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MILITARY HANDBOOK

ELECTROMAGNETIC COMPATIBILITY MANAGEMENT GUIDE FOR PLATFORMS, SYSTEMS AND EQUIPMENT

FSC EMCS
AMSC NUMBER N3132

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DEPARTMENT OF DEFENSE
Washington, DC 20360

Electromagnetic Compatibility Management Guide for Platforms, Systems, and Equipment

MIL-HDBK-237A
2 February 1981

1. This Military Handbook is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Electronic Systems Command, ATTN: ELEX 5043, Washington, DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWORD

The existence of operational problems in the tri-services resulting from the effects of electromagnetic energy has been documented in numerous military exercises and survey reports. These electromagnetic incompatibilities led to mission aborts and costly delays, thereby reducing the operational availability of military platforms, systems and equipments. The severity of military electromagnetic environments (EME), the damaging effects of electromagnetic (EM) problems to personnel, ordnance, fuels, and other equipments, and the degraded equipment performance and security underscore the importance of electromagnetic compatibility (EMC). The incompatibilities are traceable to the following:

- Platforms, systems and equipments were not being designed to operate in their intended electromagnetic environment

- Deficiencies in management, planning and control of the efforts necessary to achieve EMC including the definition and transfer of responsibilities and information from the Acquisition Program Manager to the Logistics Manager

Experience has shown that the desired degree of EMC can best be achieved by first identifying the operational EM environment and then defining and adhering to proper design, development, test, production and installation requirements and procedures, and continuing with adequate maintenance and support measures throughout the life cycle. EMC must be considered as a principal design parameter with the magnitude, scope and level of the effort tailored to the specific type and mission of the platform, system or equipment and the program phase. Emphasis must be placed on implementing practical requirements and procedures to meet the desired EMC requirements with available resources, while still meeting the intended mission requirements.

To accomplish this, an effective program of EMC management, assessment, engineering and configuration control is required and must be integrated into the overall design and engineering effort from early in the conceptual phase and throughout the life cycle.

Under most circumstances it is impractical to consider after-the-fact fixes. Experience has shown that correction of EM problems after an equipment or system is designed or in operation always involves considerable expense, and yields less than optimum results. For this reason, the Department of Defense (DoD) has required the implementation of specific efforts to deal with EMC matters from the early conceptual and design phases, and throughout the life cycle and requires.

- Early determination of EMC requirements

- Achievement of total system EMC in the operational environment

- Attainment of built-in EMC in the design of electronic systems, rather than resorting to after-the-fact remedial measures

- Assurance that EMC can, in fact, be achieved; or, if not, duly considered and remitted in favor of overriding operational necessity

- Establishment of control procedures to correct EM problems throughout the life cycle

This handbook provides guidance for establishing an effective EMC program throughout the life cycle of platforms, systems and equipments. In addition, it is assumed that the manager has a background which is primarily managerial. Compliance with these guidelines dictates the size of the document. A summary of EMC milestones and tasks is depicted on FIGURE 1. If additional general management information is desired, it is suggested that Naval Ocean Systems Center Technical Document, TD 108 Project Managers Guide, or any other comparable document, be reviewed.

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APPENDICES

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FIGURES

TABLES

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1. SCOPE

1.1 Scope. This document is intended to provide managers responsible for the design, development and acquisition of DoD platforms, systems and equipments with the guidance necessary to establish an effective program for achieving the desired degree of EMC. The handbook describes the steps which must be taken to ensure that EMC considerations are incorporated during the life cycle to achieve the desired compatibility for the life cycle of the platform, system, or equipment.

1.2 Applicability. Provisions of this handbook are to be applied by procuring agencies, and by development and operations activities at appropriate times during the life cycle of any platform, system or equipment which emits or which can be susceptible to electromagnetic energy. For example, the handbook is applicable as follows:

a. During acquisition to assure visibility, accountability, and controllability of the EMC effort, as well as its integration into the overall program
b. During the design process to assure a coherent design, management awareness and cost effective tailoring of applicable EMC standards and requirements

It may also be applied by contractors as a guide for establishing and implementing an EMC program during the contract phase.

1.3 Format. To assure early consideration of EMC as well as to provide the necessary continuity for achieving and monitoring the required EMC, the guide follows the framework of the life cycle for platforms, systems and equipments. Section 4 describes the overall approach which should be taken during the life cycle for EMC. Section 5 describes specific actions which must be taken by the manager to implement the approach in Section 4. Together these actions describe the steps which must be taken during the life cycle and the responsibilities of the manager for ensuring that his equipment, system, installation or platform is not only compatible within itself (that is, self-compatibility) but has a high probability of continued operation, within acceptable tolerances, with other systems and platforms in its intended EME. The appendices describe in greater detail the various aspects of EMC which are to be implemented by the manager, and include:

- EME
- Prediction and Analysis
- Tailoring General EMC Standards to EM Operational Requirements
- Checklist for Major EMC T&E Planning Considerations (Navy)
- EMC Training
- Frequency Management and Control
- Configuration Management
- EMC Considerations in Program Documents
- EMC Bibliography for Managers

1.4 Relationship between EME and EMC. The electromagnetic environment in which military platforms, systems and equipments must operate is created by a multitude of sources. Primary contributors are intentional, unintentional, friendly and hostile emitters. Electromagnetic pulses, atmospheric, solar and galactic emissions, lightning, and the like, are other sources. The contribution of each emitter to the environment may be described in terms of its technical characteristics, such as power, modulation, frequency, bandwidth and so forth. Effects depend on the receiver's characteristics, relative locations of emitters and receptors, operational concepts, and so forth. However, it can be concluded that the EME can adversely affect all electronic, electro-optical, electrical and electromechanical equipments and systems, personnel, fuels, and weapons.

1.4.1 Terminology. Various terms have been used to describe the programs established to reduce or prevent adverse effects from electromagnetic energy. These terms include: EMC, EMI, EMV, EMP, ECCM, EM-power, P-static, HERO, EME, E^3, HERF, HERP, and RADHAZ. To avoid confusion, the term EMC will be used in this document and encompasses any source of electromagnetic energy and any type of potential victim.

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1.4.2 Intra-system versus inter-system. EM interactions between elements of a system are termed intra-system EMC whereas EM interactions between systems are inter-system EMC. This concept may be extended to platforms by considering EM interactions between equipments and systems on a platform as intra-platform EMC whereas interactions between the platform and its EM environment or other platforms are considered inter-platform EMC.

2. APPLICABLE DOCUMENTS

2.1 Government documents. The following documents, of the issue listed in the Department of Defense Index of Specifications and Standards (DoDISS) and its supplements, form a part of this document to the extent specified herein. The date of the applicable DoDISS and supplements thereto shall be as specified in the solicitation.

SPECIFICATIONS

MILITARY

MIL-E-6051	Electromagnetic Compatibility Requirements, Systems (Aircraft And Associated Weapons Systems)

STANDARDS

MIL-STD-449	Radio Frequency Spectrum Characteristics, Measurements Of
MIL-STD-461	Electromagnetic Emission And Susceptibility Requirements For The Control Of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement Of
MIL-STD-463	Definitions And System Of Units, Electromagnetic Interference And Technology
MIL-STD-469	Radar Engineering Design Requirements, Electromagnetic Compatibility
DOD-STD-480	Configuration Control - Engineering Changes, Deviations And Waivers
MIL-STD-1605	Procedures For Conducting A Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships)

HANDBOOKS

MIL-HDBK-235	Electromagnetic (Radiated) Environment Considerations For Design And Procurement Of Electrical And Electronic Equipment, Subsystems And Systems

PUBLICATIONS

INSTRUCTIONS

OPNAVINST 1500.8	Preparation And Implementation Of Navy Training Plans (NTP) In Support Of Hardware And Non-Hardware Oriented Developments
OPNAVINST 2410.11	Procedures For The Processing Of Radio Frequency Applications For The Development And Procurement Of Electronic Equipment
OPNAVINST 3960.10	Test And Evaluation
NAVMATINST 2410.1	Electromagnetic Effects (E^3) Policy Within The Naval Material Command (NMC)

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OTHER

NTIA MANUAL	Manual Of Regulations And Procedures For Radio Frequency Management

(Copies of specifications, standards, handbooks, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

3.1 Definitions. The definitions included in MIL-STD-463 and MIL-HDBK-235 shall apply.

3.2 Acronyms and abbreviations. The following are EMC related acronyms and abbreviations of terms used in this handbook:

ASEMICAP	Air Systems Electromagnetic Interference Corrective Action Program
CASREP	Casualty Report
CEP	Circular Error Probability
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
CONAR	Commanding Officer's Narrative Report
E^3	Electromagnetic Environment Effects
ECAC	Electromagnetic Compatibility Analysis Center
ECCM	Electronic Counter-Countermeasures
EED	Electro-Explosive Device
EM, em	Electromagnetic
EMC	Electromagnetic Compatibility
EMCAB	Electromagnetic Compatibility Advisory Board
EMICP	Electromagnetic Interference Control Plan
EMCON	Emission Control
EMCPP	Electromagnetic Compatibility Program Plan
EME	Electromagnetic Environment
EMI	Electromagnetic Interference
EMP	Electromagnetic Pulse
EMR	Electromagnetic Radiation
EMV	Electromagnetic Vulnerability
HERE	Hazards of Electromagnetic Radiation to Equipment
HERF	Hazards of Electromagnetic Radiation to Fuels
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
PK	Probability of Kill
P-Static	Precipitation Static
RADHAZ	Radiation Hazards to Personnel

4. INCORPORATING EMC DURING PROGRAM LIFE CYCLE

4.1 General. Management and engineering personnel must establish and implement a procedure for integrating EMC into the various phases of the life cycle of platforms, systems and equipments. This approach is required to assure early consideration of EMC as well as to provide the necessary continuity for achieving and maintaining the required EMC. The approach, in the case of a complex system usually includes modeling, analyzing, simulating and testing to determine emission and susceptibility characteristics and operational constraints. Final requirements are postulated by tailoring of general standards to the peculiar characteristics and operational requirements of the item in its individual specification.

