortage of basic call signs, any assigned basic call sign may be expanded by suffixing any letter (A through Z) or any number (including zero), and may consist of more than one digit.

H.5 REPORTING OF CALL SIGN ASSIGNMENTS

The Field Installation or JPL Spectrum Manager will advise NASA Headquarters Spectrum Manager of each initial assignment of a call sign to an operation, and will furnish a list of all call signs assigned together with the location of the operation (transmitter) and the program or project supported, annually. Annual reports as of January 1 each year should be forwarded to NASA Headquarters Spectrum Manager, NASA Headquarters, Code TS, to be received by February 1 (RCS 10-0000-00900).

APPENDIX I

NASA LONG RANGE SPECTRUM SUPPORT FORECAST

I.1 PURPOSE

The purpose of the NASA long range spectrum support forecast is to identify, for future agency missions, unique spectrum support requirements which may require changes in the Radio Regulations. As discussed in Chapter 5 of this Manual, long lead times are required in order to effect such changes.

The forecast is presented in terms of a 40-year time span which, due to its nature, is understood to be quite speculative. A 10-year forecast, which is driven in part by the long term requirements of the 40-year plan, shows spectrum support actions required in the near term in more detail.

I.2 LONG RANGE FORECAST

In light of potential long lead time requirements for some new mission concepts, the NASA Spectrum Management Program Manager intends to maintain this long range spectrum requirements forecast in order to identify needed spectrum management initiatives in a timely manner. This forecast will be updated as needed in response to inputs from Program Offices and field installations.

Figure I-1 presents such a forecast identifying current mission concepts and dates by which new requirements must be identified so that appropriate spectrum management action can be initiated. All dates are driven, primarily by projected launch dates of particular missions and by the anticipated date of the next World Administrative Radio Conference (WARC) which will have the authority to reallocate the RF spectrum. It is anticipated that many mission RF spectrum needs will be satisfied by existing allocations. However, for some missions, changes in international and national regulations may be required to support new and entirely unique operations in the future (such as operations on, or in the vicinity of, the far side of the Moon or for radio links between a transatmospheric vehicle and the Earth). To this end, the long range forecast attempts to identify dates by which consideration of these matters needs to be completed if NASA is to operate in an interference free environment.

The following sections discuss some of the current mission concepts for future agency programs and identifies areas where spectrum management initiatives may be necessary.

Advanced Tracking and Data Relay Satellite System (ATDRSS). Current planning calls for a first ATDRSS launch in 1997. Potential characteristics include links between Earth and geostationary orbit, links between geostationary orbit and low Earth orbit, links between the ATDRSS satellites themselves or, alternatively, an additional earth station to allow global coverage via a 3-spacecraft configuration.

