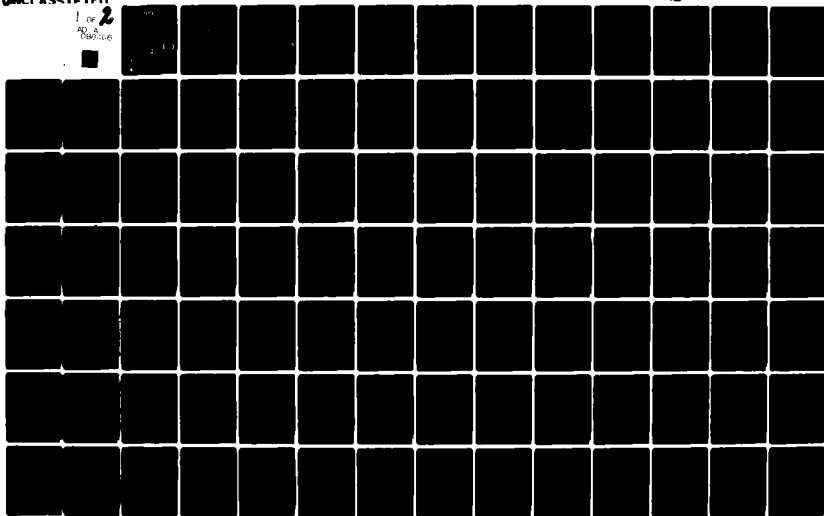


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Vol. II

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ARMY CONTRACT DAAK21-79-C-0011
6 VALIDATION OF ARMY
SPECTRUM ALLOCATION AND ANALYSIS
PROCEDURES. Volume II.

9 FINAL REPORT.

VOLUME II

Prepared for:
The Department Of The Army
Army Spectrum Management Office
(DAAC-ZS)
Room 3C640, Pentagon
Washington, D.C. 20310

Prepared By:
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VOLUME II
TABLE OF CONTENTS

SECTION	PAGE
1. INTRODUCTION	1
General	1
Organization of Details	2
2. OBJECTIVE 1	3
Statement of Objective	3
Task F.4.1.1	3
Task F.4.1.2	29
Task F.4.1.3	41
Task F.4.1.4	54
Task F.4.1.5	56
3. OBJECTIVE 2	58
Statement of Objective	58
Task F.4.2.1	58
Task F.4.2.2	59
Task F.4.2.3	76
Task F.4.2.4	77
4. OBJECTIVE 3	85
Statement of Objective	85
Task F.4.3.1	86
Task F.4.3.2	90
Task F.4.3.3	95
Task F.4.3.4	102
5. GENERAL COMMENT	104

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LIST OF ILLUSTRATIONS

FIGURE

1. Life Cycle System Management Model (LCSMM)	7
2. EMC Decisions/Actions in the LCSMM for Major Systems	10
3. EMC Decisions/Actions in the LCSMM for Non-major Systems	11
4. EMC Decisions/Actions in Relation to LCSMM Milestones	12
5. EMC Guidance Categories	12
6. Frequency Suportability Determination Path	20
7. Spectrum Allocation Guidance Chronology	27
8. Comparison of Standards and Equipment EMC Characteristics	46
9. Alternate Methods of Generating EMC Environments	81

TABLE

1. Summary of Spectrum Allocation Functions that Require Administrative and Analysis Support	28
2. Spectrum Allocation Functions and Analytic Procedures Currently in Use.	30
3. Standards Commonly Used for Army/J-12 Spectrum Allocation to Equipment Review	34
4. Deficient Applications by Standard (percentage)	90
5. Histogram of Deficient Applications by Standard	91
6. Causes of Application Failure	93

APPENDIX

- A Commands/Agencies Visited
- B References
- C Extracts of Key Spectrum Supportability Directives
- D Abbreviations
- E Extract, Chapter 4, DA PAM 11-13
- F Extract, Chapter 5, DA PAM 11-13
- G Data Elements Used in performing Analytical Functions
- H Standards and Regulations Used in Spectrum Allocation to Equipment Reviews
- I Compilation of Deficient Applications (Standard vs. Year vs. Review Stage)
- J. Army Spectrum Management Office Spectrum Allocation to Equipment Policy Guidance

SECTION 1 INTRODUCTION

GENERAL

Volume II of this Report presents an analysis of details considered under all the Tasks of the Study. The details analyzed and discussed in this Volume were gleaned from visits to various commands and agencies associated with the spectrum allocation to equipment process, and from literature searches.

Commands and Agencies visited by the contractor are listed in Appendix A, hereto.

Major Documents and References which were reviewed during the course of this Study are listed in Appendix B, hereto. These documents and references were augmented by informal handouts, briefing materials and notes obtained during the visits to the various Commands and Agencies.

Statistical data is current as of the scheduled completion date of the respective Task under which it was collected. Data sources were re-visited, however, to determine if major changes or trends had occurred between time of Task completion and the date of this Report. Any significant changes are appropriately noted.

Also, during the year long course of this Study, the following administrative changes took place.

- Chairmanship of the Frequency Panel, USMCEB, passed from Army to U.S. Marine Corps.
- The Steering Member of the J-12 Working Group, Frequency Panel, USMCEB, changed from Army to Navy.

- The title of the J-12 support group at ECAC changed from Frequency Spectrum Allocation Group (FSAG) to the ECAC Allocation Review Group (EARG).
- An effort to revise the J-12 Permanent Working Group Terms of Reference (USMCEB-M 565-78 (V)) was commenced.
- Action to transfer the Communications-Electronics Systems Division (CESD) from CORADCOM to the Army Test and Evaluation Command (TECOM) has been initiated.

The contractor wishes to express appreciation for the assistance, advice, candor and cooperation extended to this effort by all persons contacted during this study. Their generosity in making available the necessary time and facilities to accommodate the visits was most helpful.

ORGANIZATION OF DETAILS

The analysis of details presented in this Volume is organized by Objective (Sections 2, 3 and 4), and by study Task within each Objective. Objective/Task descriptions and numbering coincide with those specified in the study contract.

Supporting material is presented in the Appendices to this Volume.

SECTION 2
OBJECTIVE 1

STATEMENT OF OBJECTIVE (F.4.1)

To determine the applicability of the development and analytical procedures currently employed in the spectrum allocation process.

TASK F.4.1.1

Identify the Army spectrum allocation functions that require administrative and analysis support.

BACKGROUND

A (radio frequency) spectrum allocation to equipment is the formal approval of the electromagnetic aspects of a specific experimental, developmental, or operational device, system, or equipment. Before approval, consideration is given to all known national and international agreements and restrictions involving the use of the RF spectrum. The RF spectrum allocation will specify the frequency range, emission bandwidth, antenna characteristics, power, type of service, and other applicable spectrum usage restrictions for any geographical area that may be necessary to assume frequency support when the equipment is subsequently authorized to be operated in its intended electromagnetic environment (AR 105-16).

The importance attached to assurance of spectrum support is exemplified by the various directives, regulations and guidance which have been promulgated to inhibit the development and acquisition of communications-electronics materiel until adequate reviews and analyses establish their spectrum supportability. Key extracts from these documents are shown in Appendix C.

Communications-electronics (C-E) devices, systems and equipment are, by general definition, materiel. Within the U.S. Army, however, the term "Materiel System" refers to a major end item, all components, subsystems, and ordnance essential to its operational employment, plus its complete system support package (AR 1000-1). Thus, the many and varied C-E items required by the Army to accomplish its missions and tasks, in peace or war, in the U.S. or abroad, will range from relatively inexpensive, unsophisticated, "non-major materiel" (e.g., base taxi radios) to complex, advanced state-of-the art, multi-million dollar "materiel systems"(e.g.ballistic missile defense).

The Army spectrum allocation functions associated with the acquisition of C-E materiel, that require administrative and analysis support, will range in complexity, sophistication, and cost, accordingly.

For the purposes of this Task, the appropriate spectrum allocation functions of a major materiel system acquisition will be addressed to ensure complete coverage; the acquisition of non-major C-E materiel will include some fewer functions.

ARMY MATERIEL ACQUISITION

Methods

Materiel is acquired in response to needs. Army materiel needs generally are satisfied through four alternative methods: product improvement of current standard equipment; buying nondevelopmental equipment (commercial-domestic or foreign; military-other Services or allies); modification of commercially available items; initiation of a new materiel development program (AR 1000-1):

- a. Product improvement is usually the preferred method to satisfy requirements by exploiting the performance growth potential inherent in already developed systems (see AR 70-15).
- b. Purchase of existing domestic or foreign materiel items which do not require any development work can provide a low cost, quick response to some requirements.
- c. Existing commercial, other Services, or foreign developed items may require modification to meet specific requirements.
- d. A new development program is usually the most costly and longest alternative means to satisfy a materiel need. Materiel system design will emphasize simplicity, austerity, supportability, interoperability with systems of allies, and when the additional cost can be justified, planned future growth potential to accommodate anticipated future needs. Such provision for evolutionary development will permit the later improvement of system capability through product improvement.

Decision Points

The specific actions taken to acquire materiel in the Army are known as the materiel acquisition process. In this process, there are four key decision points which mark the end of one phase and the beginning of another. These apply specifically to major systems and in principle to non-major systems.

	<u>Milestone</u>	<u>Phase</u>
0	Program Initiation	Exploration of Alternative System Concepts
I	Demonstration and Validation Decision	Demonstration and Validation
II	Full-Scale Engineering Development Decision	Full-Scale Engineering Development
III	Production and Deployment Decision	Production and Deployment

This process is discussed in greater detail in AR 1000-1.

Life Cycle System Management Model

To assist the various Army commands and agencies engaged in the materiel acquisition process, a Life Cycle System Management Model (LCSMM) has been promulgated (DA PAM 11-25). The model illustrates by a flow chart (Figure 1) the process by which Army materiel systems are initiated, validated, developed, supported, and modified. A list of abbreviations used in the model is contained in Appendix D, hereto. The LCSMM pertains to major and non-major systems. Programs for the acquisition of non-developmental items will generally follow the procedures for non-major systems. Significant differences in management of major and non-major systems are the type of management documentation used and the level at which program decisions are made. Note that the LCSMM is divided into four major segments corresponding to the four acquisition process phases described above.

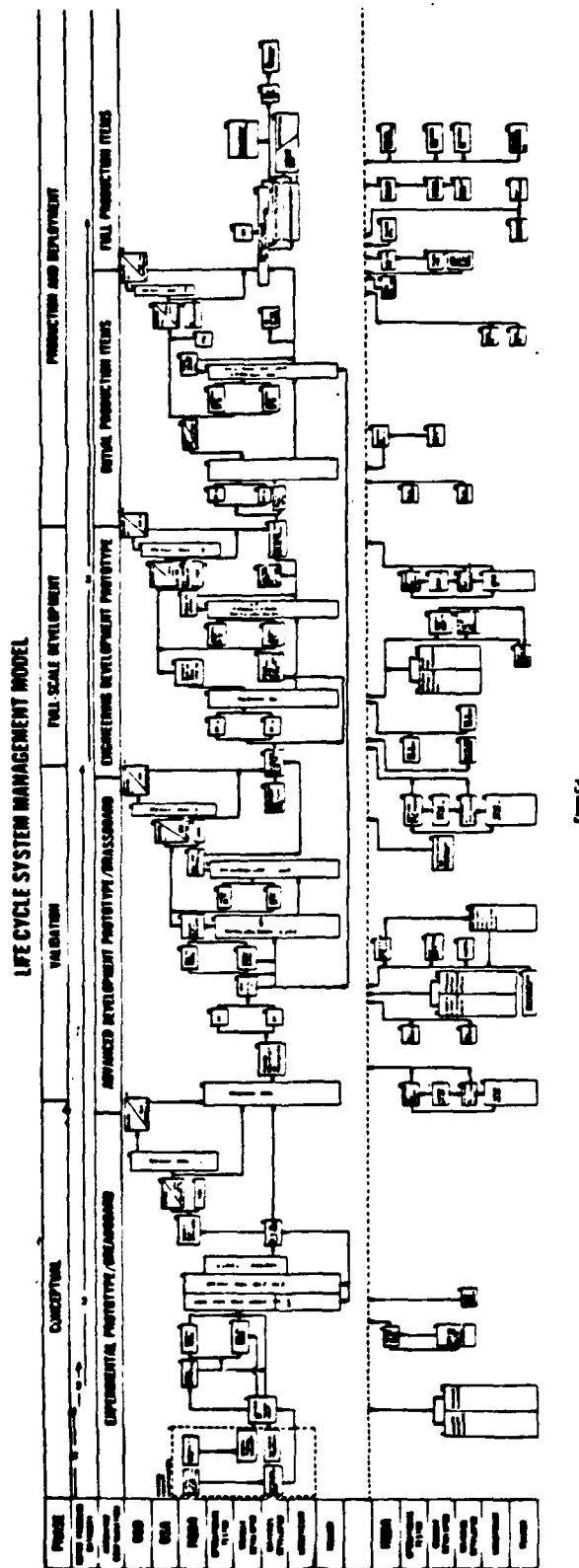


Figure 1. Life Cycle System Management Model1 (LCSMM)

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C-E SYSTEMS ACQUISITION PROCESS

General

In the life cycle of C-E equipment and systems there are two, closely associated, areas of consideration; electromagnetic compatibility (EMC), and frequency supportability.

EMC is the ability of C-E equipment, subsystems and systems to operate in their intended environment without suffering or causing unacceptable degradation because of unwanted electromagnetic radiation or unwanted responses to electromagnetic radiation. Fundamentally, EMC concerns the interaction of emitters and receptors and the exchanges of electromagnetic energy that result from that interaction. It is the intent of the Army's EMC program (EMCP) to attain electromagnetic compatibility through design rather than through the use of expensive and time consuming remedial measures. For this reason it is essential that EMC be properly considered in all phases of the LCSMM.

The unique sensitivity of C-E system feasibility to frequency supportability (i.e., the ability to assign satisfactory operating frequencies) makes the early and continuing resolution of frequency supportability problems a primary necessity. During the early development and testing of feasibility models, before the approval of a required operational capability (ROC), frequency supportability should be investigated and evaluated and the potential operational frequency problems in various host countries need to be considered. Then, frequency supportability problems must be studied and resolved on a continuing basis by the developer throughout the LCSMM.

EMC Guidance

To assist combat and materiel developers in the C-E system acquisition process, a guide has been developed; DA PAM 11-13, Army

Electromagnetic Compatibility Program Guide. The guide is applicable to all individuals involved in the planning and management of C-E materiel development and in the decision making processes and actions of the LCSMM. In the guidance provided for C-E materiel development there are portions that are applicable to the definition of the EMC support that is needed for non-C-E system developers (particularly when the non-C-E system contains C-E subsystems). This applicability is noted at the appropriate points in the guide.

Fold-out flow charts are included at the end of the guide (DA PAM 11-13) to illustrate the manner in which the combat and materiel developers give appropriate consideration to EMC during the systems acquisition process. These are reproduced herein as Figure 2, EMC Decision/Actions in the LCSMM for Major Systems and as Figure 3, EMC Decisions/Actions in the LCSMM for Non-major Systems.

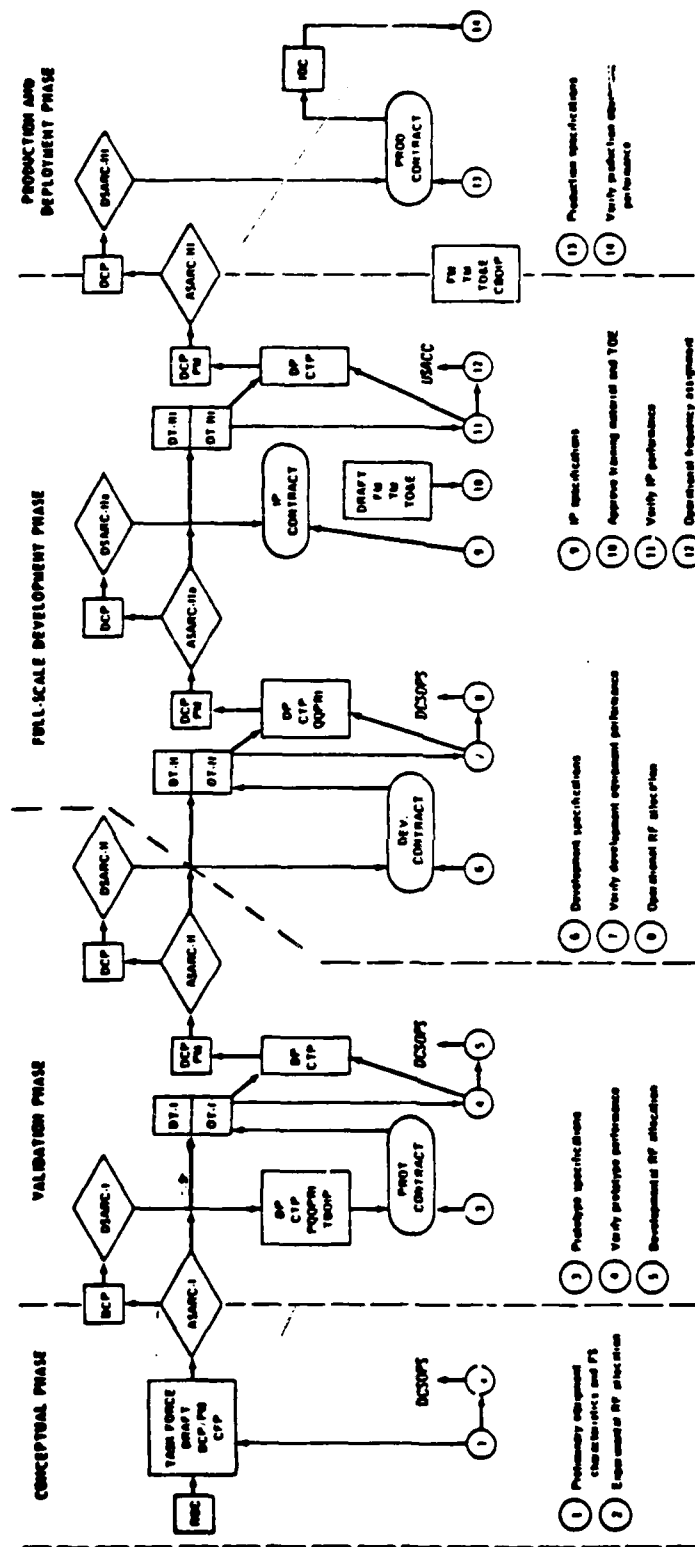
Note that the LCSMM depicted in DA PAM 11-13 is dissimilar to that depicted in DA PAM 11-25 (Figure 1, herein). This is due to the respective effective dates of the two pamphlets; DA PAM 11-25 being the more current (May 1975).

Chapters 4 and 5 of DA PAM 11-13 are particularly applicable to this task in that they identify and describe the critical EMC decisions and actions, and the EMC guidance categories, as they relate to the C-E system acquisition process.

EMC decisions/actions in relation to LCSMM milestones (extracted from DA PAM 11-13) are shown in Figure 4. Chapter 4 of DA PAM 11-13 has been extracted and reproduced as Appendix C, hereto.

EMC guidance categories (extracted from DA PAM 11-13) are shown in Figure 5. Chapter 5 of DA PAM 11-13 has been extracted and reproduced as Appendix F, hereto.

Appendices E and F, together, represent the most current guidance available to the Army C-E combat and materiel developers in terms of



- ABBREVIATIONS**
- ASARC - Army Systems Acquisition Review Council
 - CDOP - complete basis of issue plan
 - CIP - concept formulation package
 - CTP - conceptual test program
 - DCP - development concept paper
 - DT - development test
 - DTOPS - Development of Test, Operations and Plans
- ASARC**
- Define Systems Acquisition Review Council
 - Development test
 - Field manual
 - Initial operational capability
 - Initial production
 - Operational test
 - Program manual plan
- DT**
- Development test
 - Field manual
 - Initial operational capability
 - Initial production
 - Operational test
 - Program manual plan
- DTOPS**
- Development of Test, Operations and Plans
- PM**
- Production specifications
 - Verify production specifications
 - Verify production performance
- PROO CONTRACT**
- Production specifications
 - Verify production specifications
 - Verify production performance
- PM TOE TOOE CDDP**
- Production specifications
 - Verify production specifications
 - Verify production performance

Figure C-1. Flow Chart, EMC Decisions/Actions (1-12) in the LCSMM for Major Systems

Figure 2. EMC Decisions/Actions in the LCSMM for Major Systems

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- Army Systems Acquisition Review Council
- complete books of rules plan
- contract management plan
- contracting test program
- development concept paper
- development plan
- Study Chief of Staff, Operations and Plans

- DTIC - Defense Systems Acquisition Review Council
- DT - Development test
- FBI - field manager
- IOC - initial operational capability

- Inventory qualitative and quantitative personnel resources information
- Inventory and quantitative personnel requirement information
- Inventory personnel
- Inventory personnel capability
- Inventory status of those personnel
- Inventory of equipment
- Table of organization and equipment
- US Army Component Command

Figure C-4. Flow Chart, BMD: Decisions/Actions (1-16) in the LASSM for Non-Major Systems.

Figure 3. EMC Decisions/Actions in the LCSMM for Non-major Systems

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Figure 4 EMC Decisions/Actions in Relation to LCSMM Milestones

LCSMM phase	LCSMM milestones	EMC decisions/actions
Conceptual	RDC approval	1. Select preliminary equipment characteristics and ascertain frequency supportability 2. *Apply for experimental RF spectrum allocation
	ASARC-I, feasibility IPR	
Validation	Prototype contract DT-I OT-I	3. Determine prototype equipment specification 4. Verify prototype equipment performance 5. *Apply for developmental RF spectrum allocation
	ASARC-II, validation IPR	
Full-scale development		6. Determine developmental equipment specifications
	Development contract DT-II OT-II	
	ASARC-IIa, development acceptance IPR	7. Verify development equipment performance 8. *Apply for operational RF spectrum allocation
	IP contract	9. Determine IP equipment specifications
	DT-III OT-III	10. Approve TOE and training material
	ASARC-III, production validation IPR	11. Verify IP equipment performance 12. *Apply for frequency assignments
Production & deployment		13. Determine production equipment specifications
	Production contract Publication of FM, TM, TOE Initial operational capability Requirement for new/modified material Disposal	14. Verify operational equipment performance

*Not required for non C-E equipment; frequency assignment must be obtained for all equipment which requires an RF allocation before any radiation is permitted.

Figure 5 EMC Guidance Categories

- | No. | Title |
|-----|--|
| 1. | C-E system feasibility and performance requirements |
| 2. | Command and organizational principles |
| 3. | System operational factors |
| 4. | Economic assessment |
| 5. | Electromagnetic environment evaluation |
| 6. | National environment evaluation |
| 7. | Hazard evaluation |
| 8. | Equipment and performance characteristics |
| 9. | Conformance to or waivers of EMC standards or specifications |
| 10. | Spectrum signatures |
| 11. | Measures of system effectiveness |
| 12. | Site survey and selection |
| 13. | EMC training data |
| 14. | MLJ report analysis |

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analytical techniques used to ascertain the EMC of C-E systems. This information, in abbreviated form, is also available to C-E materiel developers in DARCOM Pamphlet DARCOM-P 706-410, Engineering Design Handbook, Electromagnetic Compatibility.

They do not, however, represent the most current thinking available. In 1975 the Army Communications Command contracted with the General Research Corporation to produce a draft integrated EM guide (Integrated Electromagnetic (EM) Analysis and Testing; Volume II Integrated EM Guide for Developers, OAD-CR-75). In this draft, several subject areas had not been covered. Consequently, the Army Communications Command tasked the DoD Electromagnetic Compatibility Analysis Center (ECAC) to revise the Draft Guide to include these areas. The new Life Cycle System Management Model (DA PAM 11-25) had, in the meantime, been published. The extensive revisions incorporated in the new Model expanded the ECAC task. The result of ECAC's effort are contained in ECAC-PR-76-045, Development of Draft Integrated Electromagnetic (EM) Analysis and Testing Guide for Developers, which summarizes the project, and in ECAC-PR-76-056, Draft Integrated Electromagnetic (EM) Analysis and Testing Guide for Developers, which presents the revised Guide.

ECAC-PR-76-056, the Draft Guide, has received considerable internal distribution within ECAC and to selected Army Offices. The sponsor, Army Communications Command, was to use the report as a revision to AR PAM 11-13. The subsequent realignment of responsibilities for Army Management of the Electromagnetic spectrum (AR 5-12, January 1978), however, shifted most of the responsibility for EMC during research, development and acquisition of materiel to the Commanding General, U.S. Army Materiel Development and Readiness Command (DARCOM). It is understood that the Army Communications Command has transferred the document (in October 1977) to HQDA (DAAC-ZS), together with a recommendation to transfer publishing of the AR PAM 11-13 revision to DARCOM as a matter falling under that command's

cognizance. In any event, the subject matter of ECAC-PR-76-056 is not generally available to Army combat and materiel developers in an authoritative form at the present time.

In all, there are five primary documents which should be revised or issued to promulgate current EMC and spectrum allocation to equipment process guidance within the Army.

AR 5-12 Minor revisions and editorial corrections to bring into currency (e.g., DAAC-ZS vice DTACC, where appearing; electromagnetic compatibility vice capability, paragraph 1-2c; FP vice IRAC, last line of paragraph 3-3c(4); etc.)

AR 105-16 Major revision to realign with AR 5-12, revised DD Form 1494, and current Frequency Panel policy and procedures.

DA PAM 11-13 Major revision to reflect the contents of ECAC PR 76-056.

DARCOM Supplement
to AR 5-12 Update current draft and issue.

DARCOM
P706-410 Revise in coordination with AR 105-16 and DA PAM 11-13 changes.

An estimated one-half man year of effort, over an elapsed time of eight months, would be required to effect these revisions exclusive of staffing.

FREQUENCY SUPPORTABILITY

As shown in Appendix C, there are numerous regulations and directives requiring assurance of frequency supportability prior to committing research, development or procurement funds to acquire C-E materiel. To enforce this policy, certain review bodies and processes have been established.

Review Process

It is DoD policy (USMCEB-M 565-78(V)) that it is the responsibility of each Military Department to determine the need for and to secure joint and, if appropriate, national approval of the frequency allocation aspects of telecommunications equipments and systems which will have an impact on other telecommunications equipments and systems or on national or international frequency resources. The applicable bodies for the joint and national review/approval processes are:

Joint:	U.S. Military Communications-Electronics Board
<u>Review-</u>	J-12 Permanent Working Group(Frequency Panel)
<u>Approval-</u>	Frequency Panel
National:	
<u>Review-</u>	Spectrum Planning Subcommittee (Interdepartment Radio Advisory Committee (IRAC))
<u>Approval-</u>	National Telecommunications and Information Administration (NTIA), Department of Commerce (Formerly Office of Telecommunications Policy (OTP), Executive Office of the President)

The process for national review/approval of frequency supportability is described in Part 8.3 of the OTP (now NTIA) Manual of Regulations and Procedures for Radio Frequency Management.

The process for joint review/approval of frequency supportability (i.e., spectrum allocation to equipment) is described in USMCEB-M 565-78(V), which is presently being revised by a working group under the direction of the Chairman, Frequency Panel, USMCEB. Publication date of the revised USMCEB-M is unknown at this time.

Note that neither reference requires review/approval for all C-E equipment; each has exceptions.

The procedures to be followed by U.S. Army agencies in seeking required review/approval of RF Allocations (i.e., frequency supportability or spectrum allocation to equipment), although not current, are prescribed in Chapter 2 of AR 105-16.

Frequency Allocation to Equipment Application (DD Form 1494)

The vehicle used to transmit the application for joint review/approval is DD Form 1494. Appendixes C through G of AR 105-16 provide detailed guidance on executing the DD Form 1494. Appendix H, thereto, an extract of Part 8.3 of the OTP (NTIA) Manual, covers procedures for applications submitted to the Spectrum Planning Subcommittee of IRAC for national review/approval. Part 8.3 specifies the use of OT Forms 33, 34 and 35 for applications. Both the DD and OT Forms are designed to record in the application the essential data for performing a frequency supportability review and analysis, and to report nominal equipment characteristics (transmitter, receiver, antenna) to the DoD and NTIA data bases.

A revised DD Form 1494 has recently been adopted by the USMCEB. The new form consists of five pages (vice the three pages of the previous edition), and more nearly coincides with OT Forms 33, 34, 35. It is understood that a working agreement has been reached with NTIA and SPS which permits DoD applications to be submitted for

national review/approval using pages 2-4 and possibly 5 of the revised DD Form 1494 in lieu of transcribing the data on to the OT Forms 33, 34 and 35.

Army Responsibility

As stated earlier, DARCOM has been assigned responsibility for the frequency allocation to equipment (supportability) process within the Army (AR 5-12). DARCOM has further delegated this function to the U.S. Army Communications Research and Development Command (CORADCOM), Ft. Monmouth, N.J. Within CORADCOM this function is performed by the System Engineering and Integration Division. Army research, development and acquisition agencies were advised by message in May 1977 of the realigned responsibilities and routing of DD Form 1494 applications for review/approval (as opposed to those prescribed in AR 105-16).

In February 1978, CORADCOM further advised these agencies (CORADCOM message 091641Z Feb 78) regarding submission and follow through on DD Form 1494. In this message, CORADCOM advised all concerned that that Command funds the DoD ECAC contractor, IIT Research Institute, to execute the processing of DD Forms 1494 for the Department of the Army (DA). The message also stated that CORADCOM represented DA at the J-12 Working Group of the USMCEB and at the IRAC SPS. The two messages cited above are the only written DA references, describing the internal DARCOM arrangement for processing spectrum allocation to equipment applications, uncovered by this Task.

It is understood that CORADCOM has drafted, and forwarded to DARCOM for coordination and promulgation, a DARCOM supplement to AR 5-12. This supplement is intended to outline and amplify DARCOM and CORADCOM responsibilities and procedures for EMC and frequency supportability as realigned by the publishing of AR 5-12. The current status of the draft is unknown.

DoD ECAC (through the contractor, IIT Research Institute) has been providing the DD Form 1494 processing support for the Army since April 1977.

This support was at the level of one man month/month from April through September of 1977, at which time it was increased to approximately five and one half man months per month during FY78 (October 1977 -September 1978). The FY79 level of effort, priorities, and project approach are contained in ECAC Project Plan 01-1098; the FY79 level of effort is three and seven tenths man months per month. It is understood that this level will be continued in the FY80 Project Plan which is being drafted at the time of this writing. The level is comprised of a mix of Engineering, Technician and Clerical support.

Frequency Supportability Path

The basic path for obtaining frequency supportability for C-E materiel, which has evolved from the references cited herein, is shown in Figure 6. As stated above, not all C-E materiel is required to be processed through the system. Also, as stated in AR 105-16, ECAC-PR-76-045 and Part 8.3 of the OTP (NTIA) Manual, this is an iterative process; frequency supportability must be ascertained at each stage as the C-E materiel progresses from conceptual, to experimental, to developmental and, ultimately, to the operational stage. Further, adaptation of existing (off the shelf) military or civilian C-E materiel may obviate progression through the earlier stages of the LCSMM. In these cases, such materiel may be inducted into the system "as is" and receive only an "operational" review/approval. Steps 2 through 9 of Figure 6 are intended to be accomplished within 30 working days (approximately six weeks, elapsed time) according to guidance contained in USMCEB-M 565-78 (V). Applications which require extraordinary review and coordination, and hence will exceed the target schedule, are to be reported to the J-12 Working Group by the reviewing command/agency. A random review of DD Form 1494 application processing times indicates that over 30 working days is the rule rather than the exception.

