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AUTOMATED UHF FREQUENCY ASSIGNMENT SYSTEM FOR FAA AIR TRAFFIC CONTROL COMMUNICATIONS

IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402

June 1977

FINAL REPORT

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16. Abstract

An automated UHF Frequency Assignment System (UHF-FAS) was developed as a means of providing frequency assignment plans for FAA Air Traffic Control (ATC) UHF communications facilities. The UHF-FAS consists of a series of computer programs and can be used to investigate the advantages of different frequency assignment strategies (including partial and complete assignments), detect assignments that do not meet the FAA criterion, provide statistical analyses, and plot ATC service volumes.

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PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The Center, located at North Severn, Annapolis, Maryland 21402, is under executive control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical operations function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-76-C-0017, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standard Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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METRIC CONVERSION FACTORS

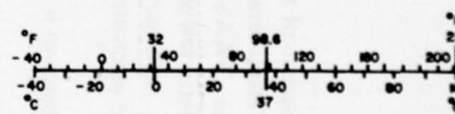
Approximate Conversions to Metric Measures

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

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 236, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

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



FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

EXECUTIVE SUMMARY

Because of the limited number of channels in the 225-400 MHz UHF band provided by DoD to the Federal Aviation Administration (FAA) for air traffic control (ATC) communications, it is becoming increasingly difficult for the FAA frequency managers to provide the necessary frequencies for adequate ATC communications support of military aircraft. An automated FAA UHF Frequency Assignment System (UHF-FAS) that can be used to provide frequency plans for ATC communications facilities was developed by the DoD Electromagnetic Compatibility Analysis Center (ECAC). This was accomplished in response to a request from the FAA for an automated means to examine different methods for assigning UHF frequencies.

The UHF-FAS described herein consists of a series of computer programs that can be utilized to provide channel assignments for existing or proposed FAA UHF ATC requirements. Included is a series of maintenance and retrieval programs that provide ready access to the FAA-supplied ATC data. The UHF-FAS can also be used to detect assignments that do not meet specified criteria (violators), to make statistical analyses, and produce plots of service volumes.

The basic modules of the UHF-FAS are the Matrix Generator and the Assignment Model. An intersite channel-separation-matrix generator uses site location, ATC function, and service volume information to construct a matrix that reflects the channel separation between sites necessary to maintain a specified, minimum, desired-to-undesired signal ratio. The assignment model is based on two assignment techniques: 1) considering first those requirements most difficult to assign, based on congestion, and 2) maximizing the usage of each channel by making as many assignments on a given channel as possible. In addition, cosite constraints necessary to prevent intermodulation and adjacent-channel interference are applied by the assignment program.

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SECTION 1

INTRODUCTION

BACKGROUND

Earlier reports described an automated VHF (118-136 MHz) frequency assignment system developed by ECAC in response to an FAA request.[1,2] The FAA desired a means of rapidly evaluating the relative merits of alternate courses of action that could be taken to meet the growing air traffic control (ATC) communications requirements.

The FAA requested that ECAC develop a similar assignment system for the 225-400 MHz portion of the UHF band. This report describes the FAA UHF Frequency Assignment System (UHF-FAS). For reader convenience and clarity of system description, information used in the VHF-FAS reports (References 1 and 2) pertinent to the UHF frequency assignment system is repeated herein. Some UHF models are more complex than their VHF system counterparts, because of the variety of equipments and their use.

The UHF-FAS selects the FAA ATC requirements[a] from the Interdepartmental Radio Advisory Committee, Government Master File (IRAC GMF) and performs the intersite analysis. The cosite (intrasite) analysis uses the non-FAA UHF frequencies from the IRAC GMF, as well as the appropriate VHF, FCC, and ARINC frequencies. The

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[1]Beall, L., Crisafulli, R., Morrow, J., and Van Gaasbeck, S., *An Automated FAA Air Traffic Control Frequency Assignment Model*, FAA-RD-73-184, ECAC, Annapolis, MD, December 1973.

[2]Hensler, T., *Automated VHF Frequency System (FAS) For FAA Air Traffic Control Communications*, FAA-RD-76-14, ECAC, Annapolis, MD, February 1976.

[a]See Glossary.

cosite model is complex because of the types of equipments encountered in the UHF band. Factors considered include modulation type, bandwidth, power, and the distance between equipments. Frequency assignments are made in conformance to FAA-provided intersite and cosite constraints. The assignment model is designed to use frequency spacing. Thus, assignments can be made with any channel spacing that is an even multiple of 25 kHz, and more than one channel-spacing increment can be used in any given assignment.

OBJECTIVE

The objective was to provide an automated UHF Frequency-Assignment System capable of developing and/or evaluating frequency-assignment plans for ATC communications, that are compatible with other frequency assignments in the UHF band.

APPROACH

The automated UHF frequency-assignment capability was developed by designing a series of three program modules that constitute the UHF FAS.

The first module was developed for the purpose of building an intersite constraint matrix that designates the channel separation between ATC requirements that is necessary to maintain a specified protection criterion [desired-to-undesired (D/U) signal ratio]. Each ATC requirement is defined by its associated ATC function plus geographical site and service-volume information. The intent is to protect the desired signal from an interfering cochannel or adjacent-channel signal under the worst-case condition. (This worst-case condition may be defined as the positioning of an aircraft in its service volume such that the D/U signal ratio is a minimum.)

The second basic module of the FAS was developed to take into account the cosite (intrasite) constraints. The cosite model produces the Site Denied-Frequency File. This file contains those frequencies denied at the sites because of the cosite harmonic, intermodulation, or adjacent-signal interference constraints and the intersite constraints. Interference calculations include 2-signal third-order intermodulation products that are considered by the FAA to be the most-probable source of intermodulation interference to ATC facilities. Non-ATC frequencies considered in the intermodulation analysis include broadcast FM radio frequencies, television frequencies, 118-136 MHz (VHF) frequencies, and 225-400 MHz (UHF) frequencies. The UHF frequencies considered in the intermodulation analysis are those of existing military requirements. As an option, 3-signal third-order intermodulation products can be considered by the model when at least one of the signals is transmitted from a continuously operating transmitter, such as a television station. Selected transmit and receive frequencies used within a specified distance of each ATC site (2 nautical miles) were considered in the intermodulation analysis. The adjacent-signal analysis considered background assignments that are used within a predetermined minimum geographic distance. Where adjacent-signal interference was determined to exist, suitable guardbands were established. The intersite constraints result from non-FAA assignments in the UHF band that either share frequencies with FAA ATC operations or are located within interference range of FAA ATC assignments.

The third basic module of the FAS was developed to produce the frequency assignments. This module uses the Channel-Separation Matrix and the Site Denied-Frequency File, to make assignments that satisfy intersite and cosite constraints. As assignments are made, the Site Denied-Frequency File is updated to reflect the current assignment situation at each site. Since the order in which assignments are made can affect the total assignment efficiency, a means was developed by which the UHF-FAS orders[a] assignment requirements according to certain congestion criteria.

The data base for the UHF-FAS was provided by the collection and verification of input information that describes the assignment requirements for FAA UHF air traffic control. The data base consists of two files. The first file describes the assignment requirements by latitude and longitude, ATC function,[a] service volume[a] radius, altitude, and frequency. This file is developed using the Interdepartmental Radio Advisory Committee's Government Master File (IRAC GMF). The second file contains latitude and longitude points that describe the tailored service volumes (TSV). These TSV's describe the service volume areas associated with the enroute[a] FAA UHF assignments. This file is constructed using data from the Adaptation Controlled Environment Systems (ACES) tapes provided to ECAC by the FAA Air Route Traffic Control Centers (ARTCC).

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[a]See Glossary.

SECTION 2

SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The frequency-assignment technique described herein is accomplished in four steps. The first step is the generation of an Intersite Matrix, which designates the cochannel and adjacent-channel assignment constraints imposed on each requirement that needs an assignment.

The second step is the development of a Site Denied-Frequency File that represents the constraints imposed on the assignment by the collocated equipments and nearby UHF military frequencies. The third step provides the priority ordering of the requirements for the assignment process. The fourth and last step is the actual assignment process, which uses the results of the first three steps.

These four steps are discussed in greater detail in the paragraphs that follow. Steps two and three, the site denied-frequency file generation and priority ordering, are both discussed in the subsection entitled "Frequency Assignment File Preparation." FIGURE 1 shows the functional flow for the Frequency Assignment System. Run procedures for all computer programs are described in APPENDIX E.

INTERSITE MATRIX CONSTRUCTION

The matrix-building phase of the FAA UHF Frequency Assignment System consists of two computer programs:

1. Matrix Generator Program
2. Matrix Transpose Program.

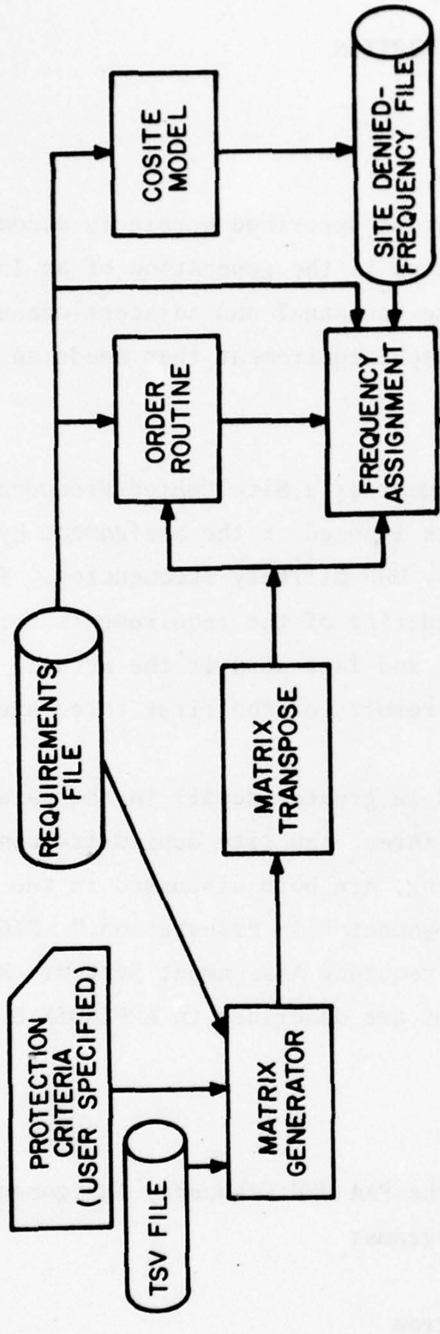

FIGURE 1. UHF FAS FREQUENCY ASSIGNMENT SYSTEM FLOW CHART.

These programs are used to construct channel-separation matrices. Since the matrix is symmetrical, i.e., element E_{ij} equals element E_{ji}, ($E_{ij} = E_{ji}$), only a partial matrix is developed by the Matrix Generator. The complete matrix is constructed by reflecting this partial matrix about the main diagonal, using the Matrix Transpose Program.

Matrix Generator Program

Inputs to the Matrix Generator Program are from the Requirements File and TSV File, in addition to user-specified information. These files provide data that describe the geographic coordinates, air traffic control function, and service-volume definition for each requirement. User-specified information includes the desired protection-criteria levels according to ATC function.

The matrix produced by the program describes the intersite relationships between the requirements described in the Requirements File. FIGURE 2 shows the structure of this matrix. Each element of the matrix reflects the interaction between the requirement of a row and the requirement of a column. In FIGURE 2, element E_{ij} reflects the interaction between the requirement of row i and the requirement for column j.

The number of rows is less than the number of columns, due to preassignment of some requirements. If, however, there should be no preassigned requirements, the matrix is square. Since a portion of the matrix is symmetrical, only a partial matrix is produced. The portion of the matrix calculated using the Matrix Generator Program is represented by A and B in FIGURE 2.

Each intersite relationship is determined by a comparison of the service volumes for each site involved. (APPENDIX A provides

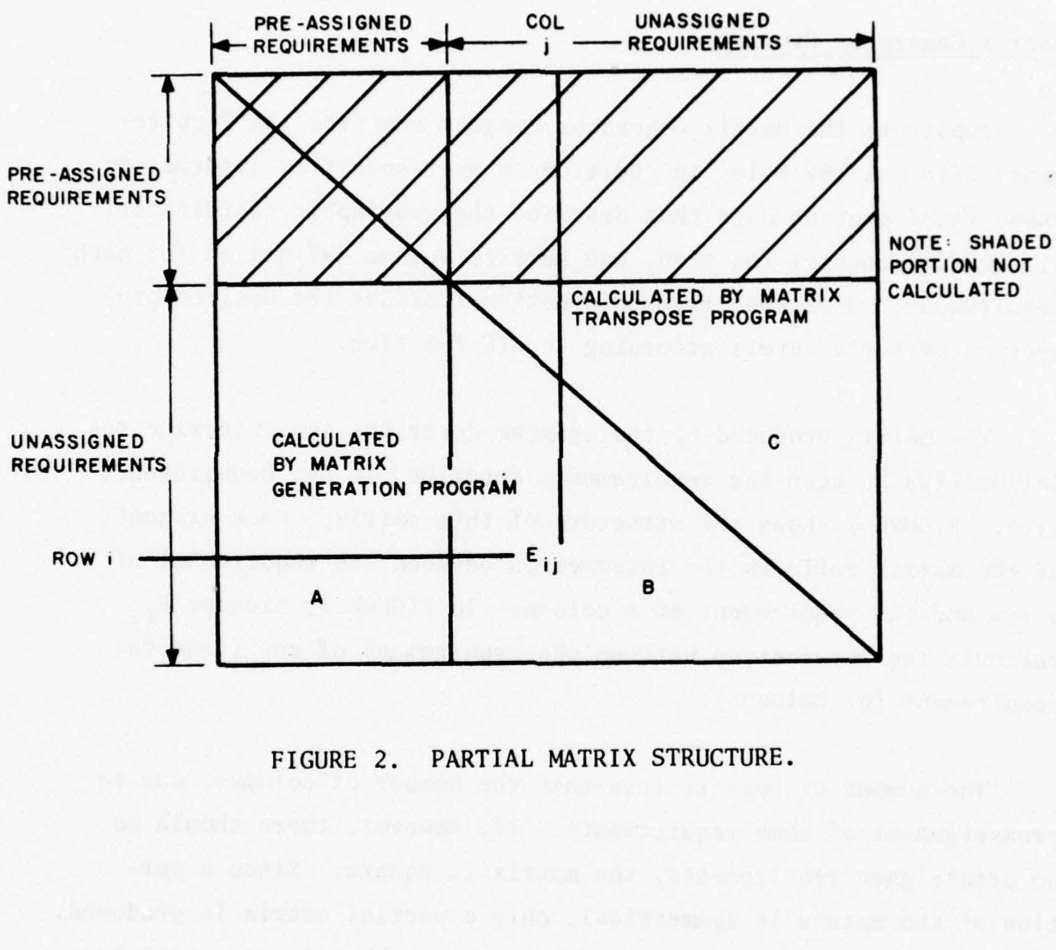

FIGURE 2. PARTIAL MATRIX STRUCTURE.

a detailed description of the procedures involved in the service volume analysis.) For a particular interaction, this analysis determines whether the sites can be assigned cochannel or adjacent-channel frequencies.

The Matrix Generator Program has the option of making a probabilistic cochannel analysis. The probabilistic method used is discussed in APPENDIX B.

Intersite Analysis Assumptions

The assumptions used to calculate the intersite constraints when using the Matrix Generator are discussed below.

Propagation losses were taken to be equal to the free-space propagation loss within the limit of radio line-of-sight (determined using 4/3 earth's radius for refraction). Beyond radio line-of-sight, the loss was assumed to be infinite. *All ground transmitters* were assumed to have omnidirectional antennas and equal power. Thus, the calculations of cochannel D/U ratios were made using only those distances within radio line-of-sight.