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4.2 Life cycle flow. The principal phases in the life cycle of a major system or platform are generally delineated as:

- Concept Development
- Concept Validation
- Full Scale Development
- Production
- Deployment

Numerous departmental and agency directives contain the policies which define the activities and decisions made during each phase. A flow diagram depicting an approach designed to integrate an EMC program into the overall acquisition process for major defense systems is shown on FIGURE 1. The relationship between these activities and specific actions required by the manager is presented in other sections and the appendices of this guide. The EMC documents which may be used to assist in carrying out these actions are listed in APPENDIX I.

4.2.1 Concept development. During this phase, technical and financial baselines for a development and acquisition program are established. Included are definitions of required operational capability, doctrines and specific material requirements. Critical technical and operational issues will be identified for study and resolution in subsequent phases, whereas performance characteristics are established only in general terms. A statement of work (SOW), and a request for quotation (RFQ) will be prepared where required. Outputs of this phase are alternate concepts, estimated operational schedules and estimated procurement costs. During this phase, proper consideration of EMC will have a significant impact throughout the life cycle. For example, preliminary selection of operating frequency band modulation and other technical parameters must be consistent with established international and national frequency management policies. Also, an assessment of the ability of a system to perform its function during its life cycle must include a threat analysis using both the friendly and hostile EM environment which may be encountered. These factors must be addressed not only in performing trade-off studies and risk assessments, but also in estimating total program costs. The culmination of these activities will be the first major design review by the Defense Systems Acquisition Review Council (DSARC I), the program initiation decision.

4.2.1.1 EMC tasks during concept development. EMC tasks which should be addressed during this phase of the program are as follows. It is recommended that the program manager either consult with the EMC authority within his activity or designate an EMC Task Manager to support him on EMC matters throughout the program life cycle.

- Prepare EMC Program Plan (EMCPP) (see 5.4)
- Budget for EMC effort during program
- Establish an EMC Advisory Board (EMCAB) (see 5.5)
- Determine spectrum requirements and submit request for frequency allocation (see 5.3 and APPENDIX F)
- Define EM environment which may be encountered during life cycle (see 5.6 and APPENDICES A and C)
- Perform an analysis to determine if proposed system or platform can operate in the anticipated EM environment (see 5.6 and APPENDIX B)
- Establish initial EMC requirements for system or platform (see 5.6 and APPENDIX C)
- Update EMCPP and refine schedules and cost estimates

4.2.2 Concept validation. The primary objective of this phase is the selection of the single concept which will be carried out through full scale development. To accomplish this, the estimates made in the concept development phase must be refined. Areas of risk must be reassessed to assure that they have been adequately defined and can be resolved or minimized. Frequently, this phase includes the construction of prototypes to evaluate operational, technical and environmental factors as well as to refine costs. An SOW and RFQ for research and development contract support will be prepared, when required. The studies, analyses and testing is culminated in the second design review, DSARC II, where a decision is made as to whether to proceed to full scale development.

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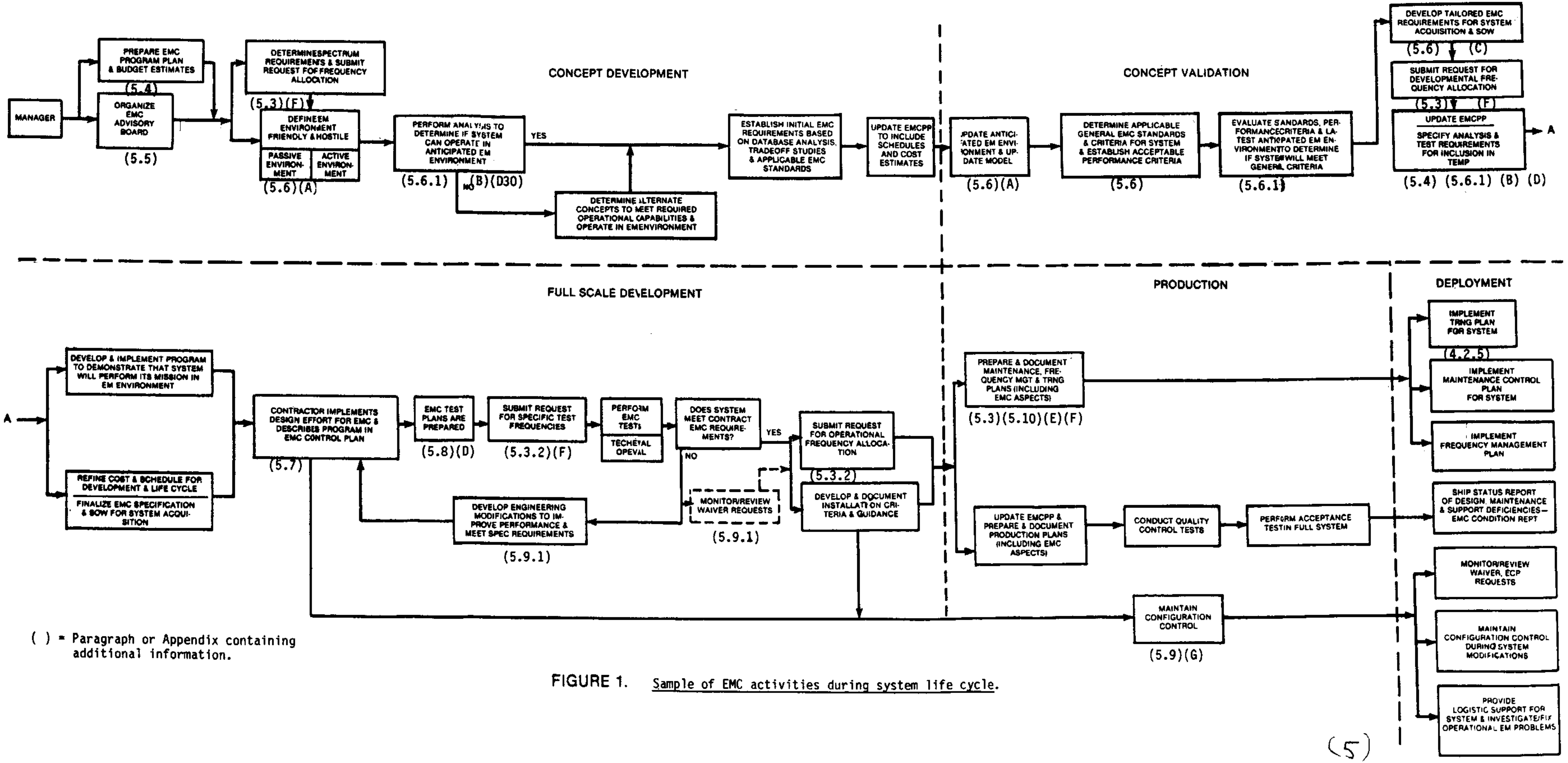

FIGURE 1. Sample of EMC activities during system life cycle.

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4.2.2.1 EMC tasks during concept validation. EMC tasks which should be addressed where applicable during this phase of the program are as follows

- Continuation of EMCAB (see 5.5)
- Review and update anticipated EME (see 5.6 and APPENDICES A and C)
- Refine analyses to determine if proposed system or platform will satisfactorily operate in the latest estimated EME
- Define acceptable performance criteria
- Evaluate EMC standards and criteria, EM environment and acceptable performance criteria to determine if system or platform will meet general EMC criteria (see 5.6 and APPENDIX B)
- Develop tailored EMC requirements for acquisition and corresponding SOW for preparation and submission of contract data items (see 5.6, 5.7, 5.8.3, 5.8.4 and APPENDIX C)
- Submit request for developmental frequency allocation (see 5.3 and APPENDIX F)
- Specify operability analyses and testing requirements for inclusion in the Test and Evaluation Master Plan (TEMP) (see 5.8 and APPENDIX D)
- Refine cost estimate for EMC effort, including testing
- Update EMCPP

4.2.3 Full scale development. The primary objective of this phase is the design and fabrication of a system or platform in accordance with requirements tailored to the specific procurement, mission, environmental factors, and so forth. The system or platform must be fully evaluated and tested to verify that the design not only meets its specifications, but that the system or platform satisfactorily performs its stated missions in the operating environment. This phase must also provide the documentation, including testing and analysis reports, to enable a decision as to whether to proceed to production. Approval for Service Use must be obtained prior to proceeding to production. An SOW and specification will be prepared and used for the development contract.

4.2.3.1 EMC tasks during full scale development. EMC tasks which should be addressed during this phase of the program are as follows:

- Continue EMCAB (see 5.5)
- Finalize EMC specification and SOW for acquisition of pre-production model. This includes requiring the preparation and delivery of contract data items, such as EMC control plans, test plans and test reports (see 5.7, 5.8.3, 5.8.4 and APPENDIX C)
- Review and comment on contractor's data items
- Monitor and review Engineering Change Proposals (ECP's) and requests for waivers to contract EMC requirements (see 5.9 and APPENDIX G)
- Develop and implement comprehensive program to demonstrate by simulation, analysis and test that the system or platform will perform its mission in the operational EM environment. The testing program will be described in the TEMP or Test and Evaluation Plan (TEP) (see 5.8 and APPENDIX D)
- Submit request for assignment of specific frequencies for testing (see 5.3 and APPENDIX F)
- Document EMC aspects of maintenance, production and training plans (see 5.10 and APPENDIX E)
- Develop EMC specification requirements for inclusion in production contract (see 5.6 and APPENDICES A, B and C)
- Develop installation criteria and guidance to preclude EM problems
- Submit request for operational frequency allocation (see 5.3 and APPENDIX F)

4.2.4 Production. This phase encompasses the program from approval for production (DSARC II) to delivery and acceptance of the last item being procured. Acceptance tests will be performed to demonstrate conformance to the requirements in the production specification as well as to assure satisfactory performance when the item is in operational use. Strict quality control methods are required to insure that proposed changes to the configuration do not degrade the performance of the item nor cause degradation to other systems or platforms. When acquisition is complete, responsibility to support the system or platform is turned over to the logistics manager.