Steps 12 and 13 of Figure 6 are intended to be accomplished between successive meetings of the SPS (two working weeks). Approval of the SPS System Review Report and signing of the NTIA approval (Step 13) adds some additional delay. Simpler systems appear to approach this schedule; those with greater impact exceed it.

Not shown is the path for determination of international frequency supportability. Since there is no formal body (such as the J-12 Working Group or the SPS) for international review of the spectrum allocation to equipment application, frequency supportability determination is pursued on a bi-lateral basis between the developing military department and the prospective host nation(s). This is facilitated by the frequency management offices of the unified commands, who are on the distribution list for all J-12 applications and actions releasable to host nations. When provided, host nation comments are also included in J-12 Working Group consideration of applications.

Relative Sequence of Events →

JOINT REVIEW/APPROVAL
USINCEB
FREQUENCY PANEL
J-12 WORKING GROUP
SECRETARIAT
NAVY/USMC
AIR FORCE

OTHER J-12 HOLDERS
(AFSC's/UNIFIED COMMANDS)

ODD ECAC
ARMY R & D SPECTRUM ENGR. SUPPORT
J-12 REVIEW GROUP

ARMY
FREQ. MGR (DAAC-ZS)
CORADCOM (CENSEI)
G-E COMBAT/MATERIEL DEVELOPERS

NATIONAL REVIEW/APPROVAL
NTIA
IRAC, SPS

LEGEND:
1 INITIATE DD1494 APPLICATION
2 LOG AND DISTRIBUTE
3 LOG, REVIEW, COORDINATE
4 REVIEW, COMMENT
5 DRAFT ARMY POSITION
6 TECHNICAL ENG REVIEW
7 JOINT REVIEW, COORDINATION
8 J/FP APPROVAL
9 LOG, DISTRIBUTE, FILE
10 NOTE, FILE
11 LOG, DRAFT APPROVAL LETTER
12 INITIATE SPS SYSTEM REVIEW
13 SPS SYSTEM REVIEW
14 NTIA APPROVAL
15 CORADCOM (DARCOM) APPROVAL
16 HODA APPROVAL ENDORSEMENT
17 DEVELOPER RECEIVES ALLOCATION

— JOINT REVIEW/APPROVAL
- - - ADVANCE COPY
- - - NATIONAL REVIEW/APPROVAL

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    1 -- Solid --> 4((4))
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Figure 6. Frequency Supportability Determination Path

NATO INTEROPERABILITY

The basic Army policy for acquisition of materiel systems (AR 1000-1) states that achieving standardization and interoperability with NATO allies is a goal that must be considered throughout the materiel system development process. This achievement of standardization and interoperability may be by NATO adoption of a U.S. Developed System or by US adoption of a NATO system. If adoption of a NATO system is not feasible, then interoperability will be required in new system developments.

Decision reviews are to ensure that NATO standardization and interoperability have been thoroughly investigated and incorporated in system development projects. As a general rule (AR 15-14) standardization and interoperability are to be included on the agenda for each Army Systems Acquisition Review Council (ASARC) Review. Further, Project Managers (PM) are to consider the technical aspects of NATO standardization and interoperability during development, procurement and product improvement of the system for which they are responsible, and will ensure compliance with existing NATO STANAGS (AR 1000-1). STANAGS (NATO Standardization Agreements) are discussed in Chapter 5 of AR 34-1 which, in general, prescribes Department of the Army policy and responsibilities concerning military standardization and cooperative research and development programs of NATO.

It should be noted that the guidance quoted above applies primarily to "Materiel Systems", or major end items, components, subsystems, etc., as defined in AR 1000-1. Similar guidance for non-major systems was not found during the literature search of this Task.

ALLIED STANDARDIZATION

The objective of military standardization is to enable the military forces of the United States and its Allies to operate together in

the most effective and efficient manner, and to make the most efficient and economical use of research, development, test, and production resources (AR 70-4).

The basis for Army participation in Allied standardization is the "Basic Standardization Agreement Among the Armies of United States-United Kingdom-Canada-Australia" of 1 October 1964. By agreement among the four Armies, New Zealand is an associate member of the program.

Accomplishment of the standardization objective requires Quadripartite adoption of common technical procedures and compatibility of equipment. Standardization may be achieved through coordination during the development of new materiel so that such equipment is made compatible and/or acceptable for common use in the four armies.

Before initiation of any U.S. Army research or development project, full consideration is to be given to the feasibility of supporting similar and existing Allied projects or of embarking on projects with the United Kingdom, Canada, and/or Australia. The consideration of foreign or other service systems is also included in ASARC Milestone Reviews to ensure this fact (AR 15-14).

JOINT STANDARDIZATION AND INTEROPERABILITY

Achieving standardization and interoperability with other Services is a goal that must be considered throughout the materiel acquisition process (AR 1000-1). As stated above, ASARC Milestone Reviews include the consideration of other Service, as well as foreign, systems (AR 15-14).

Joint standardization and interoperability may be achieved by:

- another Services adoption of an Army system or
- by Army adoption of another Service's system.

Joint interoperability between Army and other Services' systems will be achieved where these systems are required to interface in support of combat operations.

Increased emphasis is expected to be placed on rationalization, standardization and interoperability (RSI) following promulgation of DoD Directive 5000.2, now in draft.

MISCELLANEOUS ARMY SPECTRUM ALLOCATION FUNCTIONS REQUIRING
ADMINISTRATIVE AND ANALYSIS SUPPORT

Pre-application Guidance.

Prior to submitting the DD Form 1494 Frequency Allocation Application, the developer may be in need of guidance. This need may be of a technical (e.g., frequency band restrictions, power constrictions, etc.) or an administrative nature (e.g., routing of application, coordination requirements, etc.). Recognition of this need may occur (and re-occur) at any time from the inception of a system development program to the submission of the allocation application.

The logical sources for this guidance are the agencies responsible for processing the allocation applications or for providing frequency support. These agencies, the primary of which are listed below, do receive such requests for guidance from Army developers

and do, to the extent practicable, provide the necessary guidance or referral to other appropriate sources. The guidance may range from the most simple, such as a telephone number or address of a cognizant office, to the more complex replies such as a frequency band assignment policy for a given application, or the recommendation that a full band, equipment or EMC analysis be conducted.

Pre-application Guidance Agencies

- Army Spectrum Manager, Office of the Assistant Chief of Staff for Automation and Communications (DAAC-ZS), Pentagon
- C-E Services Division, U.S. Army Communications Command (CC-OPS-CE), Alexandria, VA
- U.S. Army Communications Research and Development Command (CENSEI), Ft. Monmouth, N.J.
- U.S. Army Element, DoD-ECAC, Annapolis, MD.
- ECAC/IITRI U.S. Army R & D Spectrum Engineering Group, DoD-ECAC, Annapolis, MD.

Equipment Surveys

The types, quantities and characteristics of C-E equipments populating a frequency band in question may be researched and provided in support of the spectrum allocation to equipment function.

Frequency Band Studies

Studies may be commissioned to determine the spectrum occupancy and electromagnetic environment of frequency bands in which new development, candidate C-E equipment may operate.

C-E System Studies

Detailed studies of the functioning and signatures of specified systems may be commissioned to determine their impact on, or vulnerability to, a developing C-E system.

Assignment/Allocation Policy Analysis

An analysis may be conducted of the rules, regulations and policies applicable to a given radio service, in a particular radio frequency band, for the purpose of determining frequency assignment/allocation supportability or opposition in the future.

PARTICIPATION IN SPECTRUM MANAGEMENT ORGANIZATIONS

Chapter 3 of AR 5-12 sets forth Army involvement in joint military, U.S. national and international spectrum management organizations. Participation, membership and resource support responsibilities are also stated. This support may be administrative, analysis, or both. Following are the general areas of extra-Army involvement.

- Frequency Management Group, Range Commanders Council (FMG, RCC)
- Frequency Panel, USMCEB (FP, USMCEB) and applicable Working Groups
- Interdepartment Radio Advisory Committee, its Subcommittees, and the International Notification Group (IRAC, FAS, SPS, TSC, ING, Ad HOC Working Groups)
- U.S. CCIR (International Radio Consultative Committee) National Committee and U.S. CCIR Study Groups

SUMMARY

Literature Search

A considerable portion of the effort spent on this Task was devoted to analysis of pertinent documents. A list of the documents analyzed is contained in Appendix B. This analysis revealed the following.

- Current documents identify most of the spectrum allocation functions that require administrative and analysis support.
- There is wide recognition (as witnessed by the many commands and agencies which have promulgated directives) of the spectrum allocation functions.
- There is a general framework within which administrative and analysis support is rendered these functions.
- Most of the guidance is directed towards major materiel developers; there is little definitive guidance available to the developer or acquisition agency of a minor or "off the shelf" system.
- Due to actions which have reorganized, or realigned authority, within the Army, not all directives are current. This situation can leave the combat and materiel developers with no-or conflicting-guidance. See Figure 7.

Spectrum Allocation Functions Requiring Support

Through the combined efforts of the literature search/analysis, and the visits listed in Appendix A, the spectrum allocation functions that require administrative and analysis support were identified. These functions are discussed throughout this report, and are summarized in Table 1, below. Whether the required support is administrative, analytical, or both, has been indicated.

YEAR: 19__

DOCUMENT:

69 73 74 75 76 77 78 79 80

AR 11-13, ARMY EMCP

① ————— ⑩

AR 8-12, ARMY MANAGEMENT OF THE ELECTRO-
MAGNETIC SPECTRUM

⑪ —————

AR 108-16, RADIO FREQUENCY ALLOCATIONS FOR
EQUIPMENTS UNDER DEVELOPMENT,
PRODUCTION AND PROCUREMENT

③ —————

DA PAM 108-2, G-E MANAGEMENT OF THE ELECTRO-
MAGNETIC SPECTRUM

② ————— ⑧

DA PAM 11-26, LCSM FOR ARMY SYSTEMS

⑥ —————

DA PAM 11-13, ARMY ELECTROMAGNETIC COMPATIBILITY
PROGRAM GUIDE

④ —————

ECAC PR-76-056, DRAFT INTEGRATED EM ANALYSIS AND
TESTING GUIDE FOR DEVELOPERS

⑥ — ⑨ — — ?

DRAFT DARCOM SUPPLEMENT TO AR 5-12

⑫ — ⑬ — — ?

DARCOM(USAEOM - NOW CORADCOM) ASSUMES DD 1494 PROCESSING

⑦ —————

① AR 11-13 PROMULGATED JULY 1969

⑩ AR 11-13 SUPERSEDED BY AR 8-12 ON 1 MAR 1976

② DA PAM 105-2 PROMULGATED JULY 1973

⑪ AR 5-12 PROMULGATED JAN 1976; EFFECTIVE 1 MAR 1976

③ AR 105-16 PROMULGATED DEC 1973 (EFFECTIVE 15 FEB 1974) SUPERSEDING AR 705-16

⑫ CORADCOM(CENSEI) DRAFTED DARCOM SUPPLEMENT TO AR 5-12

④ NEW DA PAM 11-13 PROMULGATED MAR 1975

⑧ DA PAM 105-2 RESCINDED BY ARMY CIRCULAR 310-2, 1977

⑬ CORADCOM FORWARDED DRAFT DARCOM AR 5-12 SUPPLEMENT TO DARCOM FOR APPROVAL. STATUS UNKNOWN.

⑨ TRANSMITTED TO HQDA(DAAC-ZS) BY ARMY COMM COMMAND WITH RECOMMENDATION TO PASS TO DARCOM

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TABLE 1
SUMMARY
OF
SPECTRUM ALLOCATION FUNCTIONS
THAT REQUIRE ADMINISTRATIVE AND ANALYSIS SUPPORT

Spectrum Allocation Function	Support	
	Administrative	Analysis
Material Acquisition		
EMC Guidance	X	X
Frequency Supportability		
Joint	X	X
National	X	X
NATO Interoperability	X	X
Allied Standardization	X	X
Joint Standardization and Interoperability	X	
Pre-application Guidance	X	
Equipment Surveys		X
C-E System Studies		X
Assignment/Allocation Policy Analysis	X	X
Participation in Spectrum Mgt. Organizations		
FMG, RCC	X	X
J/FP, USMCEB	X	
Working Groups (J-12, J-208, J-206-)	X	X
IRAC	X	
FAS	X	
SPS	X	X
TSC	X	X
ING	X	
Ad HOC	X	X
U.S. CCIR National Committee	X	
U.S. CCIR Study Groups	X	X

* Note: Army participation on the J-12 Working Group, Frequency Panel, USMCEB, and on the SPS of IRAC, facilitates joint and national frequency supportability determinations.

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EXCEPT WHERE SHOWN OTHERWISE

TASK F.4.1.2.

Determine the analytical procedures that are now in use for each type of analysis (e.g. Spectrum Allocation Application, NATO interoperability studies).

GENERAL

The analytical procedures currently in use for Army Spectrum Allocation activities are summarized in Table 2. Any of the possible matrix intersections may occur on occasion; whether they occur frequently enough to be considered as a viable intersection; however, is subject to conjecture.

The following paragraphs discuss each of the Spectrum Allocation Functions in terms of the analytical procedures that are applied, or not applied, during the course of a typical J-12 or SPS review. Apparent shortcomings in the analytical procedures, or their lack of use, are identified.

MATERIEL ACQUISITION

EMC Guidance to Developers

EMC guidance is sometimes furnished to developers or Program Managers (PM's) by the J-12 Working Group members, The ECAC Army R & D Spectrum Engineering staff and others.* A PM will sometimes contact one of these offices for advice on completing the DD Form 1494 or with other, more technical, questions. At this time, certain information may be obtained from the PM and a limited

*See Pre-application Guidance Agencies on page 23, Volume II, of this Report.

SPECTRUM ALLOCATION FUNCTION		COMPARATIVE ANALYTIC PROCEDURE							
		ENGINEERING PRACTICES	AGREEMENTS	RULES AND REGULATIONS	STANDARDS	RECOMMENDATIONS	OTHER EQUIPMENTS	OPERATING ENVIRONMENTS	
MATERIEL	EMC GUIDANCE TO DEVELOPERS		X	X		X			
	FREQUENCY		X	X		X		X	
	SUPPORT -		X	X	X	X		X	
ACQUISITION	ABILITY		X						
	INTERNATIONAL		X						
NATO INTEROPERABILITY			X						
ALLIED STANDARDIZATION			X						
ASSIGNMENT/ALLOCATION POLICY ANALYSIS									
PARTICIPATION IN SPECTRUM MANAGEMENT ORGANIZATIONS	FMG, RCC								
	USMCEB, FP								
	IRAC (SPS, TSC, etc.)								
	CCIR STUDY GROUPS								
		AS REQUIRED							

TABLE 2. SPECTRUM ALLOCATION FUNCTIONS AND ANALYTIC PROCEDURES
CURRENTLY IN USE

amount of guidance provided. For example, the ECAC Army R & D Spectrum Engineering staff would normally comment on the appropriateness of the proposed equipment to the frequency band allocation tables, and cite the applicable primary military standards. Further liaison might be extended to the C-E Services Division, Army Communications Command, Alexandria, VA., to determine precedent frequency assignment or supportability policy.

Guidance, as described above, is forthcoming only when the PM requests it, or makes his project known to a particular office. If the PM does not seek pre-application guidance, this facet of EMC guidance does not occur since there is no organized effort within the spectrum allocation community to identify and contact new development programs.

Since completion of this Task in the first half of the study, a very promising pre-application guidance program has been instituted by the First Army Area Frequency Coordinator (AFC) at Ft. Meade, MD. At seminars scheduled by the AFC, ECAC Army R & D Spectrum Engineering staff members brief prospective allocation applicants on the spectrum allocation to equipment process and its procedures.

Other guidance is furnished on occasion, but again not in a formal or consistent fashion. The present Army member of the J-12 Working Group attempts to pass along to cognizant PM's information on newly proposed and possibly conflicting systems. This occurs only if the Army J-12 member is aware of both systems, and recognizes that a potential conflict exists.

The lack of a central authority for promulgating EMC guidance to PM's is a shortcoming cited early in the study by several persons in the spectrum management community. The Army member of the J-12

Working Group and SPS (Mr. S. Segner, CORADCOM) has undertaken, on an individual basis, to cite specific allocations to cognizant PM's and to his reporting seniors via the mechanism of a weekly report. While this is a definite improvement in a previously weak area, it is individual-dependent and in need of formalizing in order to lend authority to the guidance.

The preceding primarily applies to non-major systems. The PM for a major system looks on the J-12 allocation process as a licensing function, as a means of determining host country frequency supportability, and as an approval authority which permits him to proceed in developing his equipment or system. The PM for a major system will normally be pursuing compatibility and interference studies separately. Such studies may be commissioned by the PM before, during, or after any stage of the allocation process; and independent of the process. Sources of EMC guidance to the PM outside of the allocation process are listed under Task F.4.1.1, but consist primarily of :

DoD ECAC
CORADCOM
EMETF, USAEPG
CONTRACTORS

FREQUENCY SUPPORTABILITY

Joint - The analytical procedures employed during the joint review are limited to evaluation of the data supplied on DD Form 1494. Evaluations are performed by the Army R & D Spectrum Engineering Group (pre-evaluation) and the DoD ECAC Allocation Review Group (EARG). The EARG findings are reviewed by the J-12 Working Group who subsequently make recommendations to the USMCEB Frequency Panel (FP) regarding approval/disapproval of allocations. Specific guidance on procedures to the J-12 Working Group is provided by the FP in the Terms of Reference for the Working Group dated 25 September 1978.

With reference to Table 2, the following is a summary of the analysis and evaluations procedures used:

Engineering Practices - Evaluation of whether sound engineering practices are used in the design of the systems being reviewed is not done by the Army R & D Spectrum Engineering Group and the EARG, except to the extent that engineering practices are the basis for parts of the military and other technical standards. This basis is discussed further in Task F.4.1.3.

Agreements - Agreements, such as the U.S. - Canada Agreement relating to the Coordination and Use of Radio Frequencies Above 30 MHz, are concerned with frequency assignments rather than allocations, and thus are not addressed during the Army/J-12 review.

Rules and Regulations - Review of the DD Form 1494 data for compliance with all applicable national and international allocation tables constitutes a major part of the Army/J-12 analysis. The basis for this analysis is manual reference to the allocation tables or the automated Spectrum Allocation and Use File (SAUF), maintained by ECAC. Portions of the SAUF may be retrieved for review through the use of appropriate select criteria, such as frequency ranges and operating areas. Proposed changes to the allocations, such as the U.S. proposals to the World Administrative Radio Conference (WARC), are not contained in the SAUF and are not checked. The SAUF is described in Task F.4.2.2. Evaluation of the SAUF as an analysis tool is discussed in Task F.4.1.3.

Standards - Determination of how well the DD Form 1494 data complies with applicable military and other standards is a second major part of the analyses performed. The standards considered during the joint review process are listed in Table 3. The specific application of these specifications to the DD Form 1494 data is discussed in Task F.4.1.3.

<u>Equipment Type/Class</u>	<u>Applicable Standards</u>
All	MIL-STD-461A NTIA 5.0 - 5.2
Tactical Communications	MIL-STD-188C
Communications	
Line-of-sight	MIL-STD-188-322
Troposcatter	MIL-STD-188-313
High Frequency	MIL-STD-188-317
Telemetry	MIL-STD-1572 IRIG-STD-106-77
Radar	MIL-STD-469 NTIA 5.3 (RSEC)
Secondary Radars	MIL-STD-291B DOT 00-31 DOT 1010.51A DoD AIMS-65-1000

Table 3. Standards Commonly Used for Army/J-12 Spectrum Allocation to Equipment Review

CCIR Recommendations - The International Radio Consultative Committee (CCIR) published recommendations are not considered during the joint review process.

Other Systems - Comparative analyses are routinely performed by the Army/ECAC R & D Spectrum Engineering staff. A library search is usually performed. If the proposed system is a major system or has been in development for several years, an EMC analysis comparing it to other systems may exist. The Frequency Allocation List (FAL) and Future Systems File are searched to uncover similar equipments, or equipments in the same band which may have an impact on the proposed system. One or more of these systems, in turn, may have had EMC analyses performed which considered either the candidate system or a similar system. However, the time allowed for completion of the Army/J-12 review precludes performance of a true EMC analysis, or more than a cursory review of any existing analysis. This is discussed further in Tasks F.4.1.3 and F.4.1.4. A limited analysis capability exists within ECAC to perform frequency/distance estimates using desk-top programmable calculators. However, the ECAC EARG seldom uses this tool. The value and applicability of the programmable calculator programs is discussed under Task F.4.1.5.

Operating Environments - An environment is normally constructed during the evaluation of a system. This environment usually consists of frequency records selected from the Frequency Resource Record System (FRRS) for the intended operating or testing area of the proposed system. The candidate equipment/system is considered against this environment during a run of the ECAC Model B, a "cull" model. In many cases, such as for experimental allocations, the data provided on the DD Form 1494 is insufficient to produce meaningful results from Model B. For these cases, a tabulation of the environment as represented by the FRRS selected data is provided. Model B and its applicability to these analyses is discussed further in Task F.4.1.3.

National - Army systems which operate above 400 MHz, or are considered as major systems, are submitted to the Spectrum Planning Subcommittee (SPS) of IRAC for review. The decision of whether or not to submit a system to SPS review is made by the Army J-12 member. System data is submitted on NTIA Forms 33, 34 and 35, or using copies of pages 2, 3, and 4 of the September 78 version of DD Form 1494. SPS review is valid only for applications in the U.S. and Possessions.

The evaluation procedures used by the SPS are as follows:

Engineering Practices - Similarly to the Joint allocation review process, engineering practices are considered only to the extent that they are reflected in the technical standards used by the SPS.

Agreements - Agreements are not a major concern of the SPS review since they are primarily concerned with frequency assignments. However, the SPS may note that U.S. - Canadian coordination of frequency assignments is required in certain bands and geographic areas. For space systems, the SPS initiates preparation of the coordination document.

Rules and Regulations - As with Joint review, SPS review of the system's compliance with applicable allocation tables constitutes a major part of the analysis. Proposed changes to the allocations, such as the U.S. proposals to the WARC, are routinely reviewed by the SPS. This provides a review procedure not present elsewhere in the joint spectrum allocation to equipment review process.

Standards - The SPS performs a review of the system data to determine its compliance with applicable standards. The SPS primarily considers as "applicable standards" those which are contained in Chapter 5 of the NTIA Procedures Manual. On occasion, other specifications will be checked, such as Electronics Industries Association of America (EIA) standards which have been specifically referenced for an equipment under review. Military standards and specifications are not referenced in SPS reviews.

CCIR Recommendations - Except for these recommendations that concern Radio Astronomy applications of the spectrum, CCIR recommendations are generally not considered by the SPS.

Other systems - SPS will make a determination of whether any EMC analyses exist which may be applicable to the system under review. In certain cases the SPS may request that an analysis be performed by ECAC (for military systems), NASA or NTIA. The SPS does not work under as severe constraints as to processing time as the J-12, but attempts to complete reviews of applications submitted at one SPS meeting by the time of the next SPS meeting (two weeks). Reviews requiring EMC analysis are not bound by this schedule.

Operating Environments - The SPS will generally produce a system environment consisting of operating area and frequency band selections from the Government Master File (GMF). This environment will invariably be within the U.S. and Possessions (US & P) since that is the coverage of the GMF and the jurisdiction of the IRAC. Where operating locations of the proposed equipments are well known, SPS may perform an intersystem interference analysis with the environment. The data resulting from this will be a series of Frequency/Distance curves. This level of analysis is the exception, not the rule.

International- The formal spectrum allocation to equipment process described in this study is unique to the United States. While similar processes exist in the more advanced nations (e.g., U.K., FRG), no such mechanism exists in the underdeveloped countries of the world. Thus, the Army is dependent upon two primary avenues when seeking coordination of International spectrum allocations to equipment.

AUSCANUKUS - Using the forum of the USMCEB, coordinations of spectrum allocation to equipment may be effected between Australia, Canada, United Kingdom, the U.S. (AUSCANUKUS) and New Zealand through the Combined Communications -Electronics Board (CCEB). In this manner, DD Form 1494 Allocation Applications in the J-12, USMCEB system are passed to the CCEB for comment. Assuming competent internal coordinating action by other CCEB members (Australia, Canada, United Kingdom, New Zealand), favorable comments from the CCEB would indicate frequency supportability in these Allied nations. Similarly, limited inter-Army coordination can be effected through the Armies of Australia, United Kingdom, Canada and America (ABCA) Standardization Agreement. In this way, commonality and compatibility between the armies of U.S., United Kingdom, Canada and Australia (New Zealand, also, on an associate member basis), is enhanced.

Host Country coordination using the organization and contacts of the unified and specified commands - The commanders of the unified and specified commands (CINC's) are recipients of all J-12 papers. Upon receipt of a DD Form 1494 allocation application for an equipment or system which may be deployed in a country within their area of responsibility, it is incumbent upon the CINC to effect Host Country coordination. The extent of coordination required may vary widely and is based on the sophistication and complexity of the equipment or system and the extent of its probable deployment (quantities and geographic location).

NATO INTEROPERABILITY

The Army regulations and procedures for achieving interoperability with NATO equipments are discussed under Task F.4.1.1 of this report. None of the existing NATO STANAGS, which govern interoperability considerations, specifically address electromagnetic compatibility or frequency allocations. No analytic procedures are known to exist within the allocation process that aid in securing NATO system interoperability, although this is a specific item to be considered at ASARC/DSARC reviews where the results of Operational and Developmental Tests (OT and DT) are also considered.

ALLIED STANDARDIZATION

Standardization of equipment between the United States and its Allies is discussed UNDER Task F.4.1.1 and under International Frequency Supportability, above. Electromagnetic compatibility and frequency allocations, per se, are not addressed in the Allied standardization agreement. As with NATO, there are no known analytic procedures within the allocation process that aid in Allied Standardization studies, except for consideration of such Allied equipment as may be contained in the data bases used to derive an operating environment for analysis purposes.

ASSIGNMENT/ALLOCATION POLICY ANALYSIS

As stated in Section 2 of this report, analyses may be conducted to determine frequency assignment/allocation supportability of portions of the spectrum for future uses. The analyses are primarily geopolitical in nature although various technical inputs would also be involved. The analyses are performed relatively infrequently.

PARTICIPATION IN SPECTRUM MANAGEMENT ORGANIZATIONS

According to AR 5-12, the Army maintains active membership in a number of spectrum management organizations in order to ensure cooperative and beneficial use of the spectrum. Participation in these groups is primarily administrative.

TASK F.4.1.3

Evaluate the major analysis procedures to ensure that they are: (1) applicable to the problem being addressed; (2) accurate to the extent required for the particular analysis being performed; (3) up-to-date in the application of technological advances in mathematical modeling and computer science; and (4) time/cost effective in terms of providing a timely result at a cost that is related to the importance of the output.

GENERAL

The major analytical procedures used in the evaluation of allocation requests were determined in Task F.4.1.2. These procedures listed in Table 2 were evaluated to the extent that they are applied in assessing an allocation request. Each of these procedures is discussed, and apparent shortcomings, problems and ambiguities are identified.

Engineering Practices

During joint and national reviews, an evaluation as to whether sound system design practices have been followed is not generally done. At times blatant problems are noticed on the applications and brought to the attention of the submitting military service or government agency. Design engineering and spectrum management are two separate engineering disciplines, and one is not necessarily competent in the other field. Also, these reviews are limited in time (10 working days), resources and the data as reported on the application for frequency allocation.

Engineering design evaluation is only accomplished to the extent required to assess compliance of the data submitted on the application with standards (both military and other technical standards). These standards represent a consensus of good engineering practices. These evaluations, at the joint and national levels, are accurate to the

extent required in reviewing an equipment allocation request. It should be noted, however, that these equipment allocation reviews are contingent upon the validity of the reported data and the degree of ambiguity and vagueness that is inherent in standards.

In the area of mathematical modeling and computer science, the joint review conducted by the Electromagnetic Compatibility Analysis Center (ECAC), depends primarily on the Model-B environmental analysis program executed by the EARG. This program analyzes the potential operational and interference performance aspects of an equipment in a typical environment. A cull, based on frequency range and a frequency dependent radio line of sight, is performed on the ECAC data base. This cull, centered on a known or assumed site for the candidate equipment, generates a description of equipment characteristics and functions for all transmitters and receivers in the surrounding environment. An interference prediction is performed between the selected site and the culled equipment using a smooth earth propagation model. Outputs used by the EARG consist of equipment density plots, INR predictions and a listing of the potential interfering environmental systems. Model-B inputs consists of the candidate transmitter and receiver characteristics, taken from the application for frequency allocation and assumed to be operating at the selected site, and the culled environmental equipment. Systems predicted to have an interference interaction probability are reported in the EARG review by the nature of operating service (e.g., fixed, mobile, etc.) since the data base is not normally complete enough to report specific equipment or users. The model was designed for fixed equipment because of the indeterminate location of mobile equipment, although they are culled.

The Model-B program is in the process of being replaced by the Environmental Coordination and Engineering Analysis System (ECEAS) Design model. This new model will employ two philosophies: 1) maximum use of available data to reduce an environment to the potential interference interaction case and 2) allow maximum user control of

the analysis by data manipulation and user input. The model will contain subroutines for off-frequency-rejection (including harmonics) and frequency-distance separation curves. Interference calculations are similar to the level of detail given in CCIR Appendices 28 and 29. Also, the user can specify more than one threshold level to be compared in the interference calculation. This will add the capability of using various thresholds for different interference possibilities (e.g., pulse to FM, pulse to AM, etc). It could also demonstrate the effects of failing to comply with standards.

The national review utilizes two propagation analysis models: the Pointwise Propagation Model (POPROP) and the Area Propagation Model (ARPROP). POPROP uses a digitized representation of the terrain profile. Propagation loss, electric field strength and power density are computed over a discrete point-to-point path. The path profile is obtained from a digitized terrain data base. ARPROP computes propagation loss using a smooth earth model that incorporates an earth roughness factor for the point-to-point path. Both models require inputs of frequency and antenna heights; POPROP also requires terminal coordinates and the terrain data. These propagation analysis models are only used in special cases. The national review can also include frequency-distance separation curves, but these curves are again only generated in special cases.

Band studies are the mainstay of the national review. Based on the types of services and operating practices indicated by the band study, an interference prediction is made. Using this anticipated degree of interference and the degree of band congestion, the candidate system is considered to be supportable within the requested frequency range or a recommendation for a detailed EMC study will be made.

Agreements

Agreements, detailing the coordination and use of radio frequencies between countries, are for the most part related to frequency

assignments rather than allocations. Consequently, they are not addressed by the joint or the national review. The reviews may note that such agreements exist in certain frequency bands and geographical regions. The SPS does initiate and coordinate agreements for space systems.

Rules and Regulations

Each application submitted for spectrum allocation review must be identified as to nature of service (e.g., fixed, radio location, etc.) and, at times, the class of station within a service. The nature of service is required to determine if operations will be in conformance with frequency allocation tables. These tables contain the divisions in which the frequency spectrum is divided, and the services permitted or allocated to operate within each division.