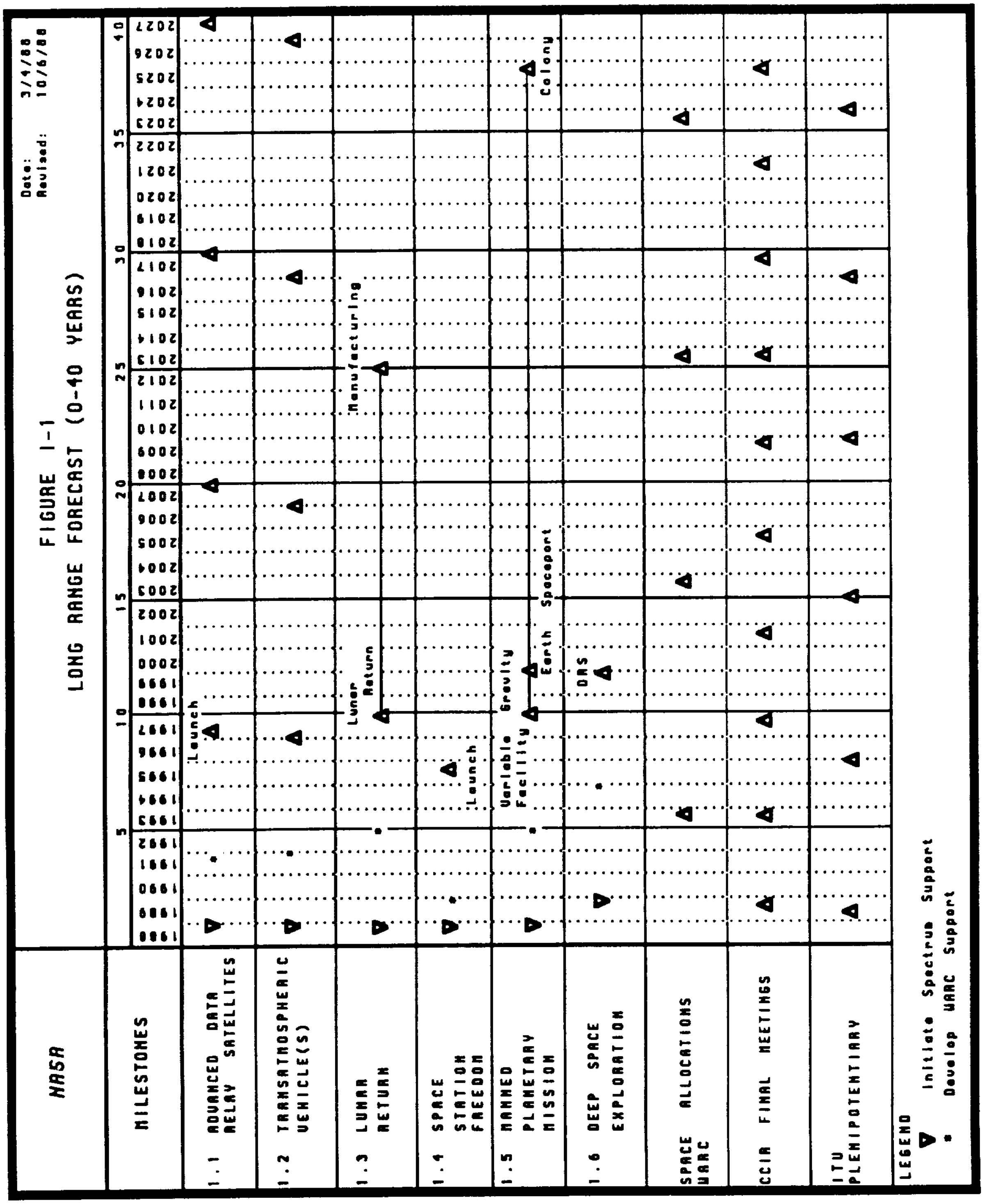


FIGURE I-1. LONG RANGE FORECAST (40 YEARS)

Plans include use of 2 GHz and 14 GHz bands for space/space and space/Earth links with the addition of bands above 20 GHz for space/space link support.

Use of space/space links in bands above 20 GHz, is dependent upon spectrum management initiatives being undertaken in the immediate future, as indicated in Figure I-1, so that necessary spectrum allocation changes can be effected in the Radio Regulations.

Transatmospheric Vehicles. The National Aerospace Plane is planned to be in use in the late 1990's time frame. Although communication link requirements are not clearly defined, it is known that the Aerospace Plane will require airport facility take-off and landing communications, aeronautical communications, in addition to orbital communications while above the majority of the Earth's atmosphere. It is not clear that spectrum support is readily available in existing aeronautical mobile and space research bands.

It is also anticipated that communication links will be required during periods of atmospheric flight which include high concentrations of ionized plasma. The choice of frequencies for this activity will not be based upon where current allocations exist but rather will be driven by the physics of the propagation of radio waves in this medium. It is expected, therefore, that if this communications technique proves feasible, new allocations may be required.

If new bands or operational procedures are required, activities to ensure spectrum support should be initiated soon to meet a first flight date in the late 1990's.

Lunar Return. The overall objective of the lunar return missions as currently anticipated is eventually to establish lunar outpost(s) for long term habitation. During the initial stages of this activity due to commence around 1992 and throughout its realization, numerous communication links will be required between the lunar surface, lunar orbit, Earth and possibly the Space Station Freedom. Section 6 of Article 29 of the Radio Regulations, in declaring the far side of the Moon as a radioastronomy quiet zone, states:

> "In the shielded zone of the Moon emissions causing harmful interference to radio astronomy observations and to other users of passive services shall be prohibited in the entire frequency spectrum except in the following bands:
>
> a) the frequency bands allocated to the space research service using active sensors;
>
> b) the frequency bands allocated to the space operation service, the earth exploration-satellite service using active sensors, and the radiolocation service using stations on spaceborne platforms, which are required for the support of space research, as well as for radiocommunications and space research transmissions within the lunar shielded zone."