An adjacent-channel rejection value of 60 dB was assumed for airborne receivers that use the same channel spacing (whether 25 or 50 kHz). This assumption can permit overlapping of service volumes for adjacent-channel analysis. However, according to the FAA Handbook,[3] a 2-nmi separation between airplanes on adjacent channels is needed to prevent the receiver muting threshold from being exceeded in the airplane. Therefore, adjacent-channel protection was

[3]Federal Aviation Agency, *VHF-UHF Air/Ground Communications Frequency Engineering Handbook,* Washington, DC, June 1965.

provided by requiring at least a 2-nmi separation between service volumes, in addition to the assumption of 60-dB adjacent-channel rejection.

Matrix Transpose Program

The Matrix Generator Program produces that portion of the intersite matrix that is unique. The intersite matrix is then completed using the Matrix Transpose Program, which reflects a portion of the intersite matrix about the main diagonal. This is done to facilitate the assignment process, where the entire matrix row is needed to make a compatible assignment. In FIGURE 2, portions A and B constitute the partial matrix calculated by the Matrix Generator Program. Portion C represents the portion created by transposing Portion B about the diagonal. Portion A, however, is not transposed, since this portion represents the intersite relationships between background requirements (fixed assignments) and FAA ATC requirements. The matrix rows representing the requirements to be assigned are the only rows needed.

FREQUENCY ASSIGNMENT FILE PREPARATION

In addition to the generation of an Intersite Matrix, two steps must be completed prior to making the actual frequency assignment. The first step is the creation of the intrasite file, called the Site Denied-Frequency File, which is discussed here and in Section 3. The second step is the ordering of requirements for the assignment model.

Site Denied-Frequency File

A Site Denied-Frequency File is created for each frequency-assignment task. This file contains the UHF frequencies (225-400 MHz) that are denied for use at each FAA ATC site. The Site Denied-Frequency File is used as an input to the assignment model and is updated each time a requirement is assigned a frequency.

All collocated requirements reference the same record in the Site Denied-Frequency File. These denied frequencies result from cosite and intersite restrictions imposed at each site because of preassigned ATC requirements. These preassignments include frequencies used for emergency services, ground control, private aircraft, and flight test; frequencies used for military functions at the ATC site or nearby military bases; and frequencies used by radio and television stations.

The IRAC GMF contains more than 10,000 frequency assignments in the UHF band. Of this total, approximately 3,000 are used by the FAA. These FAA requirements are used in the intersite analysis by the matrix generator, while the non-FAA requirements are considered in the cosite analysis. This intersite analysis in the cosite model is based on bandwidth, modulation type, and power of individual equipments, in conjunction with the geographic proximity of the non-FAA frequency assignments to the FAA requirements.

Three radii of selection are used. A 2-nmi radius is used when selecting frequencies for intermodulation, harmonic, and receiver image frequency analysis, except for television and FM broadcast frequencies. These latter frequencies are selected using a 15-nmi radius and are only used for the intermodulation analysis. An arbitrarily small-radius value (presently 0.2 nmi) is used to identify collocated frequencies for which adjacent-signal protection must be provided. Additional radii can be specified to take into account unusually high-power and/or wide-bandwidth transmitters. For assignment plans where it is desirable to use resource frequencies having non-FAA ATC background assignments, a radio line-of-sight radius value can be used to determine which frequencies at each site location cannot be shared with military assignments.

Intermodulation, harmonic, and image-related frequencies from the 225-400 MHz band derived from the cosite analysis for each site location are denied for use by the assignment model.

Requirement Ordering

The assignment model assigns the requirements in a prescribed order. This order is derived from an analysis of the Intersite Matrix. After investigating various ordering techniques, a node-coloring algorithm was selected as the ordering technique used. This algorithm is described in a previous ECAC report.[4]

FREQUENCY ASSIGNMENT

The assignment phase of the FAA UHF Frequency Assignment System is accomplished using the Reassignment Analysis Model (RAM; Reference 2) with modifications incorporated to handle 225-400 MHz frequencies. The logic flow used by the RAM is shown in FIGURE 3.

The RAM attempts to assign each requirement by trying each available frequency until a violation-free assignment can be found. This assignment scheme is referred to as "frequency exhaustive." If a violation-free assignment cannot be made, the requirement is assigned the frequency that causes the lowest number of violations with existing assignments.

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[4]Metzger, B. H., *Analysis of Channel Requirements for Air Traffic Control Communication and Navigational Aid Systems*, ESD-TR-70-132, ECAC, Annapolis, MD, June 1970.

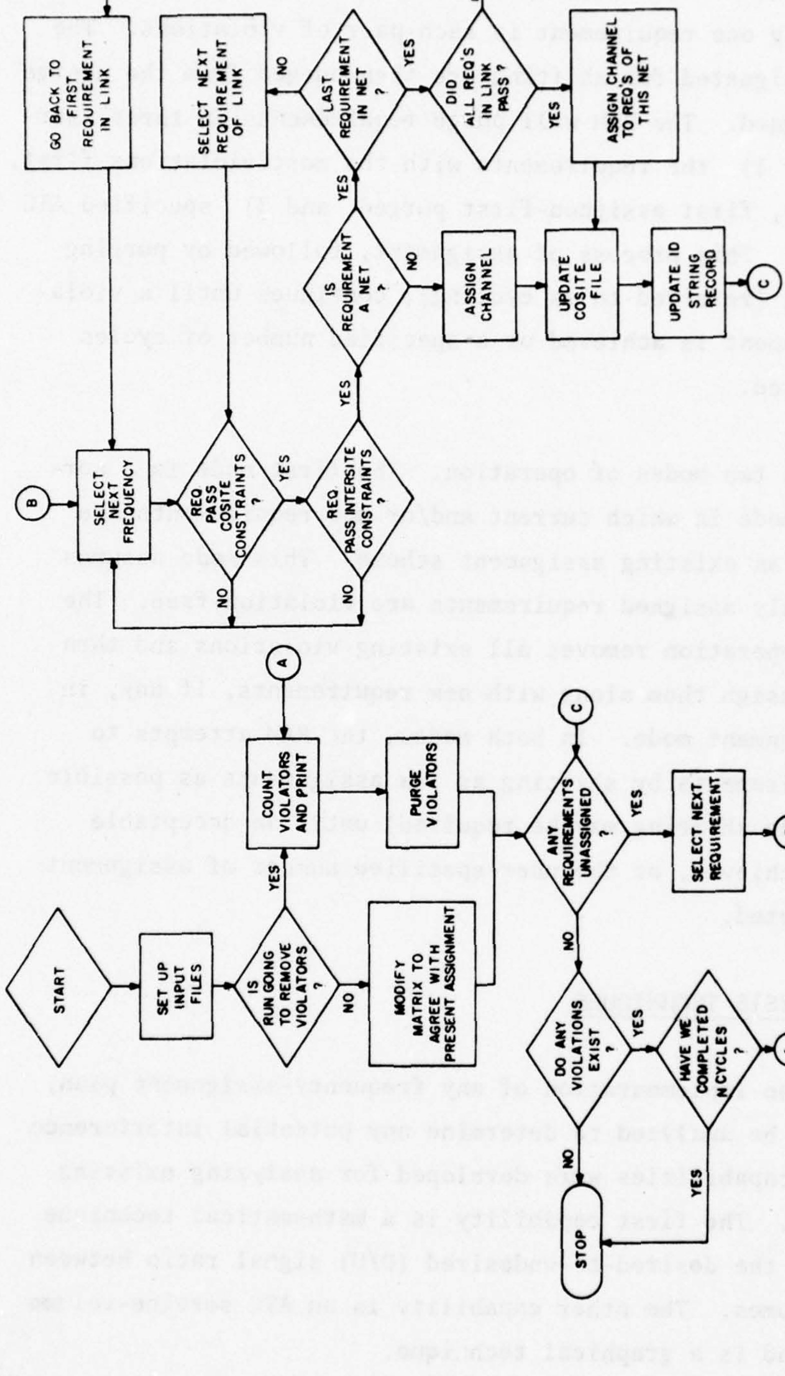


FIGURE 3. REASSIGNMENT ANALYSIS MODEL (RAM) FLOW DIAGRAM.

Initially, all requirements are assigned even if they create violations. The RAM will then try to reach a violation-free assignment by shifting one requirement in each pair of violations. The requirements designated for shifting are then purged from the assignment and reassigned. The RAM will purge requirements in three user-specified ways: 1) the requirements with the most violations first, 2) sequentially, first assigned-first purged, and 3) specified ATC functions first. This process of assignment, followed by purging and reassignment (referred to as cycling), continues until a violation-free assignment is achieved or a specified number of cycles has been completed.

The RAM has two modes of operation. The first mode is a normal assignment mode in which current and/or new requirements are integrated into an existing assignment scheme. This mode assumes that all currently assigned requirements are violation-free. The second mode of operation removes all existing violations and then proceeds to reassign them along with new requirements, if any, in the normal assignment mode. In both modes, the RAM attempts to assign the requirements by shifting as few assignments as possible (in some cases no shifting may be required) until an acceptable assignment is achieved, or the user-specified number of assignment cycles is completed.

ASSIGNMENT ANALYSIS TECHNIQUES

Prior to the implementation of any frequency-assignment plan, the plan should be analyzed to determine any potential interference problems. Two capabilities were developed for analyzing existing FAA assignments. The first capability is a mathematical technique that calculates the desired-to-undesired (D/U) signal ratio between ATC service volumes. The other capability is an ATC service-volume plot routine, and is a graphical technique.

These techniques complement one another, since service-volume plots for given frequency plans can be made after the D/U ratios are calculated, to graphically portray problem areas. The D/U and plot capabilities also provide a check of the data base used to develop the assignment. These verification checks may be made for any assignment, existing or planned. Intersite analysis techniques are described in APPENDIX A.

Desired-to-Undesired (D/U) Signal Ratio Program

This program calculates the D/U values for all requirements assigned the same frequency and produces, for each frequency, an array of the D/U values and a list of the requirements utilizing that frequency. When an acceptable level of protection is specified by the user, the list will indicate whether the particular assignment is a violator, victim, or both. No D/U value is printed in the array if the service volumes are beyond radio line-of-sight of each other.

There are two types of service volumes: polygons and circles. In the case of polygons, D/U ratios are calculated for every point within line-of-sight. If the ground site is located at the center of a circular service volume, the worst-case point is the point on the circle closest to the interfering service volume. If the ground site is not in the center of the circular service volume, the worst-case point can be anywhere on the circle, depending on the geometry involved. The worst-case D/U ratio for circles, and the minimum D/U ratio for polygons, are printed by the program.

Service-Volume Plot Program

The Tailored-Service-Volume (TSV) Plot Program provides a composite plot of a given list of TSV's. The Lambert conformal map projection is used, with map scale and standard parallels provided as inputs. Political boundaries may be plotted with the TSV's.

The input list of TSV's to be plotted may be generated in several ways. Specific TSV identification numbers may be given to the program, either individually or in a range. TSV's may also be generated by choosing all the assignment requirements on a given frequency, and obtaining their corresponding service volumes. This method of running the program is especially useful for a graphical verification of the data base, as discussed above.

Additional features of the plot program include the ability to select TSV's on the basis of ATC function code (e.g., all the *high* functions may be plotted together) and the option to plot the sites associated with the selected service volumes.

SECTION 3

FAA UHF DATA BASE

FILE DESCRIPTIONS

The FAS data base at ECAC consists of two master files: the Requirements File and the TSV File. An additional file, the Site Denied-Frequency File, is a temporary file that is prepared as needed for assignments. These files contain the data that are necessary to make a compatible frequency assignment and that are used as input to the various programs in the assignment sequence. Master files are continually updated as new/revised data become available.

Requirements File

The present FAA UHF Requirements File is developed from the Interdepartmental Radio Advisory Committee's Government Master File (IRAC GMF). This file contains the frequency authorized for use at a particular site for a specific function and location. Each record in the FAA UHF Requirements File contains data on an FAA requirement. These data include:

1. Requirement Identifier (REQ ID) - a unique identification generated by ECAC.
2. Site/Terminal Name - the name in the GMF.
3. Site Latitude - geographic site latitude in seconds.
4. Site Longitude - geographic site longitude in seconds.
5. Site Denied-Frequency File Identification - an identification link to the Site Denied-Frequency File.
6. Tailored Service Volume File Identification (TSV ID) - an identification link to the Tailored Service Volume File.
7. ATC Function - a 1-character function descriptor. (e.g., H = high, A = approach control).

8. Altitude - height above sea level in 1000's of feet.

9. Operational Year - year of activation.

10. Channel Number - channel number corresponding to Item 15.

11. Sort Key - a value placed in the file to permit sorting the file by ATC function.

12. Link Number - an identifier associating those function records requiring the same frequency assignment.

13. D/U Ratio - the specified minimum ratio of desired-to-undesired signal (desired protection criteria), given in dB.

14. Date of Latest Entry - year, month, day.

15. Background/Preassigned Frequency - the frequency (Item 16) in MHz for those requirements that are to be considered as preassigned by the assignment system.

16. Actual Frequency - the actual frequency in MHz that is presently being used to satisfy this requirement.

17. Operating Agency - a 1-character agency descriptor (e.g., A = FAA, C = Canadian).

18. Service Volume Radius - the radius (in nautical miles) of the circular service volume as shown in the GMF.

19. GMF Identification (GMF ID) - the agency serial number taken from the GMF data file.

20. Receiver Latitude - geographic service volume center latitude, in integer seconds.

21. Receiver Longitude - geographic service volume center longitude, in integer seconds.

22. Region Code - a code placed in the file to permit sorting the file by FAA region.

The Requirements File is updated from the GMF as necessary and is permanently stored on disc. Each record is 14 words in length, and the first record (header record) of the file contains general information about the file. These record formats are shown in APPENDIX D.

Tailored Service Volume File

The TSV File contains specific service-volume data for FAA-controlled sectors. These data are latitude and longitude point descriptions used to describe sectors. The multipoint sector data is derived from the Adaptation Controlled Environment Systems (ACES) tapes that are provided to ECAC by the FAA centers on a periodic basis. Data representing geographic nodes are combined to form sectors that are defined by a series of latitude and longitude points. These sectors become the tailored service volumes used in the FAS.

In some instances, a large or odd-shaped sector cannot be properly served by one frequency. In these cases the sector is divided into subsections and each subsection is served by one frequency. These subsections are represented in the TSV file by the intersection of GMF service-volume circles and the sector constructed from the ACES tape. The GMF references the enroute sectors described by the data on the ACES tapes. The shaded area in FIGURE 4 represents such an intersection and would be the service volume used by the matrix generator in the intersite analysis.

The frequency assignment system can use circles, normal TSV's from the ACES tapes, or intersections as described above.

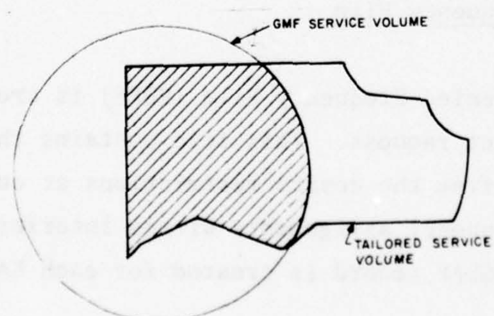


FIGURE 4. INTERSECTION OF TSV AND GMF SERVICE VOLUME CIRCLE.

Each record in the TSV file contains the following data items:

1. TSV Identification (TSV ID) - a unique identification for each record.

2. Number of Points - number of points that describe the TSV polygon (maximum = 25).

3. Center Latitude - latitude in seconds for the center of the circle that encloses the TSV.

4. Center Longitude - longitude in seconds for the center of the circle that encloses the TSV.

5. Radius - radius in statute miles for sectors whose shape is described by a circular volume (converted to nautical miles by the FAS).

6. Latitude/Longitude Points - points corresponding to the vertices of the TSV polygon.

7. Sector Name - 6-character descriptor from ACES tape.

8. Sector Use Code - single-character identifier indicating sector use (e.g., H = high altitude, L = low altitude).

The Master TSV File is permanently stored on a disc. Each record is 56 words in length, with the header record of the file containing general information about the file. APPENDIX D contains the record formats for the TSV File header record and TSV records.