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4.2.4.1 EMC tasks during production. EMC tasks which should be addressed during this phase of the program are as follows.

- Review and approve proposed EMC tests and reports for acceptance tests
- Perform special EMC acceptance tests (see 5.8 and APPENDIX D)
- Finalize EMC aspects of integrated logistics support (ILS) maintenance and training plans (see 5.10 and APPENDIX E)
- Develop and document frequency management and usage plan (see 5.3 and APPENDIX F)
- Update EMCPP and turn it over to the logistics manager
- Ensure ECP's are reviewed for EMC impact (see 5.9 and APPENDIX G)
- Include EMC Condition Report in platform status report of design, maintenance and support deficiencies

4.2.5 Deployment. This phase begins with the acceptance of the first operational system or platform and extends until all are phased out of the inventory. There is usually an overlap with the production phase. In-service performance must be monitored by a reliable, established feed-back system to detect, report and correct operational problems. Any modifications, ECP's and overhaul plans must be reviewed in accordance with the program configuration control system.

4.2.5.1 EMC tasks during deployment. EMC tasks which should be addressed during this period are as follows:

- Implement maintenance, training and frequency management and usage plans including activation of procedures for EM problem reporting and requests for assistance
- Investigate and fix EM problems as may be reported by a formalized reporting process
- Maintain configuration control during systems modifications. ECP's must be reviewed for EMC impact.

4.3 Procedural method for addressing EMC. TABLE I and FIGURE 1 summarize the procedures described in 4.2 and provide the program manager with an orderly and coherent approach for addressing EMC involving platforms, equipments and systems. Although the specific design and acquisition procedures may differ depending on whether the procurement is for a platform, system or equipment, the overall approach for ensuring EMC in the end product is essentially the same. In cases where the detailed design and production is done by the contractor, the project manager's major responsibilities in EMC are to define the applicable EMC requirements and monitor the contractor's efforts to comply with the requirements. In cases where the detailed design is done by the procuring activity and a contractor is responsible for production in accordance with Government-furnished information (GFI), the program manager must, in addition to the above, conduct all aspects of the EMC effort, including establishing installation criteria, performing analyses, and so forth. In any case, the program manager may delegate these responsibilities to the EMC authority in his activity or he may establish an EMCAB to provide advice and assistance so that he can carry out the responsibilities, or a combination of both approaches.

4.3.1 Design methodology. Electromagnetic compatibility can be achieved through proper design, development, test and production methods, accepted installation practices and life cycle maintenance and support. To be effective, the design methodology must provide a clearly defined, coherent approach for preventing electromagnetic problems and for achieving the required electromagnetic compatibility. Normally, electromagnetic compatibility will not be attained unless these aspects are emphasized by management in an EMC program established early in the conceptual and design phases of equipment and systems. An example of the methodology for addressing ship EMC is shown in TABLE II. FIGURE 2 illustrates graphically the key elements impacting platform EMC.

TABLE I. Typical EMC tasks related to the various phases of ship platform design & construction.

EMC Tasks	Concept Development	Concept Validation	Full Scale Development	Production
• Prepare EMCPP and updates (5.4)	X	X	X	X
• Establish EMC advisory board (EMCAB) (5.5)	X	X	X	X
• Review plans, programs, and contracts to ensure EMC provisions		X	X	
• Apply MIL SPECS & STDs		X	X	
• Prepare and update EMC control plan	X	X	X	X
• Prepare EMC inputs to TEMP	X	X	X	X
• Maintain liaison with acquisition managers of electronic systems, subsystems, and equipments		X	X	
• Study EMC impact of all ship alterations (SHIPALTS), ECP's, ordnance alterations (ORDALTS), and requests for waivers		X	X	X
• Ensure application of EMC predictions techniques in time to influence ship design		X	X	
• Support utlization of selected materials where feasible, to achieve interference reduction (e.g., fiber optics)		X	X	X
• Develop frequency management plan	X	X	X	X
• Coordinate application of EMC criteria in EW, EMP, EMV, HERO, and RADHAZ	X	X	X	
• Ensure adequate funding for accomplishment of necessary EMC engineering tasks		X	X	X

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TABLE II. Sample procedural method for addressing ship EMC.

Ship Acquisition Program (SHAPM)

- Generate EMC program plan (EMCPP) - update as required
- Designate EMCAB members and liaison personnel (Ship Design Agent (SDA) and participating managers (PARM))

EMCAB/SDA/PARM

- Generate EMC control plan (EMCCP) - update as required
- Inventory proposed platform
  - Topside - Intersystem structural components
    - Antenna & cabling
  - Below deck - Systems & equipment
    - Cabling & arrangement
  - Recognize any system EMC requirements that must be incorporated into ship spec.
  - Tailor specs to fit mission requirements & incorporate into ship eqpt spec
  - Establish EMC data base from proposed design/modernization specifications
- Identify problems
  - EM problems which may be identified prior to detailed analysis
  - Identify potential EMC problem areas that need to be subjected to analysis

SDA

- Predictive analysis (performed by SDA - directed & approved by EMCAB)
  - Inventory proposed environmental elements
  - Essence of analysis protective margin calculations
  - Initial gross analysis to resolve problems, and to identify potential EMC problem areas requiring further analysis.
- Define problem & data required for solution
  - o Detailed analysis and recommended solutions (options)
- Determine ship impact based on options

EMCAB

- Make recommendations to ship program manager (SPM)

SHAPM

- Final disposition of problems (options selected)
- Contract for solution

SHIPYARD

- Ship construction/industrial availabilities
- Installation and design
- EMC test plan integrated in ship test program
- Acceptance tests

FLEET LOGISTICS MANAGER

- Transfer of responsibilities from SHAPM to SLM
  - Ship status rept of design, maintenance & support deficiencies (SHAPM)
    - EMC condition report with SHAPM
  - Update EMCPP with SLM
  - EMC requirements in in-service support plan
  - EMC feedback to detect and correct EMC problems
  - Review for EMC.
    - Fleet modernization plans
    - Conversion plans
    - Other industrial availabilities

" [ ] " Primary responsible activity

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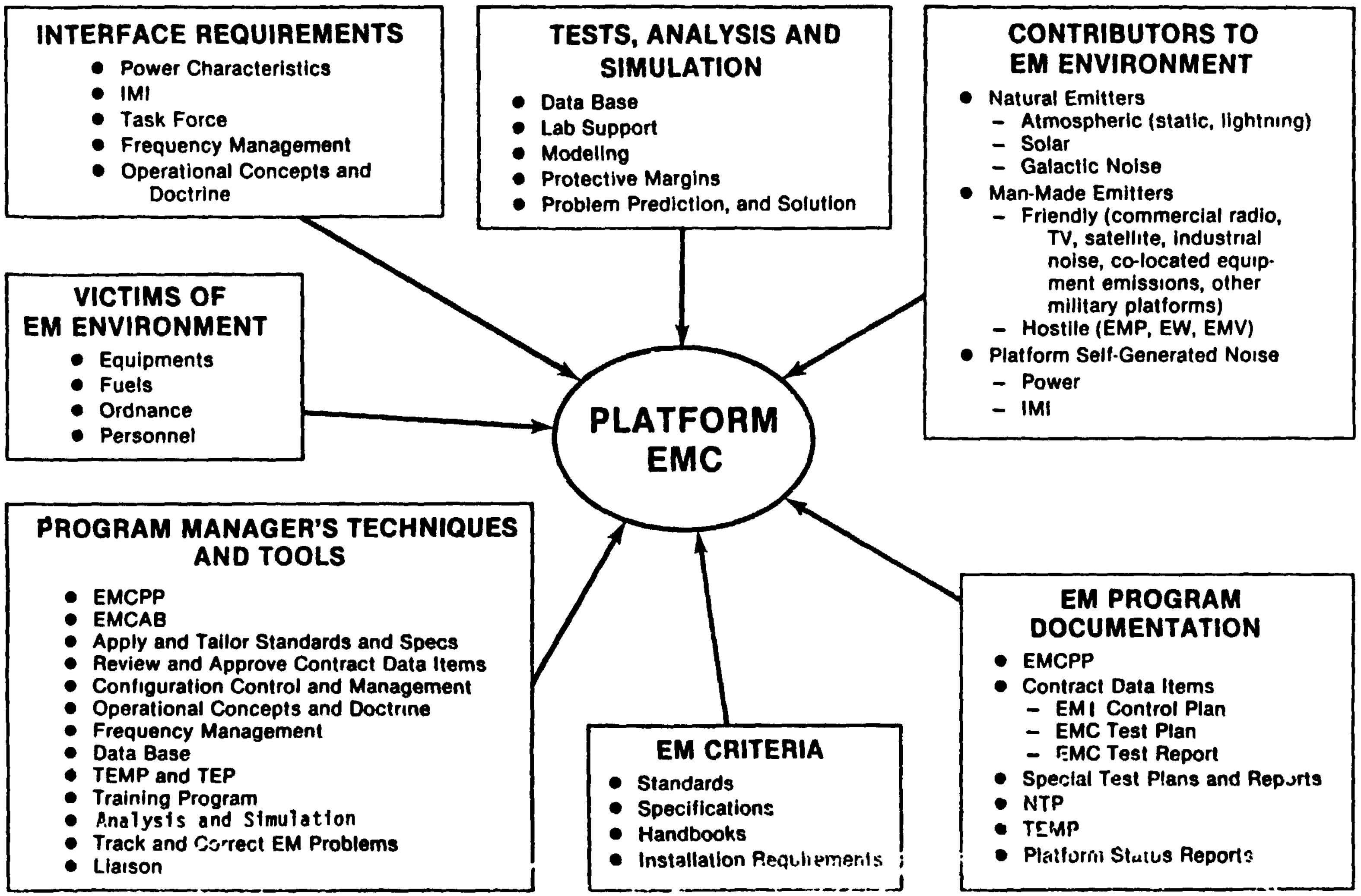

FIGURE 2. Key elements impacting platform EMC.