It is not clear that the wording of this section will allow unrestricted agency operations in the vicinity of the Moon. Consequently, modifications to this section of Article 29, may be required for some Lunar Return Mission frequency use. Additionally, with the new definition of deep space distance there are no wide band space research allocations currently available for links between the Earth and the Moon.

Space Station Freedom. By the late 1990's, Phase I of the S.S. Freedom, which involves permanent manned facilities, may be complete. Numerous communications links to and from the Freedom station will be required to support the large volume (including international participation) of co-orbital and Data Relay Satellite (DRS) traffic. The issues related to DRS spectrum selection are also of concern to the Freedom station since it will depend upon the contemporary Tracking and Data Relay Satellite (TDRS) system for support.

Considering the anticipated launch dates for the Freedom station, it is imperative that decisions be reached soon concerning proximity links to and from users. In particular, opting for use of bands above 20 GHz for these links will require a reallocation of spectrum for which a long lead time is required.

Manned Planetary Missions. It may be projected that by the year 2010, the U.S. space program will have conducted three missions to Mars to map and observe the surface of the planet to locate appropriate landing sites, with the ultimate goal of establishing a permanently manned outpost. Communications links which are anticipated include links between the Martian surface, a Mars Spaceport, a Cycling Spacecraft, an Earth Spaceport and Earth.

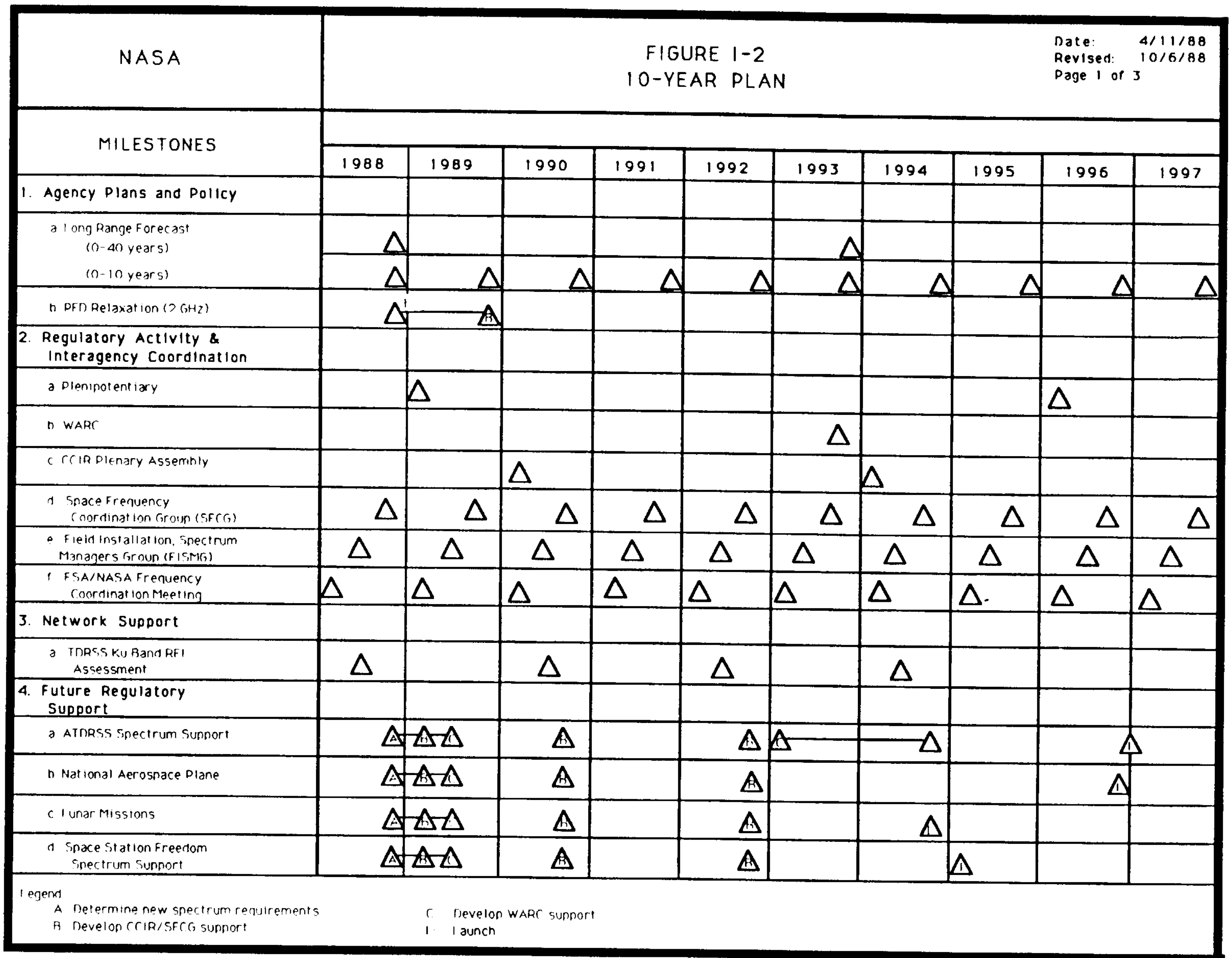
Spectrum issues raised by the Martian Mission concepts include:

- Consideration of optical links and determination of regulatory authority.
- Determination of bands for Martian surface communications.
- Use of deep space bands and near earth space research bands which may conflict.

Deep Space Exploration. In the early 21st century, it is anticipated that the agency may provide support to deep space missions via a DRS located, most probably in geostationary or planetary orbit. It is expected that links between this DRS and deep space probes will occur in existing allocated deep space bands. It is not clear, however, where in the spectrum the links between the DRS and Earth should lie. In any event, it is not expected that new allocations would be required since this activity can probably be accommodated in "feederlink" bands.

I.3 TEN-YEAR PLAN

Figure I-2 presents a more detailed schedule of essential NASA Spectrum Management Program activities to be performed over the next 10 years. Included in this list are some of the advanced mission concepts presented in the long range forecast as well as other initiatives necessary for ongoing mission support.



[1] Ad Hoc 199 support

FIGURE I-2. TEN-YEAR PLAN

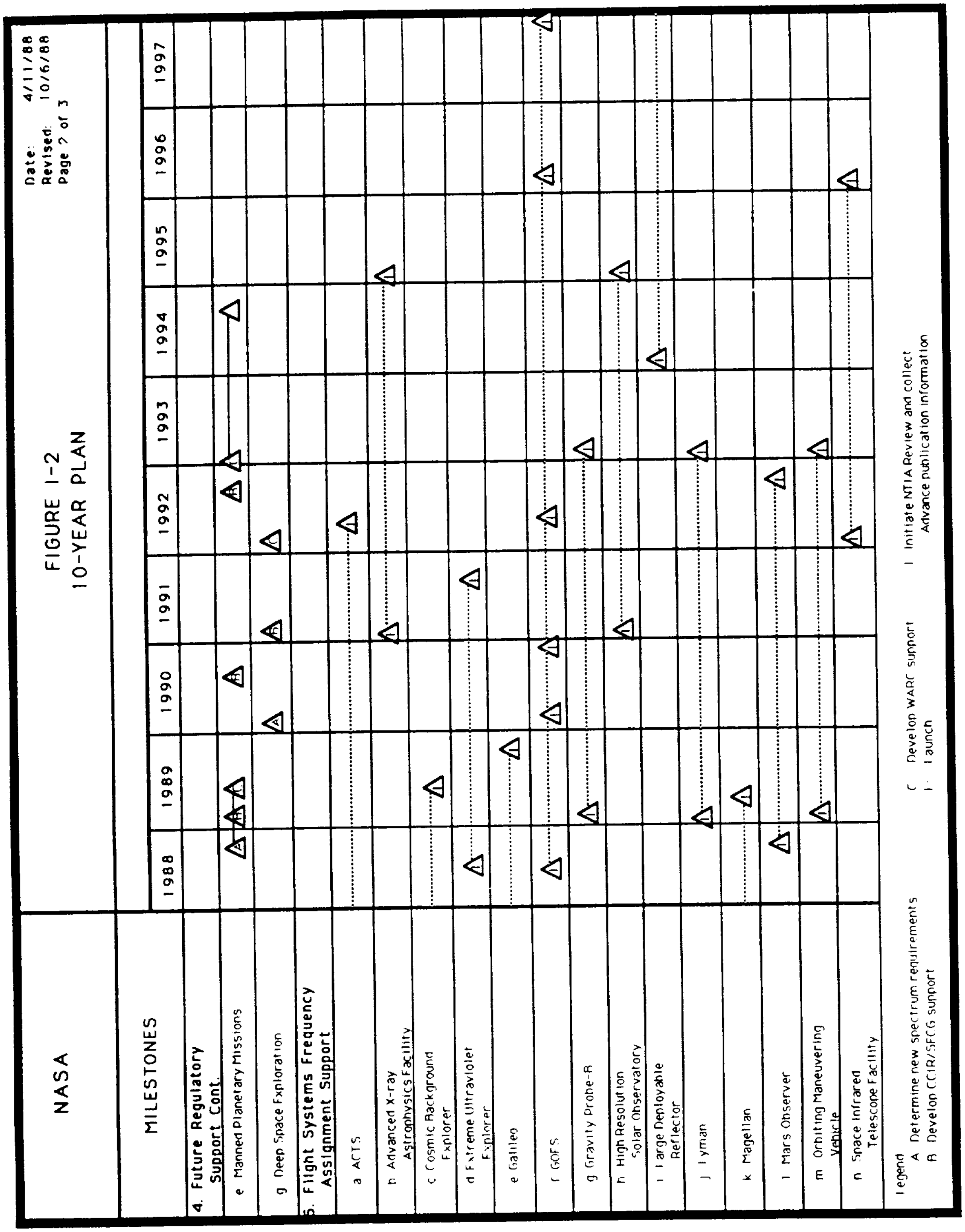


FIGURE I-2. TEN-YEAR PLAN (CONTD)