Site Denied-Frequency File

The Site Denied-Frequency File (SDFF) is created for each frequency assignment request. This file contains the denied frequencies resulting from the cosite restrictions at each site and from non-FAA UHF frequency assignments within interference range of the FAA sites. An SDFF record is created for each FAA UHF ATC site.

The frequencies used to create the SDFF are selected from the FCC, IRAC, and ARINC files provided to ECAC. The frequencies chosen from the FCC file are those between 54 and 72 MHz, 76 and 108 MHz, and 174 and 216 MHz. The ARINC records selected are those with frequencies between 108 and 136 MHz. The frequencies selected from the IRAC file are those between 108 and 136 MHz and between 215 and 410 MHz.

Each record in the SDFF contains five sections. The first section consists of frequencies assigned to collocated equipment (within 0.2 nmi) at the given FAA ATC site for which the SDFF record is being created. The second section contains frequencies assigned within 2 nmi of the given FAA ATC site. These frequencies serve as the parent frequencies for the computation of image frequencies, intermodulation products, and harmonics. The SDFF identifiers of certain other sites are stored in the third part of the record. These indicators are used to identify the other sites within a specified radius (2 nmi) of the site for which the SDFF record was created. When a frequency is assigned to a particular ATC site, the SDFF record for that site is updated with the new frequency and any constraints (e.g., intermodulation products) caused by the new assignment. The SDFF records identified in the third part of the ATC SDFF record for the site are also updated with the newly assigned frequency. Section four of the SDFF record contains all frequencies denied at the site because of image, intermodulation, and harmonic interference problems. The last section of the SDFF record is necessary because of the nature of the non-FAA equipments. This part of the record contains frequencies in the 225-400 MHz band denied for use at the site as a result of non-FAA UHF frequencies assigned within a specified distance (e.g., 200 nmi or radio line-of-sight) of the site. Frequencies within ± 'X' MHz of these non-FAA operating

UHF frequencies are also noted in this section of the record as being denied for use. The 'X' value is a function of the bandwidth, modulation type, power of the equipment, and the distance from the equipment to the FAA UHF ATC site.

APPENDIX C contains a detailed description of the analysis used by the UHF cosite model.

MAINTENANCE/RETRIEVAL CAPABILITIES FOR PROJECT/MASTER FILES

Maintenance programs for the Requirements File and the TSV File feature single-record additions, changes, and deletion capabilities based on record ID (Requirement ID, GMF ID, or TSV ID). When a record is changed, one or more data items within the record can be altered. A multiple-change capability is available for the Requirements File. This allows the modification of records which, as a group, have one or more data items satisfying given input criteria. The following multiple-change options are available:

1. Multiple altitude change based on ATC function and altitude.

2. A multiple change to D/U ratio based on ATC function and/or TSV range (e.g., set D/U ratio = 12 dB in all records with function = 'H' and TSV number within 1200-1299).

3. A change to background frequency on the basis of function and/or TSV number.

4. Multiple frequency initialization (e.g., set all background frequencies equal to actual frequencies).

5. Individual background frequency change based on actual frequency (e.g., set background frequency equal to actual frequency for all records with an actual frequency of 126.2 MHz).

Record retrieval for a Requirements File is accomplished by means of a Select/Sort/Print Program. This program uses the Requirements File as an input to produce a full-record print of the selected records. This program will also sort the Requirements File in a user-specified order.

The TSV File has two full-record print options. The user can designate a simple full-record print in TSV order, or include a full-record print of all requirements referenced by each TSV record.

The select/sort parameters of the Requirements File Select/Sort/Print Program are entered as card input under user control. The following fields in any combination are selectable items: ATC FUNCTION, FREQUENCY, REQUIREMENT ID, OPERATIONAL YEAR, TSV ID, OPERATING AGENCY, and all functions within a given radius of a specified location. As an option in ordering the selected records, the program allows the user to sort up to seven different items.

Run procedures and data cards for each of the maintenance/retrieval programs are described in APPENDIX E.

SECTION 4

RESULTS

The design of the FAA UHF Frequency Assignment System provides to the FAA a means to automatically and effectively make ATC frequency assignments in the 225-400 MHz band that are compatible with existing assignments in that band. The system consists of a group of computer programs that incorporate the capability to:

1. Generate frequency assignment plans for up to 4000 requirements, shifting assignments, if necessary, to attain a violation-free assignment plan.
2. Update existing assignment plans.
3. Assign frequencies to ATC requirements, using specified assignment constraints (intersite, cosite, and operational).
4. Provide an analysis of new and existing assignment plans by calculation of desired-to-undesired (D/U) signal ratios.
5. Provide information, and displays of the FAA data, as well as information generated by the UHF-FAS.
6. Assist the FAA frequency manager in making manual assignments by providing, for selected frequencies, geographic plots of service volumes that correspond to cochannel assignments.

APPENDIX A

INTERSITE ANALYSIS

The channel-separation matrix represents the results of an intersite analysis that involve all possible pairs of requirements.

The basic programming logic is shown in FIGURE A-1. The decision-making process is dependent on calculations that involve three different types of service volume descriptors: Tailored Service Volume (TSV), Tailored Circular Volume (TCV), and Standard Service Volume (SSV). Enroute functions generally control multipoint TSV's while non-enroute functions control a TCV or SSV.

Each TSV may be described by a maximum of 25 boundary points joined to form a polygon. The radius and center of a TCV or an SSV are extracted from the GMF and stored in the requirements file. The center of a TCV is not necessarily located at the site and its radius value is tailored for the particular site. The center of an SSV is located at the site and the radius defined according to ATC function. The formatting for these files is described in APPENDIX D.

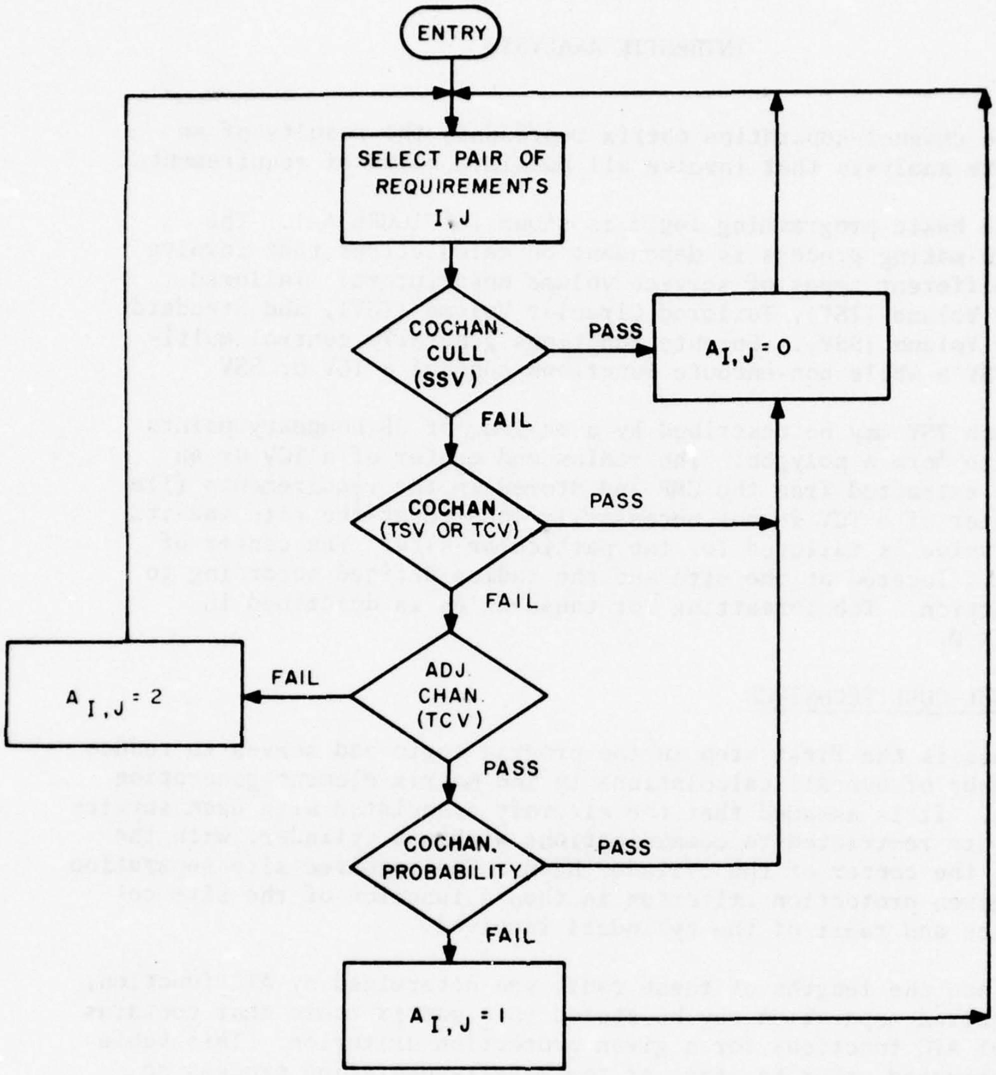
COCHANNEL CULL TECHNIQUE

This is the first step in the program logic and serves to reduce the number of overall calculations in the matrix-element-generation process. It is assumed that the aircraft associated with each service volume are restricted to communications within a cylinder, with the site at the center of the cylinder base. The required site separation for a given protection criterion is then a function of the site coordinates and radii of the cylinders involved.

Since the lengths of these radii are determined by ATC function, the required separation may be stored in a matrix table that contains pairs of ATC functions for a given protection criterion. This table is constructed prior to start of the matrix-generation process so that the cull analysis involves only the calculation of site separation that is compared to the appropriate value in the table.

COCHANNEL TSV ANALYSIS

This analysis involves two sites (S_1, S_2) and their associated service volumes (V_1, V_2). Three types of interference are air-to-air, ground-to-air, and air-to-ground.



Notes: $A_{I,J}$ = 0, if I and J require no channel separation.

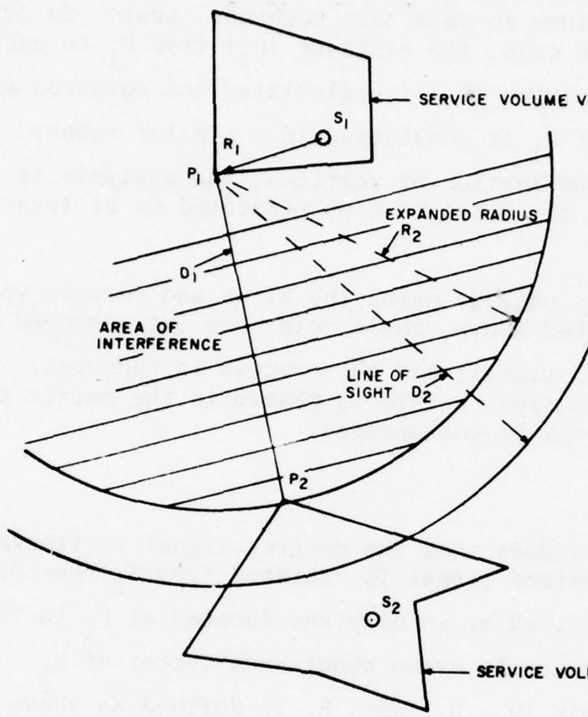
$A_{I,J}$ = 1, if I and J require separation of one or more channels.

$A_{I,J}$ = 2, if I and J require separation of two or more channels.

FIGURE A-1. INTERSITE ANALYSIS LOGIC.

Air-to-Air

It is assumed that the desired signal is transmitted from site S_1 and received by an airplane located at a vertex P_1 of the associated TSV V_1 (FIGURE A-2). The undesired signal is transmitted from an airplane at P_2 of the associated TSV V_2.



Note: In this example, the cochanneling of S_1 and S_2 is prohibited.

FIGURE A-2. AIR-TO-AIR INTERFERENCE.

R_1 equals the distance from S_1 to P_1 corrected by the altitude of the sector. An expanded radius corresponding to the prescribed D/U ratio is calculated using Equation A-1:

$$R_2 = R_1 \cdot 10^{(D/U)/20}, \text{ nmi} \qquad \text{(A-1)}$$

To describe a circle of interference about P_1, the line-of-sight distance between airplanes that are located in V_1 and V_2 is calculated using Equation A-2:

$$D_2 = (\sqrt{2A_1} + \sqrt{2A_2}) \cdot (.87),\ \text{nmi} \qquad \text{(A-2)}$$

where A_1 is the altitude in feet of V_1 and A_2 is the altitude in feet of V_2. The radius R_{Int} = min (R_2, D_2) defines a circle of interference about the point P_1; i.e., if any interfering airplane lies within this circle, the given protection criterion is violated which results in failure to pass this cochannel test. To determine if this is indeed the case, the distance (D_1) from P_1 to each vertex of the interfering polygon (V_2) is calculated and compared against R_{Int}. Each vertex of V_1 is considered in a similar manner. If this test fails for any combination of vertices, the analysis is terminated which indicates that the sites must be separated by at least one channel.

If every test is passed, using the sites and service volumes in the manner described above, their roles are interchanged (S_2 generates the desired signal) and the process is repeated. If again every test is passed, a zero is placed in the matrix to indicate that the sites may be cochanneled.

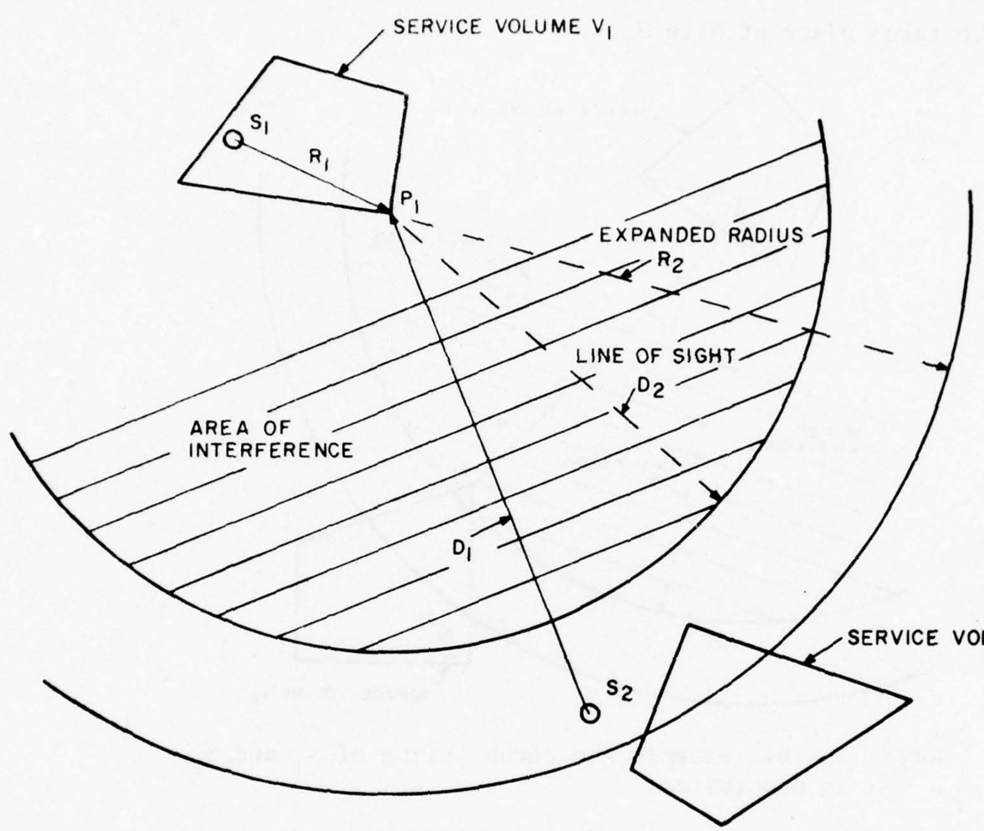
Ground-to-Air

This analysis assumes that the desired signal is transmitted from S_1 and the undesired signal is radiated from S_2 (see FIGURE A-3). Both signals are received by an airplane located at P_1 in TSV V_1. A circle of interference is drawn about each vertex of V_1. Using the radius, R_{Int} = min (R_2, D_2) nmi, R_2 is defined as above and D_2 is the line-of-sight distance from an airplane located at P_1.

$$D_2 = .87 \cdot \sqrt{2A_1} + 8.7,\ \text{nmi} \qquad \text{(A-3)}$$

Ground antenna height is assumed to be 50 feet.