Both the joint and the national reviews devote a major part of their effort to checking frequency allocation tables. The national and international frequency allocation tables are examined by both reviews. The joint review also examines allocation tables of some foreign countries and military channelization and wartime frequency plans. The national review includes the U.S. position on proposed changes to the international frequency allocation tables being considered by the World Administrative Radio Conference presently in session.

The Spectrum Allocation and Use File (SAUF) is an automated compilation of national and international allocation tables, footnotes, rules, regulations and agreements. Information concerning spectrum allocation is retrieved by stipulating frequency range and location. The Army's R & D Spectrum Engineering Support Group (SESG) at ECAC uses the SAUF to review an application for compliance with allocation tables, whereas the EARG and national reviewers manually look-up the tables. Provided one has ready access to the allocation tables, the SAUF appears to have no clear advantage over the manual look-up. If the SAUF is addressed via the real time CRT terminals, one must wait for a terminal to become

available (unless a terminal is dedicated to the allocation group), contend with the operating system's hierarchy within the computer, and machine failures. If a batch retrieval method (card input) is used, computer turn around time becomes the pacing factor. Also, when changes are made to allocation tables, they can be incorporated into manuals more readily than into computer files.

STANDARDS

Electromagnetic Compatibility (EMC) is the ability of Communications-Electronics (C-E) equipment to operate in their intended environment without suffering or causing unacceptable degradation because of unwanted electromagnetic radiation or unwanted response to electromagnetic radiation. In general, EMC planning is intended to prevent, eliminate or reduce mutual interference between C-E equipment due to adjacent channel, spurious, harmonic or other unwanted electromagnetic emissions. The role of standards and specifications conform with good engineering practices with regard to RF emissions so that equipment can perform its designed function without creating or receiving unacceptable interference with other systems that use the electromagnetic environment. The following characteristics should be design objectives for optimum flexibility of electromagnetic radiating equipment: tuneability (either continuous or in narrow increments), multiplicity of emission types, minimum emission bandwidth, minimum and variable radiated power levels, and directive antennas as appropriate.

Figure 8 depicts the requirements contained within the standards that are most often applied in the review processes to equipment characteristics that bear upon EMC. The only standards that are mandatory to the Army allocation process are the military standards and the NTIA Manual. The national review evaluates only the NTIA Manual, whereas, the joint review evaluates both of these.

Equipment Characteristics Which Bear Upon EMC

		EQUIPMENT CHARACTERISTICS WHICH BEAR UPON EMC										
		TRANSMITTER					RECEIVER				ANTENNA	
		HARMONIC ATTENUATION ^f	SPURIOUS ATTENUATION	TUNEABILITY ^c	FREQUENCY STABILITY	MAXIMUM EMISSION BANDWIDTH	SPURIOUS RESPONSE	IMAGE RESPONSE	FREQUENCY STABILITY	MINIMUM REQUIRED ACCEPTANCE BW	ANTENNA REQUIREMENTS	
STANDARDS	MILITARY	MIL-STD-188C	X ^a	X ^a	X	X	X ^b	X ^a	X ^a			
		MIL-STD-461A NOTICE 4	X	X				X	X			
		MIL-STD-469	X	X	X	X	X	X	X	X	X	X
		MIL-STD-1572	X	X	X	X	X		X	X		
STANDARDS	NATIONAL											
		NTIA 5.2.3	X	X		X	X					
		NTIA 5.3	X	X	X	X	X	X ^e	X			X ^e
		NTIA 5.9	X	X	X ^d		X					

Figure 8. Comparison of Standards and Equipment EMC Characteristics

- Notes
- (a) MIL-STD-188C calls out MIL-STD-461A for transmitter attenuations and receiver response requirements.
 - (b) MIL-STD-188C requires a maximum necessary bandwidth.
 - (c) Where a standard had a channelization requirement, it was considered under tuneability.
 - (d) The channelization plan is contained in paragraph 4.3.4.
 - (e) NTIA 5.3.1 (Criteria B) has no image response or antenna requirements, but 5.3.2 (Criteria C) does.
 - (f) Both the military and national standards define spurious emissions to include harmonic emissions; however, the military has separate requirements for harmonic attenuations.

These equipment characteristics can be grouped into three general classes: transmitter, receiver and antenna. The equipment parameters within each of these categories have a bearing upon EMC and/or frequency management. Each of these classes will be discussed individually.

Transmitter EMC characteristics are concerned with restricting emissions so that the minimum possible frequency spectrum is used, and with reducing extraneous emissions that could interfere with other spectrum users. The relation between transmitter characteristics and EMC follows:

- 1) Spurious emissions (including harmonic emissions) are frequencies outside the necessary bandwidth which can be reduced in amplitude or eliminated without affecting the communication. These spurious emissions could appear within the assigned frequency band of another station and degrade the performance of that station.

- 2) Tuneability permits frequency assigners or managers to make the most judicious use of the frequency spectrum. By changing frequency assignments, the assigner could make frequencies available for new stations to operate within the frequency band. When an equipment can only operate on one frequency, it puts constraints on the frequency manager because he must coordinate around all fixed frequency equipment.

- 3) Frequency stability is the lack of undesired departure from a given frequency assignment. Not only does frequency stability help improve communications, by limiting frequency drift, but it also conserves frequency spectrum by reducing the assigned frequency band of a station.

- 4) The maximum emission bandwidth is another method of conserving frequency spectrum. For a particular set of transmission parameters, there exists a maximum emission bandwidth that will permit the information to be communicated effectively. Any bandwidth in excess of

that is not being used efficiently. This maximum emission bandwidth also maintains the assigned frequency band at a minimum value and, thereby, permits more stations to utilize the spectrum.

The purpose of receiver EMC characteristics is to prevent unwanted signals from disrupting the desired communication. This area of EMC is not given adequate consideration by the J-12 Working Group within the joint review. Generally, when increased efficiency or reliability of a communication system is desired, primary consideration is given to the transmitter. By increasing receiver performance, comparable operational results can often be obtained without increasing the demand on the frequency spectrum. The receiver EMC parameters have the following bearing upon equipment performance.

- 1) Spurious response is the reproduction of extraneous emissions which carry no meaningful intelligence. This appears as noise to the user and may cause the desired reception to be unintelligible or unusable.

- 2) Image response in a superheterodyne receiver is the reception and processing of an undesired signal in the same manner as the desired signal. The undesired signal is displaced twice the intermediate frequency from the carrier frequency. This results in the reception and processing of two signals at the same time with the signals garbling each other.

- 3) A receiver with good frequency stability will not drift around the tuned frequency and will maintain a reliable communications link.

- 4) Depending on the transmitted signal, there is a minimum receiver acceptance bandwidth. A receiver bandwidth smaller than this will result in the loss of information or ineffective communication. When the receiver bandwidth gets too broad, undesired signals pass through the receiver and increase the noise level or cause other disruptions to the communication.

Directional antennas, where they can be utilized, can provide increased reliability and reduced susceptibility. Increased reliability is achieved by providing a stronger transmitted or received signal level in the direction of maximum antenna gain. Reduced susceptibility and interference is achieved by providing a weaker signal level in the direction of lesser gain. Consequently, most of the signal energy is directed over the desired communication link and reduces the possibility of interference to other spectrum users. Directional antennas result in a more effective use of the frequency spectrum, reduced interference and improved communications.

Chapter 5 of the NTIA Manual restricts requirements to items that relate to frequency management. Paragraphs 5.2.3, 5.3, 5.5 and 5.9 are the ones most often applied. The "Table of Spurious Emissions and Frequency Tolerances" of 5.2.3 must be applied to all transmitting equipment. These specifications are applied depending upon frequency band and class of transmitting station. The spurious emission tolerance levels and the maximum emission bandwidth are dependent upon the necessary bandwidth of the equipment. The table contains frequency stability requirements, but no receiver requirements. The table references other paragraphs (e.g., 5.3 and 5.9) where technical provisions have been adopted for specific services.

The Radar Spectrum Engineering Criteria (RSEC, Para. 5.3) are concerned with promoting efficient use of the spectrum without requiring particular numerical values that have to do with a radar's mission or operational effectiveness, or restricting research directed at more effective radars. The emission bandwidth and spurious emission tolerance level criteria are based on such factors as pulse width, pulse rise time, frequency deviation (for FM type radars), the frequency range over which the carrier frequency is shifted (for frequency hopping radars), pulse repetition rate, peak power, operating frequency, total number of chips within a pulse (for coded pulse systems) and processing gain. The antenna criteria requires antennas, which rotate through

360° of the horizontal plane, to have a median gain of -10 dB or less. Other antennas should have their first three sidelobes suppressed 17 dB and all other lobes down 26 dB with respect to the main beam.

Certain statements directing the use of RSEC have had different interpretations. The statement "All primary radars shall be classified in one of the three groups as shown in the following table and then shall come under the criteria indicated for that group" has had more than one interpretation. A primary radar is defined within RSEC as one which utilizes a reflected radio signal from the position to be determined. Originally, the EARG interpreted this to mean that primary radar systems must be categorized into one of the three groups but does not restrict the application of these criteria to other systems. The EARG was, therefore, applying RSEC to both primary and secondary surveillance radar (SSR). A question arose within the joint review as to whether this was appropriate. The words "All primary radars" was interpreted by others to mean that only primary radars were to be classified in the three groups. The EARG conferred with NTIA which stated that the intention was to use the FAA National Standard (Order No. 1010.51A) for SSR systems and not RSEC. However, the FAA standard only applies to systems operating on frequencies of 1030 and 1090 MHz. Consequently, if RSEC is not to be applied to secondary radars, no national standards are applicable to SSR systems unless they operate on 1030 and 1090 MHz.

Paragraph 5.5 has to do with conserving frequency spectrum. This paragraph requests, rather than requires, that the occupied bandwidth be maintained as close as possible, within the state of the art, to the necessary bandwidth in equipment design and operation.

Requirements for telemetering stations, operating within the 1435-1535 and 2200-2290 MHz frequency ranges, are contained in paragraph 5.9. Spurious attenuation and emission bandwidth requirements are dependent upon the necessary bandwidth, and the size of this bandwidth compared to 1 MHz. No requirements are made of receivers.

The purpose of MIL-STD-188C (revised 24 Nov. 1969) is to provide technical design standards for military communications systems which are primarily used by tactical military forces. The parameters were selected so that communications between military units can be achieved without undue interface and compatibility problems. This objective is accomplished by standardizing the end output features of equipment (e.g., signal, bandwidth, levels, etc.), specifying the maximum extent of a system, specifying the maximum permissible signal degradation and standardizing the type of signal at various points in the communication system. The standard has criteria, depending on frequency band, for system parameters such as frequency stability, modulation techniques, necessary bandwidth, modulation index, modulation rate and frequency deviation. In addition, MIL-STD-188C requires that the criteria of MIL-STD-461A be applied to tactical communication systems.

The intention of MIL-STD-461A Notice 4 (dated 9 Feb. 1971) is to insure that interference free design is considered and incorporated into equipment to enable compatible operations within a complex electromagnetic environment. This standard covers the requirements and test limits for determining the electromagnetic interference characteristics (emission and susceptibility) of electronic, electrical and electromechanical equipment. Transmitter harmonic and spurious attenuation requirements are based upon the peak power of the transmitter. For receivers, the EARG has held that the image and spurious response requirements contained in Notice 4 page 61, "Figure 9 Limit for CS04" is incapable of being evaluated. Consequently, the EARG reverts to the requirement in MIL-STD-461A (dated 1 August 1968) page 44, "Figure 18 Limits for CS04 and CS08."

The primary goal of MIL-STD-469 (revised 30 March 1967) is to enhance radar design so that EMC is achievable and to conserve the limited spectrum available to the military so that their expanding radar requirements are met. The engineering design requirements were established to control the spectral characteristics of radar systems,

but not to restrict or inhibit research aimed at the development of new radars with increased effectiveness or capabilities. Criteria for maximum allowable emission bandwidth, minimum harmonic and spurious attenuation, emission limits outside the allowable emission bandwidth and minimum required receiver acceptance bandwidth are based on factors such as pulse width, pulse compression ratio, carrier frequency, peak power, antenna gain, frequency deviation and pulse repetition frequency. The antenna criteria requires that the first major sidelobes be down at least 20 dB and all other lobes be down at least 30 dB from the main beam.

The joint review only applies MIL-STD-469 to primary radars and not to SSR systems. No justifiable reason was ascertained as to why this was done. However, the definition of the term "radar" from MIL-STD-188-120, along with the "Scope" of MIL-STD-469, seems to indicate that 469 should be used in the evaluation of SSR systems also.

MIL-STD-1572 (revised No. 1975) provides the necessary criteria on which to base telemetry equipment design and modification. The ultimate purpose is to ensure efficient spectrum usage and interference free operations for telemetry systems at the Range Commanders Council (RCC) member ranges. The Telemetry Group of the RCC prepared these standards to foster the compatibility of telemetry transmitting, receiving and signal processing equipment at all Test and Evaluation (T&E) ranges under the cognizance of the RCC. Based on this, the standard only applies to telemetry equipment that will operate on T&E ranges; however, the joint review applies this standard to all telemetry equipment. Maximum power, transmitter harmonic and spurious attenuation, and maximum emission bandwidth are parameters for which criteria are specified. The only equipment parameters required to evaluate this standard are transmitter power and necessary bandwidth.

CCIR Recommendations

The International Radio Consultative Committee (CCIR) recommendations are, in general, not considered by the joint or national review process. The national review does consider radio astronomy recommendations and the ECEAS model, to be used by the EARG at ECAC in the joint review

process, uses or closely approximates some of these recommendations. It should be noted that CCIR recommendations are just that; recommendations. They are not any type of standard or specification to which the ITU members must adhere. They do represent a set of good engineering practices that have been agreed to by the ITU member nations. Also, the CCIR recommendations do contain policies and guidance for space systems which do not appear to be adequately covered by MIL-STD's.

Other Equipment

Both the joint and national reviews try to identify other equipment that can operate co-band with the system under consideration. The EARG and SESG, within the joint review process, use the Frequency Allocation List (FAL) as their primary source of co-band military systems. Data on future systems is also available in the Nominal Characteristics File. In addition, the Model-B program, used by the EARG, makes selects on environmental files (FRRS, ITU, GMF and FCC) based on frequency range and location. From the select, telecommunication services capable of interference interactions are reported. Finally, the Organization and Platform Allowance File (OPAF) is searched by the EARG when an application reports the specific platform (e.g., ship or aircraft) on which the equipment is to be installed. At times, harmonically related systems are also identified when high transmitter output power (usually greater than 1kW), poor harmonic attenuation and high receiver spurious response warrant.

No system-to-system analysis is performed between the candidate system and other systems within the environment or within the same frequency range. If the subject system has been in development for several years, an EMC analysis may already have been conducted. This information is located by a library search, and the results are extracted and reported. Because of the 10 work day time constraint the EARG is presently operating under, library searches are currently being restricted to special request on major systems. If the system under consideration will operate in a congested frequency band or appears to be a major interference source, the J-12 WG and/or EARG will recommend that an EMC analysis be accomplished.

Utilizing previous analyses is one method used by the national review to identify co-band systems. If a previous analysis exists for a system similar to the one under review, the data is extracted and incorporated into the review. If no related analysis exists, the SPS will request an analysis to be done. When SPS performs an analysis, it is usually a band study primarily utilizing the GMF and Non-GMF. The SPS does not restrict their reviews on systems requiring an analysis to their two week review cycle.

Operating Environments

When the EARG makes a Model-B computer run, a C-E environment is generated with respect to the given deployment sites or representative sites (if none are specified). The frequency range and radius employed in the select depends upon the tuning band, three dB emission bandwidth and propagation characteristics (which considers power, antenna gain, antenna height, etc) of the candidate system. Environmental records are selected from FRRS, GMF and FCC files for deployments within the U.S. & P. For deployments outside the U.S. & P., the environmental records are selected from the ITU and FRRS files. Because the ITU file can only contain those frequency assignments that each member nation deems to register, the environment is not an accurate representation for overseas deployments.

The SPS uses a similar approach to generate a C-E environment. Records are selected from the GMF and Non-GMF. The selection criteria are the tuning range of the subject equipment and an approximation to the radio line of sight (square root of twice the antenna height) as a radius. Because NTIA only has authority within the U.S. & P., no foreign deployments are considered.

TASK F.4.1.4

Identify new analysis procedures, where required, to align the capabilities that are available to the Army spectrum allocation community with the assets that are required.

In general, there appears to be no need for new analysis procedures within the Army spectrum allocation to equipment arena because no

in-depth analysis can be performed in the allotted review time frame. The role of the allocation community is essentially reduced to processing allocation applications at a rate which permits a review for basic compliance with standards and regulations, but without imposing undue delay in development and/or acquisition. For this purpose, the current models and analysis procedures are adequate. Consequently, the additional effort and resources required to develop models to perform sophisticated EMC predictions would not be justifiable. Effort directed toward improving analysis models for use within the Army's project development arena would be more worth while. The results of these analyses should be appended to allocation request which would provide improved EMC support information for reviewers of allocation requests.

There are two areas within the allocation process that should be improved; coordination and updating.

- Communication and coordination of information between the components of the Army spectrum allocation community should be improved. There appears to be a lack in relating information that is relevant to the EMC of systems (e.g., EMTF findings). Increased communications would reduce redundancy, and enlighten personnel processing the allocation applications, thereby improving the efficiency and capacity of the allocations process.

- Analysis models, used to make EMC predictions, should be updated to be more reflective of the state of the art. The use of advanced digital and spread spectrum systems, packet radios, pulse compression radars and frequency agile radars is increasing. Although the majority of these advanced systems are in the experimental and developmental stages, some are beginning to reach operational status. Military planners are attempting to exploit the capabilities of these advanced systems in the area of satellite communication systems; missile, telemetry, command and control systems; remotely piloted vehicles; sensor data link systems; tactical radio/radio relay/data link systems; and navigation (IFF and ATC) systems.

Model B (the analysis model used by EARG and SESG), ECEAS (the replacement for Model B) and EMETF can only evaluate fixed frequency equipment. Consequently, the attributes of these advanced systems (such as improved output signal to noise ratio, improved reliability, secure transmissions, decreased potential for being an interference source, resistance to interference or jamming, anti-interception, multiple access capability and multiple function capability) can not be evaluated within the allocation to equipment process.

TASK F.4.1.5

Identify cases where manual analysis techniques could be automated, if this would result in a more efficient procedure, and conversely, identify cases where automated analyses are inappropriate and are causing unacceptable delays in obtaining results.

The spectrum allocation process has become a series of tasks involving the evaluation of standards, allocation tables and the results of analysis modeling. These tasks can be accomplished by automated or manual methods. The execution of analysis models is complex and can only be realistically accomplished by computer, whereas the other tasks can often be efficiently accomplished by manual methods if dedicated computer accessibility is not provided.

The various allocation tables, for example have been placed in computer files at ECAC (e.g. SAUF; see Task F.4.2.2.). Selection is made by frequency band or other constraints. However, due to the demands placed on ECAC data processing facilities, ready reference to a hard copy is usually much more efficient. Also, the hard copy form of allocation tables can be updated more quickly than a computer file. This will be demonstrated in the near future when the results of the ongoing World Administrative Radio Conference are ratified and promulgated.

The evaluation of standards often involves just locating a value within a table. At other times some computation and plotting is required (e.g. emission bandwidth limits). Although these calculations are not complex, and members of EARG and SESG perform them at their desk, they could be more efficiently accomplished by a programmable calculator with plotter. Only the availability and application of automated tables, standards and plots (using programmable calculators) will determine the effectiveness of automating these manual methods. There is a high degree of probability, however, that these calculator assisted techniques would prove to be more efficient than using a large ADP facility in this application. Tasks F.4.1.3 and F.4.2.4 contain additional information.

SECTION 3
OBJECTIVE 2

STATEMENT OF OBJECTIVE (F.4.2)

To evaluate the degree to which the technical data requirements of the Army spectrum allocation and analysis community are met by the data bases currently being used, and to identify areas where improved performance of the data/analysis interface is required.

TASK F.4.2.1

Identify the data items required to perform the analytical functions.

DATA SOURCES

In visiting the various DoD and Army organizations concerned with analytical procedures, several data files were identified which support this process. Task F.4.2.2 describes these in detail, and should be considered in relation to this task.

In addition to the various data files available, a number of non-automated sources, such as the DD Form 1494, the OT 33, 34, 35 forms, etc. were also considered as sources of analytical data.

The chart in Appendix G depicts the sources of analytical data which were examined for this project. The data elements (items) are grouped for ease of use, and an "X" under the "file" column indicates that it is supported in that particular file. For certain of the data elements, a "P" is listed in appropriate columns. This indicates that the data is not collected on an a priori basis. Rather, it is obtained for a specific task, or project, and can then be made available for analysis by allowing it to reside in a particular file.

It should be noted that this chart contains only those data elements (items) which are required to support current analysis procedures. Task 4.2.3 explores data needs for future analysis.

In identifying the data elements (items) to be included in this chart, several hundred data elements were examined. Those data used in support of administrative functions, or those required by a computer system unique to processing a particular file, were eliminated.

Consequently, the chart in Appendix G contains only those data elements (items) which are used in either manual or automated analyses. A separate volume has been compiled, with a separate sheet per data element (item), which describes the content, use, and availability of the data. This is being provided as supporting material at the completion of this study.

TASK F.4.2.2

Determine the sources and availability of the data items in the data bases maintained by various Army and DoD organizations.

During the course of study on this task, four agencies were visited which maintain data bases. These were (1) the DoD Electromagnetic Compatibility Analysis Center (ECAC); (2) U.S. Army Communications-Electronics Systems Division (CESD), (3) Communications/ADP Laboratory, both of the U.S. Army Communications Research and Development Command (CORADCOM); and (4) the Electromagnetic Environmental Test Facility (EMETF), of the U.S. Army Electronic Proving Ground.

In the following pages, each agency's data base will be discussed in the areas of (1) content, (2) currency, (3) access restrictions, (4) source, (5) method of storage, and (6) ease of update.

DOD ELECTROMAGNETIC COMPATIBILITY ANALYSIS CENTER (ECAC)

By far the largest concentration of data resides at the DoD Electromagnetic Compatibility Analysis Center (ECAC) located in Annapolis, Maryland. In addition to a large number of automated data

files, the ECAC has an extensive technical library and, through it, access to other excellent technical sources such as the Defense Documentation Center (DDC) and the National Technical Information System (NTIS). This permits both automated and manual sources to be used in their EMC analysis techniques.

In all, nine automated data files were identified to be resident at ECAC, and all of them are available for EMC analysis. These data bases are stored in various record and file formats, and all have retrieval capabilities to access and manipulate the data. Certain of the files have merge capabilities, so that a composite environment can be created when required.

In the following narrative, each automated file will be discussed in light of the criteria specified on the preceding page.

FREQUENCY RESOURCE RECORD SYSTEM (FRRS)

Content - The FRRS is the DoD Frequency Assignment data base, and contains the frequency assignment records for the Commanders-in-Chief of the unified and specified commands (CINCs), the Military Departments (MILDEPs), and the DoD Area Frequency Coordinators (AFCs).

Currency - The currency of the data in the FRRS varies with the participant. There is a capability to maintain the data on a daily basis in a temporary file, which is used to update the master file on a specified schedule. The CINC files are generally updated once a week (depending on transaction rate); the MILDEP files are updated once a month for US&P records and as required for OUS&P records; the AFC files are updated as required by the cognizant AFC. Frequency assignment records are required to be reviewed every five years to insure accuracy and completeness of the data. This is the over-all currency standard of the files; however, many records have not been updated within that time frame.

Access Restrictions - In general, all FRRS data is releasable only within DoD. However, releasability to non-DoD agencies can be accomplished with approval of the cognizant frequency manager.

Source - The source of the FRRS data is the cognizant frequency manager. Input to the DoD ECAC may be AUTODIN message, letter, form, or updated listing.

Method of Storage - All of the FRRS files are maintained on-line to the UNIVAC 1100/82 computer. The data is stored in the Consolidated Frequency Environment File (CFEF)/record file.

Ease of Update - Both batch and interactive capabilities exist for the maintenance of the FRRS files. Although updates are generally accomplished on a periodic basis, data can be entered quickly if the occasion demands.

INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

Content - The ITU File contains transmitter frequency assignment records on a world-wide basis. These records have been registered with the ITU by member nations as notification of their existence in areas over which they may exercise administrative or operational control. The file contains transmitters only.

Currency - The ITU File is provided to ECAC for updating on a purge-and-replace basis once a year.

Access Restrictions - The ITU File is unclassified, and is obtained on a purchase basis. Consequently, no restrictions on its use are imposed.

Source - The source of the file is the International Frequency Registration Board (IFRB), International Telecommunications Union, in Geneva, Switzerland.

Method of Storage - The ITU File is stored on magnetic tape. Its record format is a 28-word ITU format, which can be mapped to be compatible with the CFEF formatted records and can be merged with them in an output product.

Ease of Update - Several computer runs are required to create the ITU File. Update is tedious and time-consuming but, as stated above, occurs only annually.

GOVERNMENT MASTER FILE (GMF)

Content - The Government Master File contains all U.S. Government frequency assignments approved for use within the U.S. and Possessions. It is primarily a transmitter file, although some receiver records are included for information and protection purposes.

Currency - The GMF is updated at the National Telecommunications and Information Administration computer (located in Annapolis, Maryland) on a monthly basis. The requirement for all its records is that they can be reviewed once every five years. Although some agencies are on a five-year update schedule, there are still hundreds of records which have not been reviewed in that time frame.

Access Restrictions - The GMF is provided to the DoD ECAC with the stipulation that it not be released outside of DoD without prior approval of NTIA. The overall classification of the file is confidential.

Source - The GMF is maintained by NTIA which is responsible for the content of the file.

Method of Storage - The entire GMF is resident at ECAC, and is maintained on magnetic tape. It is stored in the same record format as the FRRS records (CFEF format).

Ease of Update - The GMF is provided to ECAC each month in the GMF format, and must be mapped into the CFEF format. The mapping procedure, because it involves tapes and a large number of records, is often cumbersome and time-consuming.

NOMINAL CHARACTERISTICS FILE (NCF)

Content - The Nominal Characteristics File contains technical characteristic data on U.S. military and civilian equipment which is presently used, formerly used, or will be used in the future. The data included in the file on each equipment is "nominal" which describes the design characteristics, not the actual operating mode in an environment (e.g. the tuning range capability of a transmitter is recorded; not a discrete operating frequency).

Currency - The data in the NCF is updated on a daily basis using information from the various data sources.

Access Restrictions - Since the NCF is maintained and controlled by ECAC, releasability is established by the cognizant military deputy. It is available for release throughout DoD, and other government agencies on an as-required basis. The data in the file is classified up to secret.

Source - The sources for the NCF data are many. Most often, data is extracted from technical manuals, manufacturers' brochures, and equipment allocation applications (DD Form 1494)

Method of Storage - The NCF is maintained on-line to the UNIVAC 1100/82 computer. Its record structure is unique to the NCF.

Ease of Update - The file is easily updated through the use of an interactive maintenance program.

In order to provide data on emerging C-E systems, a Future Systems File is available at ECAC which provides data on future equipments. It is really an index which contains skeletal data on the equipment, and points to other files where additional data can be retrieved. This is particularly true of its relationship to the NCF, since NCF records are built to support future systems when possible. Most often the data is derived from a DD Form 1494 application, and additional data is added as it becomes available. The data elements in this file, therefore, are those of the NCF.

FEDERAL COMMUNICATIONS COMMISSION (FCC)

Content - The FCC file contains frequency assignment records of users of the non-government portion of the frequency spectrum in the U.S. and possessions. It includes aviation, broadcast, fixed public, satellite, common carrier, private microwave, experimental and industrial services. The file contains approximately 700,000 records, and are transmitter records only.

There is currently discussion with FCC to acquire the license files of the various FCC bureaus to replace the present FCC File. This acquisition would provide the EMC engineers more data in the FCC records.

Currency - The FCC File is provided to ECAC for updating on a purge-and-replace basis, every six months.

Access Restrictions - There are no access restrictions imposed on the FCC File. Its data content is unclassified.

Source - The source of this file is the Federal Communications Commission, which is responsible for the content.

Method of Storage - The FCC File is stored on magnetic tape. It is first mapped into a 28-word FCC record format, which can be mapped to be compatible with the CFEF formatted records, and can be merged with them in an output product.

Ease of Update - Because of the mapping procedure, and the large number of magnetic tapes necessary to store this data, the update process is both cumbersome and time-consuming.

FREQUENCY ALLOCATION LIST/FREQUENCY ALLOCATION INDEX (FAL/FAI)

Content - The FAL/FAI contains data extracted from the Frequency Allocation Application (DD Form 1494). Additional information is extracted from subsequent action memoranda which may often amend the technical/operating characteristics of the equipment. Those applications which have been coordinated with other CCB members, primarily Canada, provide other data to this file from the C/F-299 Frequency Allocation Application form.

Currency - The file is updated on an as-required basis, as data is available from the DD Form 1494 and C/F-299 applications.

Access Restrictions - Since the FAL/FAI is maintained and controlled by ECAC, releasibility is established by the cognizant military deputy. It is available for release throughout DoD and other government agencies on an as-required basis. The data in the file is classified up to secret.

Source - The sources of data for this file are the DD Form 1494 and C/F 299 applications.

Method of Storage - The FAL/FAI is stored on magnetic tape. Its record structure is unique to the FAL/FAI.

Ease of Update - Although this file is stored on tape, it is easy to update due to the small number of records in the file.

ORGANIZATION AND PLATFORM ALLOWANCE FILE (OPAF)

Content - The Organization and Platform Allowance File (OPAF) exists to aid in the identification of communications-electronics equipment which operate in the mobile/tactical environment. It consists of data on the C-E configurations on military platforms (e.g. ships, aircraft, ground tactical units, missiles, and satellites). There is also limited data on U.S. commercial aircraft and maritime ships, as well as commercial air carriers. The OPAF primarily serves as an index of equipment on mobile platforms. Technical information on the equipment parameters must be retrieved from the NCF.

Currency - Because of the multiplicity of sources for this file, updates are performed at various times. Schedules include quarterly, semi-annually, annually, and aperiodic updates.

Access Restrictions - Since the OPAF is maintained and controlled by ECAC, releasability is established by the cognizant military deputy. It is available for release throughout DoD, and other government agencies on an as-required basis. The data in the file is classified up to secret.

Source - Depending on the particular part of the OPAF, sources of the data can be from several input media. In general, data is entered from magnetic tape, listings, documents, official correspondence, reports, project plans, and licenses.

Method of storage - The OPAF, is maintained on-line to the UNIVAC 1100/82 computer. Its record structure is unique to the OPAF.

Ease of Update - The file is easily updated through the use of an interactive maintenance program.

SPECTRUM ALLOCATION AND USE FILE (SAUF)

Content - The Spectrum Allocation and Use File (SAUF) contains data on national and international rules, regulations, and agreements governing the use of the radio frequency spectrum. It actually consists of two files - a Utility File, and a Prose File. The Utility File contains selected data fields from the rule or regulation which permit the user of the file to select a sub-set of data for given requirement. The Prose File contains the actual text of the rule itself.

Currency - The SAUF is updated on an as-required basis, based on republication of documents, or changes thereto.

Access Restrictions - Since the SAUF is maintained and controlled by ECAC, releasability is established by the cognizant military deputy. It is available for release throughout DoD and other government agencies on an as-required basis. The data in the file is classified up to secret, with certain data requiring a NATO clearance.