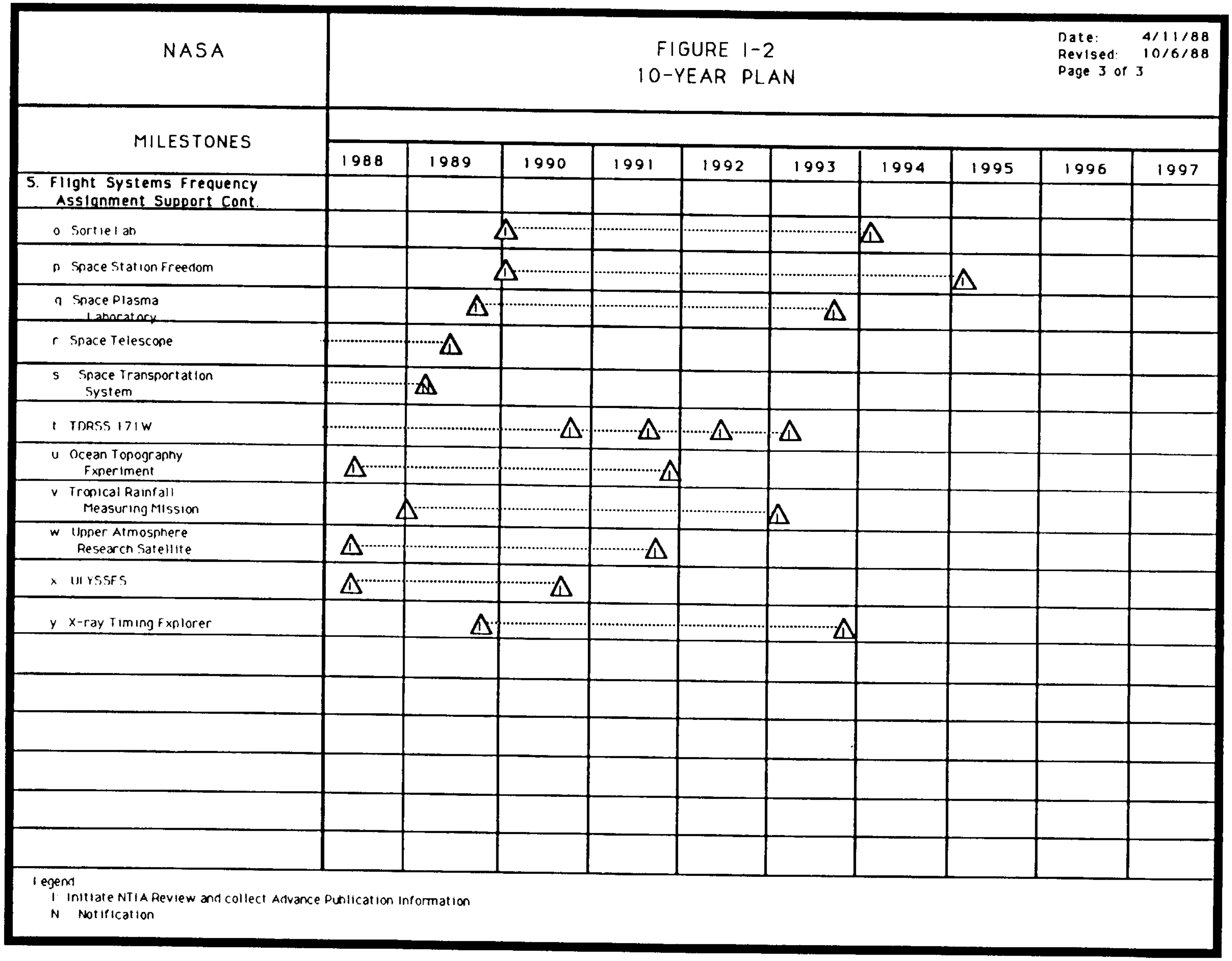


FIGURE I-2. TEN-YEAR PLAN (CONTD)

PAGE ________ INTENTIONALLY BLANK

APPENDIX J

GLOSSARY OF COMMONLY USED TERMS APPLICABLE TO NASA RF SPECTRUM MANAGEMENT

J.1 GENERAL TERMS

EXPERIMENTAL STATION: A station utilizing radio waves in experiments with a view to the development of science or technique. This definition does not include amateur stations.

FACSIMILE: A system of telecommunication for the transmission of fixed images, with or without half-tones, with a view to their reproduction in a permanent form.

FREQUENCY ALLOCATION: The process whereby a portion of the frequency spectrum is set aside for a particular use or service.

FREQUENCY ASSIGNMENT: The authorization for the use of a particular frequency to either Government or non-Government operations. When assigned, it is the license to use the specific frequency at a specific station.

FREQUENCY COORDINATION: Procedures established to provide portions of the RF spectrum or specific frequencies to two or more users that best accommodate the services required by each.

FREQUENCY MANAGEMENT (RF SPECTRUM MANAGEMENT): The control of the radio frequency interference through the processes of frequency allocation and assignment, monitoring of equipment research and development, frequency records administration, engineering analysis and international negotiations.

FREQUENCY SUPPORT (SPECTRUM SUPPORT): The availability of authorized frequencies or portions of the RF spectrum to accommodate the operational requirements of particular electronic equipment.

FREQUENCY-SHIFT TELEGRAPHY: Telegraphy by frequency modulation in which the telegraph signal shifts the frequency of the carrier between predetermined values. There is phase continuity during the shift from one frequency to the other.

HARMFUL INTERFERENCE: RF interference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communications service.

NON-INTERFERENCE BASIS (NIB): Use of radio frequencies not in accordance with all applicable radio regulations shall not cause harmful interference to nor claim protection from stations of other services operating in accordance with the Radio Regulations.

RADIOASTRONOMY: Astronomy based on the reception of RF radio waves of cosmic origin.

RADIO WAVES: Electromagnetic waves of frequencies lower than 3000 GHz, propagated in space without artificial guides.

RADIOCOMMUNICATION: Telecommunication by means of radio.