The possibility of ground-to-air interference is then determined by computing the distance (D_1) from P_1 to S_2. If D_1 is less than R_{Int}, S_2 lies within the circle of interference and the cochannel protection criterion is violated. To test for ground-to-air interference where S_2 emits the desired signal, the analysis is reversed.

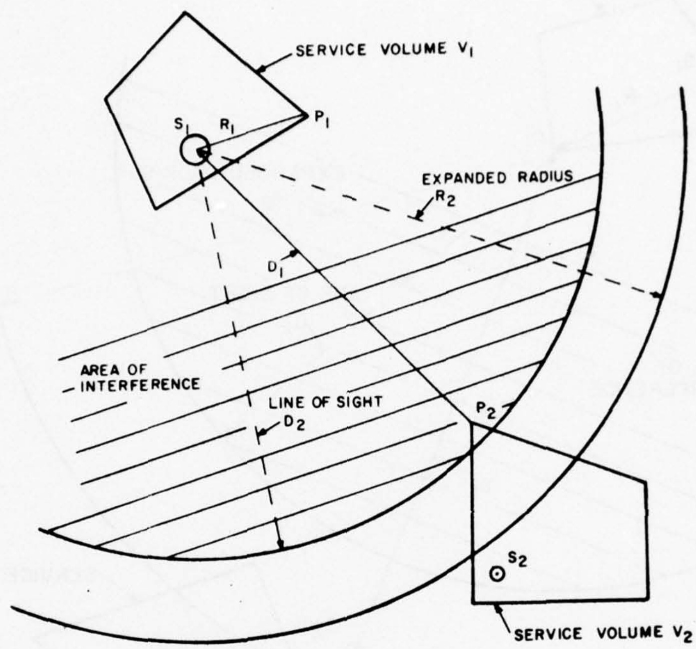


Note: In this example the cochanneling of S_1 and S_2 is not prohibited.

FIGURE A-3. GROUND-TO-AIR INTERFERENCE.

Air-to-Ground

In this case, the desired signal is transmitted from an aircraft located at vertex P_1 of V_1, and the undesired signal is transmitted from an aircraft at P_2 of TSV V_2 (see FIGURE A-4). The interference takes place at site S_1.



Note: In this example, the cochanneling of S_1 and S_2 is prohibited.

FIGURE A-4. AIR-TO-GROUND INTERFERENCE.

A circle of interference is drawn about S_1 using the radius R_{Int}. The possibility for interference is determined by calculating the distance (D_1) from S_1 to P_2 and comparing it with the radius R_{Int}. If P_2 is found to lie within the circle of interference, S_1 and S_2 cannot be cochanneled. This process is repeated for each vertex of V_1. To determine the possibility of air-to-ground interference at S_2, the role of arguments is reversed.

$$D_2 = .87 \cdot \sqrt{2A_2} + 8.7, \text{ nmi}$$

COCHANNEL CYLINDRICAL SERVICE-VOLUME ANALYSIS

Some sites serve airspaces that have circular plots in lieu of polygon plots. The basic concepts used in TSV cochannel analysis are modified to accommodate circular service-volume description. For TSV analysis, computations were made assuming that the airplanes were located at the vertices of the polygon service area descriptions. When a cochannel analysis is conducted for circular volumes, airplanes are assumed to be at worst-case position; i.e., the ratio of the distance from the desired signal to the distance from the undesired signal is maximized.

AN ALGORITHM FOR FINDING WORST-CASE LOCATION ON A CIRCLE

This analysis determines the worst-case position of an aircraft located in a sector V served by a site S. The location of the site is arbitrary and the sector is circular with radius r_1. FIGURE A-5 describes a typical orientation of the site, its service volume, and the location of an interfering transmitter.

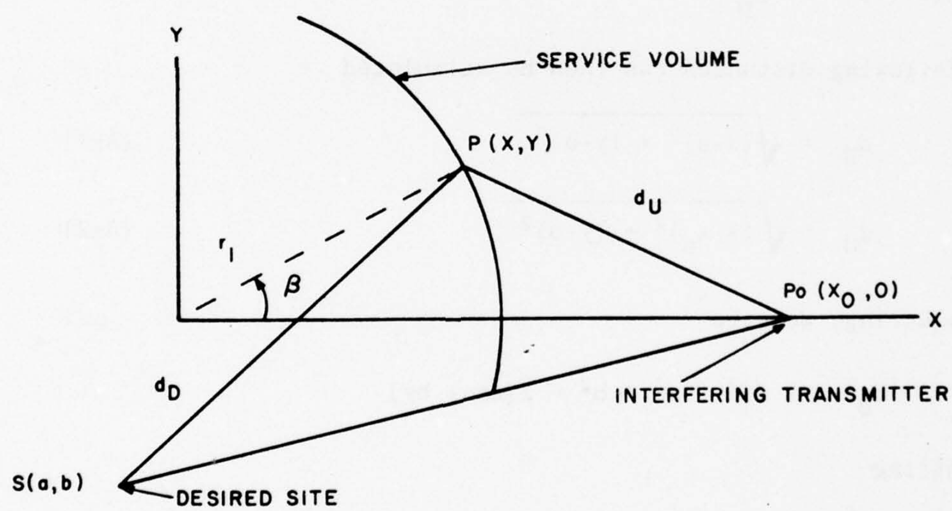


FIGURE A-5. WORST-CASE CONFIGURATION.

The problem is to find the coordinates of P such that the ratio of d_D/d_U is maximized (thereby minimizing D/U Signal Ratio), where

d_D = desired distance

d_U = undesired distance

which gives the following:

S (a,b) = site location (desired transmitter)

Po (x_o, 0) = undesired signal transmitter location

r_1 = radius of sector

Knowing that P is on the perimeter of the circle we have,

$$x^2 + y^2 = r_1^{\,2}$$

The following distances can then be calculated

$$d_D = \sqrt{(x-a)^2 + (y-b)^2} \qquad \text{(A-1)}$$

$$d_U = \sqrt{(x-x_o)^2 + (y-o)^2} \qquad \text{(A-2)}$$

Now squaring, we have

$$d_D^{\,2} = r_1^{\,2} + a^2 + b^2 - 2(ax + by)$$

by letting

$$c^2 = r_1^{\,2} + a^2 + b^2 \qquad \text{(constant)}$$

then

$$d_D^{\,2} = c^2 - 2(ax + by) \qquad \text{(A-3)}$$

Now, squaring d_U we have

$$d_U^2 = r_1^2 + x_o^2 - 2x_o x \qquad \text{(A-4)}$$

by letting

$$e^2 = r_1^2 + x_o^2 \qquad \text{(constant)}$$

we have

$$d_U^2 = e^2 - 2x_o x$$

Let

$$R = d_D/d_U$$

then

$$R^2 = \frac{c^2 - 2ax - 2by}{e^2 - 2x_o x} \qquad \text{(A-5)}$$

and

$$2 \ln R = \ln (c^2 - 2ax - 2by) - \ln (e^2 - 2x_o x)$$

But

$$y = \sqrt{r_1^2 - x^2}$$

Therefore,

$$2 \ln R = \ln \left(c^2 - 2ax - 2b\sqrt{r_1^2 - x^2}\right) - \ln (e^2 - 2x_o x) \qquad \text{(A-6)}$$

Now, taking the derivative with respect to x and setting it equal to zero we have

$$\frac{dR}{dx} = \left[\frac{-2a + 2bx(r_1^2 - x^2)^{-\frac{1}{2}}}{c^2 - 2ax - 2b\sqrt{r_1^2 - x^2}} + \frac{2x_o}{e^2 - 2xx_o}\right]\frac{R}{2} = 0$$

on simplifying, we obtain

$$(c^2x_o - e^2a)\sqrt{r_1{}^2 - x^2} = 2bx_or_1{}^2 - e^2bx \qquad \text{(A-7)}$$

Letting

$$x = r_1 \cos\beta$$

we have

$$(c^2x_o - e^2a)\sin\beta + e^2b\cos\beta = 2bx_or_1$$

Now, set

$$c^2x_o - e^2a = f$$

and

$$e^2b = g.$$

And substituting into the above

$$f\sin\beta + g\cos\beta = 2bx_or_1 \qquad \text{(A-8)}$$

then

$$\frac{f}{\sqrt{f^2 + g^2}}\sin\beta + \frac{g}{\sqrt{f^2 + g^2}}\cos\beta = \frac{2bx_or_1}{\sqrt{f^2 + g^2}} \qquad \text{(A-9)}$$

and

$$\sin\psi = \frac{g}{\sqrt{f^2 + g^2}}; \qquad \cos\psi = \frac{f}{\sqrt{f^2 + g^2}}$$

then

$$\sin(\beta + \psi) = \frac{2bx_or_1}{\sqrt{f^2 + g^2}} \qquad \text{(A-10)}$$

or

$$\beta = \sin^{-1} \left(\frac{2bx_o r_1}{\sqrt{f^2 + g^2}} \right) - \psi \qquad \text{(A-11)}$$

together with the radius r_1 define the point P (x,y)

INTERSITE ADJACENT-CHANNEL ANALYSIS

Adjacent-channel assignment, by FAA practice, requires at least a 2-nmi separation between aircraft. The matrix generator module makes a conservative test by requiring that the circles encompassing the sector TSV's do not overlap. For two requirements, this test is made by calculating the distance between the centers and subtracting the sum of the two radii. If the result is 2 nmi or more, the requirements may be assigned adjacent-channels and a 1 is entered in the matrix for this interaction; otherwise that element of the matrix is assigned a 2. See FIGURE A-6.

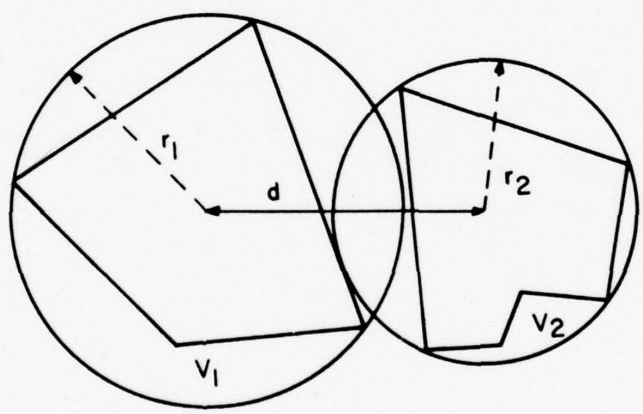


FIGURE A-6. ADJACENT-CHANNEL ANALYSIS.

APPENDIX B

PROBABILITY METHOD OF FREQUENCY ASSIGNMENT (AIR-TO-AIR INTERFERENCE)

APPENDIX A provides a detailed explanation of the method used by the Frequency Assignment System (FAS) to ensure meeting the required cochannel assignment criterion. The cochannel criterion is an option selected by the user. (FAA has been using 14 dB desired-to-undesired (D/U) signal ratio.) This appendix presents the method used by the FAS to determine which cochannel assignments can be made using probability. The theory of this probability method is discussed in detail in Reference 5 where it is referred to as "Method 3."

FIGURE B-1 depicts a case of air-to-air interference. The aircraft in service-volume A is receiving a message from the ground site serving A at the same time that the aircraft in service-volume B is attempting to communicate with the ground site serving B.

The cochannel probability analysis takes advantage of the random use of the communication equipment and the random placement of interfering aircraft. The formula used to calculate the probability of interference, P(I), is given by:

$$P(I) = P(A) \times P(G) \times P(AI/SI)$$

where

P(A) = the probability that an interfering aircraft will be transmitting (aircraft communications utilization)

P(G) = the probability that a ground site will be transmitting (site communications utilization)

P(AI/SI) = the probability that an aircraft is in the area of interference (AI), given that the aircraft is in the sector of interference (SI). See FIGURE B-2.

The desired signal originates from the ground site while the undesired signal originates from the transmitter of another aircraft. FIGURE B-2 is a two-dimensional drawing showing a victim sector with its ground site and victim aircraft and a sector of interference. The 14 dB D/U arc of protection is drawn from the "worst-case" point in the victim sector through the sector of interference. The worst-case location is defined as that point in the victim service volume that yields the minimum desired-to-undesired (D/U) signal ratio. The technique used to find this point is described in APPENDIX A. An aircraft in the area of interference (AI, the shaded portion of SI) could cause air-to-air interference (i.e., less than 14 dB D/U signal ratio) at the victim aircraft receiver. An aircraft in the non-shaded portion of SI would not cause air-to-air interference in the victim aircraft.

The utilization values for P(A) and P(G) can be estimated using actual FAA data. Typical values assumed are P(A) = 0.1 and P(G) = 0.5 or 0.7. The value of P(I) therefore can be determined as soon as P(AI/SI) is calculated. P(AI/SI) is the ratio of AI, the area of interference in SI, to the total area of SI.

$$P(AI/SI) = \frac{\text{area of interference}}{\text{total sector area}}$$

The determination of AI is made by calculating that portion of SI that is within the 14 dB D/U arc of protection drawn from the worst-case location on the victim service volume (see FIGURE B-2).

The FAS permits cochannel assignment only if the value of P(I) is less than 0.05. This value means that there would be no more than a 5% chance that interference would occur if the ATC requirements for these service volumes were given the same frequency.

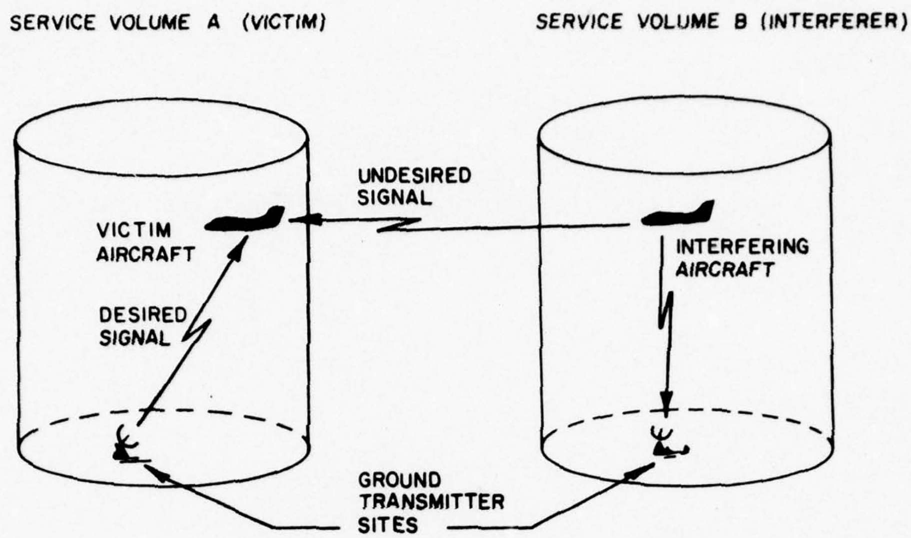


FIGURE B-1. GEOMETRY OF AIRBORNE TRANSMITTER IN SERVICE VOLUME B INTERFERING WITH AIRBORNE RECEIVER IN SERVICE VOLUME A.