Source - The source of the data in the SAUF are the documents which define the rules, regulations, and agreements governing the use of the radio frequency spectrum.

Method of Storage - Both the SAUF Utility and Prose Files reside on-line to the UNIVAC 1100/82 computer. The record structures for these files are unique to the SAUF.

Ease of Update - The files are easily updated through the use of interactive maintenance programs. Batch maintenance programs are also available.

NATO ALLIED RADIO FREQUENCY AGENCY/MASTER RADIO FREQUENCY LIST (ARFA/MRFL)

Content - The ARFA/MRFL contains frequency assignments for NATO forces in certain frequency bands.

Currency - The ARFA/MRFL is provided to ECAC for updating on a purge-and-replace basis every month.

Access Restrictions - Access to this file is on a need-to-know basis, and users must have a NATO clearance. Data in this file is classified up to secret.

Source - The source of this data is the Allied Radio Frequency Agency which is responsible for its content.

Method of storage - The ARFA/MRFL is stored on magnetic tape. It is mapped into CFEF format, and can be merged with other CFEF-formatted records in an output product.

Ease of Update - Although the file mapping procedure requires the use of magnetic tapes, the rather small number of data records on the ARFA tape permits a relatively straightforward update procedure.

U.S. ARMY COMMUNICATIONS-ELECTRONICS SYSTEMS DIVISION (CESD)

The U.S. Army Communications-Electronics Systems Division (CESD) of The U.S. Army Communications Research and Development Command (CORADCOM), is located in Alexandria, VA. Its mission is to develop large-scale Deployments, and to maintain the files required to support them. It is understood that this Division will be transferred from CORADCOM to the Army Test and Evaluation Command (TECOM) in the near future.

CESD itself does not have its own computing system. It is tied into the IBM system located in the Pentagon which consists of an IBM 370/165 and an IBM 3033. A secure terminal is available at CESD to allow processing of the classified data maintained in its files.

The large-scale scenario or deployment which is created by CESD is designed to define the communications-electronics (C-E) environment of deployed tactical combat forces. The finished deployments contain a complete tactical and technical portrayal of FRIENDLY and THREAT, ground and tactical air, C-E and EW equipments and net structures, and in themselves constitute a compilation of data reflecting the C-E environment for a given tactical situation or deployment.

The support files for these deployments include basic organizational and technical information on C-E equipment in general, without regard to any specific tactical situation. These include the Equipment Authorization File (EAF), the Equipment Characteristics File (ECF), the Equipment Netting File (NET), the Antenna Characteristics File (ANT), and the Equipment Application File (APPL).

These files will be discussed in turn.

LARGE-SCALE TEST BED DEPLOYMENT FILES

Content - Large scale C-E deployments (up to a two Corps Field Army with tactical air in size) are usually centered around major Army studies and provide the basic tool for analyzing the EMC implications or new equipment, organizations and concepts. Deployments include C-E equipments for both friendly and opposing forces. However, it should be noted that all data in the deployment files is based on a single moment in time for a specific tactical situation and scenario.

Currency - The currency of the test bed deployment files is of a specific moment in time. It takes approximately a year to develop a large deployment file, but it is current only for the task for which it was generated. A large project, requiring a transitioning posture (defense, attack, etc.), will require a series of these "snapshot" deployments.

Access Restrictions - Data from the deployment or test bed support files is available to DoD or DoD contract activities. However, some of the information in the data base (primarily THREAT data) is derived from documentation which has been designated as not releasable to contractor personnel. All requests for data to be released to contractors must be fully justified and must establish a valid need-to-know. Headquarters, Department of the Army, Office of the Army Frequency Manager (DAAC-ZS), Washington, D.C. must approve all release of this information.

Source - There are many sources for the data resident in the Deployment file. Included are documents from the U.S. Army Training and Doctrine Command (TRADOC), intelligence community data (primarily from the Defense Intelligence Agency (DIA)), the developers of new equipment, program managers, technical manuals, Army TOE's, and any other sources which would have information both on the FRIENDLY and THREAT forces depicted in the scenario.

Method of Storage - The deployment files are stored on magnetic tape.

Ease of Update - The files are updated using a tape maintenance system available on the Pentagon computer.

TEST BED SUPPORT FILES

Content - There are five test bed support files used by CESD in their deployment file. These are:

- a. Equipment Authorization File (EAF) - This file contains the equipment complement information for force authorization. Netting information is also inserted. The data are derived from DA Tables of Organization and Equipment (TOE), US Air Force, and opposing force authorization documentation.
- b. Equipment Characteristics File (ECF) - This file contains the nominal C-E equipment technical characteristics for each component in the EAF. The technical characteristics of the equipment are entered in the file as a function of the equipment application or operational mode.
- c. Equipment Netting File (NET) - This file is used to identify the various C-E equipment net types typically associated with tactical military operations. It defines the operational characteristics of the nets themselves.
- d. Antenna Characteristics File (ANT) - This file contains specific antenna data related to the production of deployment data. Its purpose is to reference the type of antenna used with the C-E equipments in the ECF and the EAF.
- e. Equipment Application File (APPL) - This file provides data on the use and purpose of the C-E equipment.

Currency - The Test Bed Support Files are constantly being updated from various sources as new data is available. They are not static in nature, but are maintained to support various deployment requirements.

Access Restrictions - Access to the Test Bed Support Files is determined by Headquarters, Department of the Army, Office of the Army Frequency Manager (DAAC-ZS), Washington, D.C. and is provided on a need-to know basis.

Source - For the FRIENDLY forces, the source for the EAF is primarily the Army TOE's, and other documentation or studies on the equipment complement of a force organization. The THREAT forces are provided from DIA intelligence documents. For the supporting equipment, antenna, and netting files, the FRIENDLY data is derived from published documents on standard equipments, and the THREAT data is again derived for DIA intelligence reports. When a developing equipment is to be part of a scenario, data on its characteristics are obtained from the cognizant program manager.

Method of Storage - The Test Bed Support Files are maintained on disk on the Pentagon computer.

Ease of Update - Update of these files is accomplished through the use of a batch update program which manipulates the disk files.

COMMUNICATIONS/ADP LABORATORY

The Communications/ADP Laboratory of the U.S. Army Communications Research and Development Command (CORADCOM) is located at Ft. Monmouth, New Jersey. It is involved in EMC design compatibility, C-E equipment, EMC systems analysis, and EM Vulnerability Analysis.

In the past, a series of computer programs for the USAECOM B5500 computer was available for the synthesis and analysis of electromagnetic compatibility (EMC) and electromagnetic vulnerability (EMV) problems of communications-electronics equipments, systems, and deployments. The primary group of programs was called the Allen Model, and consisted of 12 separate, but interconnected-function, computer programs.

As of December of 1978, the B5500 computer was replaced by an Interdata 832, which is now available to the Communications/ADP Laboratory on a time-sharing basis. This change in hardware has rendered the Allen Model totally inoperable, since no conversion of the programs has been attempted. In addition, due to limitations of staff personnel, it is anticipated that the Allen Model, per se, will not be reproduced on the new computer. Due to its general nature, it proved too cumbersome and inflexible in the past, and the personnel at the Communications/ADP Laboratory feel that a new model could better meet their needs in keeping up with state-of-the-art technology. A new analysis model, called CENCOMS, is planned to provide this type of capability. Early design on this system is underway.

There are no large-scale data bases in support of any of the analysis done by the Lab. In the past, test beds provided by CESD have been used by them, but often the scenario and the threat are too static for their purposes. Equipment data bases have not been necessary, since they are primarily testing a new equipment against the existing environment, and data gathered over the years is input, when required, on a manual basis. Quite often, since they are working with the development engineers, they have access to very detailed data on a new equipment. The data are never available in one of the existing data bases due to its developing nature.

ELECTROMAGNETIC ENVIRONMENTAL TEST FACILITY (EMETF)

The Electromagnetic Environmental Test Facility(EMETF) of the United States Army Electronic Proving Ground(USAEPG) is located in Tuscon, Arizona. It is involved in automated electromagnetic compatibility testing of military communications equipment and weapons systems.

To perform its mission, EMETF has developed a combination of automatic empirical testing facilities to determine the degree of degradation that different types of interference or jamming cause to C-E equipments and weapons systems and the conditions under which this degradation occurs. This empirically derived degradation data is used in conjunction with computer-automated analysis capabilities to provide a probability of satisfactory operation for the equipments or systems in typical tactical environments or deployments.

The computing power used by EMETF to perform its analysis is provided by a CDC 6600 computer located at Ft. Huachuca, Arizona. A PDP 11/45 is available at the EMETF, but it is not powerful enough to accomplish the large-scale analyses often required.

EMETF has two major requirements for data on the performance of the equipment or system under varying conditions. These are: (1) the effects of interference or jamming on its performance, and the operating characteristics of the equipment or system and, (2) the deployment in which the system is tested. Both threat and friendly data are required.

These two data requirements will be discussed below.

EMPIRICAL DATA

Content - The empirical data required for EMETF analysis is derived from the five testing facilities which are a part of the EMETF itself.

Currency - The currency of the data is excellent, since it is derived from testing done on-site for a particular analysis requirement.

Access Restrictions - Access to testing data is very limited because, quite often, the testing being conducted is "competition sensitive." Other than program managers who request the testing, this data would be released on need-to-know basis.

Source - The source of the empirical data is the EMETF testing facility. There are actually five interrelated facilities which provide the data: (1) The Instrumented Workshop where laboratory-type measurements and closed-link tests are conducted; (2) The Scoring Facility where the degree of information transfer of communication equipment is measured; (3) The Weapon System Electromagnetic Environment Simulator, where the effects of interference on weapon systems and radars evaluated, are (4) the Spectrum Signature Facility, where technical characteristics of C-E systems are measured, and (5) the Field Facility where special measurements on propagation and performance data are made on systems too large for laboratory type measurements.

Method of Storage - The data produced by the EMETF test facilities are stored on magnetic tape.

Ease of Update - Test data is not updated. If a test needs to be updated, it is simply redone.

DEPLOYMENT DATA

Content - The deployment data used by the EMETF contain the C-E environment of deployed tactical combat forces. It includes both friendly and threat, ground and tactical air, C-E and EW equipments and net structures.

Currency - The actual test bed provided to EMETF is valid only for a given type of deployment at a given moment in time. However, there are capabilities which allow smaller deployments to be derived from the large ones, and these are more tailored to a particular requirement. Unfortunately, they are still good only for a given moment in time.

Access Restrictions - The access restrictions for the deployment files is the same as that described for CESD. However, those smaller test beds provided by EMETF for particular projects would require the coordination of both EMETF and CESD.

Source - The source of the deployment data is the U.S. Army Communications-Electronics Systems Divison (CESD) of the U.S. Army Communications Research and Development Command (CORADCOM).

Method of Storage - The deployment files are stored on magnetic tape.

Ease of Update - The deployment files provided by CESD are not updated by EMETF. However, when modified deployments are created from the CESD files, this is done at EMETF. Computer programs are available to make this as easy a process as possible.

In addition to the empirical data, and the deployment data, EMETF also maintains a manual file of equipment characteristics which is used in the creation of modified test beds.

A completely separate, and unrelated, file is maintained at the EMETF. It is the Frequency Allocation to Equipment File (FAEF). The file contains data which are taken from the DD Form 1494, and has been maintained by EMETF since the early 1960's. To the best of EMETF'S knowledge, the file is complete and up to date since the time. It should be noted, however, that although this file exists, no users of it were identified.

TASK F.4.2.3

Identify the practical methods for obtaining and storing the data items identified under 4.2.1 that are not found to be available under 4.2.2.

No data elements have been identified as necessary for analyses that are not already available from the DoD and/or Army data bases, or other sources of data.

This, in itself, is a significant finding of the study. Generally, in the past, the agencies responsible for the analyses, and those responsible for the data bases, have been in agreement as to what data is needed and how to best provide it. Lack of foresight has not been a problem. But, rather, the weakness has come in the accuracy, currency, and completeness of the data once it has been identified as a requirement.

It should be noted that during the visits to the various agencies, the overall feeling expressed regarding the data itself, was that it is not always accurate, current, or complete. This is a direct result of the multiplicity of data sources feeding the data files. This problem can only be corrected if the organizations responsible for providing the source information do so in a prompt manner.

Overall, the data elements available on the DD Form 1494 and the OT Forms 33, 34, and 35 meet the requirements for the EMC review conducted during the spectrum allocation to equipment process. However, the data values submitted are quite often projected data which is estimated early in the equipment conceptual phase. Adjustments or changes frequently occur after the submission of these forms as equipment development progresses and the equipment's actual characteristics materialize. These revised data are not always made available to those reviewing the application.

TASK F.4.2.4

Study the interfaces between the data bases and the related analysis procedures to determine: (1) changes that will improve the interface between the data base and engineer in those cases where the analysis employs manual algorithms; and (2) changes that will enhance the exchange of data from the data bases to analysis computer programs where applicable.

DATA BASE/ENGINEER INTERFACE

General The primary analysis procedures presently performed in the joint allocation-to-equipment process are those done by the ECAC Allocation Review Group (EARG) and the Army R & D Spectrum Engineering Support Group (SESG) at ECAC. It is the mission of the SESG to screen Army J/12 Frequency Applications as they are submitted for joint frequency allocation guidance. It is the mission of the EARG to provide technical support to the J/12 Working Group of the Frequency Panel in the joint review process. At the national level, applications are reviewed by the Spectrum Planning Sub-committee of the IRAC for NTIA approval.

One of the primary functions carried out by the EARG and the SESG is the review of applications as they relate to the national and international allocation tables. This frequency band allocation study effort is the mainstay of the national review process.

Automated Data An automated data file of allocation rules and regulations is available at ECAC, and is known as the Spectrum Allocation and Use File (SAUF). The SAUF is explained in detail in Task F.4.2.2. It contains data on national and international rules, regulations, and agreements governing the use of the radio frequency spectrum. By utilizing retrieval capabilities available for this file, users may select sub-sets of the data to determine which allocation tables govern the use of the selected bands.

Although the automated capability exists, the engineers working in the EARG and SESG find that it is usually easier and faster to use the appropriate hard-copy reference volume to determine if an equipment meets allocation criteria. This is due, in part, to the lack of a devoted terminal for use in accessing the SAUF. Although batch processing capabilities are also available, the turn-around time from request to output is often longer than can be tolerated when an analysis must be performed in a short period of time. To keep the data current, it has been the engineers' experience that it is faster to insert update pages to documents than it is to update records in the data base to reflect these changes. This is considered a valid assessment and no change is recommended.

Manual Reference Data Data is not always available to ensure an in-depth review of applications. In some cases, where time is available, a library search of the documents in the ECAC library (and its link with the Defense Documentation Center) is conducted. Provided these sources are complete, the engineer at least is aware of other studies conducted on the equipment. However, it is quite often the case that the reports which contain the most data on the system are not part of the library resource.

It would seem practical for an index of reports to be prepared which listed those studies or tests which have been conducted on a system. This would permit the engineers to check on the existence of data, and to obtain copies of the report when necessary. This could be extremely useful when comparison of a new system is based on the characteristics of a similar system already in existence. This would eliminate the requirement of a specific search each time an equipment is analyzed, which often cannot be accomplished within a limited time frame.

DATA BASE/ANALYSIS MODEL INTERFACE

Models Used in Analysis at ECAC As stated earlier, the EARG and the

SESG at ECAC presently perform the primary analyses on the joint level in the allocation-to-equipment process.

These groups use the currently available "cull" model at ECAC, known as Model B, to assess the impact of an emerging equipment or system on a given environment. Based on information in the application regarding intended operational use, a representative environment is created using the ECAC data bases, and an evaluation is made as to whether or not the new equipment is a potential source or victim of interference to other equipments normally operating in the test environment. As stated under Task F.4.1.3, the EARG can frequently only review the system based on nature of operating service, since the data base is not always complete enough to report specific equipment or users.

Presently under development is a new "cull" model, known as the Environmental Coordination and Engineering Analysis System (ECEAS) Design Model. It is intended to make maximum use of the data resident in the data base, and to give the engineer control over the analysis by permitting data manipulation and user input.

Models Used in Analysis at NTIA On the national level, the major emphasis again is on band studies, and interference predictions are made. In special cases, two propagation models, the Pointwise Propagation Model (POPPROP) and the Area Propagation Model (ARPROP) can be used. These capabilities are discussed in depth under Task F.4.1.3.

Data Bases Used at ECAC Even though Model B and the ECEAS Model are available to analysis engineers, the underlying assumption in their use is that the engineer knows the environment in which the candidate equipment is intended to operate. This information is not always provided on the J/12 application. In addition, there is no indication as to what the specifications were when the design concept was validated, nor what considerations were given to its mission-essential requirements during development.

In order to create environments against which a candidate equipment/system can be analyzed, several environmental data bases are available at ECAC. These are described in detail under Task F.4.2.2. Technical characteristics data can be retrieved from the Nominal Characteristics File(NCF), when these are required.

Data Bases Used at NTIA The primary data bases used in environmental analysis at NTIA are the Government Master File (GMF), and the Non-Government Master File (NGMF). The GMF contains all U. S. Government frequency assignments approved for use within the U. S. and Possessions. The NGMF primarily contains data on FCC assignment actions which comprise the civilian sector.

A technical characteristics file, the Equipment Characteristics File (ECF), is also available at NTIA when this type of data is required in analysis.

USE OF DEPLOYMENTS IN CREATING ENVIRONMENTS

As an equipment moves from one stage in the allocation-to-equipment process to another, the passage of time will tend to affect the deployment in which it will function at the completion of this cycle. Deployments must consider and include new systems which will be in the inventory in the time frame in which the candidate equipment/system is being targeted for introduction into the environment. Keeping current environments available against which systems can be analyzed is a major problem area in determining frequency supportability.

Figure 9 depicts the steps which must be accomplished in order to create an environment. ECAC and NTIA select data subsets from existing environmental files, and this data is then used in models which determine the interference potential of candidate equipments/systems. A different approach is taken by CESD and EMETF. CESD creates a scenario and deployment, together with technical equipment characteristics for a specific purpose and period of time. EMETF then uses this deployment, and empirical data from its laboratories, to determine the interference potential of a candidate system.

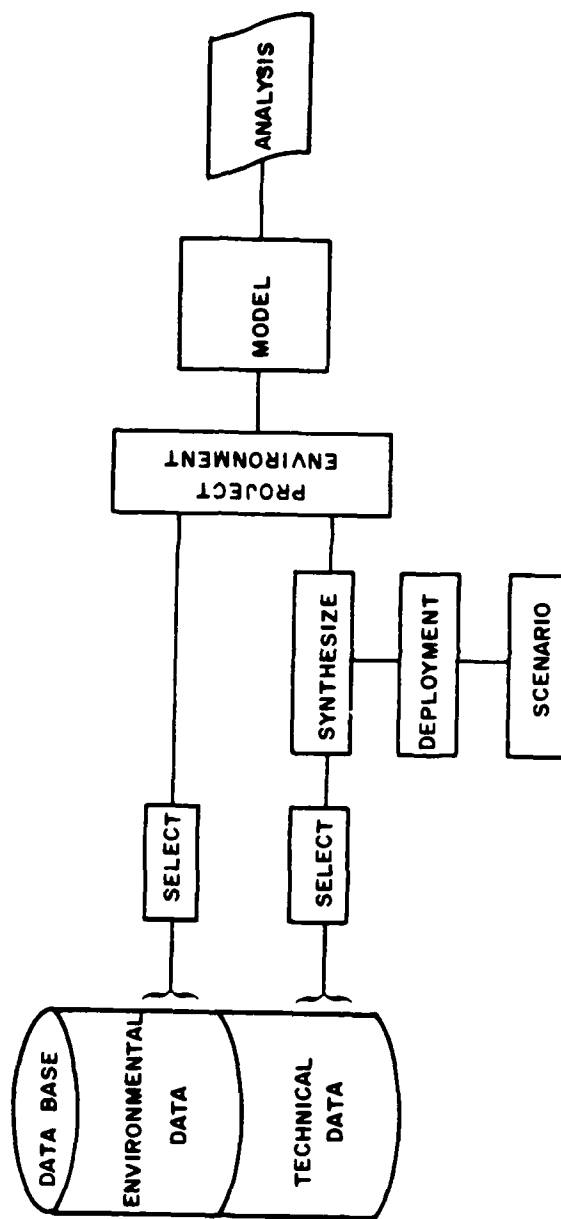


Figure 9. Alternate Methods of Generating EMC Environments

Neither approach appears to be the "best" way to create environments. However, it is the existence of two different approaches, and consequently two different testing environments, which tends to compound the problems involved in analyzing new equipments/systems.

The primary data base of the DoD for EMC data is ECAC. However, in discussion with members of the EMC community, the general feeling expressed was that ECAC's data were not accurate, current or complete. Consequently, environments created from the data base were also lacking for the same reasons.

The CESD/EMETF deployments are "two corps, field army with tactical air" in scope. Although this is generally regarded as too sterile, parochial and limited for joint or national evaluation (no Navy, no Marines, no civilians, no foreign, etc.), they could be of some assistance in forming the Army and tactical air portion of the J/12 EARG synthesized environment. This could reduce the task of the EARG in determining the type of environment in which the equipment will operate.

It would be possible to provide the CESD/EMETF test beds to ECAC, and make them available to program managers who are testing equipments against them. In this way, the data could reside in a central computing system, and be available to the EMC community. Results of tests would then be used by members of the J/12 engineering groups, and the process of re-creating environments would be considerably reduced.

Thus, it appears that a great deal of effort and resources are expended to produce environments which now have only limited distribution in the EMC community. Once this considerable effort has been accomplished, it would seem that the results should receive wider application.

REMOTE ACCESS

It has long been discussed by members of the EMC community that direct access into the ECAC data base should be permitted. This would accomplish two things: (1) by requiring that the originators of the data be responsible for the validity of the data, the data could be kept current on an aperiodic, but frequent, basis rather than waiting for specified update periods, and (2) the timely retrieval of data from the data base would be available when requirements did not permit long elapsed times to produced desired outputs. The technical feasibility of remote access data retrieval has already been demonstrated and is presently operational using the AUTODIN network between ECAC and the Defense Communications Agency (DCA).

As noted in Tasks F.4.2.3 and F.4.3.1 one of the major problems in assessing the impact of systems is the lack of accurate, current and complete data on the J/12 application form (Form 1494). This has forced limited analysis of systems in the past and, even though the forms have been recently re-designed for ease of use and reporting of only data pertinent to the allocation process, the deficiencies in data content as submitted by applicants continues to be a problem for the EARG review engineers.

The EMETF and the Communications/ADP Laboratory of CORADCOM have available to them at all stages of development very detailed information on the technical characteristics of developing Army equipments. However, the frequency allocation application does not travel the same administrative channels as the continuing technical appraisal of emerging systems.

If a method could be provided to the SESG and EARG which would permit them to access these technical characteristics directly from the Army Laboratories, more accurate, complete and current data on new Army C-E equipment and systems would be available for analysis.

Conversely, the exchange of data between ECAC and the Army Laboratories, would provide more accurate, complete and current data on new, non-Army C-E equipment and systems. This would enable Army engineers assessing the system to have current data on these new systems, and permit a more complete analysis of their impact on existing environments.

It is the opinion of this study group that remote access to the ECAC data bases should be provided to the Army EMC community. This would permit an exchange of data on existing and developing systems, and provide a more complete base of data on which to perform future EMC analyses.

SECTION 4
OBJECTIVE 3

STATEMENT OF OBJECTIVE (F.4.3)

To review the criteria and design guidelines that are used as the basis for the evaluation of Army Communications-Electronics Systems from the standpoint of spectrum allocation.

TASK F.4.3.1

Review all documents containing evaluation criteria and analysis guidelines that are used by the Army spectrum allocation community; obtain data on the background, originator and technical basis for each.

GENERAL

The major sources of data considered in all phases of this study were: (1) literature searches and, (2) command and agency visits. Appendix B lists the primary references reviewed during this study. These, and the briefings and handouts received during the various command and agency visits, provided the evaluation criteria and analysis guidelines considered in the review conducted under this Task.

Documents shown in Appendix B in general, and DA PAM 11-13 and DARCOM-P 706-410 in particular, provide the majority of analysis guidelines available to the Army materiel developer and spectrum allocation community. Evaluation criteria, on the other hand, are contained in national and international spectrum management rules and regulations, USMCCEB Memorandums, Military Standards, and miscellaneous specifications. A summary listing of these evaluation criteria, currently referenced during the J-12 review, is presented in Appendix H.

A separate volume has been compiled, with a separate Summary Sheet for each document containing evaluation criteria. These Summary Sheets contain the title, effective date, originator, coverage, technical basis and applicability of each document. This volume is being provided as supporting material at the completion of the study. It was also used in conjunction with Task F.4.3.3, which compares evaluation criteria with the state-of-the-art in each area.

The review conducted of the documents listed in Appendices B and H is discussed below.

Evaluation Criteria

The basic reference for the imposition of standards and specifications on materiel acquisition programs is DoD Directive 4120.3, the Defense Standardization and Specifications Program. It is the intent of this program to achieve economy and compatibility of U.S. Department of Defense materiel through commonality and standardization. In the program it is recognized that the blanket imposition of standards on every development would result in prohibitively expensive, time consuming programs. Accordingly, the program advocates the "tailoring" of specifications. In this way, materiel developments may attain the essential level of performance, reliability, ruggedness, etc., without being burdened with the requirement to meet idealistic specifications.

The Defense Standardization Program is implemented in the Army by AR 700-47, of the same title.

Following this tailoring concept (described in detail in Section 7 of DoD 4120.3M, The Defense Standards and Specifications Program Policies, Procedures and Instructions) materiel developers are able to call out such specific standards and specifications as they deem appropriate to the success of their project consistent with design objectives and resource availability. These may consist of applicable paragraphs of a Military Standard (Mil-Std), a complete Mil-Std, a standard or

specification of another agency, a unique specification drafted for a specific equipment, or any combination of the above. Used in this way, a universally recognized standard serves as a tool with which the developer conveys his qualitative desires without having to state them completely and in extensive detail.

The ultimate test of a materiel development is the performance of the equipment or system in its mission environment. To forecast this performance, in the case of C-E materiel, the spectrum allocation community employs the technique of reviewing Spectrum Allocation Applications (DD Form 1494) against certain standards, specifications, rules and regulations (Appendix H). Thus, documents originally referenced by the materiel developer as development or procurement criteria are later employed as evaluation criteria. On the surface, this appears to be a logical practice. In reality, however, its application suffers from certain deficiencies inherent in the present spectrum allocation to equipment process.

- No Common Reference. The materiel developer calls out, in his development contract or effort, those standards and specifications which he feels will assure the requisite performance qualities in his equipment or system within the schedule and resource limitations of his project. The spectrum allocation community, on the other hand, evaluates the spectrum allocation application against their own list of evaluation criteria. While in many cases these may stem from the same source documents, there is no feature of the system that assures that it will. Further, the allocation review has no knowledge of which paragraphs were called out by a developer when the specification was "tailored". As a result, the application is reviewed against all probable paragraphs of a standard or specification.

- Questionable Data. The spectrum allocation to equipment review is conducted on the data presented on the application (Form

DD-1494). Because many data values may be projected, calculated or estimated, particularly in the early (conceptual, experimental, and even developmental) stage applications, the ability of the review to accurately assess the characteristics of the candidate equipment is diminished. The materiel developer, meanwhile, may monitor the performance of his equipment against contractual specifications using actual test data. These test data seldom get reflected in the application form until the succeeding review stage.

- Lack of Appropriate Standards and Specifications. This deficiency may manifest itself by either a total lack of an appropriate standard against which in equipment's performance may be measured (e.g., spread spectrum, frequency agility), or by questionable values cited in a supposedly applicable standard or specification. Task F.4.3.3 addresses the comparison of evaluation criteria with the state-of-the-art in the respective technical areas. The results of that Task provide an assessment of the impact of this deficiency.

In summary, it may be said that the evaluation criteria used in the spectrum allocation to equipment process is applied:

- Without regard for the performance criteria against which the equipment is being developed,
- Against equipment characteristics data which may be invalid, and
- Using standard values which may be inappropriate or inadequate for the technology involved.

Analysis Guidelines

Although the document review conducted under this Task revealed sources of analysis guidelines, none were addressed to the spectrum allocation

community. As stated in General, above, DA PAM 11-13 and DARCOM-P 706-410 present guidelines regarding the analysis of C-E equipment during its life cycle. The only documents directed to the spectrum allocation community, addressing analyses to be performed during the review process, are USMCEB-M 565-78 (V) and the internal task plans covering the efforts of the Army R & D Spectrum Engineering Support Group and the J-12 Review Group (EARG) of the IIT Research Institute at ECAC. The extent of these analyses is discussed under SECTION 2, Task F.4.1.2. An evaluation of them is contained in Task F.4.1.3.

Chapters 4 and 5 of DA PAM 11-13 represent the most comprehensive analysis guidance available to the Army as a whole. These chapters have been extracted and appear as Appendices E and F, hereto.

A condensed version of Chapters 4 and 5 of DA PAM 11-13 appears in DARCOM-P 706-410, Engineering Handbook, Electromagnetic Compatibility. This serves to make this guidance more readily available to the Army research and development community but, again, provides no insight into the analysis techniques which may be employed by the spectrum allocation community.

To summarize, there are no authoritative analysis guidelines directed to the spectrum allocation community. Notwithstanding this, there are analysis guidelines available to, and used by, the spectrum allocation community. These are, generally, the analysis guidelines applicable to C-E materiel developers.

TASK F.4.3.2

Compile a listing of Army applications, covering the period 1970 to present, Frequency Panel/Military Communications-Electronics Board (FP/MCEB) on which waivers have been granted.

REVIEW

To accomplish this task, a review was conducted at the U.S. Military Communications-Electronics Board (USMCEB) of all DD Form 1494 applications submitted by the Army during the years 1970-1979. The following number of applications of concern to this study were found to have been approved by the Frequency Panel:

Number of Army Applications -	434
Number of Army Note-to-Holders -	76
Number of Joint Applications -	56
Number of Joint Note-to-Holders -	37

Of the applications reviewed, 271 failed to meet one or more of the required standards. The pie chart in Table 4 depicts the standards failed, and the percentage of the total number of deficient applications which they represent. Table 5 on the following page shows the actual number of failures per standard. A more complete breakdown of this data is given in Appendix I, Compilation of Deficient Applications (Standard vs. Year vs. Review Stage).