RADIOSONDE: An automatic radio transmitter in the meteorological aids service usually carried on an aircraft, free balloon, kite or parachute, and which transmits meteorological data.

RADIOTELEMETERING: Telemetering by means of radio.

TELECOMMUNICATION: Any transmission, emission or reception of signs, signals, writing, images and sound or intelligence of any nature by wire, radio, visual or other systems.

TELEGRAPHY: A system of telecommunication which is concerned in any process providing transmission and reproduction at a distance of documentary matter, such as written or printed matter or fixed images, or the reproduction at a distance of any kind of information in such a form.

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

TELEPHONY: A system of telecommunication set up for the transmission of speech or, in some cases, other sounds.

TELEVISION: A system of telecommunication for the transmission of transient images of fixed or moving objects.

TERRESTRIAL SERVICE: Any radio service other than a space service or the radio astronomy service.

TROPOSHERIC SCATTER: The propagation of radio waves by scattering as a result of irregularities or discontinuities in the physical properties of the troposphere.

J.2 SPACE SYSTEMS, SERVICES AND STATIONS

ACTIVE SATELLITE: An Earth satellite carrying a station intended to transmit or retransmit radiocommunication signals.

BROADCASTING-SATELLITE SERVICE: A space service in which signals transmitted or re-transmitted by space stations, or transmitted by reflection from objects in orbit around the Earth, are intended for direct reception by the general public.

EARTH STATION: A station in the space service located either on the Earth's surface, including on board a ship, or on board an aircraft.

FIXED AND MOBILE SATELLITE SERVICE: A space service (1) between earth stations, when using active or passive satellites for the exchange of communications of the fixed or mobile service, or (2) between an earth station and stations on active satellites for the exchange of communications of the mobile service, with a view to their retransmission to or from stations in the mobile service.

FIXED SATELLITE SERVICE: A radio communication service between earth stations at specified fixed points when one or more satellites are used; in some cases this service includes satellite-to-satellite links, which may also be effected in the intersatellite service; the fixed satellite service may also include feeder links for other space radiocommunication services.

GEOSTATIONARY SATELLITE: A satellite, the circular orbit of which lies in the plane of the Earth's equator and which turns about the polar axis of the Earth in the same direction and with the same period as those of the Earth's rotation.

MAINTENANCE SPACE TELEMETERING: Space telemetering relating exclusively to the electrical and mechanical condition of a spacecraft and its equipment together with the condition of the environment of the spacecraft.

MOBILE SATELLITE SERVICE: A radiocommunication service: between mobile earth stations and one or more space stations, or between space stations used by this service; or between mobile earth stations by means of one or more space stations.

PASSIVE SATELLITE: An Earth satellite intended to transmit radiocommunication signals by reflection.

SATELLITE SYSTEM: A space system using one or more artificial earth satellites.

SPACE RESEARCH SERVICE: A space service in which spacecraft or other objects in space are used for scientific or technological research purposes.

SPACE SERVICE: A radiocommunication service (1) between earth stations and space stations or (2) between space stations or (3) between earth stations when the signals are retransmitted by space stations, or transmitted by reflection from objects in space, excluding reflection or scattering by the ionosphere or within the Earth's atmosphere.

SPACE STATION: A station in the space service located on an object which is beyond, is intended to go beyond, or has been beyond, the major portion of the Earth's atmosphere.

SPACE SYSTEM: Any group of cooperating earth and space stations, providing a given space service and which, in certain cases, may use objects in space for the reflection of the radiocommunication signals.

SPACE TELECOMMAND: The use of radiocommunication for the transmission of signals to a space station to initiate, modify or terminate functions of the equipment on a space object, including the space station.

SPACE TELEMETERING: The use of telemetering for the transmission from a space station of results of measurements made in a spacecraft, including those relating to the functioning of the spacecraft.

SPACE TRACKING: Determination of the orbit, velocity or instantaneous position of an object in space by means of radiodetermination, excluding primary radar, for the purpose of following the movement of the object.

SPACECRAFT: Any type of space vehicle, including an Earth satellite or a deep-space probe, whether manned or unmanned.

J.3 SPACE AND ORBITS OF SPACECRAFT

APOGEE: Altitude above the surface of the Earth of the point on a closed orbit where a satellite is at its maximum distance from the center of the Earth.