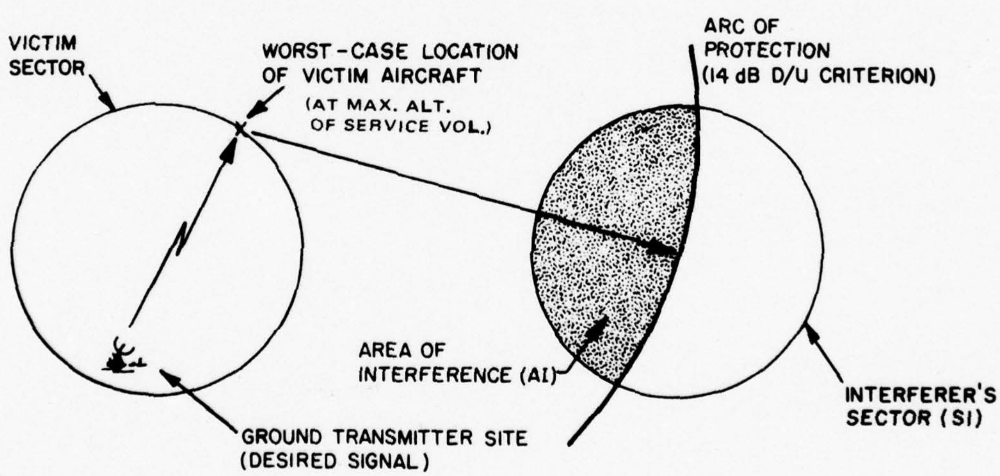


FIGURE B-2. GEOMETRY INVOLVED IN PROBABILITY-OF-INTERFERENCE CALCULATION.

APPENDIX C

UHF COSITE ANALYSIS MODEL

GENERAL

The UHF cosite analysis model discussed in this appendix performs both cosite and intersite analyses in developing the Site Denied-Frequency File (SDFF). The SDFF is developed from information contained in the Government Master File (GMF), FCC, and ARINC data files. The objective of the cosite portion of the analysis is to determine which UHF (225-400 MHz) channels are denied at each FAA ATC site as a result of adjacent-signal, intermodulation, harmonic, and image-frequency compatibility restrictions imposed by cosite assignments. The objective of the intersite analysis is to prevent interactions between FAA ATC frequency requirements being assigned and non-FAA frequency assignments existing within the UHF band.

If assignments are made using subband allocations allotted for exclusive use by the FAA, the analysis is limited to cosite interactions. Subband allotment for exclusive use by an agency is a frequency-management technique used to avoid adjacent-signal interactions with assignments belonging to other agencies.

If a requirement for frequency assignment allows the sharing of frequencies with other agencies, a cochannel and adjacent-signal analysis are performed to determined locations where frequencies that are not exclusively allotted to FAA can be used.

ASSUMPTIONS

The cosite analysis model is based on the following assumptions.

1. The leading digits in the emission designator (e.g., 6A3) indicate the system "necessary bandwidth" as defined by OTP. The bandwidth designators reported in the GMF are assumed to indicate the 20 dB system bandwidth; that is, both the transmitter emission bandwidth and the associated receiver bandwidth are assumed to be the same reported value.
2. For each system, the transmitter emission spectrum and the receiver selectivity characteristic beyond the 20 dB bandwidth are assumed to have the same slope. That slope is assumed to be constant in dB/octave, beginning at the edge of the 20 dB bandwidth through an additional 50 dB in the characteristic (i.e., to the 70 dB bandwidth).
3. The analysis of noncosite systems is performed using the bandwidths derived from assumptions 1 and 2.

4. The calculation of the frequency separation necessary to avoid interference with noncosite systems can be simplified by considering the bandwidths of those systems relative to the bandwidths of the ATC systems. ATC systems are narrowband (6A3). The four possible noncosite interference situations are:

a. ATC transmitters to narrowband receiver environment
b. ATC transmitters to wideband receiver environment
c. Narrowband transmitter environment to ATC receivers
d. Wideband transmitter environment to ATC receivers.

In situations a and c, it is assumed that only a cochannel analysis problem is presented, since the equipment bandwidths are approximately 6 kHz and the channels are 25 kHz wide. In situations b and d, it is assumed that sufficient difference exists between the wideband and narrowband equipment so that the power received by the victim receiver is proportional to the appropriate characteristic (emission spectrum or selectivity) of the wideband equipment. These assumptions may not provide complete accuracy for determination of bandwidth, since variation exists in determining necessary bandwidths for different types of modulation and channel capacities. However, with respect to frequency-assignment criteria, these assumptions will provide adequate results for most of the systems operating in the 215-410 MHz frequency band.

APPROACH

The analysis is performed in two steps. Frequency data from the three sources listed below are classified in the first step:

FCC: 54-72 MHz, 76-108 MHz, and 174-216 MHz.
ARINC: 108-136 MHz.
GMF: 108-136 MHz, and 215-410 MHz.

The GMF (215-410 MHz) frequency assignments are categorized according to modulation type, bandwidth, and maximum allowable transmitter power. Frequencies only are extracted from FCC, ARINC, and GMF (108-136 MHz) sources.

The second step in the analysis uses the classification determined in step one plus the geographic separation between ATC sites and service volumes and the preassigned ATC frequency assignments, to determine the number of frequencies to be denied at each ATC site. The result of this second step is the SDFF.

FREQUENCY CLASSIFICATION

Each background frequency is assigned a code from 0 through 63. These codes, except for code 0, account for necessary bandwidth, modulation type, and power. (See TABLE C-1.) The codes are used by the model to determine frequencies to be denied at each ATC site.

TABLE C-1

CODE ASSIGNMENTS

$\Delta f = \frac{BW \cdot BF}{C}$	Power Ranges (W)		
	P<50	50<P<250	$250<P<10^4$
1	1	21	41
2	2	22	42
3	3	23	43
4	4	24	44
5	5	25	45
6	6	26	46
7	7	27	47
8	8	28	48
9	9	29	49
10	10	30	50
11	11	31	51
12	12	32	52
13	13	33	53
14	14	34	54
15	15	35	55
16	16	36	56
17	17	37	57
18	18	38	58
19	19	39	59
20	20	40	60

GMF frequencies in the 108-136 MHz band, and all FCC and ARINC frequencies, are given a code of 0. These frequencies are all assigned to equipments that do not cause cochannel or adjacent-channel interactions with UHF (215-410 MHz) ATC requirements. The code 0 frequencies are, however, used in intermodulation and/or harmonic interference analyses.

A nonzero code is assigned to each GMF frequency in the 215-410 MHz band. For all equipments except high-power transmitters or unusually sensitive receivers, the code is based on a calculated Δf. This Δf is the protection guardband, and is needed to determine the frequencies to be denied for ATC assignments to prevent interference with the system represented by the GMF record.

$$\Delta f = \frac{BW \cdot BF}{C} \tag{C-1}$$

where

BW = bandwidth, in kHz

BF = bandwidth factor, determined from the modulation type (from TABLE C-2)

C = channelization value (25 kHz/channel)

Δf = number of 25-kHz channels, rounded up to the next integer.

The bandwidth factors (BF) from TABLE C-2 are chosen such that if multiplied by the bandwidth value in stored GMF records, the corresponding Δf's obtained will prevent interactions among noncollocated frequency assignments. If a necessary bandwidth (assumed to be equal to the 20 dB bandwidth) is multiplied by a BF of 0.5 (1.0 for single-sideband systems), a Δf representing the 20 dB bandwidth will be produced. If a Δf representing a bandwidth larger than 20 dB is required, then a BF equal to the ratio of the larger bandwidth to the 20 dB bandwidth multiplied by 0.5 (or 1.0) is needed. For example, if the 60 dB Δf for 240F9 is needed and the spectral falloff for 240F9 is such that the 60 dB bandwidth is 1.44 times the 20 dB bandwidth, a BF of 0.72 will produce a Δf of 173 kHz as opposed to 120 kHz if the 20 dB Δf were sufficient. An adjacent-signal rejection of 60 dB is presently assumed to be necessary for ATC frequency assignments.

CHANNEL DENIAL

Each Δf value represents the basic number of channels denied because of a non-FAA system operating within radio line-of-sight (RLOS) of an ATC site or service volume. If the circle defined by

TABLE C-2

BANDWIDTH FACTORS

Modulation Type	Bandwidth Factor (BF)
A0	.5
A1	.5
A2	.51
A3	.51
A3A	1.15
A3B	1.15
A3H	1.15
A3J	1.15
A4	1.15
A5	.625
A5C	.625
A9	1.15
A9B	1.15
A9C	1.15
F0	.5
F1	.5
F2	.69
F3	.69
F4	.69
F6	.69
F9	.72
P0	.75
P1	.75
P9	.75
All others	.5

the radius-of-operation reported in the GMF record for the non-FAA system is within 2 nmi of the ATC service volume, an adjustment factor is applied to deny channels beyond the basic number indicated by the Δf value. (A distance of 2 nmi is needed to prevent adjacent-signal interference from a 50-watt transmitter when the receiver adjacent-signal rejection is 60 dB.) For distances greater than 2 nmi, another adjustment factor is used to deny channels beyond the basic number indicated by the Δf value. This is done to account for transmitters with more than 50 watts power.

The above adjustment factors are different for the two basic categories of modulation types (AM and FM) to account for different spectral-falloff slope factors. These two categories do not apply to narrowband systems (which are discussed later).

Adjustment factors are also applied for the special cases represented by codes 61, 62, and 63. Channels are denied beyond the basic number indicated by the Δf value, to account for ground-to-air, air-to-ground, or ground-to-ground interactions involving high-power transmitters or highly sensitive receivers.

For A3 and other narrowband use, one channel is denied at ATC sites to prevent cochannel interference on nonclear frequencies used within RLOS of these ATC sites or their respective service volumes. Plus-and-minus one adjacent channel is denied about nonclear frequencies assigned for narrowband use within ATC service volumes. "Narrowband" is defined here as any system whose overall receiver rejection to a CW signal is $\geq$ 60 dB at 1-channel separation (25 kHz). Examples are systems with emissions represented as 0A0, 2A2, 6A3, 10A9, 0F0, 5F1, 3F3, and 6F9. For these systems, the calculated Δf will be one channel (25 kHz). Using the Δf value and the equipment power, the code to be attached to a particular frequency is selected from TABLE C-1. Special codes are given to high-power equipment. Code 61 is assigned to all transmitters with power between 10 and 20 kilowatts. Code 62 is assigned to all transmitters with power between 20 kilowatts and 1 megawatt. Transmitters with power greater than 1 megawatt are assigned code 63. At the present, no special code is used to represent unusually sensitive receivers.

DENIED-FREQUENCY FILE CREATION

After all background frequencies are classified, a Site-Denied Frequency File (SDFF) record is constructed for each ATC site. Sites within 0.2 nmi of one another are considered to be collocated and have the same SDFF record.

Two types of compatibility analysis -- cosite and intersite -- are performed for each site. The cosite analysis includes potential interference involving intermodulation products, image frequencies, and second- and third-order harmonics. All frequencies assigned to locations within 2 nmi of the site are considered in the cosite analysis. Broadcast frequencies assigned by the FCC to locations within 15 nmi of the ATC site are considered in the cosite analysis. For the intersite analysis, non-FAA UHF frequencies assigned to locations within radio line-of-sight of the ATC site are protected by denying frequencies on the basis of code assignments and the distances to the ATC site.

A general flow chart of the site analysis model is shown in FIGURE C-1.

SDFF FORMAT

The SDFF record format consists of five parts. Part 1 contains all frequencies assigned at or very near the ATC site (within 0.2 nmi). Part 2 contains all frequencies used for intermodulation, harmonic, and image analyses. Part 3 contains a list of all other SDFF records for sites within 2 nmi of the ATC site. (Part 3 is required during the assignment process when a requirement is assigned a new frequency. All SDFF records for nearby sites must be updated to reflect the new assignment.) Part 4 contains the frequencies denied as a result of the analyses performed on part 2 frequencies. Part 5 contains frequencies denied for use because of intersite problems associated with the background.

When a new ATC frequency is assigned at a site it is stored in parts 1 and 2 of the SDFF record for that site. The analysis of intermodulation, harmonics, and image frequencies is performed with the new frequency and any new denied frequencies are stored in part 4 of this SDFF record as well as part 4 of all SDFF records listed in part 3 of this SDFF record. Part 5 does not change after the initial site analysis. Preassigned ATC frequencies can be in parts 1 and 2 prior to the initial site analysis.

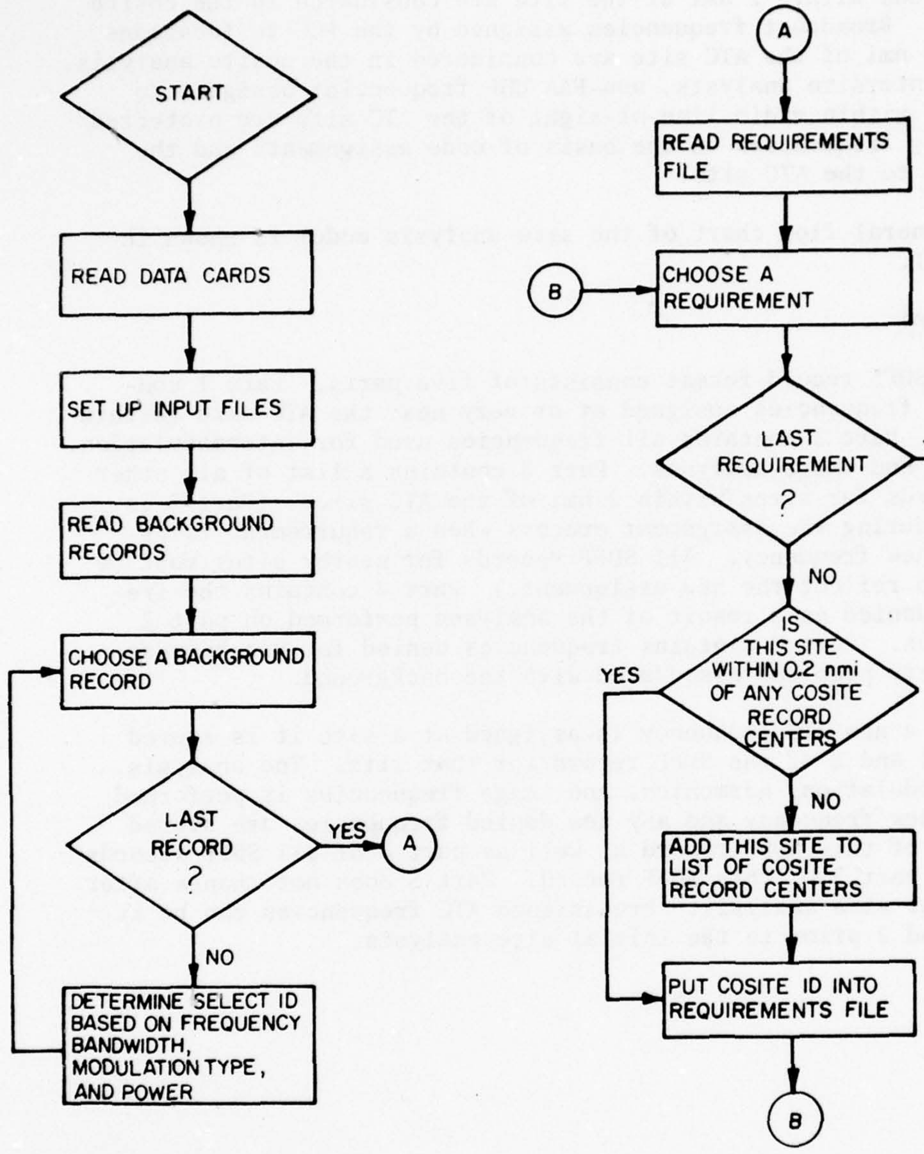


FIGURE C-1. COSITE MODEL FLOW CHART. (Page 1 of 2)