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5. PROGRAM MANAGER RESPONSIBILITIES

5.1 General. This section identifies the manager's responsibilities in establishing a workable and effective EMC program which will ensure design, procurement and operation of an end product which meets the required EMC criteria.

5.2 Program milestones and tasks. The following tasks are essential for preventing EM problems and are discussed in greater detail in other paragraphs and appendices of this handbook.

- Frequency management
- EMCPP
- EMCAB
- Development of applicable specification requirements
- Require and review EMI control plan
- Test and evaluation, including test plans and reports
- Configuration management and control
- EMC training program

The depths to which these areas are applied on a program depend on costs schedules, risks associated with not covering area in the program, and goals. The proper application of management controls, electromagnetic compatibility controls and practices can lead to a successful program.

5.3 Frequency management. For telecommunications equipment and systems, the action required by the program manager is first to initiate a request, where applicable, for an experimental frequency allocation on DD Form 1494. Data on the form are reviewed for conformance to international, national and DoD criteria. Approval of a frequency allocation request provides an authorization to utilize defined frequency bands or frequencies to accomodate a specific function. As the program progresses through development and eventually into procurement, requests for frequency allocations must be updated. An approval is required before a contract can be let. However, such approval does not provide authorization to operate an equipment on a specific frequency within the tuning range of the equipment. For this, a frequency assignment is required. The program manager is responsible for submitting all requests for frequency allocations (DD Form 1494's) in accordance with the latest departmental instructions. In the case of the Navy, OPNAVINST 2410.11 provides the procedures for the submission of the form. In all cases, failure to comply with the international, national and DoD EMC criteria could result in denial of the request.

5.3.1 Frequency allocation data. When frequency allocations are required, the following will be provided:

- For each situation requiring a frequency allocation, appropriate data will be provided by the procuring activity through their frequency management offices. When specific contracts exist, contractors should be requested to provide the appropriate data to the procuring activity. The submission of a DD Form 1494, Application for Frequency Allocation is normally required when any of the following conditions exist:
  a. Sufficient information becomes available during the experimental stage on the intended use and feasible frequency limits of a proposed system or equipment to warrant consideration of a specific allocation.
  b. A system or equipment is being considered for development.
  c. Procurement of a commercial item for military use is being considered.
- In addition, an amended DD Form 1494 should be submitted to correct previous application when:
  a. Experimental leads to development, or development leads to production for operational use.
  b. A new military scenario is planned for a previously approved system or equipment.
  c. The needs exist to alter any of the conditions of an existing frequency allocation regarding equipment characteristics, nomenclature or operational environmental conditions.

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5.3.2 Contractor frequency assignment applications. As noted in 5.3, an allocation does not give authority to operate on a specific frequency. Following allocation, the military departments may assign frequencies for use by a contractor having a valid contract, for contractor operations:

a. On a military installation, or
b. At a contractor's plant

under control of the installation commander or a military department representative, respectively. Requests for military department frequency support should be through appropriate channels.

If neither a. nor b. is the case, the contractor should request frequency support from the Federal Communications Commission (FCC) by filing an FCC form to obtain a station license. Coordination between contractors and cognizant procuring activities is recommended before action is taken.

Additional information on frequency management is contained in APPENDIX F.

5.4 EMCPP. For the Navy, NAVMATINST 2410.1 requires that all Naval Material Command (NMC) activities prepare a plan upon initiation of the development of all equipments, systems and platforms which involve the use of electromagnetic radiations.

The EMCPP is to be prepared by the program manager and is the top level management document for the EMC program to be conducted during the design and acquisition of the equipment, system or platform. It is initiated in the earliest stages of system development or procurement, and its emphasis is on policy, philosophy, and management of the EMC program to be implemented and the analysis techniques and general design guidance to be employed.

To achieve the greatest EMC engineering benefits, management and engineering personnel must establish the necessary EMC program early in the conceptual and design phases. The plan should document clearly defined tasks and milestones. The EMC effort must be tailored to the specific operational requirements, environment, type of contract, quantity, type and phases of procurement cost-effectiveness to meet the goals of the program to, above all:

- Assure efficient integration of engineering, management and quality assurance tasks in providing for the required level of EMC.
- Assure continuous traceability of EMC requirements and design alternatives throughout the program so that the sources and impact of design changes and deficiencies in equipment and subsystems, and the impact of contractual requirements are promptly determined, accurately identified and properly communicated.

The EMCPP will define the overall management, organizational and technical framework of the EMC program for a particular project (equipment or platform) and will present the proposed implementation of the program. The EMCPP applies to the conceptual design, preliminary design, contract design and construction phases of the acquisition of the specific equipment or platform.

The EMCPP should accomplish the following:

- Describe the organization which will manage the EMC program.
- Assign responsibilities for EMC.
- Provide authority for EMC-related actions.
- Specify the proposed implementation of the EMC program.
- Relate EMC tasks to the appropriate phases of the acquisition phases.

The EMCPP is to be updated to remain applicable to project EMC needs as the program progresses from conception to production and, eventually, to operation. Content requirements are provided in DI-R-7096.

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5.5 EMCAB. An EMC advisory board, hereafter called the EMCAB, can be established by the program manager as a major resource for review, advice and technical consultation on all EM aspects of the program. Experience has shown that a board should be established for all new platforms, platform modernizations and major complex systems.

5.5.1 EMCAB responsibilities. The EMCAB's responsibilities should be determined and defined when the board's charter is established. The responsibilities can include any or all of the following:

- Assist in generating the EMCPP.
- Assist in identifying and resolving potential operational EM problems that may be identified during the design, development or procurement.
- Participate in the scheduled design reviews during the development phase.
- Serve as a formal adjutant to the procuring activity's configuration control process concerning EMC matters.
- Review predicted and reported EM problems to determine their applicability as potential problems in the specific procurement.
- Direct required tasks and analyses, and report findings via appropriate channels for action.

5.6 Development of applicable specification requirements. The complexity of EM problems requires specification requirements tailored specifically to mission and mission requirements including the intended EM operational environment. It is through the application and tailoring of general military EMC standards that this can be accomplished. Compliance with general military EMC standards, by itself, can result, in some cases, in unnecessarily costly design-to requirements, and in others, requirements that are inadequate for a particular operational environment. EMC requirements must be tailored to specific needs with program risks and costs considered and trade-offs established. The application and tailoring of EMC standards and requirements is to be based on adequate analysis and should be initiated in the conceptual phase of system acquisition, updated, as required during the acquisition process. Tailoring of EMC requirements by program managers is reflected in the preparation of solicitation documents. Tailoring takes the form of deletion, alteration or addition to the EMC requirements. In tailoring the requirements, the depth of detail, level of effort required, and the output data expected should be defined. Subsequent tailoring of EMC requirements may be recommended by the contractor but is subject to approval by the Government during contract negotiations. The agreement reached on the engineering effort will be reflected in the resultant contract. Additional factors to be considered when tailoring are described in APPENDIX C.

5.6.1 EMC analysis and prediction. One of the most vital elements of the EMC program is analysis and prediction to identify and prevent electromagnetic problems. It is far less costly to analyze, predict, and control potential problems related to EMC at the outset than to be overtaken by problems late in the schedule - problems whose solutions are usually extensive, time-consuming and costly.

An EMC analysis should include the following:

- Intended operational EM environments
- System design concepts
- Mission requirements
- EM characteristics of interfacing equipments and systems
- Signal flow, power distribution and installation diagrams
- Equipment EM characteristics

The program manager will define the initial or baseline EMC requirements that will be included in the request for proposal (RFP) or invitation for bid (IFB) including anticipated uses or platforms for the item. The RFP or IFB should specify the tailored EMC requirements which the equipment or system will be required to meet (see APPENDIX B). Subsequent to an RFP or IFB, the bidder may determine the adequacy of the baseline requirements. If they are not considered feasible, the bidder may propose alternate requirements. The mission objectives, operational electromagnetic environment, minimum acceptable system functional requirements and desired technical performance as stipulated in the RFP or IFB should be examined for consistency and attainability.

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Subsequent to contract award, the contractor should be required to perform other analyses and predictions for critical items, including their simulation in the intended operational EME. Effective use of EMC analysis and modeling techniques can be made so as to provide the sufficient EM data and preclude the need for many specific tests which are usually called out for EMC programs.

5.7 Require EMI control plan (EMICP). EMICP's are required by MIL-STD-461 for equipment and MIL-E-6051 for aerospace and associated weapons systems. Content requirements for these control plans are specified in existing Data Item Descriptions (DIDs), DD Form 1664's, for these documents. The EMICP will not be prepared, delivered or updated, unless specifically required by the SOW and the Contract Data Requirements List (CDRL), DD Form 1423. When required by the contract, the EMICP is prepared by the contractor, submitted for review and approved by the program manager and EMCAB. The EMICP is a more specific technical document than the EMCPP. The EMICP is a document that identifies how all EMC requirements will be implemented. It contains summaries of parts of the EMCPP, where applicable, but also emphasizes the specific techniques to be employed in the system or platform of interest. It basically is a detailed, yet comprehensive, account of all those things which will be done in the EMC Program to ensure meeting contractual EMC requirements in the end product. The EMICP describes in detail the contractor's effort used for controlling electromagnetic environmental effects, beginning with program initiation, through final design and production, and throughout the operational life of the system being procured.

5.8 Test and evaluation. The objective of EMC testing is to obtain a reasonable degree of confidence that a system and its integral components will function in a specified manner in their intended operational environment. A measurement program is necessary to determine compliance with the contractual EMC requirements (intra-system and inter-system EMC, emission and susceptibility). Critical test points should be specified for circuits suspected of having low susceptibility margins and these circuits then categorized by degree of mission criticality. Measurements shall be made in accordance with the applicable military standards and an approved test plan. The data obtained by the various measurements form the basis for acceptance or rejection, and the action to be taken to correct operational deficiencies or malfunctions. Unless otherwise specified by the procuring activity, the contractor will be responsible for the performance of all tests required to demonstrate compliance with the contractual EMC requirements. The Government reserves the right to witness any of the tests in this or any of the referenced documents, when such tests are necessary to assure conformance with requirements. Additional information on Navy's Test and Evaluation (T&E) considerations is contained in APPENDIX D.