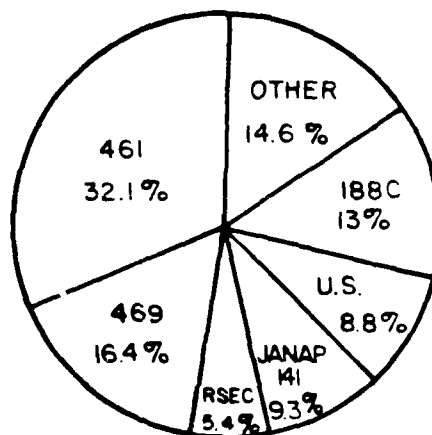


TABLE 4. Deficient Applications By Standard (Percentage)

AD-A086 406

HYDROTRONICS INC MCLEAN VA COMMUNICATIONS ENGINEERING DIV F/6 S/1
VALIDATION OF ARMY SPECTRUM ALLOCATION AND ANALYSIS PROCEDURES.--ETC(U)
1979 DAAK21-79-C-0011

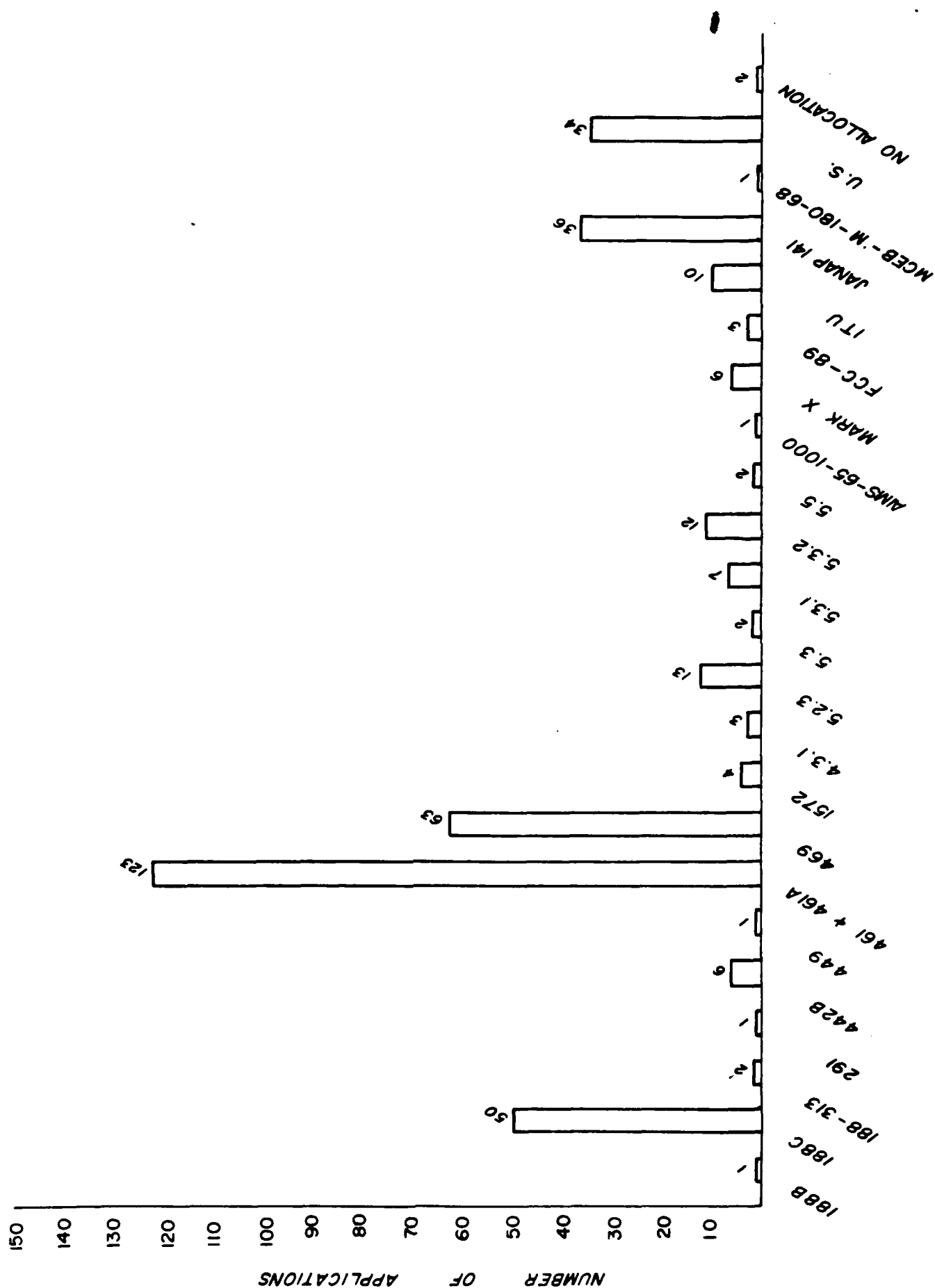
UNCLASSIFIED

2 of 2
AD-A
086 406

NL

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9-80
DTIC

TABLE 5. HISTOGRAM OF DEFICIENT APPLICATIONS BY STANDARD



There were found to be many reasons why applications failed the required standards. Table 6, Causes of Application Failure, depicts the data collected.

Special attention should be given to the fact that the primary causes of application failure were Harmonic and Spurious Attenuation, and Spurious Response. This was true, regardless of standard, when these criteria were applied to an application.

WAIVER LETTERS

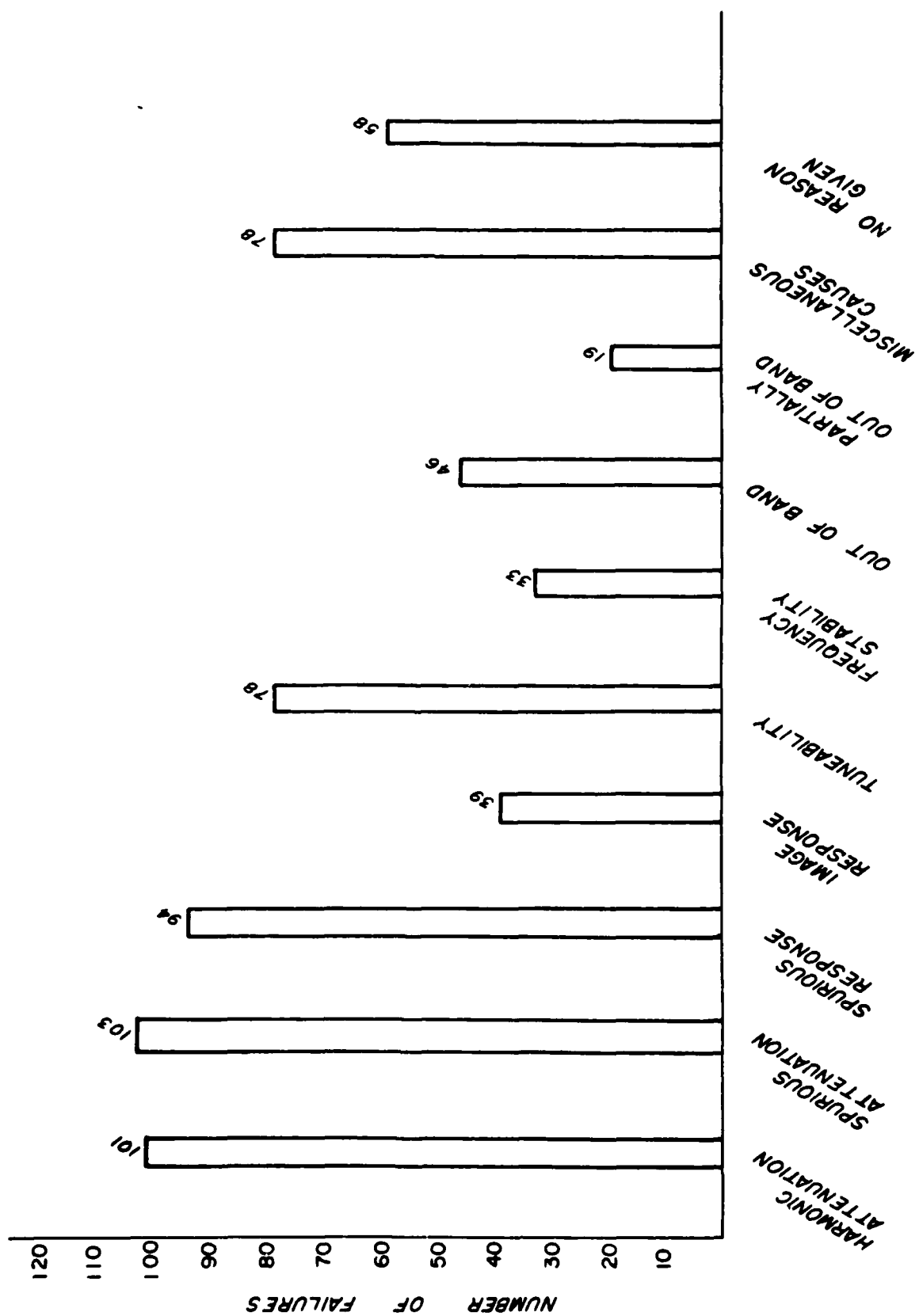
A review of Army waiver letters which have been issued since 1970 was conducted. The present office of record for these documents is the DoD Electromagnetic Compatibility Analysis Center (ECAC) in Annapolis, Maryland. However, this facility has only been maintaining this data since 1975, so many of the waiver letters were not available for review. In fact, even though applications are available from 1975 at ECAC, waiver letters exist only from September 1977. Consequently, only about two and one-half years issue of waivers could be examined.

There were a total of 242 Army and joint applications on file at ECAC at the time the review was conducted. Of these, 50 received waiver letters. An additional two applications were disapproved by the Army, even though the Joint Frequency Panel had approved them.

It should be noted that these letters only waived the requirement to meet MIL-STD-461 and 461A. Quite often, these same applications also failed to meet other standards. There was no record that the requirement to meet these other standards had been waived.

A re-visit to the ECAC files, just prior to completion of this study, revealed that Army has issued waiver letters in the latter half of 1979 for non-compliance with MIL-STD-469 and Chapter 5 of the NTIA Manual.

TABLE 6. CAUSES OF APPLICATION FAILURE



In all, there were 35 categories of deficiencies. Five categories, alone, accounted for two thirds of the deficiencies. These were:

- Harmonic Attenuation
- Spurious Attenuation
- Image Response
- Spurious Response
- Tuneability

The high incidence of failure in these categories raises the question of: (a) validity of the standard values, or (b) R & D Community attention to these design features. The validity of the standard values is addressed in Task F.4.3.3.

TASK F.4.3.3

Compare the criteria set forth in each document used for each analytical category (allocation applications, etc.) with the current state of the art in that technical area.

COMPARISON OF NATIONAL AND MILITARY STANDARDS

The following assessment is based upon empirical knowledge gained from Task F.4.3.2. It must be realized that the comparison of standards to allocations is accomplished with the data as reported on the allocation request. This data may not reflect actual equipment capabilities. The assessment was limited to the standards most often applied and the most common causes of application failure. Task 4.1.3 contains a description of each standard and the requirements contained therein.

NTIA 5.2.3. and MIL-STD-461A Notice 4 are both general purpose or catch-all standards. They apply where technical provisions have not been adopted for specific services. The military standard is more restricting than the national standard, and it has receiver requirements where 5.2.3. does not. Consequently, equipment allocations tend to meet 5.2.3. and fail Notice 4. A provision is contained in Notice 4 to relax the spurious emission limits by 20 dB for commercial off the shelf equipment. When this happens, the equipment tends to meet the standard.

Reviewing the Army's J-12 allocations for the past 20 months (ending May '79) revealed the following average failure values when the equipment usage came under the purview of MIL-STD-461A Notice 4:

<u>Parameter</u>	<u>Average Failure Value</u>
Harmonic Attenuation	19
Spurious Attenuation	17
Image Response	20
Spurious Response	26

MIL-STD-461A Notice 4 require non-airborne transmitters to have harmonics (less than the fourth) suppressed in accordance with equation 1 or 70 dB which ever is less.

$$40 + 10 \log P \text{ (watts peak) (dB)} \quad (1)$$

All other extraneous emissions must meet the requirement of equation 2 or 90 dB which ever is less.

$$80 + 10 \log P \text{ (watts peak) (dB)} \quad (2)$$

Transmitters with less than 0.1 watt of peak power are exempt from these requirements.

Spurious and harmonic signals from FCC Type Acceptance^a transmitting equipment must meet the requirement of equation 3 with 50 μ W as a minimum value (i.e. -43 dBW).

$$43 + 10 \log P \text{ (watts average) (dB)} \quad (3)$$

The ITU has a minimum value of 25 μ W (-46 DBW). Because the U.S. is an ITU signatory, it has an obligation to this lower ITU requirement. Although this lower value has not as yet been enforced, the FCC stated¹ that most of the systems tested are 3dBw or more below the -43dBw level and are, therefore, meeting the 25 μ W level. The national standard also employs equation 3 and the -43dBw value.

a. The FCC only performs a spot check for Type Acceptance equipment, but they can check any percentage of the equipment produced by a given manufacture. So, the FCC tests a higher percentage of the manufacturers who tend to not meet the standards.

1. Telephone conversation with Mr. Frank Rose of FCC, Research and Standards Division, August 1979.

However, the application of these criteria within the national standard is dependent upon frequency band and type of service of the equipment and is not as readily comparable to 461A Notice 4 as was the FCC usage.

These two requirements (equations 1 and 3) can only be compared when the average power is one-half the peak power. Under this condition, the equations are equivalent and such is the case for a sinusoidal wave. For frequency and phase modulation, the two equations are equivalent because the power relationship holds. For digital or pulsed emissions, the equations are equivalent when one considers the RF carrier within a pulse. For amplitude modulation, many factors have to be idealized or rationalized in order to make a general comparison between the equations. So, the two equations are similar or comparable. Therefore, if FCC Type Acceptance equipment can meet their standard, it appears that the Army equipment should meet the harmonic (less than the fourth) requirement of 461A Notice 4.

Of the allocations reviewed during the cited 20 month period, only two applications were noted as failing 461A Notice 4 for harmonic (greater than the third) and extraneous emission requirements while meeting the requirement for the lower harmonics. It is noted that this feature of having additional constraints on the higher order harmonics is advantageous. This action restricts the emission bandwidth and helps minimize the assigned frequency band of a station. This feature is helpful to frequency assigners and frequency managers.

Notice 4 relaxes the harmonic and spurious requirements by 20 dB for commercial off-the-shelf equipment. If the Army required only FCC Type Acceptance equipment for non-tactical purposes, it would not be necessary for the Army to make such a drastic reduction in their standard. The MCEB already permits FCC Type Acceptance equipment to be procured without going through the J-12 process if certain constraints are met. These constraints are contained in MCEB-M 549-78 "Joint Frequency Allocation For Non-Tactical/Intra-Base Radios" dated 11 September 1978. About half of the allocation requests reviewed during the 20 month period were for commercial off-the-shelf equipment.

Also, the FCC requires spurious attenuations to be down 80 dB in the radio broadcast service. Within the television broadcast service, this requirement is 60 dB, however Mr. Rose said that this could be improved.

Where receivers are concerned, the FCC generally only addresses conducted and oscillator radiation. But, in a few cases they do have image and spurious requirements. Auditory training devices, which operate within the 72-76 MHz range, have an image rejection requirement of 40 dB. This low value was selected to keep the equipment within monetary means (Part 15 of FCC Rules and Regulations and Mr. Rose). The marine rules (Part 83.715 FCC R & R) requires receivers in the bridge-to-bridge service to have spurious response attenuation of 85 dB for nonportable receivers and 50 dB for portable receivers. In addition, the Electronics Industries Association specification RS-204 requires that receivers in the land mobile service (being utilized within the 24-470 MHz frequency range) have a spurious rejection of 85 dB. If off the shelf receiver equipment could be classified into three grades: useable, good and high quality, then the spurious response rejection levels would be on the order of 40, 55 and 70 dB, respectively (Mr. Rose).

According to the above discussion, the 80 dB attenuation requirement of MIL-STD-461A for image and spurious rejection, appears to be inappropriate as an inflexible requirement for all types of communications receivers. Where equipment use requires high performance receivers (e.g. tactical, digital, etc.), the 80 dB value is justifiable. However, for other communication services the requirement should be lowered. Initially, the "TAILORING OF STANDARDS" process provides a convenient avenue to effect this change. Ultimately, however, this change should be provided by a revision or "NOTICE" to MIL-STD-461A, because it provides a common criteria that is available to all developers and project managers.

NTIA 5.3 (RSEC) and MIL-STD-469 are both radar standards and, again, the military standard experiences more failures than the national standard. The most common area of failure is tuneability. The tuneability requirement contained in MIL-STD-469 states:

"The frequency band of the radar shall be the band approved for the specific equipment by the Joint Frequency Panel, United States Military Communications Electronics Board and shall be specified in the contract. Radar systems shall be capable of being tuned over this approved band or a band of frequencies at least as great as 10 percent of the midband frequency. Radar systems may be continuously tunable, or have the capability to tune in discrete steps of no more than 2 percent of the operating frequency."

This tuneability requirement is met by satisfying either of the two criteria: tuning over a Frequency Panel approved band or tuning over a band of frequencies at least as great as 10 percent of the midband frequency. Because the allocation request is not yet approved when the EARG evaluates it, they cannot apply the "approved band" criteria. The problem arises when the tuning range of the equipment is less than the 10 percent value. In this case the EARG would fail the allocation request on the tuneability requirement; whereas, once the FP approves the allocation, the requirement is met provided it tunes across the frequency band. Consequently, more systems are failed on the tuneability requirement than should be.

The national standard expresses their tuneability requirement as either over the band allocated within the frequency tables or 10 percent of the midband frequency. There was no difficulty in applying this requirement.

As mentioned in Task F.4.1.3, neither the national standard (RSEC) or the Military Standard (469) is used to evaluate secondary surveillance radar (SSR) systems. This problem should be resolved at the earliest convenience.

NTIA 5.9 and MIL-STD-1572 have very similar requirements for telemetry equipment, and failures to these standards are not too common. The only areas of difference is that the military standard has receiver requirements and is only applicable to equipment used on test ranges. This test range restriction should be removed.

MIL-STD-188C has no national counterpart. The common failures are in the areas of frequency stability and tuneability. Since this standard utilizes MIL-STD-461A for transmitter spurious attenuation and receiver response requirements, failures to meet these requirements were considered under that standard.

The following list shows the last revision date of the military and national standards.

<u>Standard</u>	<u>Date of Last Revision</u>
MIL-STD-188C	24 Nov 1969
461A Notice 4	9 Feb 1971
469	30 Mar 1967
1572	Nov 1975
NTIA Section 5.2.3	Sept 1977
5.3	May 1978
5.9	Sept 1974

As can be seen, the national standards are more current than the military. Although the military standards are in the process of being revised, the new editions will lag behind some of the technology and techniques that are presently becoming popular. For example, the new 188 series for communications systems will not be applicable to spread spectrum techniques. Consequently, many of the tactical systems that are in the experimental or developmental stages and utilizing current technology may not come under the purview of any standard. This is especially true for systems that perform more than one function, which is a current trend. Also, ideas and techniques that previously only existed in technical papers are beginning to be realized with present

technology. The state of the art is also improving established methods by increasing performance, reliability and cost effectiveness. Standards should therefore be kept current so that new technology may alleviate the problem of a shrinking frequency spectrum and not aggravate it.

A minor difference, between the revision of a document and the military standards, was pointed up in equations 1 and 3:

- a. The frequency allocation application (DD Form 1494), which was revised in September 1978 (and the previous version), calls for power to be recorded in average or peak values depending on the type of emission.
- b. MIL-STD-461A Notice 4 requires peak power for evaluation.
- c. Average power is not easily convertible to peak values for all emission types (e.g. AM).
- d. Therefore, when a document is revised, consideration should be given to the impact of the revision upon other documents.

Task F.4.3.4

Determine the impact, with respect to spectrum allocation, of relaxing certain guidelines that are found as a result of Task F.4.3.2 and F.4.3.3 to be the cause of problems.

The results of Tasks F.4.3.2 and F.4.3.3 indicate that there is no need to relax most present guidelines. The major problems with the present guidelines are ambiguities in interpreting various statements, standards that have become outdated, no correlation between documents that must be used in conjunction with one another, and a lack of enforcing the standards.

In two specific categories of applicant equipment, however, the need to relax or revise present guidelines is indicated.

- Army non-tactical C-E equipment should only be required to meet the national standards or FCC type acceptance criteria. Tactical C-E equipment should continue to be required to meet applicable military standard requirements due to possible national survival and a safety of life factor for Army combat personnel in time of military conflict.

- There appears to be a need for requirements to permit short duration interference (2 minutes or less). Guided missiles (e.g., air to air, air to ground, and ground-to-air) and expendable transmitters (e.g., artillery launched transmitters) are examples of the types of equipment that fall into this category. Because of their expendable nature, it is not cost effective to require such equipment to meet stringent military standards. This reduction in requirements can be accomplished by the issuance of a new military standard or, more appropriately, by "NOTICE" to existing standards. Also, the "TAILORING OF STANDARDS" process is another method to achieve this goal; however, the former would provide a common reference criteria for all developers and project managers.

To aid the spectrum allocation process, the allocation application should contain any information regarding tailoring of standards and compatibility studies performed (at least by title and document number). This data would increase the efficiency of the review process by not applying portions of standards which the equipment has been exempted from meeting. The reviewers could critique any EMC studies that have been performed on the candidate equipment and use this information in place of, or in addition to, their EMC assessment.

SECTION 5

GENERAL COMMENT

Detailed conclusions and recommendations developed from the Tasks performed in this Study are presented in Volume I.

During the course of the Study, however, certain impressions were formed regarding the spectrum allocation to equipment process as a whole. These impressions are in general reference to:

- What it is, and what it isn't.
- What it does, and what it does not do.
- What it should be, and what it should not be.

The basis for these impressions is not how well each of the examined procedures function in isolation, as examined under each Task. Rather, it is how well they function when combined as a total process.

As stated in Volume II, under Task F.4.1.1, there have been a number of organizational changes within the Army in recent years. Many of these changes have impacted the Army spectrum management function. Official documentation covering the organization and functioning of the spectrum management activity has not been kept abreast of these changes. As a result:

- the Army is represented on various external spectrum management agencies by individuals drawn from several different commands and agencies,
- there is no common statement of policy or guidance available to these various representatives to ensure that they pursue common goals with a singular approach, and
- the spectrum allocation to equipment process is therefore highly individual-dependent.

While it is a tribute to the individuals involved that the process performs as well as it does, this situation is prone to weaken the Army's stature in the joint and national spectrum management arenas. More importantly, it does not serve to accomplish the gaining of spectrum allocations for qualified - and needed - C-E equipment in a time/cost effective manner.

Three basic measures need be taken to provide and foster a strong sense of central direction to the Army spectrum allocation to equipment effort.

- A basic statement of policy should be directed to all commands and agencies representing the Army externally in the process. A suggested statement is provided as Appendix J, hereto. While Appendix J may not represent the exact statement the Army Spectrum Manager chooses to issue, the important point is that such a statement is necessary.

- Official policy, procedure and assignment of responsibility, as covered by the various AR's, DA PAM's, etc., should be made current and should reflect the essence of the Army Spectrum Manager's policy. The titles of affected documents, and extent of change needed, are covered under Task F.4.1.1, herein.

- All individuals assigned to the various facets of the Army spectrum allocation to equipment process should be directed to follow the above centrally directed policy and procedures, and to convey their purpose and intent to the Army C-E community and to joint and national spectrum allocation application review agencies. In this regard, Army allocation applicants should be visited by a pre-application guidance team which would assist them in filing their application and in understanding the allocation review process. This would be a more useful expenditure of a portion of the support contracted from ECAC than at present.

Although the comments offered herein do not represent a panacea for all problems experienced in the spectrum allocation to equipment process, they are considered directly applicable to the fundamental problem of providing central direction to the process. This basic approach is felt to be simple, straight forward, effective, and necessary.

APPENDIX A

COMMANDS/AGENCIES VISITED

APPENDIX A
COMMANDS/AGENCIES VISITED

<u>COMMAND/AGENCY</u>	<u>CONTACT</u>	<u>SCHEDULED DATE</u>	<u>ACTUAL VISIT DATE</u>	<u>PURPOSE/REMARKS</u>
DAAC-ZS	A.W. Anderson P.J. Phillips	20 Dec 78	20 Dec 78	Initial Sponsor/COTR/Contractor Meeting
CORADCOM	S. Segner	10 Jan 78	10 Jan 78	Initial meeting, Army J-12 rep and contractor. Meeting held at Pentagon (DAAC-ZS). General J-12 process discussed.
DOD-ECAC	J.A. Zoellner Lt Col E. Mitchell R. Titus R. Lancaster	17 Jan 78	17 Jan 78	DAAC-ZS introduction of study to ECAC Deputy Director and Army Deputy Director, ECAC. Study concept discussed. Specific discussions re Army J-12 support held by R. Lancaster and contractor.
DOD-ECAC	R. Titus R. Larson W. Bunk	6 Feb 78	6 Feb 78	Follow-up discussions re Army allocation process held by R. Titus and contractor. Specific discussions re ECAC J-12 support effort/procedures held by Larson/Bunk and contractor.
NTIA	W. Gamble P. Roosa	8 Feb 78	8 Feb 78	Discussions re IRAC SPS procedures held by NTIA reps, P. Phillips and contractor
USACC (CC-OPS-CE)	Lt Col G. Wees E. Keefe	9 Feb 78	9 Feb 78	Discussions re ACC role in allocation process held by Lt Col Wees, E. Keefe and contractor reps.
MCEB Secretariat	Lt Col G. Lovelace	9 Feb 79	9 Feb 79	Discussions re MCEB Policy/procedures in J-12 process held by Lt Col. Lovelace,

<u>COMMAND/AGENCY</u>	<u>CONTACT</u>	<u>SCHEDULED DATE</u>	<u>ACTUAL VISIT DATE</u>	<u>PURPOSE/REMARKS</u>
CORADCOM	S. Segner	26-27 Feb 79	26-27 Feb 79	Follow-up discussions re DARCOM/CORADCOM role, activities and directives in J-12 process, NATO interoperability, systems integration, standards.
CESD	D. Jones	8 Mar 79	8 Mar 79	CESD role in allocation/analysis process. Scenario availability, capability and development.
DOD-ECAC	R. Lancaster W. Bunk	14 Mar 79	14 Mar 79	Follow-up meeting re data items used to support analyses and analysis techniques employed in allocation process.
NTIA	P. Roosa	2 Mar 79	2 Mar 79	Follow-up meeting re SPS analytical techniques and models.
J-12 WG	S. Segner	21 Mar 79	21 Mar 79	Observe J-12 Working Group, J/FP, USMCEB, in session (at ECAC, Annapolis, MD)
SPS	W. Gamble	29 Mar 79	29 Mar 79	Observe Spectrum Planning Subcommittee (SPS) in session.
TECOM	L. Doughty	13 Apr 79	13 Apr 79	Discuss TECOM role in C-E R&D and EMC analyses and to arrange EMETF visit
EMETF (Bell Tech.) Tucson, AR	R. McCluskey	3 May 79	3 May 79	Discuss EMETF role in Army Spectrum Allocation and analysis process
DoD-AFC Arizona Ft. Huachuca, AR	H. Berger	4 May 79	4 May 79	Discuss DoD-AFC views and participation in spectrum allocation process

<u>COMMAND/AGENCY</u>	<u>CONTACT</u>	<u>SCHEDULED DATE</u>	<u>ACTUAL VISIT DATE</u>	<u>PURPOSE/REMARKS</u>
COMM/ADP LAB, Ft. Monmouth NJ	P. Major	7 May 79	7 May 79	Determine CORADCOM capability for EMC design capability, EMC systems analysis and EM vulnerability analysis.
SOTAS PM Evans Area Ft. Monmouth, NJ	M. Shuhandler	8 May 79	8 May 79	Discuss Project Manager (PM) views and handling of spectrum allocation applications.
NAVELEX Crystal City, VA.	S. Caine	8 Jun 79	8 Jun 79	Discuss EMC/EMI Military Standard Coordination and approval procedures.
DARCOM	J. Bender	19 Jun 79	19 Jun 79	Discuss DARCOM role in spectrum allocation to equipment process and in providing direction to CORADCOM.
DOD-ECAC	B. Whitewhead R. Lancaster LTC L. Martin	6 Nov 79	6 Nov 79	Follow-up meeting to up-date study material and data.
DOD-ECAC	B. Whitehead	12 Nov 79	12 Nov 79	Update Army waiver letter statistics.

APPENDIX B

REFERENCES

APPENDIX B
REFERENCES

ASPR	Armed Services Procurement Regulation
AR 5-12	Army Management of the Electromagnetic Spectrum
AR 11-4	Army System Program Reviews
AR 15-18	Army Spectrum Management Steering Committee
AR 34-1	U.S. Participation in NATO Military Standardization Research, Development, Production and Logistic Support of Military Equipment
AR 70-4	Standardization Among Armies of U.S., U.K., Canada, Australia
AR 70-10	Test and Evaluation During Development and Acquisition of Materiel
AR 70-15	Product Improvement of Materiel
AR 70-16	Department of the Army System Coordinator (DASC) System
AR 70-17	System/Program/Project/Product Management
AR 70-41	Cooperation with Allies and Other Nations in R&D of Defense Equipment
AR 71-9	Materiel Objectives and Requirements
AR 105-16	Radio Frequency Allocations for Equipments Under Development, Production, and Procurement.
AR 105-24	Radio Frequency and Call Sign Assignments for U.S. Army C-E Activities
AR 105-64	U.S. Army Communications-Electronics Operation Instructions (CEOI) Program
AR 381-11	Threat Analysis
AR 700-47	Defense Standardization Program
AR 1000-1	Basic Policies for Systems Acquisition
DA PAM 11-13	Army Electromagnetic Compatibility Program Guide
DA PAM 11-25	Life Cycle Management Model for Army System
DA PAM 310-1	Index of Administrative Publications

DARCOM Pamphlet DARCOM-P 706-410	Engineering Handbook, Electromagnetic Compatibility
DoD Dir 3222.3	Department of Defense Electromagnetic Compatibility Program
DoD Dir 4120.3	Defense Standardization and Specification Program
DoD 4120.3 M	Defense Standardization Manual
DOD Dir 4650.1	Management and Use of the Radio Frequency Spectrum
DoD Dir 5100.35	Military Communications-Electronics Board(MCEB)
DoD Dir 5160.57	Electromagnetic Compatibility Analysis Center (ECAC)
ECAC CR 77-080	Annual Status Report, U.S. Army Allocations Project, Reporting Period April-September 1977
ECAC CR 78-107	Annual Status Report, U.S. Army Allocations Project, Reporting Period October 1977-October 1978
ECAC PP 012-1098	Project Plan, U.S. Army R & D Spectrum Engineering Support
ECAC PR 75-030	An Analysis of Army Frequency Allocation Procedures
ECAC PR 75-045	Development of Draft Integrated Electromagnetic (EM) Analysis and Testing Guide for Developers
ECAC PR 76-056	Draft Integrated Electromagnetic (EM) Analysis and Testing Guide for Developers
NTIA (OTP) MANUAL	Manual of Regulations and Procedures for Radio Frequency Management
OMB Circular No. A-11	Office of Management and Budget, Executive Office of the President, Circular No. A-11
OTP Circular No.11	Office of Telecommunications Policy, Executive Office of the President (Since Redesignated National Telecommunications and Information Administration (NTIA), Dept. of Commerce), Circular No. 11
USMCEB-M 565-78(V)	USMCEB Frequency Panel (FP), Permanent Working Group on Frequency Allocations for Telecommunications Equipments and Systems.

APPENDIX C

EXTRACTS OF KEY SPECTRUM SUPPORTABILITY DIRECTIVES

APPENDIX C
EXTRACTS OF KEY SPECTRUM SUPPORTABILITY DIRECTIVES

Office of Management and Budget (OMB), Executive Office of the President, Circular No. A-11.

"Section 11.5 (d):" Estimates for the development and procurement of major communications-electronics systems (including all systems employing satellite (space) techniques) will be submitted only after certification by the National Telecommunications and Information Administration, Department of Commerce that the space in the radio frequency spectrum required for such systems is available."

Office of Telecommunications Policy (OTP), Executive Office of the President, (Since redesignated National Telecommunications and Information Administration (NTIA), Circular No. 11.