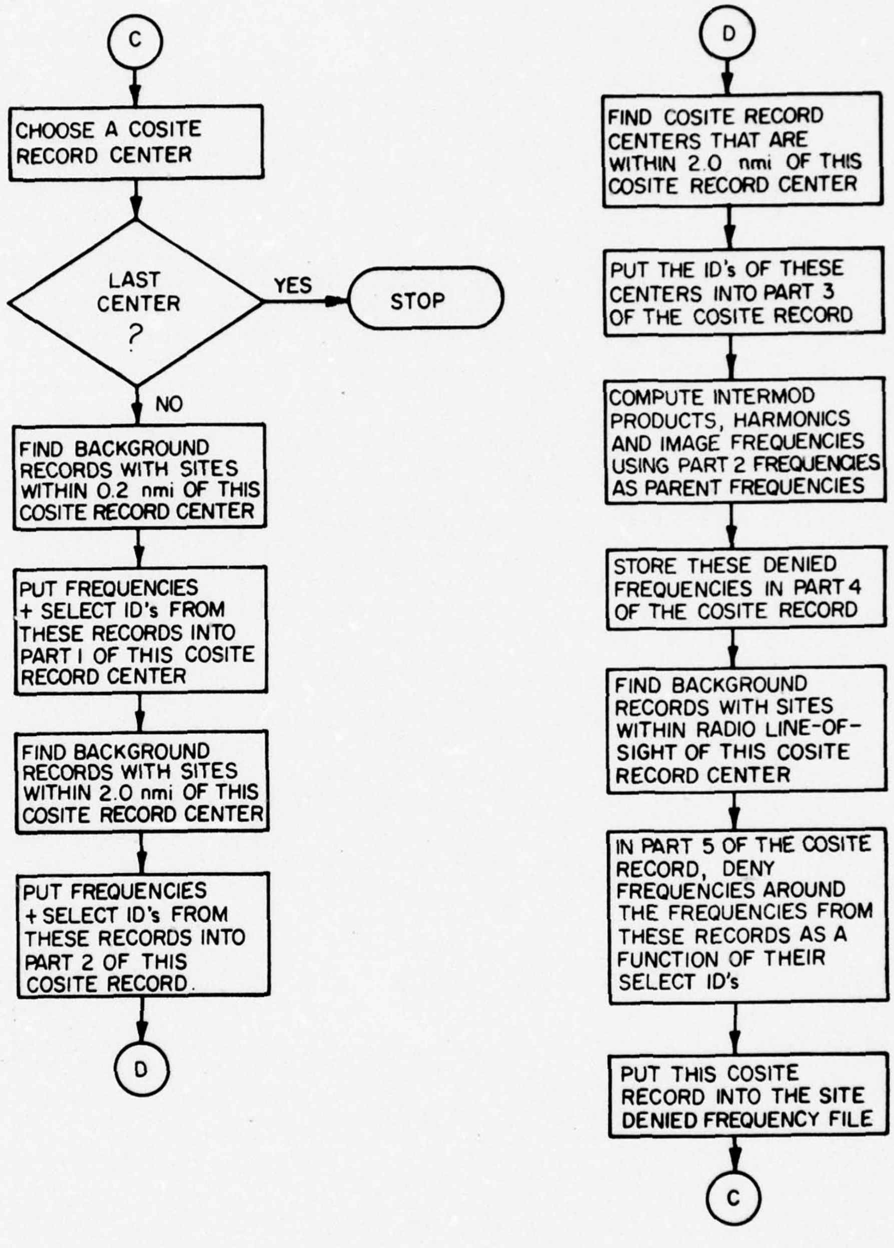


FIGURE C-1. (Page 2 of 2)

APPENDIX D

DATA BASE RECORD FORMATS

WORD #	Format S1	Format S2	Format S3	Format S4	Format S5	Format S6	S1	S2	S3	S4	S5	S6
1	INT						Number of Requirements					
2	FLD						Date Created (1)					
3	FLD						Date Created (2)					
4	FLD						Date of Last Change (1)					
5	FLD						Date of Last Change (2)					
6	FLD						Date Verified (1)					
7	FLD						Date Verified (2)					
8	INT						Last Requirement ID Assigned					
9	INT		INT			INT	# of	S	# of	H	# of	L
10	INT		INT			INT	# of	A	# of	D	# of	C
11	INT		INT			INT	# of	G	# of	R	# of	P
12	INT		INT			INT	# of	T	# of	X	# of	V
13	INT						# of	W				
							S1	S2	S3	S4	S5	S6

NOTE: S - Super High Enroute
A - Approach Control
G - Clearance Delivery
T - Automatic Terminal Information Service
H - High Altitude Enroute
D - Departure Control
R - Helicopter Control
L - Low Altitude Enroute
C - Local Control
P - Precision Approach Radar
W - Approach/Departure Control (Canadian)
X - Clearance Delivery (Canadian)
V - ATIS (Canadian)

FIGURE D-1. REQUIREMENTS FILE HEADER SECTOR FORMAT.

WORD #	Format S1	Format S2	Format S3	Format S4	Format S5	Format S6	S1	S2	S3	S4	S5	S6
1	INT			INT			Requirement Record ID			Channel No.		
2	FLD						State, City					
3	FLD						State, City					
4	INT						Latitude of Site (seconds)					
5	INT						Longitude of Site (seconds)					
6	INT			FLD	INT		Cosite Record ID			Operating Agency	Service Volume Radius (nmi)	
7	INT			FLD	FLD		TSV Record ID			ATC Function	Altitude/1000 (ft.)	
8	INT						IRAC ID					
9	Bits 0-3	Bits 5-9	Bits 11-17	INT			Date of Latest Entry Month | Date | Year			FTN SRT KEY		
10	INT			INT			D/U Ratio (dB)			Link No.		
11	INT				FLD		Latitude of TCV Center (seconds)				Op Year	
12	INT				FLD		Longitude of TCV Center (seonds)				Region Code	
13	FL PT						Background/Pre-Assigned Freq. (MHz)					
14	FL PT						Actual Freq. (MHz)					
							S1	S2	S3	S4	S5	S6

FIGURE D-2. REQUIREMENTS FILE SECTOR FORMAT.

WORD #	Format						S1	S2	S3	S4	S5	S6
	S1	S2	S3	S4	S5	S6						
1	INT						Number of TSV Records					
2	FLD						Date Created (1)					
3	FLD						Date Created (2)					
4	FLD						Date of Last Change (1)					
5	FLD						Date of Last Change (2)					
6	FLD						Date Verified (1)					
7	FLD						Date Verified (2)					
							S1	S2	S3	S4	S5	S6

FIGURE D-3. TAILORED SERVICE VOLUME FILE HEADER SECTOR FORMAT.

WORD #	Format S1	Format S2	Format S3	Format S4	Format S5	Format S6	S1	S2	S3	S4	S5	S6
1	INT						TSVTCV ID					
2	FLD	INT				FLD	Cell Type	TCV Radius (Hundredths of Miles)				No. of Points
3	INT						Latitude (seconds)			Center of		
4	INT						Longitude (seconds)			TSVTCV Circle		
5	INT/FL PT *						Lat. #1 (seconds)/Radius * (Cell Type = C)					
6	INT						Long. #1 (seconds)					
7	.						Lat. #2 (seconds)					
8	.						Long. #2 (seconds)					
.	.						.					
.	.						.					
.	.						.					
.	.						.					
.	.						.					
.	.						.					
.	.						.					
.	.						.					
53	INT						Lat. #25 (seconds)					
54	INT						Long. #25 (seconds)					
55	FLD						Sector Name					
56	FLD						Sector Use Code					
							S1	S2	S3	S4	S5	S6

FIGURE D-4. TAILORED SERVICE VOLUME RECORD FORMAT. MANY-POINT/CIRCULAR (56 WORDS/RECORD).

WORD #	FORMAT S1	FORMAT S2	FORMAT S3	FORMAT S4	FORMAT S5	FORMAT S6	S1	S2	S3	S4	S5	S6
1			FLD				Name of Cosite File					
2			INT				Number of Records in file					
3			INT				Number of words in each cosite record					
4			INT				Number of words in Part 1 of a cosite record					
5			INT				Number of words in Part 2 of a cosite record					
6			INT				Number of words in Part 3 of a cosite record					
7			INT				Number of words in Part 4 of a cosite record					
8			INT				Number of words in Part 5 of a cosite record					
9			FLD				Name of input Requirements File					
10			FLD				Name of output Requirements File					
11			FLD				Date Cosite File created (Part 1)					
12			FLD				Date Cosite File created (Part 2)					
13			FLD				Status word-used by RAM					
14			FLD				Name of input cosite file when creating					
							a backup file-used by RAM					
16-25			INT				IF image values-used by RAM					
							S1	S2	S3	S4	S5	S6

FIGURE D-5. COSITE FILE HEADER RECORD FORMAT.

WORD #	FORMAT S1	FORMAT S2	FORMAT S3	FORMAT S4	FORMAT S5	FORMAT S6	S1 S2 S3 S4 S5 S6
1			INT				Cosite Record ID
2			INT				Center latitude (seconds)
3			INT				Center longitude (seconds)
4-50	INT		INT				Select ID | Frequency (kHz) (Part 1)
51-262	INT		INT				Select ID | Frequency (kHz) (Part 2)
263-282			INT				Cosite Record ID's
283-477			INT				Denied Channel array (Part 4)
478-672			INT				Denied Channel array (Part 5)
							S1 S2 S3 S4 S5 S6

FIGURE D-6. COSITE RECORD FORMAT.

WORD #	Format											
	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6
1	INT						# of String Records					
2	INT						# of Preasg Records					
3												
4												
5												
6												
7												
8												
10												
.												
.												
.												
28	INT						Restart Freq.					
29	INT			INT			Site ID #			Cosite File #		
30	INT			INT			Channel #			Link #		
.	.			.			.			.		
.	.			.			.			.		
.	.			.			.			.		
55	.			.			.			.		
56	.			.			.			.		
							S1	S2	S3	S4	S5	S6

FIGURE D-7. REQUIREMENT ID STRING FILE FORMAT.

APPENDIX E

COMPUTER PROGRAM RUN PROCEDURES

REQUIREMENTS FILE GENERATOR PROGRAM

Data Card Forma_s

Col(s)	Format	Description
1-6	FLD	Name of output requirements file
8-13	FLD	Write key for output requirements file
15	FLD	Security classification for output requirements file
17	FLD	TSV ID option; S = all TSV ID's from state codes blank = L, H, S, ENRT TSV IS's from AGN/ SECT data, all others from state codes
19	FLD	Record creation option; A = create requirements records from good & bad GMF records blank = create requirements records from *only* good GMF records
21	FLD	Sector name/number print option; T = print the tables blank = don't print the tables
23	INT	Agency and/or frequency select; 1 = select agencies from agency card 2 = select agencies and frequencies (both) 3 = select freq. from frequency card 4 = select on agency or frequency
	Note	Blank or Ø is an error
24	FLD	VHF or UHF Indicator: 'Y' = VHF Run Blank = UHF Run

The following set of cards may be elements on a card-image disc file, in which case an '@ADD' card would be inserted after Card #1.

	Col(s)	Format	Description
Card No. 1	1-2	INT	Center number (1-21)
Card No. 2	1-20	FLD	Sector name
	21-22	INT	Sector number (1-99)
Repeat Card No. 2 for each sector in the center.			
Card No. 3	1-6	FLD	'$$$$$$' represents end of data for this center

Repeat Card Nos. 1, 2 and 3 for each additional center.

REQUIREMENTS FILE GENERATOR PROGRAM (Cont'd)

DATA CARD FORMATS

	Col(s)	Format	Description
AGENCY CARD (IF COL. 23 ON CARD 1 IS NOT = 3)	1-6	FLD	1st AGENCY
	8-13	FLD	2nd AGENCY
	15-20	FLD	3rd AGENCY
	22-27	FLD	4th AGENCY
	29-34	FLD	5th AGENCY
	36-41	FLD	6th AGENCY
	43-48	FLD	7th AGENCY
	50-55	FLD	8th AGENCY
	57-62	FLD	9th AGENCY
	64-69	FLD	10th AGENCY

	Col(s)	Format	Description
FREQUENCY CARD (IF COL. 23 ON CARD 1 IS NOT = 1)	1-7	FLPT	1st FREQ. RANGE
	9-15	FLPT	2nd FREQ. RANGE

Run Setup

```
@RUN
@ASG,T A.,T,UXXX                          @GMF  input tape
@DELETE,C QUAL*FILE/U/KEY.
@ASG,UP   QUAL*FILE/U/KEY.                @Assign output requirements file
@ADD,P    FAA*FAAPRG/U.GENFUN
     DATA CARDS
@PMD,ED
@FIN
```

TSV FILE GENERATOR PROGRAM

Data Card Formats

	Col(s)	Format	Description
Card No. 1	1-2	FLD	FAA Center number (1-21)
	4	INT	1=1st run only *2=additional* card follows blank=normal run
	6-11	FLD	Name of TSV File
	15	INT	Number of altitudes $3 \geq X \geq 1$
	16-20	INT	Low Altitude
	21-25	INT	High Altitude
	26-30	INT	Super High Altitude
	41-43	FLD	L = Low H = High S = Super High
	47-76	FLD	Identifier
	77-80	FLPT	Epsilon value

Card No. 2 (used only if column 4 of Card No. 1 equals 2)

Col(s)	Format	Description
1-2	INT	Number of sectors to be mapped Sectors to be mapped $X \leq 5$
3-7		Sector #1
8-12		Sector #2
13-17		Sector #3
18-22		Sector #4
23-27		Sector #5

TSV FILE GENERATOR PROGRAM (Cont'd)

		Sectors to be mapped X≤5
28-32		Sector #1
33-37		Sector #2
38-42		Sector #3
43-47		Sector #4
48-52		Sector #5
	INT	Sectors into which mapping is done (≤5)
53-57		Sector #1
58-62		Sector #2
63-67		Sector #3
68-72		Sector #4
73-77		Sector #5

Run Setup

There are two modes of operation for the TSV File generator.

If the previous run was a success (initial runs are considered successes), use the success mode. If not, follow the failure mode setup.

Success Mode

```
@RUN
@ASG,T 2.,T,UXXX                               @FAA Center converted tape
@REWIND 2.
@QUAL FAA
@ASG,A FAA*FILE/U/KEY.                         @TSV File to be updated
@DELETE,C FAA*TSVDUM/U/BASFIL.
@ASG,UP FAA*TSVDUM/U/BASFIL.                   @Good backup file in case
                                                of failure
@COPY FAA*FILE/U/KEY.,FAA*TSVDUM/U/BASFIL.
@ADD,P FAA*FAAPRG/U.TSVGEN
          DATA CARDS
@PMD,ED
@FIN
```

Failure Mode

```
@RUN
@ASG,T 2.,T,UXXX                               @FAA Center converted tape
@REWIND 2.
@ASG,A FAA*FILE/U/KEY                          @Unsuccessful updated file
@ASG,A FAA*TSVDUM/U/BASFIL.                    @Good backup file from pre-
                                                vious run
@COPY FAA*TSVDUM/U.,FAA*FILE/U/KEY.
@ADD,P FAA*FAAPRG/U.TSVGEN
          DATA CARDS
@PMD,ED
@FIN
```

REQUIREMENTS FILE MAINTENANCE PROGRAM

Input Card	Col(s)	Format	Description
	1-6	FLD	Requirements File Name
	8-13	FLD	Requirements File Write key
	15	FLD	Blank = changes done by REQ ID Y = changes done by GMF ID
Add/Change Card	1-6	INT	Requirements/GMF ID to be added/ changed*
	7-10	FLD	Site State/Country
	11-18	FLD	Site City
	19-24	INT	Site Latitude (DDMMSS)
	25-31	INT	Site Longitude (DDDMMSS)
	32-37	INT	TSV ID
	38	FLD	ATC function
	39-40	INT	Altitude (/1000) feet
	41-44	INT	Link number
	45-50	INT	Receiver latitude (DDMMSS)
	51-57	INT	Receiver longitude (DDDMMSS)
	58-64	FLPT	Background/Pre-assigned frequency (MHz)
	65-71	FLPT	Actual Frequency (MHz)
	72	FLD	Operating Agency
	73-75	INT	Radius (nmi)
	76-78	FLD	'VHF' or 'UHF' as appropriate
	80	FLD	A = add C = change

*Note: Changes made by REQ ID and GMF ID may *not* be combined in one run.