5.8.1 Test and evaluation master plan (TEMP). The TEMP is the controlling management document which defines the test and evaluation for each acquisition program. It contains the integrated requirements for the developing agencies for development, test, and evaluation (DT&E) and in the Navy, Commander, Operational Test and Evaluation Force (COMOPTEVFOR) for operational test and evaluation (OT&E), and the schedules and resources required for accomplishment. The TEMP is prepared early in each acquisition program and will be reviewed at least annually and updated as necessary to incorporate significant results achieved and changes in plans and milestones.

DT&E relative to EMC for the four major phases is as follows:

- During the conceptual phase to support initiation decisions to proceed with development.
- During validation phase to demonstrate that design risks are identified and acceptable to the procuring activity.
- During full scale development, it is crucial that tests demonstrate that the design meets the specified performance in the anticipated EME.
- After the first major production decision, to verify product improvement or correct deficiencies discovered during operational evaluation (OPEVAL), follow-on test and evaluation (FOT&E) or Fleet employment.

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OT&E to independently address EMC is not generally required. However, any OT&E testing should be conducted in the most realistic EME and have provisions for monitoring and reporting adverse EM effects. In the case of systems, Production Acceptance T&E (PAT&E) may be required to assure that the item meets requirements. For a platform (in particular ships) PAT&E is a vital part of the EMC T&E because this may be the first time all the equipment and systems can be tested and evaluated as a unit. Since T&E provides the basis for key decisions, the TEMP must be periodically reviewed to assure that the T&E is complete and comprehensive. For less than major programs, the T&E is governed by TEPs. The TEPs should cover the same aspects as the TEMP and be subject to the same review as TEMPs.

5.8.2 Request for approval for service use (ASU). The request for ASU states the results of the T&E conducted and plans for correcting deficiencies identified in technical and operational evaluations. The request for ASU must document the basis for assuring that the requisite EMC has been achieved. As such it must be reviewed to insure that the item is in compliance with the provisions of the Development Proposal (DP) and, for the Navy, the Navy Decision Coordinating Paper (NDCP).

5.8.3 EMC test plan. The content of the EMC test plan (procedures) for demonstrating compliance with contract requirements should be in accordance with applicable DIDs and the CDRL.

- Test plans are required by the various EMC standards; that is MIL-STD-462, MIL-STD-469 and MIL-STD-449 to verify compliance with the contractual EMC requirements. In general, the plans indicate measurement objectives, test configurations, test points, detailed measurement procedures, and the formats for recording data. The specific test techniques should be based on procedures in the EMC standards and specifications referenced in the contract. The test procedures should be described in sufficient detail to enable the procuring activity to duplicate the proposed methods.
- The contractor should be required to submit an EMC test plan conforming to its content requirements to the procuring activity for approval.
- Specific details regarding inter-system and intra-system EMC testing, and emission and susceptibility testing of equipment and subsystems provided by subcontractors must be considered and included by the overall system contractor in his test plan.

5.8.4 EMC test reports. The results of all EMC tests must be presented to the procuring activity for evaluation before acceptance of the equipment or system. The EMC standards and corresponding DIDs specify the content requirements for completely certified test reports. When required by the contract, the contractor will forward the test reports to the procuring activity for approval. The formats for recording and reporting test results have been established to aid in the analyses that follow. The EMC test report format must be in accordance with the DID. Omissions of apparently minor facts can render data worthless.

5.8.5 Off-the-shelf equipments. Off-the-shelf equipments should be tested during the screening process to assure compliance to their EM requirements. Because of the peculiarly stringent military environments, many commercial off-the-shelf equipments will require additional techniques and careful installation control to assure compatibility with the military EME. Some commercial equipments which show susceptibility to damage in military EM environments should be disqualified if damage occurs during normal operations. If adequate protection cannot be provided economically, additional tests must be performed to demonstrate satisfactory operation.

5.8.6 Retrofit and new design. The program manager should require his contractor to prove by analysis or by demonstration that any equipment changes during retrofit procedures have no adverse impact on the EMC characteristics of the equipment, system or platform being retrofitted. The contractor may have to repeat the previous tests.

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5.9 EMC configuration management. A Configuration Management System will normally be required, approved and monitored by the program manager in accordance with DOD-STD-480. EMC must be included in the overall configuration management program.

To provide for the effective implementation of EM Configuration Management the following actions are necessary:

- Introduce, at the appropriate time, the degree and depth of EM configuration control necessary for production and logistic support of deployed operational systems
- Provide specifications, engineering drawings and related technical data adequate for EM configuration needs
- Provide verified EM configuration technical documentation
- Maintain EM standardization and compatibility
- Analyze the total impact of EM engineering changes upon performance, cost and schedules
- Control physical and functional EM interfaces
- Ensure timely processing of EM-related ECPs

The procuring activity may require the contractor to perform EMC Configuration Audits performed in conjunction with system audits so that system trade-offs may be recognized. See APPENDIX G for a further discussion of configuration management.

5.9.1 Waiver action. The procuring activity will take action and process the requests for waivers in accordance with their departmental EMC directives, regulations, or instructions and applicable contractual documentation, such as DOD-STD-480. Usually the most difficult aspects to determine are the side-effects of the waiver, if granted, and the cumulative effects of a multiplicity of approved waivers. The contractor must demonstrate that the failure to meet EMC contractual requirements is not due to his own neglect in employing EM principles in conceptual design; and further that he has attempted to locate and remedy the fault, before a waiver will be considered. These effects, if not controlled, can degrade the end product. The contractor's waiver request will consider but not be limited to the following factors; however, the granting of a waiver is not automatic:

- The number of units involved
- Cost and weight considerations
- Effect on delivery schedule
- Effect on power requirements
- Measured radiated and conducted emission levels and their effects on all associated equipment, subsystems, and systems
- Measured radiated and conducted susceptibilities and the resulting degradation of performance
- History of previous waiver actions
- Assessment of impact of waiver on total system performance, as installed and operated in its intended EME.
- Effect of measured levels on input and output signal characteristics.
- Effect of proposed waiver on reliability and other system or equipment characteristics.
- Logistics impact of waiver

5.10 EMC training. EMC techniques and the consequences of incompatibility must be known, understood and accurately communicated in order to avoid degraded operational performance. This includes knowledge of emission characteristics and susceptibility mechanisms of equipments and systems. This is especially true where the operator and service technician are concerned. Therefore, the manager responsible for the development and acquisition of a system or equipment should require that the training plan developed when introducing new or modified systems or equipments provides for EMC training, including techniques and procedures for maintaining the platform's EMC. Any training aids, manuals, special instructors, and so forth required for EMC must be programmed and funded for as part of the overall procurement package. If the contractor is to provide initial training, the plan must define how the training community is

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to assume responsibility for the maintenance of the training aids, manuals, and so forth. Technical publications should address operator and maintenance actions required to ensure that EMC features are not compromised during use. Furthermore, the training publication should describe how EM problems can manifest themselves in the item and the possible effect on performance. These publications will eventually serve as a basis for training of all personnel who use or maintain the system or equipment, hence the importance of EMC.

Furthermore, planned maintenance procedures for the system or equipment should be reviewed and modified, where necessary, to include guidelines for identifying and preventing EM problems. Those guidelines can be used later in the Overall Combat System Operability Test (OCSOT). See APPENDIX E for more details on EMC training.

6. NOTES

6.1 Deliverable data items requirements. When this handbook is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Defense Acquis-tion Regulation (DAR), the data requirements identified herein will be developed as specified by the approved DID, DD Form 1664 and delivered in accordance with the approved CDRL, DD Form 1423 incorporated into the contract. When the provisions of DAR 7-104.9(n) are not invoked, the data specified herein will be delivered by the contractor in accordance with the contract requirements. Deliverable data required by this standard are as follows:

Paragraph	Data requirement	Applicable DID
5.4	Electromagnetic Compatibility Program Plan	DI-R-7096

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Custodians:
Army - CR
Air Force - 11

Review activities:
Army - AV, AR, AL, SC, MD
Navy - AS, OS, SH, TD, MS
Air Force - 17, 68, 99

User activities:
Army -
Navy - YD, MC
Air Force -

Other activities:
NA
ECAC

Preparing activity:
NAVY - EC
(Project EMCS-0083)

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APPENDIX A

EM ENVIRONMENT

10. General. One of the basic objectives of the DoD is to provide equipments and systems whose performance will not be adversely affected by the EME during all phases of the equipment or system life cycle. The effects may be either permanent, in which case the system will not operate until the problem has been corrected, or temporary, in which case the system will operate in a degraded mode when the emissions are present. Examples of the different effects which can be produced, depending on the victim, are:

- Burnout or voltage breakdown of components, antennas, and so forth.
- Performance degradation of receiver signal processing circuits.
- Erroneous or inadvertent operation of electromechanical equipments, electronic circuits, components, ordnance, and so forth.
- Unintentional detonation or ignition of electro-explosive devices, flammable materials, and so forth.
- Personnel injuries.

The effects on a given victim in a specific EME depend on the victim susceptibility characteristics and the amplitude, frequency and time-characteristics of the environment. To prevent these problems, it is imperative that the possible effects of the EME on each new equipment system or platform be considered. A requirement to demonstrate satisfactory performance in a defined environment should be included in the system or equipment specification.

20. Contributors to the EME. The EME is created by a multitude of sources. Primary contributors are own forces and friendly transmitters, enemy transmitters, electromagnetic pulses (EMP), spurious emissions from own equipment such as motor noise and intermodulation products from ship topside nonlinear interactions (rusty bolt effect), and natural sources such as lightning, static, or atmospheric noise (see FIGURE 2). The dominant contributor to the environment will depend upon locale and circumstances. For example, during normal noncombat operations, primary sources of emissions would be own and nearby units' transmissions and intermodulation sources. In an attack scenario, enemy transmitters would be an added major contributor. Hence, the environment in which equipment must survive and operate in is use-dependent and scenario-dependent.