Paragraph 3. "Policy: Executive Agencies will ensure that no funds are obligated for either the development or procurement of communications-electronics systems requiring the use of the frequency spectrum until the availability of appropriate spectrum support is assured. This policy does not apply to uses of the spectrum for basic research or experimentation wherein recognition or protection is not required."

Manual of Regulations and Procedures for Radio Frequency Management, National Telecommunications and Information Administration, Department of Commerce, Sections 8.2.5 and 8.3.1

"8.2.5 Withholding Funds Pending Availability of Frequency Support

The obligation of funds by Government agencies for the development of procurement of communication-electronic equipments, requiring the assignment and protection of radio frequencies for their use, should be withheld pending assurance of the availability of appropriate frequency assignment support. Requirements for obtaining frequency support for telecommunications systems or major modifications of an existing system are under Part 8.3. This includes the selection,

procurement, and development of earth or terrestrial station sites and facilities as indicated in Section 8.2.8. This is particularly important in the selection of sites and frequencies for earth and terrestrial stations to be operated in the coequally shared bands as indicated in Section 8.2.33 (see Sections 8.4.12 - 8.4.15). In addition, in the case of a Government-funded study, or a Government-funded equipment procurement, by non-Government interest, wherein the use of radio frequencies is foreseen as a result of the study or procurement, the Government agency concerned should, as far as practicable, apprise the contractor(s)/grantee(s) of the need for ensuring that radio frequency support appears feasible. In this regard, it may be necessary for the Government agency, the non-Government entity, or both, to coordinate with the FCC...."

8.3.1 General

Government agencies planning the use of, conducting experiments relating to, or developing and procuring telecommunications systems requiring the use of radio frequencies shall take all reasonable measures to ensure that such systems will neither cause nor receive harmful interference to or from other authorized users when placed in their intended operational environments. To assist Government agencies in meeting this responsibility and to support the OTP and the IRAC in the management of radio spectrum resources for the satisfaction of Government requirements, and in the national interest, these procedures provide for the review of new Government telecommunication systems and subsystems by the Spectrum Planning Subcommittee (SPS), at a number of the stages of their evolution prior to the assignment of frequencies. Such review will, as appropriate, require an examination of the existing systems in the frequency band(s) being considered. Full participation of the FCC in these procedures for the review of Government systems intended for operation in bands of mutual Government/non-Government interest occurs through the normal FCC liaison representation on the IRAC and its subcommittees. The matter of preparation and submission to OMB of budget estimates for Government systems is covered in Section 8.2.5."

Department of Defense Directive 4650.1, Management and Use of the
Radio Frequency Spectrum.

VI RESPONSIBILITIES

....H. DoD Components shall:

1. Obtain frequency guidance prior to assuming contractual obligations with respect to either the development or procurement of telecommunications equipment designed purposely to radiate or receive electromagnetic energy. Radio frequency guidance will also be obtained prior to assuming obligations for the selection, procurement, or development of earth or terrestrial stations sites and facilities which will be used to support telecommunications equipment. This guidance will be obtained from the MCEB or the Office of Telecommunications Policy, Executive Office of the President, in accordance with procedures issued by the MCEB."

Department of Defense Directive 5100.35, Military Communications-Electronics Board(MCEB).

"IV MISSION

Within the functions and responsibilities assigned herein, the mission of the MCEB is to:

....B. Provide Dod guidance and direction in those functional areas of military communications-electronics for which the MCEB is assigned responsibility....

VI FUNCTIONS AND RESPONSIBILITIES

....D. Allocate and coordinate the use of emission frequencies...."

USMCEB ORGANIZATION, MISSION AND FUNCTIONS MANUAL.

....Frequency Panel

....C. Functions.

.... 14. Provide radio frequency guidance to DoD components concerning the procurement and/or development of communications-electronics equipment designed purposely to radiate or receive electromagnetic energy."

USMCEB-M 565-78(V) of 20 September 1978; USMCEB FREQUENCY PANEL (FP), Permanent Working Group on FREQUENCY ALLOCATIONS FOR TELECOMMUNICATIONS EQUIPMENTS AND SYSTEMS (Terms of Reference).

".... 2. Radio frequency allocation requests shall be submitted to the USMCEB by the Military Departments and the National Security Agency, utilizing DD Form 1494. Other Department of Defense (DoD) Agencies will forward request to the USMCEB Military Secretary.

3. The USMCEB frequency panel will review the allocation requests and provide guidance for DoD components based on internal review, and recommendations or comments of the DoD electromagnetic Compatibility Analysis Center (ECAC)....

PURPOSE

7. The purpose of these terms of reference is to provide the USMCEB Frequency Panel J-12 Permanent Working Group on Frequency Allocations for Telecommunications Equipments and Systems with guidance and procedures."

ARMED SERVICES PROCUREMENT REGULATION, CONTRACT CLAUSES AND SOLICITATION PROVISIONS.

"7-104.61 Frequency Authorization. Any contract which calls for developing, producing, constructing, testing, or operating a device for which a radio frequency authorization is required shall contain the following provision:

FREQUENCY AUTHORIZATION (1966 OCT)

(a) Authorization of radio frequencies required in support of this contract shall be obtained through the Contracting Officer by the Contractor or subcontractor in need thereof. Frequency management procedures prescribed in the Schedule of this contract shall be followed in obtaining radio frequency authorization.

(b) For any experimental, developmental or operational equipment for which the appropriate frequency allocation has not been made, the Contractor or subcontractor shall provide the technical operating characteristics of the proposed electromagnetic radiating device to the Contracting Officer during the initial planning, experimental, or developmental phases of contractual performance. DD Form 1494, "Application for Frequency Allocation," shall be used for this purpose and shall be prepared in accordance with instructions contained on the form.

(c) This clause including this paragraph (c), shall be included in all subcontracts which call for developing, producing, testing, or operating a device for which a radio frequency authorization is required."

ARMY REGULATION 5-12, ARMY MANAGEMENT OF THE ELECTROMAGNETIC SPECTRUM

"1-4. Policy....

b....(4) Funds for the research, development, production, purchase, lease, or use of spectrum dependent materiel will not be released by the obligating authority until spectrum supportability has been established in accordance with this regulation.

(5) Army materiel which is either dependent or impacts on the use of the electromagnetic spectrum will be introduced in the Army only after the results of appropriate EMC analyses have demonstrated the compatibility of the proposed materiel with the coexisting electromagnetic environment.

(6) Compliance with the ITU Radio Regulations, the OTP Manual of Regulations and Procedures for Radio Frequency Management, DoD spectrum management directives, and all applicable spectrum management military standards and specifications is mandatory unless specifically waived by HQDA.

c. Authorization for use of the spectrum within the United States and possessions will be obtained by HQDA through the Interdepartment Radio Advisory Committee of the Office of Telecommunications Policy, Executive Office of the President. Unified commanders will obtain authorizations for Army use of the spectrum in foreign countries from the host government in accordance with applicable agreements. Frequency assignments will be made only in accordance with the conditions set forth in approved RF allocations to equipment (AR 105-16) except for those equipments for which a RF allocation is not required...."

ARMY REGULATION 105-16, RADIO FREQUENCY ALLOCATIONS FOR EQUIPMENTS
UNDER DEVELOPMENT, PRODUCTION, AND PROCUREMENT.

CHAPTER I, GENERAL

"1-1. Purpose. To prescribe policies, establish procedures, and define responsibilities to insure that communications-electronics equipment considered for development, purchase, lease or use by the Army, will, prior to the obligation of Government funds, comply with the constraints of international, national, and military regulations governing the use of the electromagnetic spectrum.

1-2. General. a. This regulation establishes the procedures for obtaining a radio frequency (RF) allocation for equipments or systems using the electromagnetic spectrum. Obtaining an RF allocation will assure the restrictions, agreements and appropriate Military Standards regarding the use of the electromagnetic spectrum can be satisfied when the equipment is operated in its intended environment.

b. Equipments except as stated in paragraph 1-8 below for which no RF allocation has been granted, or which have not received an appropriate waiver will not be authorized frequency assignments (see AR 105-24)...."

....1-7. Policies. a. General. Funds for the development, purchase, lease, or use of equipment, or systems the operation of which is dependent upon the use of the radio frequency spectrum, will not be released to the contracting officer until DA (Deputy Chief of Staff for Operations and Plans) has formally approved an RF allocation for such equipment or system.

b. RF allocation requirement. All items of equipment affecting the radio frequency spectrum require an RF allocation unless specifically exempted by paragraph 1-8 of this regulation. An RF allocation is required for configurations formed by the addition of substitution of devices to previously approved equipment or systems

when such additions or substitutions modify the RF technical parameters. (Examples of such devices include multiplexers, separate modulators and amplifiers, and security equipment.)"

ARMY REGULATION 105-24, RADIO FREQUENCY AND CALL SIGN ASSIGNMENTS FOR U.S. ARMY COMMUNICATIONS-ELECTRONICS ACTIVITIES.

CHAPTER 2, REQUIREMENTS FOR APPLICATION

"2-1. Preliminary requirements. a. Withholding funds pending availability of frequency support (AR 11-13). Funds will not be expended for the development, purchase, production or lease of C-E equipment which will require radio frequency spectrum use to perform its intended function until the Department of the Army (Office, Deputy Chief of Staff for Operations and Plans, DAMO-TCF), has formally indicated that an application for a frequency allocation for this equipment, submitted in accordance with AR 105-16, has been received and that the equipment has a suitable frequency allocation.

b. Frequency allocation for equipment (AR 105-16). Applications for radio frequency assignment normally will not be processed until information on the equipment and its frequency allocation status is known. AR 11-13 and AR 105-16 prescribe requirements for submission of information for radio frequency allocations for Army electronic equipment prior to experimentation, development, production, service testing, procurement through military services or the direct procurement or lease (off the shelf) from commercial suppliers....

....e. Tactical and training frequency requirements. Frequencies will not be assigned for tactical and training operations unless the equipment to be used has undergone the frequency allocation process."

APPENDIX D

ABBREVIATIONS

APPENDIX D ABBREVIATIONS

ACSI-Assistant Chief of Staff for Intelligence	DEPSECDEF-Deputy Secretary of Defense
AD-Advanced Development	DEVA-Development Acceptance
ADP-Automatic Data Processing	DOD-Department of Defense
ADPE-Automatic Data Processing Equipment	DODD-Department of Defense Directive
AOP-Additive Operational Project	DODI-Department of Defense Instruction
AMDF-Army Master Data File	DP-Development Plan
AMIS-Army Management Information Systems	DPM-Defense Program Memorandum
AMMH-Annual Maintenance Manhours	DS-Direct Support
APE-Advanced Production Engineering	DSA-Defense Supply Agency
APM-Army Program Memorandum	DSARC-Defense System Acquisition Review Council
APP-Army Procurement Procedures	DT-Development Testing
AR-Army Regulation	DT(I,II,III)-Development Test(I,II,III)
ARTEP-Army Training Evaluation Program	DTACCS-Director, Telecommunications and Command Control System
ASA-Army Strategic Appraisal	DTC-Design to Cost
ASARC-Army Systems Acquisition Review Council	ECCM-Electromagnetic Spectrum, Electronic Counter-Counter Measures
ASPR-Armed Services Procurement Regulation	ED-Engineering Development
ATP-Army Training Program	EDT-Engineer Design Testing
ATT-Army Training Test	EW-Electronic Warfare
BCE-Baseline Cost Estimate	FDTE-Force Development Testing and Experimentation
BOI-Basis of Issue	FM-Field Manual
BOIP-Basis of Issue Plan	FYTP-Five Year Test Program
BTA-Best Technical Approach	GFE-Government Furnished Equipment
CAA-Concepts Analysis Agency	GS-General Support
CAIG-Cost Analysis Improvement Group	HQDA-Headquarters, Department of the Army
CCE-Commercial Construction Equipment	ICP-Inventory Control Point
CF-Concept Feasibility	IE-Independent Evaluations
CFP-Concept Formulation Package	IEP-Independent Evaluation Plan
COA-Comptroller of the Army	IER-Independent Evaluation Report
COEA-Cost and Operational Effectiveness Analysis	IPCE-Independent Parametric Cost Estimation
CM-Configuration Management	IPF-Initial Production Facilities
CONOPS-Continuity of Operations	IPP-Industrial Preparedness Planning
CONUS-Continental United States	IPPL-Industrial Preparedness Planning
CSA-Chief of Staff, US Army List	
CTA-Common Table of Allowance	IPR-In-Process Review
CTP-Coordinated Test Program	JTA-Joint Table of Allowances
DA-Department of the Army	LCSMM-Life Cycle System Management Mode
D and F-Determination and Finding	LEA-Logistics Evaluation Agency
DCP-Decision Coordinating Paper	LIN-Line Item Number
DCS-Defense Communications System	LOA-Letter of Agreement
DCSLOG-Deputy Chief of Staff for Logistics	LR-Letter Requirementment
DCSOPS-Deputy Chief of Staff for Operations and Plans	LRIP-Low-Rate Initial Production
DCSPER-Deputy Chief of Staff for Personnel	LSP-Logistic Support Plan
DCSRDA-Deputy Chief of Staff for Research, Process Development, and Acquisition	MACRIT-Manpower Authorization Criteria
DDRE-Director of Defense Research and Engineering	MADP-Materiel Acquisition Decision
	MILPERCEN-Military Personnel Center
	MTT-Manufacturing Methods and Technology
	MOS-Military Occupation Speciality

MSO-Materiel Status Office	SIGINT-Signal Intelligence
MTOE-Modification Table of Organization and Equipment	SIGSEC-Signal Security
NET-New Equipment Training	SPEF-Single Program Element Funding
NSN-National Stock Number	SPF-Single Project Funding
OASD(I&L)-Office, Assistant Secretary of Defense (Installations and Logistics)	SSG-Special Study Group
OCO-Operational Capability Objective	STF-Special Task Force
ODP-Outline Development Plan	TAADS-The Army Authorization Document System
OSA-Office, Secretary of the Army	TAG-The Adjutant General
OSD-Office, Secretary of Defense	TAGO-The Adjutant General's Office
OT-Operational Testing	TAMMSO-The Army Maintenance Management System
OT-(I,II,III)-Operational Test(I,II,III)	TC-Type Classification
OTE-Operational Test and Evaluation	TDR-Training Device Requirement
OTEA-US Army Operational Test and Evaluation Agency	TDA-Table of Distribution and Allowances
OTP-Outline Test Plan	TIG-The Inspector General and Auditor General
PEP-Producibility Engineering and Planning	TM-Technical Manual
PIP-Product Improvement Proposal	TMDE-Test Measurement and Diagnostic Equipment
POM-Program Objective Memorandum	TMOS-Tentative Military Occupation Speciality
PQPRI-Provisional Qualitative and Quantitative Personnel Requirements Information	TOA-Trade-off Analysis
PV-Production Validation	TOD-Trade-off Determination
QQPRI-Qualitative and Quantitative Personnel Requirements Information	TOE-Table of Organization and Equipment
RAM-Reliability, Availability, Maintainability	TRADOC-US Army Training and Doctrine Command
RDTE-Research, Development, Test and Evaluation	USAFORSCOM-US Army Forces Command
RFP-Request for Proposal	USAMC-United States Army Materiel Command
ROC-Required Operational Capability	USATRADOC-United States Army Training and Doctrine Command
SA-Secretary of Army	VAL-Validation
SACS-Structure and Composition System	VCSA-Vice Chief of Staff Army
SECDEF-Secretary of Defense	WBS-Work Breakdown Structure
SEMP-System Engineering Management Planning	

APENDIX E

EXTRACT, CHAPTER 4, DA PAM 11-13

APPENDIX E

CHAPTER 4

CRITICAL EMC DECISIONS AND ACTIONS DURING THE SYSTEM ACQUISITION PROCESS

4-1. Introduction. a. Chapter Content. This chapter presents major action requirements and program milestones in the Life Cycle System Management Model (LCSMM); the associated critical EMC decisions and actions; and the relation of EMC decisions and actions to documentation, milestones, and EM guidance categories. Also, since the checklists provided in AR 15-14 for ASARC reviews or IPRs are more general than is needed for program reviews of C-E equipment or systems, EMC checklists are provided for each major milestone review.

b. Technical Characteristics Factors. Spectrum conservation and operating flexibility are of prime importance in the successful implementation of the Army Electromagnetic Compatibility Program. The factors listed below should be addressed in the selection of equipment technical characteristics in the conceptual, validation, and full-scale development phases. All have a bearing on the EMC decisions made during the system acquisition process:

- (1) The electromagnetic spectrum must be utilized in an efficient and economical manner.
- (2) The extent of frequency support available in the eventual operating areas must be considered.
- (3) Operational flexibility must be provided in order to minimize EMC problems resulting from congested or hostile electromagnetic environments.
- (4) The EMC impact on the equipments/systems of friendly forces must be considered in the selection of ECCM techniques to be employed with a given equipment/system.

4-2. EM Flow Charts. Fold-out flow charts, figures C-1 and C-2, illustrate the manner in which the combat developer and the materiel developer should give appropriate consideration to EMC during the systems acquisition process. These flow charts also are applicable to non-EMC technical considerations of concern

to the developer, even for non-C-E systems. These flow charts track with the narrative discussion of the LCSMM phases and EM decisions and actions in paragraphs 4-3 and 4-4. Figure C-1 is a flow chart of the LCSMM for major systems that relates the EMC decisions and actions to the LCSMM milestones, principal documents, and decision reviews. Numbered circles represent the EM decisions and actions; rectangular boxes indicate the principal documents produced during the LCSMM; and diamonds indicate the decision review milestones for the Army Systems Acquisition Review Council (ASARC) and the Defense Systems Acquisition Review Council (DSARC). Figure C-2 is a similar diagram for nonmajor systems, where decision reviews are in-process reviews (IPR).

4-3. EMC Decisions/Actions and Frequency Supportability. The discussion of major EMC decisions/actions of the LCSMM which follows considers each LCSS phase in chronological order. Distinctions between major and nonmajor systems are made where important differences exist. However, before the LCSMM, which starts with ROC approval, there is a development and testing of feasibility models. During this early stage there is some preliminary selection of equipment technical characteristics and an assessment of potential mission performance. Also, at this early stage frequency supportability should be investigated and evaluated. During these pre-LCSMM feasibility evaluations, tuning methodology or channelization techniques and frequency separation criteria need to be studied and the potential operational frequency problems in various host countries need to be considered. Frequency supportability problems must be studied and resolved on a continuing basis by the developer throughout the LCSMM. This necessitates continuing informal and formal contacts with agencies that possess and can evaluate frequency allocation data bases. Preparation of DD Form 1494 in connection with frequency

allocation requests require particularly sound developer inputs and evaluation for adequate frequency supportability problem resolution. A frequency allocation based on one geographic area may result in operating frequencies that cannot be used in other geographic areas, and thus the system cannot be operated in these other geographic areas.

4-4. EMC Decisions/Actions During the LCSMM Phases. *a. Conceptual Phase.*

(1) The conceptual phase of the LCSMM begins with approval of a Required Operational Capability (ROC) by Headquarters, Department of the Army (AR 15-14, AR 71-1).

(2) For all tactical command, control, and communications equipments, DOD Directive 4630.5 requires that DA coordinate the requirement (ROC) with the other services and provide a record of this coordination to the Joint Chiefs of Staff (JCS).

(3) In the case of major programs, the principal action required during the conceptual phase is the preparation of a Development Concept Paper (DCP), if the program requires Office, Secretary of Defense (OSD) approval, or otherwise a Program Memorandum (PM) (AR 15-14). The DCP or PM, prepared by a special task force convened at the direction of the Chief of Staff, must define mission profiles and bands of performance and identify critical issues associated with EM areas. The DCP or PM is used as the basis for ASARC-I (and DSARC-I if required) which terminates the conceptual phase of the LCSMM for major systems. ASARC-I is the milestone I Army Systems Acquisition Review Council (ASARC) review; DSARC-I similarly is the milestone I Defense Systems Acquisition Review Council (DSARC) review.

(4) For nonmajor systems the principal action required is preparation of the Development Plan (DP) by the materiel developer, to include system and subsystem characteristics and a specific paragraph on EMC considerations which require quantitative statements of EMC requirements and plans for achieving these requirements (AR 70-27). These actions occur later in the LCSMM for major systems. The conceptual phase for nonmajor systems terminates with the Feasibility IPR.

(5) The major milestones in the conceptual phase for C-E equipments which are designed to use the electromagnetic spectrum are preliminary selection of the frequency band, in-

cluding frequency supportability consideration; type of modulation, channelization; and other principal characteristics of the system; and submission of an application for an experimental radio frequency (RF) spectrum allocation. This application must contain sufficient developer-originated data to enable an evaluation of frequency supportability to be performed in the application review. These actions are required for evaluation of EMC feasibility at the IPR, ASARC, or DSARC review and to satisfy DOD Directive 4630.5 on compatibility and commonality of equipment. An EMC checklist for these reviews of C-E equipment or system development is provided in paragraph 4-6.

(6) For non-C-E systems and C-E systems which are not designed to utilize the radio frequency spectrum, a determination of system technical characteristics is required to a level of detail adequate to permit evaluation of potential unintentional receptor susceptibility or unintentional radiation interference.

(7) Thus, in the conceptual phase, there are two critical EM decisions/actions:

1. *Select preliminary equipment characteristics and ascertain frequency supportability.*

2. *Apply for experimental RF spectrum allocation.*

b. Validation Phase.

(1) The validation phase begins for major programs after ASARC-I approval to begin prototype development; for nonmajor systems after the Feasibility IPR.

(2) Principal activities during this phase include completion of the development plan (DP) (if major system), prototype development, first development test (DT-I), the initial operational test (OT-I), and the Validation IPR (nonmajor systems) or ASARC-II (major systems).

(3) Major milestones include award of the prototype development contract; preparation, coordination, and approval of test plans for DT-I and OT-I; review of test reports; and ASARC/DSARC review (IPR for nonmajor systems) of the prototype development program to determine whether to proceed with full-scale engineering development. A checklist for these reviews of C-E equipment or system development is provided in paragraph 4-7.

(4) EMC considerations or actions during the validation phase include preparing the EMC-related portion of the equipment performance specifications for the prototype equipments, developing plans for the EMC portion of

development and operational tests, reviewing results of EMC testing as part of DT-I and OT-I, and verifying that potential EMC problems have been averted or can be expected to be resolved during engineering development. Prior to ASARC-II/DSARC-II the application for a developmental frequency allocation must be made. This and all subsequent applications must include new FS data if change in the previous approved frequency allocation is contemplated. Thus, three critical EMC decisions/actions are required in the validation phase:

3. *Determine prototype equipment specifications.*

4. *Verify prototype equipment performance.*

5. *Apply for developmental RF spectrum allocation.*

c. Full-Scale Development Phase.

(1) The full-scale development phase begins after an ASARC-II/DSARC-II or Validation IPR decision to enter into full-scale development.

(2) Principal activities in this phase are the engineering development of the system or equipment, development testing (DT-II), Operational Testing (OT-II) and, for major systems/programs, ASARC-IIa/DSARC-IIa, for nonmajor systems, Development Acceptance IPR, low-rate initial production (IP), development testing (DT-III), operational testing (OT-III), and finally production approval by ASARC-III/DSARC-III or a Production Validation IPR.

(3) Major milestones include award of the engineering development contract, approval of test plans for DT-II and OT-II, review of test reports for DT-II and OT-II, approval for initial production by ASARC-IIa/DSARC-IIa or Development Acceptance IPR, award of IP contract, approval of test plans for DT-III and OT-III, review of DT-III and OT-III test reports, and approval for full-scale production in ASARC-III/DSARC-III or Production Validation IPR. A checklist for these reviews of C-E equipment or system development is provided in paragraph 4-7.

(4) EMC considerations and actions include preparing EMC portions of equipment development specifications, preparing EMC portions of test plans for DT-II and OT-II, reviewing EMC test results, verifying that EMC performance of developmental equipment is satisfactory, preparing EMC portions of equipment specifications for initial production, preparing EMC test requirements for DT-III and OT-III, re-

viewing DT-III and OT-III test results, and verifying that the system or equipment is ready for production from an EMC viewpoint.

(5) During the initial production (IP) phase of the program, applications must be made for operational RF spectrum allocations based on previously ascertained FS data. Prior to DSARC-III which authorizes full-scale production, DA approval of organization-equipment authorization documents and training material including tables of organization and equipment (TOE), TM, and FM is required in order to provide time for publication and use prior to introduction of the equipment to the field.

(6) Application for frequency assignments, also keyed to current inputs on FS feasibility, should be made immediately after ASARC-III/DSARC-III or the production validation IPR.

(7) Thus, there are seven critical EMC decisions/actions in the full-scale development phase of the LCSMM, the first three occurring before ASARC-IIa/DSARC-IIa for major systems:

6. *Determine developmental equipment specifications.*

7. *Verify developmental equipment performance.*

8. *Apply for operational RF spectrum allocations.*

9. *Determine IP equipment specifications.*

10. *Approve TOE and training material.*

11. *Verify IP equipment performance.*

12. *Apply for frequency assignments.*

d. Production and Deployment Phase.

(1) The production and deployment phase of the LCSMM begins after ASARC-III/DSARC-III or Production Validation IPR decision to enter into full-scale production.

(2) Principal activities in this phase include the production of the system or equipment; publication of field manuals, technical manuals, tables of organization and equipment; resident training; introduction of the system or equipment into the field; unit training; operational use of the system or equipment; and finally disposal.

(3) Major milestones include award of the production contract, publication of FM, TM, and TOE, achieving initial operational capability (IOC), identifying a requirement for a new or revised system or equipment, and finally replacement or disposal. A checklist for these

views of C-E equipment or system development is provided in paragraph 4-7.

(4) EMC considerations and actions include preparing EM portions of the production equipment specifications and verifying performance by review of operational performance reports and reports of interference or electronic warfare (meaconing, intrusion, jamming, interference: MIJI). Performance verification includes modification of operational procedures or frequency assignments (as approved) in accordance with field conditions.

(5) The following are the critical EMC decisions/actions in the production and deployment phase of the LCSMM:

13. Establish production equipment specifications.

14. Verify operational equipment performance.

c. Summary.

(1) Of the fourteen critical EMC decisions/actions identified in this chapter, it is clear that all of them apply to both C-E and non-C-E equipment, with the exception of those concerned with radio frequency spectrum allocation and frequency assignment.

(2) Timing of the decisions and actions has not been precisely fixed; in fact, the timing will vary and must be established as a part of the development plan. In table 4-1, EM decisions and actions are shown in general time sequence with the major milestones of the LCSMM. The actual timing of milestones may be related only in a minor manner to EM considerations for a non-C-E system. Thus, in the conceptual phase selection of preliminary equipment characteristics is made on the basis of performance requirements stated in the ROC, and must be made prior to the determination of feasibility in ASARC-I/DSARC-I or the Feasibility IPR. EM decisions on equipment specifications must be made prior to award of prototype, development, initial production or production contract bid solicitation. Obtaining FS supporting data for experimental, developmental, and operational RF spectrum allocations must be obtained early enough to permit timely applications, planning for tests, and to be considered as a factor in equipment parameter selection. Verification of equipment performance in the validation, full-scale development and production and deployment phases of the LCSMM depends upon DT and OT test results and must be accomplished prior to ASARC or IPR action.

4-5. Relation of EMC Decisions and Actions to Documentation, Milestones, and EMC Guidance Categories. This section emphasizes the EMC-related factors that affect LCSMM decisions and actions. The developer's primary framework for reaching the required decisions and actions is the overall system application, in which C-E functions may have only supporting roles. A detailed description is presented of the nature of each critical EMC decision or action and of the relation of these decisions or actions to the major milestones of the LCSMM and to the EMC guidance categories. Each EMC decision or action is discussed in the order in which it occurs during the LCSMM. Distinctions between major and nonmajor systems are made clear at each step in the discussion. Reference is made as appropriate to regulations described in appendix A, to materiel development documents described in appendix B, and to EMC guidance categories defined and described in chapter 5. The EMC guidance categories include the input information that may be required as the basis for EMC decisions/actions. A tabular summary relating the EMC decisions/actions and guidance categories is presented at the end of this section.

a. Select Preliminary Equipment Characteristics and Ascertain Frequency Supportability. Following approval of the ROC (AR 15-14) which contains a brief statement of the performance characteristics and operational employment concepts for the proposed system or equipment, the materiel developer must further define equipment characteristics and FS factors at a level of detail sufficient to permit preliminary evaluation of feasibility. In this step he will normally require the input information included in EMC guidance categories 1-6, 8, and 11 (para 5-2b):

1. C-E system feasibility and performance requirements.
2. Command and organizational principles.
3. System operational factors.
4. Economic assessment.
5. Electromagnetic environment evaluation.
6. Natural environment evaluation.
8. Equipment and performance characteristics.
11. Measures of system effectiveness.

The equipment characteristics defined in the conceptual phase of the LCSMM will normally

be specified as upper and lower bounds of various parameters, and distinctions will be made between required and desired characteristics. For a communications equipment, for example, upper and lower bounds might be provided for tuning range, bandwidths, and antenna gain. For the contemplated BOI, the tuning range will be closely related to frequency supportability of the system.

(1) For major systems (table 4-1) selection of preliminary equipment characteristics and assessment of FS is made by the materiel developer and is provided to the special task force (AR 1000-1 and AR 15-14) which prepares the DCP or PM depending upon whether the system has been designated for Office, Secretary of Defense (OSD) review or only DA review. The equipment characteristics are utilized in the preparation of the CFP to assess feasibility, are summarized in section IV of the DCP, and become a part of the DP when it is prepared after ASARC-I and DSARC-I.

(2) For nonmajor systems (table 4-2) the preliminary equipment characteristics and FS assessment are prepared by the materiel developer and become a part of section II of the DP (AR 70-27). Characteristics are required by the combat developer as well as the materiel developer for preparing the concept formulation package (CFP), preliminary qualitative and quantitative personnel requirements information (PQQPRI), and tentative basis of issue plan (BOIP I).

(3) For both major and nonmajor systems the preliminary equipment characteristics of C-E systems and assessment of frequency supportability are an essential input to the developer in his preparation of the application for an experimental RF allocation.

(4) In addition these characteristics form the basis for the evaluation of EMC feasibility required for major systems in ASARC-I (AR 15-14 provides a checklist) or the Feasibility IPR (DA Pam 11-25) for nonmajor systems.

b. Application for Experimental RF Allocation. During the conceptual phase the materiel developer must make application for an experimental RF allocation for C-E equipment or systems which radiate EMC energy and which fall within the purview of AR 105-16. The experimental allocation application is required this early in the cycle because of the review process specified in DODD 8222.3 and AR 105-16 and the need to have spectrum allocation approval prior to initiation of prototype devel-

opment (AR 11-18). The combat developer, during ROC preparation, and the materiel developer in preparing the application for experimental RF application must obtain informal but thoroughly supportable assessments of the FS available for the system.