REQUIREMENTS FILE MAINTENANCE PROGRAM (Cont'd)

REQ ID/GMF ID Delete Card

Col(s)	Format	Description
1-6	FLD	REQ ID/GMF ID 1
13-18	FLD	REQ ID/GMF ID 2
25-30	FLD	REQ ID/GMF ID 3
37-42	FLD	REQ ID/GMF ID 4
49-54	FLD	REQ ID/GMF ID 5
61-66	FLD	REQ ID/GMF ID 6
76-78	FLD	'VHF' or 'UHF'
80	FLD	D = delete

Altitude Multiple Change Card

Col(s)	Format	Description
1	FLD	ATC Function Indicator
3-4	FLD	Existing altitude (/1000) feet
7-8	FLD	New altitude (/1000) feet
76-78	FLD	'VHF' or 'UHF'
79-80	FLD	'1M'

NOTE: the changes are made based upon the ATC function and the altitude.

D/U Ratio Multiple Change Card

Col(s)	Format	Description
1	FLD	ATC function indicator
3-8	FLD	TSV ID lower limit } inclusive
10-15	FLD	TSV ID upper limit } inclusive
18-22	FLD	New D/U ratio
76-78	FLD	'VHF' or 'UHF'
79-80	FLD	'2M'

NOTE: the changes are made based upon the ATC function and/or TSV ID range.

REQUIREMENTS FILE MAINTENANCE PROGRAM (Cont'd)

Background Frequency Multiple-Change Card

Col(s)	Format	Description
1	FLD	ATC function indicator
3-8	FLD	TSV ID
11-18	FLD	New background frequency (MHz)
76-78	FLD	'VHF' or 'UHF'
79-80	FLD	'3M'

NOTE: changes are made based upon ATC function and/or TSV ID

Frequency Initialize Card

Col(s)	Format	Description
76-78	FLD	'VHF' or 'UHF'
79-80	FLD	'4M'

NOTE: all background frequencies are set equal to the actual frequencies.

Background Frequency Change Based on Actual Frequency

Col(s)	Format	Description
1-7	FLPT	Actual Frequency
10-16	FLPT	New Background Frequency
76-78	FLD	'VHF' or 'UHF'
79-80	FLD	'5M'

NOTE: background frequencies are changed based on actual frequencies.

Run Setup

```
@RUN
@ASG,A QUAL*FILE/U/KEY.          @Assign requirements file
@ADD,P FAA*FAAPRG/U.FUNMNT
    DATA CARDS
@PMD,ED
@FIN
```

TSV FILE MAINTENANCE PROGRAM

Card No. 1

Col(s)	Format	Description
1-6	FLD	TSV File name

Card No. 2

Col(s)	Format	Description
1	FLD	A=add record D=delete record M=modify record
2	FLD	L=Lat/Lon point change O=other changes (use only when modifying)
3	FLD	C=change point 'N' D=delete point 'N' I=insert point between N-1 and N, where N equals the point to be inserted
5-6	INT	Point N (right justified)
15-18	INT	TSV ID
20	FLD	C=circular cell type M=many-point cell type
22-30	FLPT	TSV radius in nautical miles (circular cell type only)
31-36	INT	Circular cell type = 1 Many-point cell type = Number of points
41-46	INT	Latitude of TSV Center (DDMMSS)
50-56	INT	Longitude of TSV Center (DDDMMSS)
60-65	FLD	Sector name from ACES tapes
66-71	FLD	Altitude Indicator L=Low H=High S=Super High

NOTE: Cols. 15-18 are always filled in. If Col. 1 equals D, then Cols. 15-18 are the *only* columns filled in. Cols. 20-71 are used only for Add and Modify options.

TSV FILE MAINTENANCE PROGRAM (Cont'd)

Lat/Lon Card for Adding Multi-Point TSV's

Col(s)	Format	Description
1-2	FLD	'LL'
10-16	INT/FLPT	Latitude #1 (DDDMMSS) or Radius (nmi) if cell type = C
20-26	INT	Longitude #1 (DDDMMSS)
31-36	INT	Latitude #2 (DDMMSS)
41-46	INT	Longitude #2 (DDDMMSS)
50-56	INT	Latitude #3 (DDMMSS)
60-66	INT	Longitude #3 (DDDMMSS)

Lat/Lon Card for Modifying Many-Pointed TSV's

Col(s)	Format	Description
1-2	FLD	'LL'
10-16	INT	Latitude of New or Replacement Point
20-26	INT	Longitude of New or Replacement Point

Note: This card is used only when Col. 1 of Card No. 2 = M
and Col. 2 of Card No. 2 = L
and Col. 3 of Card No. 2 = C or I

Run Setup

```
@RUN
@ASG,A QUAL*FILE/U/KEY.            @Assign TSV file
@ADD,P FAA*FAAPRG/U.MNTTSV
     DATA CARDS
@PMD,ED
@FIN
```

REQUIREMENTS FILE SELECT/SORT/PRINT PROGRAM

Output Card

Col(s)	Format	Description
1-6	FLD	Output File Name
7-12	FLD	Output File Write key
80	INT	'1'

Input Card

Col(s)	Format	Description
1-6	FLD	Input File Name
80	INT	'2'

NOTE: If more than one input file, add file names in Columns 7-12, 13-18, 19-24 and 25-30. '//////' must follow last file name and there can be no more than 5 input files.

Select Card

Col(s)	Format	Description
1	FLD	Select Codes 1 = ATC Function 2 = REQ ID/GMF ID 3 = operational year 4 = TSV ID 5 = Background frequency 6 = Actual frequency 7 = Radius (nmi) 8 = operating agency
7-18	FLD	First Test Value (left adjusted)
19-30	FLD	If not blank, denotes that the first test value was the lower limit of the range and this is the upper limit
43-54	FLD	Second test value (or lower limit of second test value
55-66	FLD	Upper limit of second test value (if needed)
80	INT	'3'

NOTE: If selection on blank fields is necessary, Cols. 7-18 *must* be blank. If Cols. 43-54 are blank, it is assumed that the card has no alternative value.

REQUIREMENTS FILE SELECT/SORT/PRINT PROGRAM (Cont'd)

Radius Select Card (if Col. 1 on Select Card = 7)

Col(s)	Format	Description
1	FLD	'7'
7-8	FLD	Latitude Deg.
9-10	FLD	Latitude Min.
11-12	FLD	Latitude Sec.
19-21	FLD	Longitude Deg.
22-23	FLD	Longitude Min.
24-25	FLD	Longitude Sec.
31-36	FLD	Radius (nmi)

Sort Card (Max. of 6 sort keys)

Col(s)	Format	Description
1	FLD	A = alphanumeric sort B = binary sort (INT & FLPT)
3-4	FLD	Bit position
6-7	FLD	Word number within record
9-10	FLD	Length of field in bits
80	INT	'4'

NOTE: for additional sort keys follow the same procedure in the following cols.
13, 15-16, 18-19, 21-22
25, 27-28, 30-31, 33-34
37, 39-40, 42-43, 45-46
49, 51-52, 54-55, 57-58
61, 63-64, 66-67, 69-70

REQUIREMENTS FILE SELECT/SORT/PRINT PROGRAM (Cont'd)

Print Card

Col(s)	Format	Description
1	FLD	blank = print requirements records only C = print combined print of TSV and requirements records
2	FLD	A = all TSV records are printed, regardless of whether it has a requirement record or not
7-12	INT	Number of records to print (blank indicates *all* are to be printed)
13-18	FLD	TSV File Name
80	INT	'5'

NOTE: For 'C' option input requirement file must be in the TSV ID order.

NOTE: If the print card is omitted all requirement records are printed.

Run Setup

```
@RUN
@ASG,A QUAL*FILE/U/KEY.          @Assign Input Requirements File
@ASG,A QUAL*FILE2/U/KEY.         @Assign TSV File (if needed)
@DELETE,C QUAL*FILE3/U/KEY.
@ASGN,CP QUAL*FILE3/U/KEY.       @Assign Output Requirements File
                                  (if needed)
@ADD,P FAA*FAAPRG/U.FUNSEL
       DATA CARDS
@PMD,ED
@FIN
```

TSV FILE PRINT PROGRAM

Input Card

Col(s)	Format	Description
1-6	FLD	TSV File Name

Run Setup

```
@RUN
@ASG,A QUAL*FILE/U/KEY.                    @Assign TSV File name
@ADD,P FAA*FAAPRG/U.PRTTSV
        DATA CARD
@PMD,ED
@FIN
```

MATRIX GENERATOR PROGRAM

Input Card

Col(s)	Format	Description
1-5	FLD	'INPUT'
8-13	FLD	Requirements file name
15-20	FLD	TSV file name

Output Card

Col(s)	Format	Description
1-6	FLD	'OUTPUT'
8-13	FLD	20 dB Matrix name
15-20	FLD	18 dB Matrix name
22-27	FLD	16 dB Matrix name
29-34	FLD	14 dB Matrix name
36-41	FLD	12 dB Matrix name
43-48	FLD	10 dB Matrix name
50-55	FLD	8 dB Matrix name
57-62	FLD	6 dB Matrix name

MATRIX GENERATOR PROGRAM (Cont'd)

Debug Card (optional)

Col(s)	Format	Description
1-5	FLD	'DEBUG'
8	INT	0 = no input print 1 = input print
10	INT	0 = no console print 1 = console print

Title Card (optional)

Col(s)	Format	Description
1-5	FLD	'TITLE'
9-80	FLD	User description

D/U Recovery Card (optional)

Col(s)	Format	Description
1-6	FLD	'DURECV'
8-9	INT	S recovery value
11-12	INT	H recovery value
14-15	INT	L recovery value
17-18	INT	A recovery value
20-21	INT	D recovery value
23-24	INT	C recovery value
26-27	INT	G recovery value
29-30	INT	R recovery value
32-33	INT	P recovery value
35-36	INT	T recovery value

Text Card

Col(s)	Format	Description
1-4	FLD	'TEXT'
5-6	FLD	D/U Ratio
9-80	FLD	User text

MATRIX GENERATOR PROGRAM (Cont'd)

Restart Card

Col(s)	Format	Description
1-6	FLD	'RESTAR'

NOTE: This card is needed only if the matrix was not completed in the initial execution of the program.

Run Setup

```
@RUN
@ASG,A  QUAL*FILE/U/KEY.                    @Assign requirement file
@ASG,A  QUAL*FILE2/U/KEY.                   @Assign TSV file
@DELETE,C  QUAL*FILE3/U/KEY.
@ASG,UP QUAL*FILE3/U/KEY.                   @Assign output ½ matrix file
@ADD,P  FAA*FAAPRG/U.GENRAT
       DATA CARDS
@PMD,ED
@FIN
```

MATRIX FLIP PROGRAM

Data Card

Col(s)	Format	Description
1-6	FLD	Matrix File Name

Run Setup

```
@RUN
@ASG,A  QUAL*FILE/U.                        @Assign input ½ matrix file
@ASG,T  O.,T,UXXXW                          @Assign output full matrix tape
@REWIND O.
@ADD,P  FAA*FAAPRG/U.FLIPIT
       DATA CARD
@PMD,ED
@FIN
```

NODE COLORING PROGRAM

Data Card

Col(s)	Format	Description
1	INT	1 = make all 2's in matrix equal to 1 2 = keep matrix as is
5-10	FLD	ID string file name

NOTE: The ID string as input is used to determine links, therefore, it is optional as input.

Run Setup

```
@RUN
@ASG,T   A.,T,UXXX                        @Assign input matrix tape
@ASG,A   QUAL*FILE/U.                     @Assign input ID string (if needed)
@ADD,P   FAA*FAAPRG/U.NODE
         DATA CARD
@PMD,ED
@FIN
```

ID STRING GENERATOR PROGRAM

Data Card

Col(s)	Format	Description
1-6	FLD	Input Requirement File name
8-13	FLD	Output ID String File name
15-20	FLD	Output ID String Write key
22	INT	0 = no print of input requirements file 1 = print input requirements file

Run Setup

```
@RUN
@DELETE,C    QUAL*FILE/U.KEY.
@ASG,UP      QUAL*FILE/U/KEY.          @Assign output string file
@ASG,A       QUAL*FILE2/U/KEY.         @Assign requirements file
@ASG,A       QUAL*FILE3/U/KEY.         @Assign program file
@USE   P.,QUAL*FILE3/U.
@FOR,USW    P.UCODE,UCODE,UCODE
      FORTRAN CHANGE CARDS (IF NEEDED)
@ADD,P  FAA*FAAPRG/U.STRING
      DATA CARDS
@PMD,ED
@FIN
```

COSITE FILE PROGRAM

Card No. 1

Col(s)	Format	Description
1-10	FLPT	Lower limit of frequency band (MHz) (defaults to 225.0)[a]
11-20	FLPT	Upper limit of frequency band (MHz) (defaults to 400.0)[a]
21-30	FLPT	Radius of inner circle - defines cosite area (nmi) (defaults to .2)[a]
31-40	FLPT	Radius of second circle - defines area to be used in intermod analysis (nmi) (defaults to 2.0)[a]
41-50	FLPT	Radius of third circle - defines area to be used in adjacent-channel protection (nmi) (defaults to 200.0)[a]
56	FLD	3-signal intermod option ('Y' or blank)
57	FLD	If this column contains 'Y', radius of third circle will be calculated by the program for each cosite record.
59-61	INT	Number of channels to be denied around a frequency with select ID of 61.
63-65	INT	Number of channels to be denied around a frequency with select ID of 62.
67-69	INT	Number of channels to be denied around a frequency with select ID of 63.
71-72	INT	Number of the word in the function file record to be checked to determine whether or not the record is to be added into the background area (defaults to 13)[a]

Card No. 2

Col(s)	Format	Description
1-6	FLD	Input function file name
8-13	FLD	Output function file name
15-20	FLD	Output function file write key
22-27	FLD	Cosite file name
29-34	FLD	Cosite file write key
36	FLD	Option for printing background frequency block numbers and number of records found for each block ('Y' or blank)

[a]This value is used by the program if input is blank.

COSITE FILE PROGRAM (Cont'd)

Card No. 2 (Cont'd)

Col(s)	Format	Description
38	FLD	Option for printing cosite file records ('Y' or blank)
39	INT	Debug print option (1 or blank)
41-45	INT	ID of first cosite record to be printed (defaults to first cosite record ID) (used only if column 38 contains 'Y')
46-50	INT	ID of last cosite record to be printed (defaults to last cosite record ID) (used only if column 38 contains 'Y')
56-57	INT	Latitude (deg) - upper limit of background area
58	FLD	Latitude direction
61-62	INT	Latitude (deg) - lower limit of background area
63	FLD	Latitude direction
66-68	INT	Longitude (deg) - the left-most longitude of the background area
69	FLD	Longitude direction
71-73	INT	Longitude (deg) - the right-most longitude of the background area
74	FLD	Longitude direction
76-78	INT	Length of square to be used in blocking of background frequencies (deg)

Run Setup

```
@RUN
@ASG,T   A.,T,UXXXX            @Assign background input tape
@ASG,A   QUAL*FILE1/U/KEY.     @Assign input Requirements File
@ASG,A   QUAL*FILE2/U/KEY      @Assign output Requirements File
@ASG,UP  QUAL*FILE3/U/KEY      @Assign output Cosite File
@ADD,P   FAA*FAAUHF/U.WOK
         Data Cards
@PMD,ED
@FIN
```

COSITE FILE PRINT PROGRAM

Card No. 1

Col(s)	Format	Description
1-6	FLD	Cosite File name
8	INT	Option to print bit arrays in octal format (1 or blank)
10	FLD	Option to print cosite records from starting ID to ending ID ('Y' or blank)
12	FLD	Option to print individual cosite records ('Y' or blank)
16-20	INT	ID of first cosite record to be printed (defaults to first cosite record ID)[a] (used only if column 10 contains 'Y')
21-25	INT	ID of last cosite record to be printed (defaults to last cosite record ID)[a] (used only if column 10 contains 'Y')
31-40	FLPT	Lower band limit in MHz (defaults to 225.0)[a]
46-50	FLPT	Radius of inner circle - defines cosite area (nmi) (defaults to .2)[a]
51-55	FLPT	Radius of second circle - defines area to be used in intermod analysis (nmi) (defaults to 2.0)[a]
56-60	FLPT	Radius of third circle - defines area to be used in adjacent channel protection (nmi) (defaults to 200.0)[a]

Card No. 2

Col(s)	Format	Description
1-5	INT	First ID
6-10	INT	Second ID
:	:	:
76-80	INT	16th ID

Note: As many No. 2 cards as necessary may be used. No No. 2 cards necessary unless column 12 of Card No. 1 contains 'Y'.