30. Victims of the EME. There are two basic causes of adverse EME effects. One results from undesired energy entering through intended avenues of entry (antenna, transmission line) into systems, equipment or devices that by intent use EM energy. The second results from unintended entry and response. Degradation of receivers can result from either responses caused by signals outside the intended frequency band or undesired signals in the operating frequency band. Elimination of the first cause is primarily a receiver design problem; the second cause is much more difficult to resolve, since it involves not only design but control of frequency use and spurious emissions as well. Although the control of problems resulting from the unintended reception of energy is primarily a design consideration, it also involves control of the EM environment that equipment and personnel must operate and survive in by appropriate installation practices or operational constraints.

40. Determination of the EME. One of the difficulties of specifying the performance of a system, from the standpoint of electromagnetic compatibility is that in many cases the characteristics of the intended operational electromagnetic environment are unknown quantitatively. The factors specified in 40.1 through 40.6 must be considered when defining the anticipated EM environment for a system or platform. (Additional information is available in MIL-HDBK-235.)

40.1 Environment profile. Each equipment, system and platform will be exposed to several different electromagnetic environments during its life cycle. MIL-HDBK-235 is intended for use in defining representative environment levels to which each may be exposed. It is necessary to define each distinct environment. For example, a missile will be exposed to different environments during shipment, storage, checkout, launch, and during approach to a target.

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40.2 Configuration. The configuration of a system or equipment will vary depending on its intended location with the result that its susceptibility to the electromagnetic environment will also vary. Therefore, in developing the performance requirement the configuration in each of the environments defined should be identified.

40.3 Operate vs. survive. It is also important to distinguish between the conditions of operate and survive. There is usually a significant difference between the environment levels that will degrade performance and the levels that will permanently damage. In addition, there are many precautions that can be taken to protect an equipment from damage when it is not operating that are not feasible when it is operating.

40.4 Susceptibility. The susceptibility characteristics of the equipment or system may be different depending on the design characteristics. The item may be frequency selective or may respond to a broad frequency range. Certain victims have response times in milliseconds and are affected by short-term, peak levels in the environment, whereas others are affected by heating and may respond more slowly to average signal levels. All of these characteristics as well as the shielding integrity, choice of components and use of filtering must be considered when evaluating the effect of the electromagnetic environment on the equipment or system.

40.5 Future considerations. The definition of the EME which a system or equipment may encounter should also include consideration of any possible future applications of the system or equipment and changes in the environment. Equipments designed to operate in one environment may be installed in another, or used to perform functions and missions that were not planned when the equipments were originally designed. Therefore, it is important to realize that although the cost of an equipment or system may increase when a severe EME is predicted, the increase may be justified in terms of adaptability for future applications.

40.6 Conditions precluding exposure. When defining the applicable EME within which an equipment or system will be required to survive and operate during its life cycle, any operational or installation conditions which can preclude exposure to this environment and any additional information which may affect the exposure to the environment should be considered. For example, the complement of intentional emitters on a platform or site will provide an indication of those frequency bands where high environment levels can probably be encountered. Furthermore, dimensional restrictions and intervening structures may exist thereby causing a system or equipment to operate in the near or induction field region of an antenna. Other factors which must be considered are its platform usage, and operational use.

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APPENDIX B

PREDICTION AND ANALYSIS

10. Introduction. In order to succeed in achieving the required EMC and to permit efficient use of the frequency spectrum, it is essential that Program Managers, engineers, technicians, and users responsible for the planning, design, development, installation, and operation of electrical and electronic equipments employ suitable prediction and analysis techniques. These techniques permit them to identify, localize, and define EM problem areas prior to, rather than after,expenditures of time, effort, and money. More timely and economical corrective measures may thus be taken. Techniques used for system EM prediction are significantly different from techniques used for analyzing equipments. In system prediction, the analyst is interested in determining inter-actions among various equipments. It is only necessary to define the output characteristics of EM sources and the susceptibility of receiving equipments. Consequently, it is not necessary to know detailed internal characteristics of equipments. Thus, in system EM prediction, the individual elements can be regarded as black boxes with defined input-output characteristics. On the other hand, in analyzing equipments to determine their EM properties, the analyst must consider the detailed characteristics of components and circuits that comprise the equipment.

20. Stages of EM prediction. Careful application of prediction and analysis techniques at appropriate stages of the system life cycle will ensure the required EMC without either the wasteful expense of over-engineering or uncertainties of under-engineering.

20.1 Concept development and validation phase. During the concept development and validation phase, the equipment or system concept is defined in its most basic form. This could be the result of an idea that originates at a research laboratory or in response to an operational requirement. It then progresses to the definition and specification of the major system characteristics such as size, weight, type of modulation, data rate, information bandwidth, transmitter power, receiver sensitivity, antenna gains, spurious rejection, and so forth. It is essential that the program manager give careful consideration to EMC during the conceptual phase because the major characteristics of equipments and systems are defined and specified at this point in time.

During these phases, the program manager should predict and analyze EM problems that are likely to be encountered: (1) within or between elements of the system (intra-system); (2) between elements of the system or platform and elements of other systems or platforms that are likely to be operating in the same general area (inter-system); and (3) between elements of the system or platform and the electromagnetic environment in which it is to be operated.

In the case of inter-system, primary problems usually result from signals that are coupled from a transmitting antenna of one system to the receiving antenna of another system. This inter-system problem is particularly serious when a number of systems are required to simultaneously operate in a limited physical area, such as a ship, an aircraft, a vehicle, military base or facility.

The types of predictions that are performed during these phases must rely on assumed or typical EM characteristics for the individual elements of the system. Concentration is directed to the manner in which these elements interact in the total system from the EM standpoint.

EM prediction during the conceptual phase will assist the program manager in his selection of frequency bands; allocation of system parameters such as transmitter power, antenna gains, receiver sensitivity, type of modulation, rise times, and information bandwidth; determination of EM specifications; and identification of potential deficiencies and problem areas.

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20.2 Full scale development and production. During the full scale development and production phases the system progresses from the previously established specifications to the final hardware item. In the process of designing a system, there are a number of decisions that must be made by the program manager and design engineer. In general, an equipment may be considered to consist of combinations of certain functional stages, such as amplifiers, mixers, or frequency converters, filters, modulators, detectors, display or readout devices, power supplies, and so forth. For each equipment, there are a number of important factors including EMC that are considered. For example, in the case of receivers, it is necessary to define the number of amplifier and converter stages that will be used, and to establish the allocation of gain, selectivity, and sensitivity between these stages. More importantly, it is necessary to develop an overall block diagram for the receiver with a complete description of the gains, frequency responses, input and output impedances, dynamic range, and susceptibility levels for each stage.

Personnel responsible for the management, design and development of a system are primarily concerned with intra-system EM problems. As a result, they must be concerned with EM problems resulting from signals externally coupled to different elements of the system, as well as internal EM problems resulting from cable coupling, case radiation, case penetration, and the like.

20.3 Deployment. During the final phase in the life cycle of the equipment or system, the equipment or system that has been designed and developed is put into operation. It is necessary to consider EMC from various operational aspects, such as siting effects, frequency assignment, effective radiated power limits, and antenna coverage. This is more generally referred to as operational inter-system EM control through frequency management and time sharing.

In general, the types of prediction that are useful at the operational level are similar to those performed at the system definition level. Usually, personnel responsible for compatible system operation are more concerned about inter-action of elements of the system, both with each other and with elements of other systems, than they are in the internal characteristics of the elements. Thus, at the operational level the primary EM problem involves signals that are coupled among elements of either the same or different systems.

30. EM prediction techniques. There exists both a number of different applications for EM prediction and a number of different types of applicable techniques. In general, the particular type of EM prediction techniques to be selected depends on the specific application, the type and quality of input information available, and the cost to perform the prediction.

Cost is certainly one of the most important factors that must be considered in deciding on the specific prediction techniques to be selected and applied in a particular problem. The costs of developing a prediction process and performing the prediction can also vary considerably depending on the specific type of problem, the number of equipments involved, information available for these equipments, and the extent to which it is necessary to evaluate the impact of EM on operational performance. If EM predictions are performed the necessary mathematical models and analysis processes may already be assembled. Most of the time is then spent in collecting data on the transmitter(s), receiver(s), antenna(s), and terrain profiles involved.

When EM prediction and analysis is performed frequently, automating the process should be considered for economic reasons. For telecommunications equipment this process can be used in conjunction with manual performance data available through the FCC, the Electromagnetic Compatibility Analysis Center (ECAC) and other sources to provide useful results at a minimum cost.

40. Applications for EM prediction. EM prediction provides an engineering tool available to the program manager that is a valuable asset in various phases of system or equipment development, such as:

- Preliminary system or equipment planning and design
- Preparation of system or equipment requirements and specifications
- Preparation of specification compliance test plans
- Evaluation of test results
- Revision of either specifications or equipments for conditions of non-compliance
- Evaluation of systems in a specific operational environment.

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Typical problems that may be handled by EM prediction and analysis include:

- Examine the EMC situation for a complex of equipments and identify problem areas.
- Examine the impact of changing the operating frequency of one or more equipments in the complex.
- Examine the impact of adding a transmitter to an existing complex of equipments.
- Examine the interference produced in a receiver when added to an existing complex.
- Determine which one of several possible locations for a transmitter or receiver provides the least probable interference.
- Determine the source and cause of a known EM problem.
- Determine the type and degree of suppression required to correct a specified EM problem.
- Obtain susceptibility information for a given receiver or a group of receivers.
- Determine propagation loss over a specified path.
- Assist in the selection of system parameters such as power, gain, sensitivity and selectivity.
- Provide information regarding the adequacy of given specifications for an equipment.
- Provide information as to the best frequency band to use for a system which is being defined.
- Provide information on frequency-distance separation requirements for co-site equipments.
- Perform frequency assignments for compatible operation.
- Evaluate system effectiveness in an operational environment.

For each of the applications listed above, the prediction requirements, input information available, and output results desired may be significantly different.

50. Types of EM prediction. Different types of EM prediction may be performed. The type that is optimum for a particular problem will depend on the specific application desired, the information available, the extent and depth of prediction required, the output results desired and cost considerations. The following represent typical types of prediction that may be performed.