(1) The developer is required to complete DD Form 1494 in accordance with AR 105-16 and DA Pam 105-2. He will normally require information included in EMC guidance categories 1, 3, 5, 6, 8, 10, and 12 (para 5-2b):

1. *C-E system feasibility and performance requirements*

3. *System operational factors*

5. *Electromagnetic environment evaluation*

6. *Natural environment evaluation*

8. *Equipment and performance characteristics*

10. *Spectrum signatures*

12. *Site survey and selection*

At this point, the materiel developer has defined preliminary equipment characteristics and made a FS assessment which provide bounds on equipment parameters. He can avail himself of informal coordination in proposing selection of a frequency band and determining overall FS prospects by contacting the Office of the Army Frequency Manager, Telecommunications and Command and Control Directorate, DCSOPS. He is not required at this stage to have the precisely defined equipment characteristics listed in DD Form 1494, but must indicate the frequency band, approximate upper and lower frequency bounds, and approximate types and values of other equipment characteristics such as antenna gain, modulation, channelization, and tuning range. The materiel developer may make his own analysis of EM considerations to support his selection of a frequency band or may seek analytic support from one of the agencies described in chapter 7.

(2) For both major and nonmajor systems the application for experimental RF spectrum allocation is prepared by the materiel developer and forwarded to DCSOPS* (AR 105-16 and DA Pam 105-2). DCSOPS* reviews the application and upon approval forwards it to the Joint Frequency Panel (JFP) of the Military Communications-Electronics Board (MCEB) for approval. The JFP normally requests an evalu-

*DCSOPS/DTACC

ation of the proposed allocation from the DOD Electromagnetic Compatibility Analysis Center (AC).

(3) In those cases specified by the Office of Telecommunications Policy's Manual of Regulations and Procedures for Radio Frequency Management, DCSOPS,* upon receipt of the application for spectrum allocation, requires the developer to submit additional information needed to support review of the allocation by the Spectrum Planning Subcommittee of the Interdepartment Radio Advisory Committee (AR 105-16 and DA Pam 105-2).

c. Determination of Prototype Equipment Specifications. Following the evaluation of feasibility accomplished at ASARC-I (AR 15-14) or the Feasibility IPR (DA Pam 11-25), the validation phase begins with the initiation of prototype development.

(1) For major systems the developer, under the direction of the System or Project Manager, contributes to the preparation of the DP (AR 70-27) including as components the CFP, BOIP I, proposed QQPRI (PQQPRI), and CTP. As a part of this effort the developer must prepare section III of the DP, the system development plan, which includes determination of the specifications for the prototype equipment.

(2) For nonmajor systems the DP has been prepared prior to the Feasibility IPR, and the developer proceeds to the preparation for prototype development on his own initiative after the IPR.

(3) The equipment specifications, frequently called RFP Technical Requirements, prescribe technical characteristics and performance requirements of the equipment or system and the type, manner of measurement, and acceptable limits of performance for all required tests. EMC guidance categories that may be required are 3, 4, 7, 8, 9, and 11 (para 5-2b):

3. System operational factors
4. Economic assessment
7. Hazard evaluation
8. Equipment and performance characteristics
9. Conformance to or waivers of EM standards and specifications
11. Measures of system effectiveness

*DCSOPS/DTACC

Prototype system and equipment development efforts frequently seek to explore alternative designs. Specifications, therefore, may utilize upper and lower bounds on performance characteristics but will include the acceptable limits of those characteristics which are required and desired. As an example, prototype contracts might be awarded to two different contractors for a counterbattery radar which included radically different antenna designs and data processing, but with the same requirements for angular sector coverage and precision of target location. The technical requirements will include by reference specific military standards and specifications. Portions of these standards and specifications can be waived only if deemed appropriate by authorized levels of command. Measurement criteria of MIL STD 462 and the EMC provisions of MIL STD 461A will normally be a part of the specifications. Specifications carefully describe desired contractor testing and conditions for acceptability.

(4) Completed specifications become a part of the prototype system or equipment development contracts and an addendum to the DP. They provide an important input to the preparation of DT and OT plans.

d. Verification of Prototype Performance. For both major and nonmajor systems, verification of prototype performance is accomplished with DT-I and OT-I. The CTP prepared earlier as a part of the DP provides a schedule and outline of DT-I and OT-I.

(1) For major systems the developer prepares the DT-I plan at the direction of the System or Project Manager. The OT Test Design plan for major and selected nonmajor systems is prepared or approved by the Operational Test and Evaluation Agency (OTEA).

(2) For other nonmajor systems the OT Test Design plan is normally prepared by a user representative, usually an element of TRADOC, and reviewed by OTEA. DT plans are prepared by the materiel developer.

(3) Format for DT and OT Outline Test Plans (OTPs) are provided in AR 70-10, and both OTPs, when approved, become part of the CTP and DP. Operational Test OTPs are reviewed by the Test Schedule and Review Committee (TSARC). Upon approval, they are entered into the Army Five Year Test Program (FYTP).

(4) DT-I and OT-I may be run concurrently as a combined test, but are separately planned and separately reported.

(5) Verification of prototype performance is based on the reports of DT-I and OT-I. Generally the focus of the evaluation is twofold: to select the best of the alternative equipments or systems evaluated against desired performance objectives, and to determine that one of the system approaches can in fact, with additional development, meet the objectives of the ROC. In his evaluation of DT-I and OT-I test reports the developer will normally require information included in EMC guidance categories 5 through 11 (para 5-2b):

5. *Electromagnetic environment evaluation*
6. *Natural environment evaluation*
7. *Hazard evaluation*
8. *Equipment and performance characteristics*
9. *Conformance to or waivers of EM standards and specifications*
10. *Spectrum signatures*
11. *Measures of system effectiveness*

The verification of prototype equipment performance, including EMC considerations, is included in the updated CTP and DP, and for major systems in the DCP or PM, and is a major aspect of the ASARC-II or Validation IPR decision to enter into full-scale development. Checklists for ASARC-II (AR 15-14) and the Validation IPR include verification of all aspects of prototype equipment performance.

(6) Data obtained from DT-I and OT-I reports and their analysis by the developer provide the major input to the preparation of the application for developmental RF spectrum allocations.

e. Application for Developmental RF Spectrum Allocation. Utilizing the results of DT-I and OT-I and their indications of the equipment or system performance to be expected, the materiel developer now performs the analysis required to select the frequency bands (if the C-E equipment or system radiates and falls within the purview of AR 105-16) and the equipment parameters. This analysis and the specifications of equipment parameters derived from it are more definitive and rigorous than those required for the experimental RF allocation. The developer may again avail himself of informal coordination with DCSOPS and may seek a more definitive evaluation of the electromagnetic and natural environment from agencies such as Assistant Chief of Staff for Intelligence (ACSI), Electromagnetic Environmental

Test Facility (EMETF), and ECAC. EMC guidance categories that may be required are 1, 3, 5, 6, 8, 10 and 12 (para 5-2b):

1. *System feasibility and performance requirements*
3. *System operational factors*
5. *Electromagnetic environmental evaluation*
6. *Natural environment evaluation*
8. *Equipment and performance characteristics*
10. *Spectrum signatures*
12. *Site survey and selection*

The developer completes DD Form 1494 in accordance with AR 105-16 and DA Pam 105-2. He is then able to supply revised or more complete and definitive information on equipment performance characteristics such as RF output power, bandwidth, channelizing method, modulation, antenna gain, beamwidth and side-lobe levels, receiver sensitivity and rejection of spurious signals. The level of detail provided still allows for some variation of certain parameters within specified bounds and does not precisely identify the frequency bands required.

(1) The procedures for review and approval by DCSOPS, the Joint Frequency Panel (J/FP), and, if required, the Interdepartment Radio Advisory Committee (IRAC) are the same as for the experimental frequency allocation request.

(2) Approval of the developmental application is a condition for entry into full-scale development (AR 11-13), and the status of spectrum allocations is reviewed at the Validation IPR and ASARC-II.

f. Determination of Development Equipment Specifications. Upon entry into the full-scale development phase the first major action is award of the development contract. The materiel developer prepares specifications including technical requirements for the RFP.

(1) These specifications are definitive with respect to equipment performance characteristics, and also contain limits on physical size, weight, and other equipment characteristics which affect operational utility. Environmental aspects of equipment performance are specified, at least in terms of required and desired limits of performance under specified conditions. The developer may require EMC guidance categories 4, 7, 8, 9, and 11 (para 5-2b):

4. *Economic assessment*

7. Hazard evaluation

8. Equipment and performance character-

9. Conformance to or waivers of EM standards and specifications

11. Measures of system effectiveness

Care is taken to cite appropriate MIL-STDs such as 461A and 462 and by other means to insure that EMC performance of the equipment and the contractor or government acceptance testing conforms to standards.

(2) The development equipment specifications are ordinarily sufficiently explicit and detailed to preclude major alternatives in design, but desired and required limits are nevertheless placed on some aspects of performance.

(3) The development specifications including technical requirements are made a part of the development contract and included in the revised DP.

(4) The specifications are a major input to the plans for DT-II and OT-II.

g. Verification of Development Equipment Performance.

(1) Plans for DT-II for major systems are prepared by the materiel developer, approved by the system or project manager, and made a part of the CTP. For nonmajor systems plans for DT-II are made and approved by the materiel development agency.

(2) Test Design Plans and Outline Test Plans (OTPs) for OT-II of major and selected nonmajor systems are prepared by OTEA. The OTP becomes part of the CTP and is reviewed by the TSARC for inclusion in the FYTP. For other nonmajor systems the OT Test Design Plan and OTPs are normally prepared by a user representative. The OTP becomes part of the CTP and is reviewed by the TSARC for inclusion in the FYTP.

(3) DT-II and OT-II may be combined and conducted by a test organization made up of representation from different test agencies of the materiel developer and the combat developer or they may be separately conducted. In either case DT-II and OT-II are separately reported. EM testing is a part of both DT-II and OT-II (DODD 5000.3 and AR 70-10).

(4) By reviewing the test reports of DT-II and OT-II, the developer verifies that equipment performance meets required objectives of the ROC and the technical, operational, and environmental limits established by the DP and the development specifications. The basic

purpose of the evaluation of test results is to determine whether the developmental equipment is ready (except for acceptable modifications) to be produced in at least limited production quantities.

(5) The developer may need to consider, in his verification of performance, EMC guidance categories 5 through 11 (para 5-2b):

5. Electromagnetic environment evaluation

6. Natural environmental evaluation

7. Hazard evaluation

8. Equipment and performance characteristics

9. Conformance to or waivers of EMC standards or specifications

10. Spectrum signatures

11. Measures of system effectiveness

The analysis of test results is included in the updated CTP and DP and is a major basis for decisions/actions made in ASARC-IIa or the Development Acceptance IPR to continue the program into initial production (IP).

(6) Results from DT-II and OT-II, and the analysis of these results by the developer, provide major inputs for the preparation of the application for an operational RF spectrum allocation.

h. Application for Operational RF Spectrum Allocation. Because of the time required for processing and approval, an operational RF spectrum allocation for C-E equipment that radiates and falls within the purview of AR 105-16 is applied for by the materiel developer as soon as the operational technical characteristics have been determined.

(1) The procedure prescribed in AR 105-16 and DA Pam 105-2 is similar to that for developmental spectrum allocations, except that all information required by DD Form 1494 must be precise and detailed. Any changes necessitated by FS problems must be included. EMC guidance categories that may be required are 5, 6, 8, 10, and 12 (para 5-2b):

5. Electromagnetic environment evaluation

6. Natural environment evaluation

8. Equipment and performance characteristics

10. Spectrum signatures

12. Site survey and selection

The developer can now describe the intended application and performance of the candidate

system with enough precision to permit a thorough analysis of interference potential, and to permit simulation of the operation of the system in its intended environment in order to evaluate frequency supportability problems. Such an analysis should be conducted either by the developer or by an EM analysis and test agency prior to submission of the application for an operational RF spectrum allocation.

(2) The request for allocation is submitted to DCSOPS for J/FP and IRAC approval (if required) in accordance with AR 105-16.

(3) The status of the operational RF spectrum allocation is reviewed at ASARC-IIa or the Development Acceptance IPR. Approval is a requirement for continuing development.

i. Determination of IP Equipment Specifications.

(1) ASARC-IIa and DSARC-IIa (if required) or the Development Acceptance IPR authorize initial production of a system or equipment.

(2) The developer proceeds to prepare specifications, including technical requirements, for the IP contract. These are detailed specifications which fully prescribe allowed performance limits, size, weight, and operational features of the equipment. IP contracts normally include requirements for complete documentation, and provide for subsequent procurement on a competitive basis. Producibility engineering and planning (PEP) and design-to-cost goals are important considerations. Consideration is also given to specific operational and environmental requirements. EMC guidance categories that may be required are 7, 8, 9, and 11 (para 5-2b):

7. Hazard evaluation

8. Equipment and performance characteristics

9. Conformance to or waivers of EMC standards and specifications

11. Measures of system effectiveness

The technical requirements are very specific with respect to EMC standards, and appropriate MIL-STDs such as 461A and 462 are made a part of the contract specifications. The specifications become part of the IP contract and are included in the revised DP. Provisions of the specifications are major inputs to preparation of plans for DT-III and OT-III.

j. Approval of TOE and Training Material. Throughout the development cycle, planning for TOE and training material is conducted by

the designated user for a particular system or equipment. This planning includes preparation of the PQPRI and the BOIPI during the conceptual phase for nonmajor systems, and early in the validation phase for major systems. QQPRI and BOIP become parts of the DP and are updated prior to each IPR or ASARC review. They form the basis for an "advance training plan" which is prepared during the validation phase and revised to become a "training program" during the full-scale development phase. These documents are prepared under the direction of TRADOC, coordinated with Deputy Chief of Staff for Personnel, DCSPER, and approved by Chief, Research, Development, and Acquisition, CRDA, whereupon they become a part of the DP.

(1) Tables of organization and equipment and draft field manuals are prepared by TRADOC, coordinated with the materiel developer and approved by CRDA. Technical manuals are prepared by the materiel developer, coordinated with TRADOC and approved by CRDA.

(2) Responsibility for scheduling and coordination of these actions rests with the system or project manager for major systems (AR 70-17), and with US Army Materiel Command, USAMC, or other developer such as US Army Security Agency, USASA, for nonmajor systems.

(3) EMC guidance category 13, EMC Training Data, applies to the action of the materiel developer in approval or coordination of training documents.

k. Verification of IP Equipment Performance. Plans for DT-III are prepared by the materiel developer for either a major or a nonmajor system. Test Design Plans and Outline Test Plans (OTPs) for OT-III are prepared by OTEA for major and selected nonmajor systems and by designated user representative organizations for other nonmajor systems. OTPs become part of the CTP and DP. The OTP for OT-III is reviewed by the TSARC for inclusion in the FYTP.

(1) DT-III and OT-III are normally conducted and reported separately. EMC testing is an integral part of both tests (DODD 5000.3 and AR 70-10).

(2) The developer reviews reports of DT-III and OT-III to verify that equipment performance fully satisfies objectives of the ROC and performance criteria of the DP. EMC guidance categories 5 through 12 may apply to evaluation of IP equipment performance (para 5-2b):

5. *Electromagnetic environment evaluation*
6. *Natural environment evaluation*
7. *Hazard evaluation*
8. *Equipment and performance characteristics*
9. *Conformance to or waivers of EMC standards or specifications*
10. *Spectrum signatures*
11. *Measures of system effectiveness*
12. *Site survey and selection*

Verification of IP equipment performance is a major and critical step in the LCSMM since it provides the basis for the decision, in ASARC-III or the Production Validation IPR, to continue the program into full-scale production and deployment.

l. Frequency Assignments. Frequency assignments are required in accordance with AR 105-24 and DA Pam 105-2 whenever a radiating equipment falling within the purview of AR 105-16 is to be operated, even for test and evaluation purposes in continental US (CONUS). Thus, frequency assignments, in the frequency bands allocated for experimental or developmental purposes, may be required in connection with experimentation by the materiel developer or for DT or OT earlier in the cycle than the end of the full-scale development phase. In any event, frequency assignments must be requested well in advance of IOC and should be consistent with the developer's most recent assessment of available frequency supportability. Procedures of AR 105-24 require the materiel developer to request frequency assignments from the Army or Area Frequency Coordinator during the development and acquisition cycle, and the user to request assignments during operational deployment and use. EMC guidance categories 5, 8, 10, 12, and 14 may apply to frequency assignments (para 5-2b):

5. *Electromagnetic environment evaluation*
8. *Equipment and performance characteristics*
10. *Spectrum signatures*
12. *Site survey and selection*
14. *MIJI report analysis*

m. Determination of Production Specifications. ASARC-III and DSARC-III (if required) for major systems, and the Production Validation

IPR for nonmajor systems, can authorize award of a production contract.

(1) The developer, in preparing specifications and technical requirements for the production contract, normally utilizes specifications of the IP contract unless specific changes have resulted from evaluation of DT-III and OT-III test results. Production specifications are detailed and thoroughly documented with appropriate references to military standards for EMC testing.

(2) Production specifications become a part of the DP when approved. EMC guidance categories that may be required are 7, 8, 9, and 11 (para 5-2b):

7. *Hazard evaluation*
8. *Equipment and performance characteristics*
9. *Conformance to or waivers of EMC standards or specifications*
11. *Measures of system effectiveness*

n. Verification of Production Equipment Performance. As equipment is introduced and utilized operationally by military units, verification of performance is made through several reporting procedures. EMC guidance categories 5-12 and 14 may apply (para 5-2b):

5. *Electromagnetic environment evaluation*
6. *Natural environment evaluation*
7. *Hazard evaluation*
8. *Equipment and performance characteristics*
9. *Conformance to or waivers of EMC standards or specifications*
10. *Spectrum signatures*
11. *Measures of system effectiveness*
12. *Site survey and selection*
14. *MIJI report analysis*

Meaconing, intrusion, jamming, and interference (MIJI) reports are made by units and commands under the provisions of AR 105-3. These reports, if their analyses indicate unintended interference problems, are provided to the materiel developer for action. After-action reports, commanders' inspection reports, and visits of AMC or other developer's contract teams to operational units also serve to uncover equipment deficiencies and to surface EMC problems. Corrective actions are initiated by developers when required, or by equipment operators in the form of changed operational

doctrines, frequency assignments (as approved), etc.

4-6. Summary of Relation of EMC Decisions/Actions to EMC Guidance Categories. The EMC guidance categories that may be required for EMC decisions are indicated for each of the 14 EMC decisions or actions listed in table 4-1. These are summarized in table 4-2. Chapters 5 and 6 provide definitions and descriptions of these guidance categories and information regarding their use.

4-7. Checklists for ASARC Reviews and IPRs. Checklists are provided in AR 15-14 for ASARC reviews but these are more general than needed for program reviews of C-E equipments or systems. Checklists provided in the following paragraphs are still general but are oriented for C-E equipment or systems. Since there is a direct correspondence between IPRs and ASARC reviews, no distinction is made between them. The Development Plan (DP) and its supporting documentation, the Concept Formulation Package (CFP), and the Qualitative and Quantitative Personnel Requirements Information (QQPRI) provide the formal basis of program reviews, and therefore checklist items are keyed to this set of documents.

a. Checklist for ASARC-I and the Concept Feasibility IPR.

(1) The electromagnetic environment including frequency supportability (FS), utilized in analysis as part of the CFP are postulated in sufficient detail to permit conceptual feasibility evaluation of EMC.

(2) Equipment characteristics defined by the materiel developer and listed in section III of the DP contain ranges (upper and lower bounds) of parameters, such as frequency range, (included after an FS evaluation), power, antenna gain, and types of modulation, sufficient to support application for experimental frequency allocation.

(3) The technical development plan in section III of the DP includes selection of performance criteria for EMC, including applicability of approved EMC standards and figures of merit for compatibility.

(4) The tentative basis of issue plan (BOIP I) reported in section IV of the DP is adequate to postulate equipment/system deployments for use in EMC analysis.

(5) In the trade-off analysis portion of the CFP, consideration has been given to alterna-

tive design approaches which enhance compatibility in order to resolve possible conflicting requirements for EMC, FS, electronic counter-countermeasures, and signal security.

(6) Outline plans for DT-I and OT-I included in the CTP provide for evaluation of EMC against specified performance criteria.

(7) The preliminary QQPRI has identified skills needed and training required to support DT-I and OT-I.

(8) The request for experimental radio frequency allocation reflects adequate FS coordination and has been submitted and status of the request reported in section I of the DP.

(9) Results of conceptual feasibility analyses of EMC reported in section I of the DP justify continuing development of the equipment/system.

b. Checklist for ASARC-II and the Validation IPR.

(1) The electromagnetic environment used as the basis for systems analysis in the CFP has been reassessed by the combat developer and found to be valid or modified as appropriate.

(2) Prototype equipment/system specifications included performance criteria for EMC and specified appropriate military standards for EMC. (Specification is an attachment to section III of the DP.)

(3) The BOIP for the equipment/system has been reviewed by the combat developer and the materiel developer for FS and changes which may affect EMC.

(4) Plans for DT-I and OT-I include criteria, measures of effectiveness, and methods of measurement for EMC. Operational test plans provide for the best possible simulation of the expected electromagnetic environment.

(5) The QQPRI and the BOIP have been prepared and used in preparation of the Advance Training Plan and these documents provide for the specialized training requirements for EMC.

(6) The request for developmental RF spectrum allocation is supported by adequate FS coordination and has been submitted and its status is recorded in section I of the DP.

(7) Reports of DT-I and OT-I indicate that prototype equipment/system performance with respect to compatibility as measured against specific performance criteria was adequate to justify entry into full-scale development.

(8) Critical problems and issues affecting

developmental equipment design including E aspects and trade-offs have been clearly identified and it is clear that they can be resolved.

c. Checklist for ASARC-IIa and the Development Acceptance IPR.

(1) The electromagnetic environment has been updated by the combat developer and utilized in plans for OT-II.

(2) Development equipment/system specifications appended to section III of the DP provide for specific application of approved EMC standards and performance criteria for compatibility, and the conditions for contractor and Government testing are specified.

(3) BOIP and QQPRI have been updated and are being utilized in the preparation of the Training Plan and in training literature to include specialized requirements relating to EMC, for the New Equipment Training (NET) and resident training.

(4) Plans for DT-II include objectives, criteria, measures of effectiveness, and methods of measurement for evaluation of EMC applied both to the basic equipment/system and ancillary communications and support equipment, including shelters, vans, vehicles, and aircraft enclosures.

(5) Plans for OT-II provide for a realistic operational environment, to include EMC and simulations of combat situations, are carefully designed to evaluate EMC aspects of performance.

(6) Trade-off, risk, cost and effectiveness analyses of the development design in the updated CFP include attention to possibly conflicting requirements of electronic counter-countermeasures protection, signal security, EMC, and spectrum occupancy or FS.

(7) The request for operational RF spectrum allocation has been submitted and its status is reported in section I of the DP.

(8) Reports on DT-II and OT-II confirm that critical questions or issues of compatibility have been resolved.

(9) All analyses, test results, and supporting studies on EMC aspects of equipment/system performance justify initiation of low-rate initial production.

d. Checklist for ASARC-III and the Production Validation IPR.

(1) The electromagnetic environment has been updated by the combat developer, utilized in planning operational tests, and analyzed to confirm that the operational equipment/system can perform its intended function in its EMC environments.

(2) IP equipment/system specifications fully define the parameters of the equipment/system including all of those factors required for frequency assignment and all standards, criteria, and measures of effectiveness for EMC.

(3) Plans for DT-III provide for detailed testing of IP equipment/system conformance to standards and technical performance criteria. Methods of measurement are prescribed.

Table 4-1. EMC Decisions/Actions in Relation to LCSMM Milestones

LCSMM phase	LCSMM milestones	EMC decisions/actions
Conceptual	ROC approval	1. Select preliminary equipment characteristics and ascertain frequency supportability 2. Apply for experimental RF spectrum allocation
	ASARC-I, feasibility IPR	3. Determine prototype equipment specification
Validation	Prototype contract DT-I OT-I	4. Verify prototype equipment performance 5. Apply for developmental RF spectrum allocation
	ASARC-II, validation IPR	6. Determine developmental equipment specifications
Full-scale development	Development contract DT-II OT-II	7. Verify development equipment performance 8. Apply for operational RF spectrum allocation
	ASARC-IIa, development acceptance IPR IP contract DT-III OT-III	9. Determine IP equipment specifications 10. Approve TOZ and training material
Production & deployment	ASARC-III, production validation IPR	11. Verify IP equipment performance 12. Apply for frequency assignments
	Production contract Publication of PM, TM, TOZ Initial operational capability Requirement for new/modified materiel Disposal	13. Determine production equipment specifications 14. Verify operational equipment performance

Not required for non C-E equipment; frequency assignment must be obtained for all equipment which requires an RF allocation before any radiation is permitted.

Table 4-2. EMC Guidance Categories That May Be Required For EMC Decisions/Actions

EMC decisions/actions within LCMET phase	EMC guidance categories (see Table 5-1)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Conceptual phase</u>																
1. Select preliminary equipment characteristics and ascertain frequency supportability	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2. Apply for experimental RP spectrum allocation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<u>Validation phase</u>																
3. Determine prototype equipment/specification	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4. Verify prototype equipment performance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5. Apply for developmental RP spectrum allocation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<u>Full scale development phase</u>																
6. Determine developmental equipment specifications	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7. Verify development equipment performance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8. Apply for operational RP spectrum allocation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9. Determine IP equipment specifications	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
10. Approve TOE and training material	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
11. Verify IP equipment performance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
12. Apply for frequency assignments	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<u>Production and deployment phase</u>																
13. Determine production specifications	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
14. Verify operational equipment performance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

APPENDIX F

EXTRACT, CHAPTER 5, DA PAM 11-13

APPENDIX F

CHAPTER 5

EMC GUIDANCE CATEGORIES

EMC guidance categories are described in this chapter in terms of the data they provide, the EMC analytic techniques required to assemble these data, and the EMC decisions and actions that they support. These EMC decisions and actions, described in chapter 4 and listed in table 4-1, must be made by a developer in order to achieve the various LCSMM milestones.

5-1. Definition, Purpose, and Use of EMC Guidance Categories. EMC guidance categories are, by definition, standard groupings of EMC information that are convenient for use by a developer who is leveling tasks on an EMC support facility (or on individuals within his own organization) to obtain input information needed for the judgments and analyses that he must make to formulate EMC and related decisions. Table 5-1 presents a numbered list of EMC guidance categories, together with page references. The purposes and uses of the guidance categories are described in this chapter, and information regarding their applications is provided in chapter 6.

a. The EMC information provided in the guidance categories has two principal purposes:

(1) To support LCSMM decisions or activities which are primarily concerned with EMC (for example, determination of frequency supportability and applications for frequency allocations or assignments); and

(2) To support LCSMM decisions or activities, in which consideration of EMC is only one of a number of major factors. Examples of such decisions or activities are cost-benefit analyses, determinations of system feasibility, and evaluations of overall system effectiveness. For most systems, whether primarily C-E or non-C-E in nature, many considerations other than EMC problems will affect decisions and actions.

b. The EMC guidance categories are numbered (table 5-1) generally in the chronological order in which they are needed during the LCSMM. This numbering scheme is provided for convenience and logical consistency, but should not be used as the basis for determining EMC guidance priorities or requirements. At each stage of the LCSMM, when a decision or documentation involving EMC is required, the

developer can refer to the EMC categories to determine his EMC support needs. Thus these categories can serve as standard formats for use by the developer in establishing his data needs, and also be used by DA staff and the EMC support agencies for defining the products of their analyses, measurements, and tests in terms of developers' EMC requirements.

c. The preparation of the various materiel development documents requires information in these guidance categories as indicated in table 5-2. The DP is included in this table along with the documents which support it: DCP, CFP, BOIP, CTP, and QQPRI. EMC support for DT and OT may be considered generally the same as that of the CTP. The Defense Program Memorandum and Army Program Memorandum requirements are essentially those of the DCP; and training requirements are obtained by summing the QQPRI and BOIP requirements.

d. The EMC decisions and actions that may require EMC guidance category information are indicated in the discussion of each of the categories in the next section, and are presented in tabular summary form in table 4-2.

5-2. The Fourteen EMC Guidance Categories.

a. This section presents definitions and technical descriptions of the fourteen EMC guidance categories listed in table 5-1. These definitions and descriptions include the kinds of EMC guidance information provided; the types of analyses, tests, and measurements needed to develop the EMC guidance; and the EMC decisions/actions within the LCSMM phases that are supported by each guidance category. Where relevant, the EMC information is also placed into context with other C-E and non-C-E information that is related to it in reaching

the decisions/actions that are supported by a particular EMC guidance category.

b. The definitions and descriptions of the fourteen guidance categories follow.

(1) Category 1, C-E System Feasibility and Performance Requirements.

(a) This category of EMC guidance information consists of data to support preliminary evaluations and analyses of the ability of candidate C-E equipment and system concepts to achieve the system performance specified by requirements such as ROCs within given technical, mission, and environmental constraints. The context of these evaluations and analyses includes other C-E and non-C-E performance factors, while the EMC considerations are principally the extent of spectrum occupancy implied by the proposed BOI, frequency supportability, mutual interference interactions, and C-E equipment technical characteristics required to meet performance objectives.

(b) The analyses, tests, and measurements required to develop this category of EMC guidance include evaluations of the electromagnetic environment, alternate C-E equipment design techniques, and the corresponding electromagnetic characteristics of equipments and emitted fields. System performance factors are also evaluated for comparing electromagnetic compatibility, spectrum occupancy, and mission performance aspects of alternate designs, including transmission security.

(c) The EMC decisions/actions supported by this EMC guidance category include the selection of preliminary equipment characteristics and ascertaining of frequency supportability, and preparation of applications for experimental or developmental RF spectrum allocations. A more general management decision supported by this EMC guidance category is the establishment of performance requirements which can be imposed upon a developmental C-E equipment or system, and the corresponding bounds on ground combat force mission capabilities.

(2) Category 2, Command and Organizational Principles.

(a) This category of EMC guidance information consists of inputs to assessments of the impact of EMC factors on the development of organization and command principles of a combat force. These principles are partially determined by the communication systems which can feasibly be implemented to satisfy command and control requirements. The perfor-

mance of these communication systems in the mission environment is greatly influenced by EMC factors. EMC guidance information is augmented by the results of other types of C-E analysis, for example: systems control (SYS-CON) studies, netting and alternate routing, and the implications of all-secure communications. Non-C-E factors provide the primary framework for the determination of command and organizational principles, including force mobility, logistics, Army command doctrine, and threat and mission considerations.

(b) The analyses, tests, and measurements required to develop this category of EMC guidance information include determinations of force deployments and scenarios, force control principles and doctrine, equipment deployments and electromagnetic characteristics, and the EMC performance of a C-E equipment or system.

(c) The EMC management decision/action supported by this guidance category is the selection of preliminary C-E equipment characteristics and ascertaining of frequency supportability. This information is also utilized along with other inputs in the selection of mission force command and organization principles from among available alternatives.

(3) Category 3, System Operational Factors.

(a) This category of EMC guidance information consists of equipment and system EMC performance data to assist in evaluating system operational performance. Measurements or predictions of operational performance capability are required for determining C-E system feasibility, comparing C-E system alternatives, and performing cost-benefit analyses, for the purpose of evaluating how well ground force mission objectives can be met.

(b) EMC guidance information such as compatibility scores is typically combined with other performance inputs; e.g., physical survivability, interoperability, and mobility, in determining system operational factors.

(c) The analyses, tests, and measurement required to develop this EMC guidance information include evaluations of the electromagnetic and physical environment; studies of typical ground force missions, deployments and scenarios; and postulations and computations of C-E equipment designs and performance scores.