[a]This value is used by the program if input is blank.

COSITE FILE PRINT PROGRAM (Cont'd)

```
@RUN
@ASG,A          QUAL*FILE/U.            @Assign input Cosite File
@ADD,P          FAA*FAAUHF/U. PRTELT
     Data Cards
@PMD,ED
@FIN
```

D/U PROGRAM

Card No. 1

Col(s)	Format	Variable Name	Description
1-6	FLD	FDEF(1)	Requirements File name
8-13	FLD	TSVFIL	TSV File name
15	INT	ITYPE	0 = individual frequencies on following card(s) 1 = frequency ranges on following card(s) 2 = individual frequencies & new requirements for each frequency on following cards
17-19	INT	INUM	If ITYPE = 0 or 2; no. of frequencies ITYPE = 1; no. of ranges
21	INT	I1314	0 = select on frequency in word 13 of requirement file 1 = select on frequency in word 14 of Requirements File
23	INT	ISPACE	0 = 25 kHz increments (Used only when 1 = 50 kHz increments ITYPE = 1)
25	INT	INOTSV	0 = use TSV File to extract information 1 = extract all information from Requirements File

D/U PROGRAM (Cont'd)

Card No. 2 for ITYPE = 0 (individual frequencies)

Col(s)	Format	Description
1-7	FLPT	Frequency #1
9-15	FLPT	Frequency 2
17-23	FLPT	Frequency 3
25-31	FLPT	Frequency 4
33-39	FLPT	Frequency 5
41-47	FLPT	Frequency 6
49-55	FLPT	Frequency 7
57-63	FLPT	Frequency 8
65-71	FLPT	Frequency 9
73-79	FLPT	Frequency 10

NOTE: Repeat card for additional frequencies.

Card No. 2 for ITYPE = 1 (frequency ranges)

Col(s)	Format	Description
1-7	FLPT	Lower frequency of range 1
9-15	FLPT	Upper frequency of range 1
17-23	FLPT	Lower frequency of range 2
25-31	FLPT	Upper frequency of range 2
33-39	FLPT	Lower frequency of range 3
41-47	FLPT	Upper frequency of range 3
49-55	FLPT	Lower frequency of range 4
57-63	FLPT	Upper frequency of range 4
65-71	FLPT	Lower frequency of range 5
73-79	FLPT	Upper frequency of range 5

NOTE: Repeat card for additional frequencies.

Card No. 2 for ITYPE = 2 (frequency & additional requirements)

Col(s)	Format	Variable	Description
1-7	FLPT	FREQ(I)	Frequency
9-10	INT	IELT	Number of additional requirements associated with this frequency

D/U PROGRAM (Cont'd)

Card No. 3 for ITYPE = 2 (only)

Col(s)	Format	Description
7-18	FLD	Site name
19-24	INT	Site latitude (DDMMSS)
25-31	INT	Site longitude (DDDMMSS)
32-37	INT	TSV ID
38	FLD	ATC function code
39-40	FLD	Altitude (/1000 feet)
41-44	INT	Link number
45-50	INT	Receiver latitude (DDMMSS)
51-57	INT	Receiver longitude (DDDMMSS)
73-75	INT	Radius (nmi)

Note: Repeat card 3 for additional requirements (IELT #) on this frequency
Repeat card 2 for additional frequencies

Run Procedure

```
@RUN
@ASG,A    QUAL*FILE/U.                 @Assign requirement file
@ASG,A    QUAL*FILE/U.                 @Assign TSV file
@ADD,P    FAA*FAAPRG/U.DUPROG
     *DATA CARDS*
@PMD,ED
@FIN
```

UHF REASSIGNMENT ANALYSIS MODEL (RAM) PROGRAM

Card No. 1

Col(s)	Format	Description
1-6	FLD	Input Requirements File - The 14-word Requirement File from which the input ID string was selected.
8-13	FLD	Input ID String - The 2-word ID string selected from the Input Requirements File. The packed preassigned *MUST* be in the beginning of the ID string. The rest of the ID string may be in any order with assigned and unassigned mixed.
15-20	FLD	Input COSITE File - The COSITE file which reflects all the assignments in the Input ID string.

UHF REASSIGNMENT ANALYSIS MODEL (RAM) PROGRAM (Cont'd)

Card No. 1 (Cont'd)

Col(s)	Format	Description
22-27	FLD	BACKUP ID String - A program-produced file reflecting the "current" status of the ID String.
29-34	FLD	BACKUP Cosite File - A program-produced file reflecting the "current" status of the Cosite File.
36-41	FLD	RUN TYPE: 'REMOVE' - This procedure removes assignments in the ID string which do not meet the matrix criteria. 'MODIFY' - This procedure changes the matrix to conform to the assignments in the ID String.
43-48	FLD	ID STRING ORDER: 'NORMAL' - The requirements are assigned in the order that they appear in the string. 'PURGED' - The requirements are assigned in the order in which they were removed (most to least violators).
50-53	INT	Requirements File of the first new requirement record; FLY option only.
55-58	INT	Requirements File ID of the last new requirement record; FLY option only.
62-64	INT	Number of Cycles - A number indicating the maximum cycles to attempt. 1 Cycle = (Modify/Remove) + Assignment + Violation Count.
66	INT	Input MATRIX Tape - Indicates the matrix tape assigned to the program is using a 2- or 3-bit code to represent intra-site conditions. MATRIX is the input file name. (2=2 bit, 3=3 bit)
68	FLD	Output MATRIX Tape - If a 3-bit tape is input a 2-bit tape may be output to unit TWOBIT. 'Y' = output tape.
69	FLD	Option to choose the frequencies for assignment randomly from the resource list. 'Y' or blank.
70	FLD	INPUT REQUIREMENTS FILE PRINT - A print of the initial input Requirement File is done if this option is selected. 'Y' = print.
72	FLD	'D' = deassign functions on Card No. 5.

UHF REASSIGNMENT ANALYSIS MODEL (RAM) PROGRAM (Cont'd)

Card No. 1 (Cont'd)

Col(s)	Format	Description
74-75	INT	Seed for random number generator (odd positive number).
77-79	FLD	1, 2 or 3 ATC function types to be purged first if they have violations. Option selected with entry in column 77.

Cards No.'s 2,3 & 4

Col(s)	Format	Description
1-7 (Begin)	FLPT	Frequency (MHz) Range - This is the closed band of frequencies used to assign the requirements.
9-15 (End)	FLPT	The beginning frequency is the first one used; the end frequency is the last (e.g., 225.0 to 400.0 or 400.0 to 350.0).
17-26	FLD	ATC Function Codes - Only those ATC codes listed here will be assigned to the previously defined band.
28-31	FLPT	Assignment spacing (kHz)
33-36	FLPT	Adjacent channel criteria (kHz)
38-41	FLPT	Cosite criteria (kHz)

Note: If one frequency band is used for all ATC function types, then cards 3 & 4 must be included as blank cards.

Card No. 5

Col(s)	Format	Description
1-7	FLPT	The upper limit of the band to be deassigned (MHz)
9-15	FLPT	The lower limit of the band to be deassigned (MHz)
17-26	FLD	ATC function types to be deassigned.

Note: 1 to 5 cards allowed, terminate with ΔEOF as last card, no cards if option not selected.

Card No. 6 (optional)

If present, this card lists up to 10 frequencies in MHz [10(F7.0, 1X)] which are not protected in the assignment.

UHF REASSIGNMENT ANALYSIS MODEL (RAM) PROGRAM (Cont'd)

Card No. 7

Col(s)	Format	Description
1-7	FLPT	Beginning frequency (MHz) of frequency resource list 1.
9-15	FLPT	Last frequency (MHz) in frequency resource list 1.
17-19	INT	Spacing for frequency resource list 1 (kHz)
61-67	FLPT	Beginning frequency (MHz) of frequency resource list 4.
69-75	FLPT	Last frequency (MHz) in frequency resource list 4.
77-79	INT	Spacing for frequency resource list 4 (kHz).

Note: As many cards as necessary may be used. Last card must be @EOF. If no cards are needed, @EOF card must be present.

Card No. 8 Individual frequencies to be added into the frequency resource list.

Col(s)	Format	Description
1-7	FLPT	Frequency (MHz)
9-15	FLPT	Frequency (MHz)
⋮	⋮	⋮
73-79	FLPT	Frequency (MHz)

Note: As many cards as necessary may be used. Last card must be @EOF. If no cards are needed, @EOF card must be present.

Run Setup

```
@RUN
@ASG,A    QUAL*FILE/U.          @Assign input requirement file
@ASG,A    QUAL*FILE2/U.         @Assign input ID string
@ASG,A    QUAL*FILE3/U.         @Assign input COSITE file
@ASG,T    MATRIX.,T,UXXX        @Assign matrix tape
@ASG,T    TWOBIT.,T,UXXXW       @Assign output 2-bit matrix (if needed)
@ASG,CP   QUAL*FILE4/U/KEY.     @Assign Backup ID String file
@ASG,CP   QUAL*FILE5/U/KEY.     @Assign Backup COSITE file
@ADD,P FAA*FAAUHF/U. UHFRAM
       *DATA CARDS*
@PMD,ED
@FIN
```

COMPOSITE PLOT PROGRAM

Card No. 1

Col(s)	Format	Variable Name	Description
1-6	FLD	INDEX	TSV File name
8-13	FLD	INDEX1	Requirement File name
14-17	INT	NOCELS	If JOPT=0; # of TSV ID's, REQ ID's, FREQS JOPT=1; # of cells in range (if KOPT=1; # of ranges) JOPT=2; # of centers on input card (KOPT must equal 0)
19	INT	JOPT	0 = values read in individually 1 = ranges 2 = input centers on following card (KOPT must equal 0)
21-24	INT	ISTART	starting value on TSV select range (KOPT=0 and JOPT=1)
26-28	FLD	ISEL(3)	ATC function select criteria If IOPT=0 or 1; select from 56-word TSV file IOPT=2 or 3; select from Requirement File
30	INT	IOPT	0 = TSV select; no RCAG plot 1 = TSV select; RCAG plot 2 = Requirement File select; no RCAG plot 3 = Requirement File select; RCAG plot
32	INT	KOPT	0 = select on TSV ID's 1 = select on frequency 2 = select on REQ ID's
34	INT	FOPT	0 = select on background freq. 1 = select on actual freq. (only used for freq. select)
36	INT	FSP	0 = .025 spacing (only used for freq. 1 = .050 spacing range)
38-76	FLD	HEDNG	Title for Plot (if KOPT=1; only 30 spaces are allowed for title)

COMPOSITE PLOT PROGRAM (Cont'd)

Card No. 2

Col(s)	Format	Description
2-3 5-6 8-9	INT	Lower standard parallel deg., min., sec.
12-14 16-17 19-20	INT	Upper standard parallel deg., min., sec.
24-25 27-28 30-31	INT	center of plot (latitude) deg., min., sec.
34-36 38-39 41-42	INT	center of plot (longitude) deg., min., sec.
46-49	FLPT	width of plot (in inches)
51-54	FLPT	length of plot (in inches)
55	INT	0 = no political boundaries 1 = political boundaries
57-64	INT	map ratio

Card No. 3 (individual select values only)

If KOPT = 0 or 2

Col(s)	Format	Description
1-4	INT	ID #1
7-10	INT	#2
13-16	INT	#3
19-22	INT	#4
25-28	INT	#5
31-34	INT	#6
37-40	INT	#7
43-46	INT	#8
49-52	INT	#9
55-58	INT	#10
61-64	INT	#11
67-70	INT	#12
73-76	INT	#13

COMPOSITE PLOT PROGRAM (Cont'd)

If KOPT = 1

Col(s)	Format	Description
1-7	FLPT	Frequency #1
9-15	FLPT	Frequency #2
17-23	FLPT	Frequency #3
25-31	FLPT	Frequency #4
33-39	FLPT	Frequency #5
41-47	FLPT	Frequency #6
49-55	FLPT	Frequency #7
57-63	FLPT	Frequency #8
65-71	FLPT	Frequency #9
73-79	FLPT	Frequency #10

Run Setup

```
@RUN
@ASG,A    QUAL*FILE/U.             @Assign TSV file
@ASG,A    QUAL*FILE1/U.            @Assign requirements file
@ASG,T    2.,16,PXXW               @Assign plot tape
@ADD,P    FAA*FAAPRG/U.COMPLT
     *DATA CARDS*
@PMD,ED
@FIN
```

GLOSSARY

Actual Frequency -	the frequency in MHz that is presently being used for the ATC requirement.
Air Traffic Control (ATC) Function -	communication responsibility characteristic of each site (e.g., high enroute).
ATC Requirement -	the requirement for an air traffic control frequency, such as a high-enroute requirement, at a specific site.
Background ATC Assignment -	an ATC assignment whose frequency is not a candidate for reassignment by the assignment system (e.g., a Canadian assignment).
Cosite -	refers to collocation. On the same station or base. (Equipment so located is often subject to interference because of its proximity to other equipment.)
Enroute -	a term used to describe low-enroute, high-enroute, and super-high-enroute ATC requirements as a single group; as opposed to non-enroute requirements.
Link Number -	an identifier associating those ATC requirements that must be assigned identical frequencies.
Master File -	a file containing information that is subject to a well-defined updating and verification process.
Node-Coloring Algorithm -	a mathematical technique (based on the theory of graphs) used for estimating the minimum number of channels required for a given frequency assignment plan and for determining the order in which assignments are to be made.
Operational Year -	the activation date for a given assignment.

GLOSSARY (Cont'd)

Ordering - the process of sorting and sequencing.

Pre-Assigned ATC Requirement - a definite frequency assignment that will not be changed by the FAS during a given exercise.

Protection Criterion - the desired-to-undesired (D/U) signal ratio that is the minimum ratio to be permitted for ATC requirements assigned the same operating frequency.

Requirements File - a file containing data on each FAA ATC ground-to-air communications requirement.

Service Volume - the geometrical volume associated with each ATC site for which radio coverage is provided. Also referred to as Sector.

Site Denied-Frequency File - a file used by the assignment model that contains those frequencies denied for use at each site due to cosite and non-FAA intersite constraints.

Violator - an ATC assignment that does not meet the intersite or cosite criterion.

Worst Case - the positioning of an aircraft in its service volume such that the D/U signal ratio is minimum.

ACES - Adaptation Controlled Environment Systems

AM - Amplitude Modulated

ARINC - Aeronautical Radio, Inc.

ARTCC - Air Route Traffic Control Center

ATC - Air Traffic Control

GLOSSARY (Cont'd)

D/U - Desired-to-Undesired

ECAC - DoD Electromagnetic Compatibility Analysis Center

FAA - Federal Aviation Administration

FAS - Frequency Assignment System

FCC - Federal Communications Commission

FM - Frequency Modulated

IRAC GMF - Interdepartmental Radio Advisory Committee, Government Master File

OTP - Office of Telecommunications Policy

RAM - Reassignment Analysis Model

SDFF - Site Denied-Frequency File

TSV - Tailored Service Volume

UHF - Ultra High Frequency

VHF - Very High Frequency