- A preliminary prediction at the system definition stage to identify potential EM problem areas and to define equipment EMC specification requirements.
- A prediction based on statistical summaries of data to identify potential EM problems between classes of equipments.
- A prediction based on specification limits to determine their adequacy for assumed operational configurations of systems.
- A prediction of system performance or operational effectiveness to define the effect of EM on the overall ability of a system to accomplish its objectives or missions.

Each of these predictions differs in terms of the system life cycle phase at which it may be applied; the type and amount of information required; the time, manpower, and cost required to perform the prediction; and the results obtained.

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APPENDIX C

TAILORING GENERAL EMC STANDARDS TO EM OPERATIONAL REQUIREMENTS

10. Introduction. The basic step in any engineering effort is to define an end product that will satisfy an operational requirement. The product becomes more precise as more detailed data becomes available. The program manager requires EMC inputs to develop technical specifications tailored to operational requirements to provide cost-effective EMC design. The EMC inputs can provide invaluable guidance to the program manager early in the conceptual phase of system development for use in determining the feasibility of meeting various electromagnetic requirements and presenting alternative means to achieve the desired results. These early feasibility and trade-off studies will save considerable effort later.

20. Operational EME. While operational environment properly includes the entire EM situation in which a system is to be placed, such a definition would be prohibitively expensive to acquire and would be too voluminous to handle. It is more practical to restrict the gathering of the data to all those systems and equipments which could interfere with intended operations and performance.

30. Platform EME. The platform EME is composed of the EM characteristics of the total parts of all the systems and subsystems within the platform. The definition of the platform environment is dependent upon the detailed system and subsystem information supplied to the EM analysis group. An initial gross analysis will indicate where further detailed analysis is required. Refer to MIL-HDBK-235 for general information on maximum EM environment characteristics.

40. Definition of EM operational requirements. As early as possible in the conceptual phase of system development, the program manager should require the users, engineers and system developers to (1) provide information which can impact on EM considerations, and (2) include this information in the definition of system development. This information should be updated as more precise information becomes available.

The following is a typical checklist which may be used (with modifications as necessary) for gathering the kind of information needed for defining EM operational requirements and environment

(1) What is the system intended to do?
(2) Is it tactical? mobile? transportable? fixed plant? strategic? target-dependent?
(3) Does it stand alone, or is it part of a larger system?
(4) What are the signal inputs and outputs, and their range of frequency and power?
(5) What are the frequency constraints and requirements?
(6) What are the basic power requirements?
(7) What are the range and power requirements?
(8) What is the sensitivity requirement for the receiving equipment?
(9) Where will the system be used?
(10) What will the platform EM environment be?
(11) Is the system required to operate continuously or intermittently?
(12) Are there any location, size, or weight restrictions?
(13) When is the system to be operative?
(14) How will the system be maintained, operated, and supported?
(15) To what extent is the system manned during operation?
(16) What are the classification aspects of the system and its application?
(17) Will classified information be accessible in clear-text form at any point?
(18) Is the system critical to some military operation; and if so, what?
(19) Are there critical sequences of operations involving this system?
(20) To what extent will malfunction affect mission success or personnel safety?
(21) What is the medium of the transmission?
(22) How is the system matched and coupled to the medium?
(23) If antennas are involved, what special characteristics should be considered?

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(24) Is the system active or passive (that is, does it transmit, receive, or both)?
(25) Is signal processing equipment required?
(26) With what equipments does the system interface directly? Indirectly?
(27) What modulation system will be used?
(28) What waveforms are involved?
(29) What are the frequency and spectrum requirements?
(30) What sensitivity and resolution are required?
(31) What are the minimum threshold responses, both amplitude and duration?
(32) What are the accuracy requirements?
(33) Is this an analog or digital operation?
(34) Are there any special remote control requirements?
(35) In what type of facility is the equipment to be installed?
(36) What other equipment will be in the same installation?
(37) Are there any inherent, definable problems expected as a result of grounding systems used?
(38) Are there space-available problems to be anticipated?
(39) Are there any special co-site problems anticipated?
(40) What are the inherent shielding characteristics of the installation?
(41) Will the system or equipment be exposed to enemy electronic countermeasures (ECM)?

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APPENDIX D

CHECKLIST FOR MAJOR EMC T&E PLANNING CONSIDERATIONS(NAVY)

10. Introduction. This Appendix is intended to be used by Navy activities as a checklist of the major EMC T&E planning considerations and their inter-relationships. It is not adequate simply to go through the checklist once and initiate action in each of the areas. All significant changes to the configuration and each major milestone should trigger a review of the EMC T&E planning checklist to determine if the individual steps need to be modified or updated.

20. Planning the T&E approach. The following factors should be considered when planning the overall T&E approach for a project:

- DT&E should be planned to resolve EMC risks, evaluate alternative design approaches and assist in selection of hardening components such as shielded cables, filters, and so forth.

- Have appropriate DT&E and OT&E tests been planned, such as:

  (1) EMC tests as specified in applicable standards such as MIL-STD-449, MIL-STD-462, MIL-STD-469, MIL-STD-1605 and so forth?
  (2) If an electronic equipment or system is to be utilized in locations where it will be subjected to high EM environments such as weather decks or when exposed to mainbeam, tests should be performed to demonstrate satisfactory operation in these high environments.
  (3) T&E for EMP should be conducted when the operational requirement (OR) states that the item is to survive and operate in a nuclear environment.
  (4) Adequate tests should be planned to verify effectiveness of proposed spectrum control and utilization techniques.

- For ordnance, have HERO tests been planned for those items containing Electro-Explosive Devices (EEDs) or some other type of electronically or electrically initiated or controlled explosive train?

- For systems or platforms being considered for utilization, are sufficient data available to assess their compatibility? If not, is DT&E planned to acquire such data?

- Is there a plan to establish relationships between test data and operational effectiveness?

- Will test results provide sufficient information to perform vulnerability analyses? This may be established by having rationale which relates specific test data required to the various steps in process. Vulnerability analyses shall be presented in terms of operational performance parameters such as time between false alarms, detection ranges, CEP, PK, and so forth.

- Items should be tested with all transmitters and receivers normally required for simultaneous operation being operated. This includes all receivers and transmitters on the item as well as those on the same or nearby platforms.

- For those systems which cannot be protected from all operational environments, OT&E tests shall be performed to exercise the item in that environment to determine if performance is acceptable.

- Are adequate test facilities available? Is special training required in regards to operation of test equipment or system or equipment being tested?

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- Costs for analysis of test results in terms of expected operational performance is often equivalent in scope to the data collection effort itself.

- Any observed deficiencies in EMC must be weighed against operational performance in terms of need, urgency, risk and worth. If there is a need for more effective control, then the application of alternative design techniques will require additional T&E.

30. Feasibility studies during the conceptual phase. Although the feasibility studies themselves are not truly T&E, it is during the conduct of these studies that the greatest impact can be made on the future status of EMC. The use of previous T&E results, operational information on similar problems, studies, and reference to the corporate memory of lessons learned can have profound impact upon the future control of the EM environment. It is during these studies that important decisions can be made relative to critical configuration arrangements and dimensional relationships.

40. Analytical studies. Whenever possible, maximum use should be made of data acquired from previous EM predictions and operational experiences, although in many areas, changes to the design may have rendered the previous predictions invalid. Previous EM predictions should be analyzed in relation to the current design to determine which predictions are still applicable and which require revision and to identify those areas requiring further prediction and analysis.

As the design changes from the baseline configuration, additional EM predictions may be performed to provide inputs for preparation of an EMC Impact Statement addressing these changes. Additionaly, it is probable that changes will continue to be made to the design until the time of, and even after, its delivery. The need for EM predictions is, therefore, continuing, and these predictions should be accomplished whenever a major change to the design, or configuration, is anticipated.

Finally, EM predictions may be used to initiate early testing to verify the existence of a major problem and to permit an early start on technically sound engineering solutions.

50. Model studies. Model study techniques have been refined to the point where they constitute rate and reliable prediction tools. As the design changes from the baseline configuration, ay be necessary to update the model study. It is vital that management procedures ensure all participants, from the analyst to the equipment installer at the outfitting dock, operating with the same and latest information.

60. Test and evaluation master plan TEMP. The TEMP, or for smaller programs, the TEP, is the controlling planning document for T&E.

The TEMP prescribes the test and evaluation, including EMC testing, for each program. As such, it contains the integrated requirements for DT&E and OT&E, together with the schedule and resources required for accomplishment. The TEMP identifies critical issues; test plans are developed to verify and test for these critical issues.

The TEMP is normally prepared by the program manager, in conjunction with OPTEVFOR and INSURV when appropriate. The TEP format is generally the same as that prescribed for a TEMP, except that all elements need not be included. OT&E, as well as other selected elements, depending on the nature of the product, may be excluded from TEPs. The OT&E portion of the TEMP is prepared by COMOPTEVFOR.

The TEMP (or TEP) should provide for appropriate EMC testing. Approval of the TEMP (or TEMP revision) constitutes direction to conduct the T&E program and includes the commitment of the Research, Development, Test and Evaluation (RDT&E) support. Failure to update the TEMP, as required, can result in inadequate T&E resources.

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Plans for DT&E and for PAT&E to be conducted by the program managers will be drawn up directly from the TEMP or TEP. A T&E Coordination Group (TECG) composed of the coordinator, the development coordinator, the project manager, the OPTEVFOR Operational Test Director, and others, as appropriate, may be established for complex programs which may require extensive coordination.