DEEP SPACE: Space at distances from the Earth equal to or greater than 2×10^6 Km.

INCLINATION: The acute angle between the plane containing an orbit and the plane of the Earth's equator.

ORBIT: The path in space described by the center of mass of a satellite or other object in space.

PERIGEE: Altitude above the surface of the Earth of the point on a closed orbit where a satellite is at its minimum distance from the center of the Earth.

PERIOD: The time elapsing between two consecutive passages of an object in space through the same point on its closed orbit.

J.4 TECHNICAL CHARACTERISTICS

ASSIGNED FREQUENCY BAND: The frequency band the center of which coincides with the frequency assigned to the station and the width of which equals the necessary bandwidths plus twice the absolute value of the frequency tolerance.

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

CARRIER POWER OF A RADIO TRANSMITTER: The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle under conditions of no modulation. This definition does not apply to pulse modulated emissions.

EQUIVALENT ISOTROPICALLY RADIATED POWER: The equivalent isotropically radiated power of an emission is the product of the power supplied to the antenna for this emission and the antenna gain relative to an isotropic antenna.

FREQUENCY TOLERANCE: The maximum permissible departure by the center frequency of the frequency band occupied by an emission from the assigned frequency or, by the characteristic frequency of an emission from the reference frequency. The frequency tolerance is expressed in parts per million or in percentage or in Hz, kHz, or MHz as applicable.

GAIN OF AN ANTENNA: The ratio of the power required at the input of a reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field at the same distance. When not specified otherwise, the figure expressing the gain of an antenna refers to the gain in the direction of the radiation main lobe.

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

ISOTROPIC OR ABSOLUTE GAIN OF AN ANTENNA: The gain of an antenna in a given direction when the reference antenna is an isotropic antenna isolated in space.

MEAN POWER OF A RADIO TRANSMITTER: The power supplied to the antenna transmission line by a transmitter during normal operation, averaged over a time sufficiently long compared with the period of the lowest frequency encountered in the modulation. A time of 1/10 second during which the mean power is greatest will be selected normally.

NECESSARY BANDWIDTH: For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specific conditions. Emissions useful for the good functioning of the receiving equipment as, for example, the emission corresponding to the carrier of reduced carrier systems, are included in the necessary bandwidth.

PEAK ENVELOPE POWER OF A RADIO TRANSMITTER: The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the highest crest of the modulation envelope, taken under conditions of normal operation.

RELATIVE GAIN OF AN ANTENNA: The gain of an antenna in a given direction with reference to an antenna which is a half-wave, loss-free dipole isolated in space and in the equatorial plane of which contains the given direction.

PAGE ________ INTENTIONALLY BLANK

APPENDIX K

TERMS OF REFERENCE OF THE SPACE FREQUENCY COORDINATION GROUP (SFCG)

The Space Frequency Coordination Group (SFCG) provides a forum for multilateral discussion and coordination of spectrum matters of mutual interest concerning, in particular, the following space radiocommunication services, as defined in the ITU Radio Regulations:

Space research.
Space operations.
Earth exploration satellite.
Meteorological satellite.
Inter-satellite.
Radioastronomy and radar astronomy to the extent that they are relevant to spacecraft missions, are also of interest.

The agreed upon results of SFCG work will be expressed in the form of Resolutions, Recommendations, Reports, or whatever form may be appropriate for the case. SFCG members will attempt to ensure that findings of SFCG are taken into account by their agencies.

SFCG will:

facilitate early understanding of present and future plans for space systems and services and of other systems affecting these;

identify problem areas and coordination needs, and study potential solutions associated therewith;

identify issues and policy matters relating to the future orderly use of the frequency bands allocated to respective space radiocommunication services;

suggest courses of action which could be taken by SFCG member agencies with regard to current and future frequency needs of the space radiocommunications services of interest, and in particular, identify those matters about which administrations should be encouraged to make appropriate contributions to the CCIR or to ITU conferences;

further the understanding of frequency management by other space agencies;

consider any other items of technical, operational, or administrative nature which affect the interests of the Group; and

maintain strong ties with other international bodies with related objectives.