(d) The EMC management decisions/actions supported by this EMC guidance category include selection of preliminary equipment

characteristics and ascertaining of frequency supportability, determination of prototype equipment specifications, and applications for experimental and developmental RF spectrum allocations. Validation or modifications of required operational capabilities can also be supported by this guidance category.

(4) Category 4, Economic Assessment.

(a) This category of EMC guidance information consists of inputs to cost comparisons, life-cycle costing analyses, cost-benefit analyses, and similar economic assessments performed in connection with equipment or system development. These analyses rely upon a wide range of cost-dependent input parameters. These parameters may include EMC performance and operating frequencies to which C-E equipment acquisition and operating costs are sensitive. Other illustrative cost-sensitive parameters not related to EMC include equipment mean time between failures, environmental flexibility, and equipment capacity versus BOIP trade-offs.

(b) The analyses, tests and measurements required to develop these EMC guidance inputs include computations of cost-estimating relationships for C-E equipments in conjunction with evaluations of the performance of alternative C-E equipment designs and construction techniques.

(c) The EMC management decisions/actions supported by this EMC guidance category include the selection of preliminary equipment characteristics and the establishment of prototype and developmental equipment specifications.

(5) Category 5, Electromagnetic Environment Evaluation.

(a) This category of EMC guidance information consists of data concerning available frequency spectrum resources and RF power flux densities and/or electromagnetic field strength distributions as functions of frequency, time, and space coordinates. Sources of these electromagnetic fields are natural, such as galactic noise; unintended manmade emissions, such as engine ignition noise, input/output device emissions, or spurious radio emissions; and intended manmade radiations from friendly or unfriendly operational communications transmitters, radars, jammers, or beacons. Propagation characteristics at specified locations are included in this guidance category.

(b) The analyses, tests, and measure-

ments required to develop this category of EMC guidance may be either empirical or theoretical. They include determinations of frequency supportability from available data bases, equipment electromagnetic characteristics and spurious emissions; and the direct measurement of field strengths and spectral distributions. Total RF power flux may be determined from a knowledge of the amplitude versus frequency distribution of an RF field.

(c) In conjunction with category 6, the EMC management decisions supported by this EMC guidance category include the selection of preliminary equipment characteristics and ascertaining of frequency supportability; applications for experimental, developmental, and operational RF spectrum allocations, and verifications of equipment performance in an actual or planned operational environment.

(6) Category 6, Natural Environment Evaluation.

(a) This category of EMC guidance information consists of data concerning terrain, meteorological, and other physical factors which can affect the performance of C-E equipment. These data include soil conductivity, vegetation characteristics, ground topography, humidity and rainfall statistics, and distributions of atmospheric particulate matter.

(b) The analyses, tests, and measurements required to develop this category of EMC guidance include references to data bases of meteorological and topographical information, and computer simulations or emission tests to determine ground conductivity, vegetation losses, and atmospheric losses, and other data.

(c) In conjunction with Category 5, the EMC management decisions/actions supported by this EMC guidance category include the selection of preliminary equipment characteristics and ascertaining of frequency supportability; applications for RF spectrum allocations, and verifications of equipment performance in actual or planned operational environments.

(7) Category 7, Hazard Evaluation.

(a) This category of EMC guidance information consists of data on potential hazards to electrical equipment, munitions, electroexplosive devices, personnel, and ecology due to specified electromagnetic emissions. This information is utilized in developing recommendations, criteria, and standards regarding maximum radiated signal strengths, separation dis-

tances, duty cycles, antenna beam widths and pointing angles, etc.

(b) The analyses, tests, and measurements required to develop this category of EMC guidance include theoretical predictions and measurements of signal levels at various locations and times, and comparisons of these levels with personnel safety and munitions hazard criteria and standards; determinations of propagation conditions; and determinations of equipment electromagnetic characteristics, including antenna patterns and emission spectra.

(c) The EMC management decisions/actions supported by this EMC guidance category include the establishment of C-E equipment specifications, selection of sites, and verification of C-E equipment performance in the prototype, developmental and operational stages. Decisions concerning the siting and operation of both C-E and non-C-E equipments and systems rely upon the information obtained in this guidance category.

(8) Category 8, Equipment and Performance Characteristics.

(a) This category of EMC guidance information consists of data on circuit, equipment, and subsystem performance parameters. Examples of equipment and circuit design parameters include types of source and error correction codes, pulse repetition and jitter frequencies, modulation techniques, receiver and component noise figures, oscillator stability, receiver selectivity and dynamic range, and receiver spurious responses. Subsystem operating parameters include effective isotropic radiated powers and spectrum signatures, receiving system noise figures, and carrier frequencies or frequency bands. Subsystem performance parameters include bit error rate statistics and voice articulation indexes.

(b) The tests, analyses, and measurements required to develop this information include laboratory and field tests to measure directly many of these required parameters; mathematical computations or modeling; and use of rules of thumb and tables of data accumulated from past experience, measurements, or computations.

(c) The EMC management decisions/actions supported by this EMC guidance category include applications for frequency allocations and frequency assignments, selection of preliminary equipment characteristics and ascertaining of frequency supportability; and specifica-

tion and verification of the performance of prototype, developmental and operational equipments.

(9) Category 9, Conformance to or Waivers of EMC Standards or Specifications.

(a) This category of EMC guidance information consists of data to determine whether equipments or equipment designs conform to the EMC portions of military standards or specifications and to determine whether to request waivers of specific equipment requirements.

(b) The analyses, tests, and measurements required to develop this EMC guidance include a broad range of susceptibility, vulnerability, emission, frequency stability, performance scoring, and similar analyses and tests for meeting appropriate technical requirements.

(c) This EMC guidance category involves the EMC military standards and specifications that pertain to design, development, production, test and measurement. These requirements are usually imposed upon equipment development or production contractors, who rely upon their own facilities for performing tests and analyses subject to Army test monitoring and test data validation. Requests for waivers must be processed through channels specified in AR 11-13 and AR 700-47.

(d) The following are the principal related military standards, specifications, and handbooks:

MIL Handbook 161A. Electronic Communications Equipment.

MIL Handbook 162A. Radar Equipment.

MIL Handbook 237. Electromagnetic Compatibility Interference Program Requirements.

MIL STD 188 Series. Military Communication System Technical Standards (Common Standards-MIL STD 188-100 series; Tactical Standards-MIL STD 188-200 series; and Long Haul Standards-MIL STD 188-300 series).

MIL STD 449D. Military Standard Radio Frequency Spectrum Characteristics, Measurement of.

MIL STD 461A. Electromagnetic Interference Characteristics, Requirements for Equipments, Subsystem and System.

MIL STD 462. Measurement of Electromagnetic Interference Characteristics.

MIL STD 463. Definitions and Systems of

Units, Electromagnetic Interference Technology.

MIL STD 469. Radar Engineering Design Requirements, Electromagnetic Compatibility.

MIL STD 1310. Shipboard Bonding and Grounding Methods for Electromagnetic Compatibility.

MIL E 6051. Electromagnetic Compatibility Requirements, Systems

MIL E 7080. Electric Equipment, Aircraft, Selection and Installation of (References MIL E 6051).

MIL C 11693. Capacitor, Feed-Through, Radio Interference Reduction, AC and DC.

(c) The EMC management decisions/actions supported by this EMC guidance category include the determination of equipment performance specifications and the verification of equipment performance.

(10) Category 10, Spectrum Signatures.

(a) This category of EMC guidance information consists of the time-and-frequency-dependent amplitude response and phase characteristics of an electromagnetic emitter.

(b) The analyses, tests, and measurements required to develop this EMC guidance include C-E equipment characteristics and susceptibility/emission measurements such as those specified in MIL STD 449 and MIL STD 462. Analytic procedures may also be employed for synthesizing spectrum signatures based upon equipment design, the modulation technique employed, and baseband characteristics.

(c) The EMC management decisions/actions supported by this EMC guidance category include applications for RF spectrum allocations and frequency assignments, and verification of the performance of prototype, developmental, initial production and operational equipment. EMC analyses utilizing rules of thumb, theoretical relationships or computer simulation also require information concerning spectrum signatures of equipments.

(11) Category 11, Measures of System Effectiveness.

(a) This category of EMC guidance information consists of data for determining how well a specified combination of equipments, links or networks provides a system function for C-E support of deployed forces. Communicability, as well as compatibility, i.e., C-E performance in the presence of unintended interfer-

ence, can be used as performance measures in computing composite system effectiveness. Other C-E system performance measures may include speed and grade of service, security, vulnerability, flexibility, mobility, and FS requirements for successful BOIP implementations.

(b) The analyses, tests, and measurements required to develop this EMC guidance include: first, the derivation of the relationship between communicability scores, compatibility scores, and mission success; then, the determination of the composite scores, in a typical force deployment, through analytic, simulation, or field test techniques; and, finally, the computation of a composite system effectiveness measure. This composite effectiveness measure combines these EMC scores with other C-E performance measures unrelated to EMC factors.

(c) The EMC management decisions/actions supported by this EMC guidance category include selection of preliminary equipment characteristics and ascertaining of frequency supportability, determination of equipment specifications, and verification of system performance.

(12) Category 12, Site Survey and Selection.

(a) This category of EMC guidance information consists of data concerning the electrical, physical, and topographic characteristics of one or more sites. The purpose of these data is to assist in determining the feasibility of locating and operating C-E equipment at these sites. Information may include frequencies available for use at the site, propagation and meteorological conditions, natural and man-made electromagnetic radiation levels, and locations of friendly and hostile emitters and surveillance devices. Physical characteristics include shielding effects of terrain, line-of-sight terrain profiles, and electrical characteristics of soil and vegetation. Characteristics of collocated equipments include emitter power levels, spectrum signatures, antenna gains and polarizations, responses to interfering signals, and separation distances. Other nearby friendly equipment may include RF hazard-sensitive components.

(b) The analyses, tests, and measurements required for this EMC guidance category include determination of the electromagnetic environment, definitions of friendly and hostile force and equipment deployments, and deter-

minations of EMC characteristics of collocated equipments.

(c) The EMC management decisions/actions supported by this EMC guidance category include obtaining spectrum allocations and frequency assignments, and verifying IP and operational equipment performance in specified electromagnetic and physical environments. The EMC information described under this category can be obtained for a number of candidate sites. Thus, it can be employed for selection of an optimum site based upon management-specified criteria.

(13) Category 13, EMC Training Data.

(a) This category of EMC guidance information consists of technical data, designs of training equipment, analysis techniques, computational aids, and curricula to ensure properly balanced emphasis on EMC in all formal training courses on concept, doctrine, operation and maintenance of C-E equipment, subsystems and systems, including preparation and evaluation of MIJI reports.

(b) The analyses, tests, and measurements required for this guidance category in a training environment include those which are regularly employed in providing the EMC guidance needed during the various LCSMM phases.

(c) The EMC management decisions/actions supported by this EMC guidance category include preparation of lesson plans and course curricula, and approval of training material.

(14) Category 14, MIJI Report Analysis.

(a) This category of EMC guidance information consists of evaluations of the sources

and types of reported interference. The evaluations are accomplished in accordance with the requirements of AR 105-3 (MIJI Reporting) and other unit directives, instructions, or regulations issued for clarifying the MIJI requirements. The purpose of the evaluations is to determine whether reported interference is intended or unintended, and to accumulate statistics on different types of interference incidents and corrective actions. The effectiveness of the various corrective actions can also be evaluated. Lessons learned through the MIJI reporting system can improve the EMC guidance provided in future ROCs and DCPs.

(b) The analyses, tests, and measurements required to develop this EMC guidance category include evaluations of the electromagnetic environment and propagation characteristics in the region of a reported incident; determination of the locations, operational characteristics, and duty cycles of C-E equipments which may have caused the interference; and determination of means available to eliminate or tolerate the interference.

(c) The primary EMC management decision/action supported by this EMC guidance category is the verification of operational equipment performance. The objectives of the MIJI program, stated in AR 105-3, include providing a basis for initiating appropriate operational reactions; determining foreign electronic warfare capabilities and application trends; and providing indications of hostile intentions. Although not a specific objective of AR 105-3, the MIJI report analysis can also serve as a tool for re-evaluating C-E techniques, and C-E system engineering and operating practices.

Table 5-1

EMC Guidance Categories

No.	Title	Page
1.	C-E system feasibility and performance requirements	5-2
2.	Command and organizational principles	5-2
3.	System operational factors	5-2
4.	Economic assessment	5-3
5.	Electromagnetic environment evaluation	5-3
6.	National environment evaluation	5-3
7.	Hazard evaluation	5-3
8.	Equipment and performance characteristics	5-4
9.	Conformance to or waivers of EMC standards or specifications	5-4
10.	Spectrum signatures	5-5
11.	Measures of system effectiveness	5-5
12.	Site survey and selection	5-5
13.	EMC training data	5-6
14.	MIJI report analysis	5-6

Table 5-2.

**EMC Guidance Category Information Required
for the Principal Materiel Development Documents**

EMC guidance category	Materiel development documents*									
	DP	ROC	DCP	CFP	BOIP	CTP	QQPRI	Spectrum alloc. request	FM	TM
1. C-E system feasibility and performance requirements	X	X	X	X		X			X	
2. Command and organizational principles	X	X	X	X	X	X	X	X	X	
3. System operational factors	X	X	X	X	X	X	X		X	X
4. Economic assessment	X		X	X						
5. Electromagnetic environment evaluation	X	X	X	X	X	X		X	X	X
6. Natural environment evaluation	X	X				X		X	X	X
7. Hazard evaluation	X	X				X		X	X	X
8. Equipment and performance characteristics	X	X	X	X		X		X	X	X
9. Conformance to or waivers of EMC standards or specifications	X					X				X
10. Spectrum signatures								X	X	X
11. Measures of system effectiveness	X		X	X		X				
12. Site survey and selection								X	X	X
13. EMC training data	X						X		X	X
14. MIJI report analysis	X						X		X	X

*Abbreviations are defined on p. 3-2.

APPENDIX G

DATA ELEMENTS USED IN PERFORMING ANALYTICAL FUNCTIONS

DATA ELEMENTS

	DATA BASES AVAILABLE AT ECAC										MCEB (1494)	SPS REVIEW	CESD	EMETF DATA BASES	
	GMF	FMS	ITU	FCC	FAL	NCF	OPAF	SAUF	ARFA/	MFL				DEPLOY- MENT FILE	ANALYSIS FILE
<u>ADMINISTRATIVE DATA ELEMENTS</u>															
Security Classification	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
General Declassification Schedule	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Frequency Range	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reference Frequency	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Excluded Frequency Bands	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Frequency Band Allocation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Antenna Frequency Range	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tuning Range	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Method of Tuning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Frequency Tolerance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Assignment Type	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Extent of Use	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
User	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Usage Code	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Circuit Usage Category	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Usage Indicator	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Record Category	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
J/F 12 Number	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Previous J/F 12 Application Number	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
C/F 299 Number	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Maximum Duty Cycle Capability	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hours of Operation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Schedule of Operation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Key:

- X - In Master File
- P - Project Files Only

DATA ELEMENTS

ADMINISTRATIVE DATA ELEMENTS	DATA BASES AVAILABLE AT ECAC										DATA BASES		
	EMET	FILE	ANALYSIS	FILE	DEPLOY-	MENT	FILE	ANALYSIS	FILE	EMET	DATA BASES	FILE	ANALYSIS
Type of Circuit													
Circuit Number or Circuit Designator													
Status of the Assignment													
Purpose of System													
Agency/Document													
Agency													
Bureau													
Canadian Coordination Serial Number													
Service Range & Height													
Line Diagram													
Related Analysis Data													
IRAC Notes													
Supplementary Details													
Remarks													
Allocation/Prose Rule													

DATA ELEMENTS

LOCATION DATA ELEMENTS	DATA BASES AVAILABLE AT ECAC										MCEB (1494)			SPS REVIEW	CE9D	DEPLOY- MENT FILE	ANALYSIS FILE	EMETF DATA BASES
	GNF	FRNS	ITU	FCC	FAL	NCF	OPAF	SAUP	ARFA/ MRL									
ITU Region	X	X	X	X				X	X			X		X			X	
State/Country Text	X	X	X	X				X	X			X		X				
Antenna Location	X	X	X	X					X			X		X				
Latitude/Longitude	X	X	X	X					X			X		X				
Authorized Mileage Radius	X	X	X	X					X			X		X				
Geographical Area for Stages 2, 3, 4	X	X	X	X					X			X		X				
Authorized States	X	X	X	X					X			X		X				
Authorized Areas	X	X	X	X					X			X		X				
Clear Transmission/Clear Reception Radius	X	X	X	X								X		X				
Number of Mobile Stations	X	X	X	X								X		X				
Number of Equipments in Initial Stage	X	X	X	X								X		X				
Number of Equipments Planned for Operational Use	X	X	X	X								X		X				
Number of Equipments Operating Simultaneously in the Same Environment	X	X	X	X								X		X				
Equipment Quantity Installed on the Platform or Allowance	X	X	X	X								X		X				
Tenant Vehicle Quantity	X	X	X	X								X		X				
Site Elevation	X	X	X	X								X		X				
Path Length	X	X	X	X								X		X				
Unit - Administrative Control	X	X	X	X								X		X				
Unit - Electrical Control	X	X	X	X								X		X				

DATA ELEMENTS

DATA ELEMENTS	DATA BASES AVAILABLE AT ECAC										EMETF DATA BASES			
											DEPLOY- MENT FILE	ANALYSIS FILE		
	GMF	FRNS	ITU	FCC	FAL	NCF	OPAF	SAUF	ARFA/ MRFL	MCEB (1984)	SPS REVIEW	CESD		
<u>EQUIPMENT DATA ELEMENTS</u>														
Equipment Nomenclature	X	X		X		X			X	X	X			X
Manufacturer's Name	X	X		X		X			X	X	X			X
Equipment Function		X	X	X		X			X	X				
Fixed/Mobile Indicator		X	X	X										
Repeater Indicator	X	X												
Platform Type		X				X				X				
RF Channeling Capability														
Link Capacity (Number of Channels)		P				X				X				X
Special Circuitry		P												
RF Filter Characteristics														
Component Type													X	
COMSEC Code													X	
Equipment Status Code													X	
<u>Transmitter Data Elements</u>														
Authorized Emission Bandwidth	X	X	X	X					X					X
Emission Bandwidth Capability				X		X								
Occupied Bandwidth														
Semi-Bandwidth		X												
Maximum Modulation Frequency (Baseband Bandwidth)														
Deviation Ratio														
Modulation Type														
Authorized Power	X	X	X	X					X	X	X			X
Power Capability	X	X		X					X					

DATA ELEMENTS

	DATA BASES AVAILABLE AT ECAC										CESD	EMETF DATA BASES		
	GMF	FRNS	ITU	FCC	FAL	NCF	OPAF	SAUP	ARFA/MRFL	MCEB (1494)	8PS REVIEW	DEPLOY- MENT FILE	ANALYSIS FILE	
Transmitter Data Elements														
Power Type Indicator	X	X	X			X			X	X	X		X	
ERP - Calculated Value	X	X	X						X	X	X			
Station Class	X	X						X	X	X	X			
Radio Service	X	X						X						
Pulse Width	X	X												
Pulse Width Capability	X	X												
Pulse Repetition Rate	X	X												
Pulse Repetition Rate Capability	X	X												
Maximum Duty Cycle														
Rise Time														
Fall Time														
Pulse Compression Ratio														
Range of Pulses per Trigger														
Pulse Position Modulation Type		P												
Transmitter Type														
Tuneability	X	X												
Type of Laser	X	X												
Number of Lasers	X	X												
Harmonic Attenuation														
Spurious Attenuation														
Output Tube Type or Device														
Output Tube Nomenclature														
Filter Employed														
Maximum Bit Rate														
Pre-emphasis														

DATA ELEMENTS

DATA ELEMENTS	DATA BASES AVAILABLE AT ECAC										MCEB (1494)	SPS REVIEW	CESD	EMETF DATA BASES		
	GMF	FRS	ITU	FCC	FAL	NCF	OPAF	SAUP	ARFA/MRFL	DEPLOY-MENT FILE				ANALYSIS FILE		
ANTENNA DATA ELEMENTS																
Nomenclature	X	X				X	X		X	X	X	X	X	X	X	X
Antenna Type	X	X				X	X		X	X	X	X	X	X	X	X
Gain	X	X	X			X	X		X	X	X	X	X	X	X	X
Horizontal Beamwidth	X	X	X			X	X		X	X	X	X	X	X	X	X
Vertical Beamwidth	X	X	X			X	X		X	X	X	X	X	X	X	X
Beam Description		P				X	X									
Directivity Code						X	X									
Number of Main Beams						X	X									
Polarization	X	X				X	X		X	X	X	X	X	X	X	X
Antenna Feed Type		X				X	X									
Antenna Lead Type		X				X	X									
Azimuth (Motion Type)		X	X			X	X		X	X	X	X	X	X	X	X
Antenna Height	X	X				X	X		X	X	X	X	X	X	X	X
Antenna Height Measurement Point Indicator		P														
Pointing Angle		P														
Horizontal Arc Scanned - From & To		P										X	X	X	X	X
Vertical Arc Scanned - From & To		P				X						X	X	X	X	X
Horizontal Motion Rate		P				X						X	X	X	X	X
Vertical Sector Scan Rate		P				X						X	X	X	X	X
Fixed Beam Elevation Angle - From & To						X										
Elevation Angle	X	X														

APPENDIX H

STANDARDS AND REGULATIONS
USED IN
SPECTRUM ALLOCATION TO EQUIPMENT REVIEWS

APPENDIX H
STANDARDS AND REGULATIONS
USED IN
SPECTRUM ALLOCATION TO EQUIPMENT REVIEWS

Military Standards

MIL-STD's

188C	Mil. Comm. System Technical Standards
188-100	Common Long Haul and Tactical Communication System Technical Standards
188-120	Military Communication System Standards Terms and Definitions
188-311	Technical Design Standards for Frequency Division Multiplexers
188-313	Subsystem Design and Engineering Standards and Equipment Technical Design standards for Long-Haul Communications Transversing Microwave LOS Radio and Trospheric Scatter Radio. (FM only)
188-317	Standards for Long-Haul Communications (HF)
188-322	Subsystem Design/Engineering and Equipment Technical Design Standards for Long-Haul Line of Sight (LOS) Digital Microwave Radio Transmission
188-341	MODEM Non-Diversity Digital Data 2400 Bits per Second
188-342	Equipment Technical Design Standards for Voice Frequency Carrier Telegraph (FSK)
188-344	MODEM Non-Diversity Digital Data 1200 Bits per Second.
291B	Standard Tactical Air Navigation (TACAN) Signal
461A	Electromagnetic Interference Characteristics Requirements for Equipment
462	Electromagnetic Interference Characateristics, Measurements of
469	Radar Engineering Design Requirements
1541	Electromagnetic Compatibility Requirements for Space Systems
1572	Telemetry Standards

Inter-Range Instrumentation Group & Range Commanders Council Documents

- 101-65 Frequency Standards for Radar Beacons
- 104-65 Frequency Design Objectives and Interference Criteria for
Scorer Systems.
- 105-63 Radio Frequency Parameters and Criteria for
Instrumentation Timing
- 106-77 Telemetry Standards

Military Regulations

AFR 55-44, Performing Electronic Countermeasures in the United States
AR 105-86, and Canada
OPNAVINST 3430.9B,
MCO 3430.1

DoT Regulation

- 65-1000 AIMS Specifications

FAA Documents

- 1010.51A U.S. National Aviation Standard for the Mark X
- 00-31 U. S. National Aviation Standard for the VORTAC System.

NTIA Manual

MCEB Papers

MCEB-M

- 415-65 Recommended Tuning Standards for Radiocommunications
Equipment in the Frequency Ranges 14 kHz-30MHz and 225-400
MHz.
- 149-71 US Military Frequency Allotment Plan for the 138.0-150.8
MHz Band
- 336-66 Recommended Standards for Radiocommunications Equipment
Operating in the Frequency Ranges 3-30 kHz, 30-300 kHz,
300-3000 kHz, 3-30 MHz, 108-136 MHz, and 225-400 MHz.
- 323-72 Withdrawal of Telemetry from the 225-260 MHz Band
- 187-75 NASA Telemetry Operations 225-260 MHz Band.
- 92-65 Frequency Assignment Plan for Air/Space-Ground
Telemetry Operations

173	MCEB Policy on 25 kHz Channel Spacing in the 225-400 MHz Band.
151-76	Frequency Plan for the 225-400 MHz Band
492-68 and 280-68	Clarification of Policy Guidance on Frequency Provisions for Test Range Safety Control Devices
180-68	Military Frequency Planning 4400-5000 MHz Band
288-74	Target Control Frequency Support for 4400-4900 MHz, 5400-5900 MHz, 406-550 MHz & 225-260 MHz.
J/F 563/20/D	Policy on Spectrum Allocation for Video/TV Air-Ground Instrumentation Systems.
240-73	Coordination of Fleet Satellite Communications (FLTSATCOM) System
130-75	Manageable Problems, 7/8 GHz Band

APPENDIX I

COMPILATION OF DEFICIENT APPLICATIONS
(STANDARD vs. YEAR vs. REVIEW STAGE)

STANDARD	1970		1971		1972		1973		1974		1975		1976		1977		1978		1979	
	E	D O	E	D O	E	D O	E	D O	E	D O	E	D O	E	D O	E	D O	E	D O	E	D O
MIL-STD-1888	1																			
MIL-STD-188C			4	2	2	1			2	2	9		1	1	1	3	1	6	3	1
MIL-STD-188-313																				
MIL-STD-2918																				
MIL-STD-4428																				
MIL-STD-449																				
MIL-STD-461 & 461A	1																			
MIL-STD-469	1	2	3		1	1	3		4	2	3	2	3	10	6	6	14	6	11	18
MIL-STD-1572			2	1	4	5	2	8	5	3			2	2	2	3	2	2	2	1
NTIA MANUAL 4.3.11																				
NTIA MANUAL 5.2.3																				
NTIA MANUAL 5.3 (RSEC)																				
NTIA MANUAL 5.3.1																				
NTIA MANUAL 5.3.2																				
NTIA MANUAL 5.5																				
DOT AIMS-65-1000																				
FAA MARK X																				
FCC-89																				
ITU																				
JANAP 141																				
MCEB-M-180-68	3		1	3	2	3	1	3	6	2			4		1	1	1	1	1	1
U.S.																				
NO ALLOCATION	2	3	1	3	2	3	1	7	1											

APPENDIX J
Army Spectrum Management Office
Spectrum Allocation to Equipment
Policy Guidance

APPENDIX J
Suggested
Army Spectrum Management Office
Spectrum Allocation to Equipment
Policy Guidance

1. Background

Department of Defense Directive 4650.1, Management and Use of the Radio Frequency Spectrum states (para. VI. H) that DoD Components shall:

"1. Obtain frequency guidance prior to assuming contractual obligations with respect to either the development or procurement of telecommunications equipment designed purposely to radiate or receive electromagnetic energy. Radio frequency guidance will also be obtained prior to assuming obligations for the selection, procurement, or development of earth or terrestrial stations sites and facilities which will be used to support telecommunications equipment. This guidance will be obtained from the MCEB or the Office of Telecommunications Policy, Executive Office of the President, in accordance with procedures issued by the MCEB."

Current U.S. Military Communications-Electronics Board (USMCEB) procedures are contained in MCEB-M 565-78(V) of 20 September 1978.

National Telecommunications and Information Administration (NTIA), Department of Commerce (formerly the Office of Telecommunications Policy, Executive Office of the President) policy and procedures are promulgated in Chapter 8 of the OTP Manual of Regulations and Procedures for Radio Frequency Management.

The primary purpose of requiring DoD Components to submit new and emerging communications-electronics (C-E) equipment and systems to the USMCEB and NTIA for review is to ensure:

- a. frequency supportability, and
- b. electromagnetic compatibility.

Within the USMCEB, the J-12 Working Group is charged with processing DoD spectrum allocation to equipment applications for Frequency Panel approval (guidance). The Spectrum Planning Subcommittee (SPS) of the Interdepartment Radio Advisory Committee (IRAC) performs a similar role for NTIA approval at the national level. The Frequency Assignment Subcommittee (FAS) of IRAC provides frequency supportability advice and assistance to the SPS. The Army provides representation to these bodies as shown in Figure 1.

2. Purpose

It is the purpose of this letter to set forth the policies of the Army Spectrum Manager spectrum allocation to equipment application review process.

3. Policy

a. The Army Spectrum Manager views the spectrum allocation to equipment process as:

- (1) providing a clearing house and office of record for existing and emerging equipment and systems in the DoD inventory,
- (2) a means of obtaining early notification of new equipment under development by other DoD Components, and
- (3) a review process which formally validates joint and national acknowledgement of a developing Army C-E system on equipment, its probable electromagnetic compatibility, and its frequency supportability.

	JOINT				NATIONAL		
	DoD (MCEB)				DOC (NTIA)		
	Princ	Coord	FP	J-12 WG	IRAC	SPS	FAS
HQDA (ACSAC)							
DAAC	X						
DAAC - PE		X					
DAAC - ZS					X		
DARCOM							
CORADCOM				X		X	
USACC							
CC-OPS-CE			X				X

FIGURE 1. Army Representation on Spectrum
Allocation Review Agencies

b. The spectrum allocation to equipment process is not viewed as an approval/disapproval action. Guidance received as a result of review of an applicant Army C-E equipment will be carefully considered and, where appropriate, remedial R & D action will be taken. Ultimately, however, the Army must bear the responsibility for determining the economical, technical and operational balance required to field a mission essential equipment or system in a time/cost effective manner.

c. An effective Electromagnetic Compatibility (EMC) Program Guide, as described in DA PAM 11-13 and as confirmed by Operational Tests (OT) and Developmental Tests (DT), is the appropriate means for determining EMC and interoperability. For major systems, Army Systems Acquisition Review Councils (ASARC's) and Defense Systems Acquisition Review Councils (DSARC's) are the appropriate control mechanisms. For non-major systems, In Process Reviews (IPR's) will be used. The compressed schedule of the spectrum allocation to equipment process does not permit its use as a competent vehicle for determining the EMC or interoperability of a major developing equipment or system.

d. All efforts and emphasis placed on the spectrum allocation to equipment process will be optimized towards obtaining useful guidance from the J-12 and SPS reviews and promulgating this guidance to cognizant Army program managers and development agencies.

e. Efforts and emphasis on resolving EMC within the spectrum allocation to equipment review process will be minimized.

f. DoD and Army policy regarding tailoring of military standards and specifications (DoD Manual 4120.3, Defense Standardization Manual; AR 700-47, Defense Standardization Program) is recognized

and supported. However, spectrum allocation to equipment applications must accurately reflect the range and extent of tailoring employed by developers if review bodies are to be aware that candidate equipment or systems are not to be evaluated against complete standards and specifications. Tailoring information and rationale shall accompany applications to the extent feasible.

g. To foster the purpose and intent of the spectrum allocation to equipment process, addressees of this letter are requested to ensure that:

(1) Army spectrum allocation to equipment applications reflect the most current, accurate and complete data available regarding the candidate equipment or system,

(2) essential information gleaned from the spectrum allocation to equipment review process, regarding equipment or systems being developed by other DoD Components, is made available to cognizant Army R & D agencies, and

(3) spectrum allocation to equipment guidance relative to Army applications is analyzed, collectively, to detect any trends in Army failure to meet applicable EMC standards or to obtain frequency support. Cause and remedy for such trends must be determined at the earliest possible time, so that prompt action may be initiated to effect corrective measures.