60.1 Review guidelines for TEMP. Specific guidelines which may be used for the preparation of TEMPs are provided below

Questions	Considerations
System Description and Mission*	
1. Is system and its mission described adequately to determine the need for various tests?	1. All electronic or electrical equipments, sybsystems, systems and platforms must be subjected to EMC.
	2. If an item is to be utilized in locations where it will be subjected to high EME such as encountered on weather decks or when exposed to mainbeam, T&E shall be performed to demonstrate satisfactory operation in the high EME.
	3. If the operational requirement (OR) states that the item is to survive or operate in a nuclear environment, then EMP T&E is required.
	4. If the item could be subjected to ECM, Electronic Counter - Countermeasures (ECCM) tests shall be conducted.
	5. If the item will be deployed where emission control (EMCON) radiation levels and EMCON recovery time are important, EMCON tests shall be performed.
	6. Does item contain EEDs or some other type of electronically or electrically initiated explosive train initiation that would require hazards of electromagnetic radiation to Ordnance (HERO) statics tests?
	7. If item is to be utilized for an airborne application, lightning and static effects should be investigated.
	8. If any of the above requirements are waived, what is the rationale for the waiver?
Critical T&E Issues	
1. Has T&E been planned in DP or NDCP to evaluate risks associated with exposure to electromagnetic energy?	1. Provide rationale if T&E is not required for resolution of risks.

* This and subsequent Roman numerals refer to outline format for TEMP as in OPNAV Instruction 3960.10, Enclosure (3), Tab A.

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Operational Suitability Effects on or from the EME

Questions	Considerations
1. Has the required degree of immunity to interference been specified along with acceptance criteria?	1. What is criteria for acceptable performance when item is exposed to EME?
	2. Will test results provide sufficient information to relate EMC to operational suitability?
	3. Will adequate tests be performed to demonstrate effectiveness of the spectrum control and utilization techniques to be incorporated into receivers or transmitters?
	4. If T&E for EMC will not be conducted on production item, provide rationale for assuring that production item will have the same EMC characteristics as the tested item.
2. Is there a plan to establish relationship between test data and operational effectiveness?	1. Vulnerability analyses shall be presented in terms of operational performance parameters such as degradation of time between false alarms, detection ranges, intercept ranges and so forth.
DT&E to Date**	
1. Have any required tests been bypassed as a result of waivers?	1. What was rationale for granting waivers?
	2. What is potential operational impact of not having test data?
2. Has there been any evidence of susceptibility?	1. Have all tests planned to date been performed?
	2. Have susceptibilities been properly evaluated in terms of operational performance according to evaluation criteria provided in TEMP?
3. Have systems been modified for any reason from configuration on which EMC T&E was performed?	1. Does modification require T&E?
	2. If required, has modified system been retested?
	3. Has modified system successfully passed tests?
	4. Have tests been performed to evaluate possible changes in other operational parameters that could have been changed by modification?

** Applicable to TEMP update.

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Questions	Considerations
Future DT&E 1. Have required types of T&E been addressed in TEMP?	1. If item is a platform, system or subsystem which utilized various auxiliary support equipment (such as an aircraft with ground support equipment (GSE)), it should be tested with and without support equipment attached with equipment and platform in various modes of operation.
	2. To maximum extent possible, laboratory bench tests shall be utilized in support of technical evaluation (TECHEVAL) and OPEVAL by providing information related to grounding, leakage paths and relative effects of various modulation parameters, and so forth.
2. Has EME simulation been adequately addressed?	1. Full threat-level facilities may be necessary for investigating certain nonlinear EM effects responses such as occur with electromagnetic vulnerability (EMV). However, in most cases, including EMP and HERO, extrapolation to some extent is possible. If full threat-level testing will not be performed, is the rationale available for this decision?
3. Will those systems that have targets be tested with various target parameters?	1. Will measurements be made with different target intensities, for example, source strength for an infrared type item, contrast ratios for a TV type or signal levels for a radio frequency (RF) type item missile or radar receiver?
Critical Items 1. Has the availability of test equipment facilities, and trained support personnel been determined?	1. Are adequate facilities available?
	2. Can full threat levels, as required, be achieved at available facilities?
	3. Are facilities with deficiencies being upgraded or tailored to these particular test requirements?
	4. Have long-lead support equipments been properly scheduled?
	5. Has special training been planned for test personnel in regards to operation of test item or support equipment?
	6. Are adequate number of test items provided?
	7. Are test item and test facility schedules sufficiently flexible to allow contingencies based on test results?

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Questions	Considerations
OT&E to Date	
1. Have any desired tests been bypassed as a result of test limitations or schedule conflicts?	1. What is possible operational impact of not having test data?
	2. What is rationale for not performing tests?
2. Has there been any evidence of RF susceptibility?	1. Have susceptibilities been properly evaluated in terms of operational performance according to evaluation criteria provided in TEMP?
Future OT&E	
1. Are tests being planned to evaluate item under most realistic conditions possible?	1. Items should be tested with all transmitters and receivers normally required for simultaneous operation being operated. This includes all receivers and transmitters on the item as well as those on the same or nearby platforms.
	2. Unless previously checked, platforms, systems or subsystems which utilize auxiliary support equipment shall be tested with and without equipments attached with equipments and platform in various modes of operation.
	3. For those systems which cannot be protected from all operational environments, tests shall be performed to exercise the item in that environment.
	4. What rationale has been utilized for the selection of ECM parameters during OT&E?
2. Have results of DT&E been utilized for planning OT&E?	1. If DT&E has revealed potentially troublesome areas related to EME effects, has OT&E been planned to evaluate operational impact?
Critical Items	
1. Has availability of specialized test equipment and facilities been programmed?	1. Equipments such as those required for implementing ECM on target are long lead times.
2. Have plans been made to train personnel to recognize adverse EM effects?	1. Have arrangements been made, as applicable, to monitor EMCON effectiveness?
	2. Special training is required to distinguish EM problems from other operation problems.
PAT&E	
1. Has evaluation of inter and intra-system compatibility been addressed?	1. Operate transmitters and receivers on adjacent channels to identify potential problem areas.
	2. Simultaneously operate receivers and transmitters to demonstrate total platform compatibility.
	3. Identify intermod products generated from various transmitter-receiver interactions or resulting from the rusty-bolt phenomenon.

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Questions	Considerations
2. Include T&E for EMC in total ship test plan (TSTP).	1. Review prior considerations of TEMP to determine those applicable to ship acquisitions.

70. Development test and evaluation (DT&E). DT&E of Naval systems is planned by, conducted by and for, monitored by, and reported by the Program Manager. The Program Manager should establish liaison with OPTEVFOR to ensure an understanding of the DT&E program, and to identify and integrate OT&E requirements. Significant DT&E test data, together with the associated EMC analysis, should be provided to COMOPTEVFOR. A final step in a successful DT&E program is certification that the system is ready for OPEVAL.

70.1 Preinstallation testing. Preinstallation testing is conducted to ensure that the integral components of a system function in a specified manner in their intended EM environment. Test programs should be designed to verify compliance with contractual EMC requirements. The test plans should indicate measurement objectives, test configurations, test points, detailed measurement procedures, and the formats for recording data. The specific test techniques should be based on the general procedures in the EMC standards. Preinstallation testing includes the following as applicable:

- Engineering development testing
- First article testing
- Acceptance testing
- Integration testing
- Spectrum signature testing

Preinstallation testing may be conducted by Government laboratories, centers, or facilities, or it may be required of prime contractors, sub-contractors, or vendors.

70.2 Shore-based test site testing. Shore-based test site testing of complete systems is a most valuable part of DT&E. Based upon recommendations of the Naval Material Command, the CNO will determine when the total system complexity warrants construction of a land-based test site. Insofar as possible, testing at land-based test sites should include EMC considerations. For ships whose complexity does not warrant construction of a land-based test site, DT&E and Initial Operational Test and Evaluation (IOT&E) will frequently consist only of T&E of individual unproven systems. For these situations EMC considerations will be addressed through engineering analysis, mathematical and brass modeling, specific system-to-system interface tests, and planning for the earliest possible EMC testing of the complete platform.

70.3 Ship construction testing. Ship construction testing is conducted by the prime contractor. It is important that management procedures provide for appropriate Navy observation of critical tests and that installation check out testing provide for EMC demonstration tests in the EM environment.

70.4 Builders trials. Builders trials are conducted by the prime contractor and are observed by the Navy. They should include the requirement for EMC demonstration tests of complete systems.

70.5 Aircraft flight safety testing. Aircraft flight safety testing is conducted by the prime contractor and is mandatory for acceptance of the aircraft by the customer.

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80. Operational Test And Evaluation (OT&E). OT&E is conducted by COMOPTEVFOR using Navy operating personnel, and insofar as practicable, Navy support. The tests are designed to demonstrate the achievement of program objective for operational effectiveness and operational suitability. In addition, tests are conducted for the purpose of tactics development. OPEVAL is usually scheduled to begin about one month after the completion of DT&E.

The program manager supports OPEVAL testing and is responsible for ensuring that the planning, programming, budgeting, and funding of all resources identified in the approved TEMP for all T&E through DT&E conducted after the first major production decision (DT-IV), and for OT&E conducted after the first major production decision (OT-IV). However, he is not responsible for:

- Fleet travel and operating costs for RDT&E support.
- OPTEVFOR travel and nonprogram administrative costs.
- PREINSURV travel and nonprogram related costs.

90. Production acceptance test and evaluation (PAT&E). PAT&E is defined as that testing conducted on production items to demonstrate that systems meet contract requirements. Most PAT&E is the responsiblility of the Program Manager. However, acceptance trials of new construction, or major conversion, ships are the responsibility of PREINSURV. The specific objectives of PAT&E are included in the TEMP.

100. Total ship tests (TST). The completion of the Total Ship Test Program for Active Fleet Ships (TSTP/AFS) provides for comprehensive tests which will determine the readiness status of equipments, single systems, or integrated ship systems during the life cycle of a ship. Test programs are developed, verified, and proven under the direction of the Total Ship Test Director (TSTD), Test Procedures Development Managers (TPDMs), and Test Procedures Development Agents (TPDAs). The TSTP is designed to provide Fleet personnel and industrial activities with the capability, utilizing standard tests developed in the Planned Maintenance Sub-System (PMS), for determining the condition of material readiness of shipboard equipment and systems. Each TSTP will provide for appropriate EMC testing.

The project manager is responsible for supporting the development of the TSTP, with the objective of providing a complete package of PMS procedures at the time of Fleet introduction.

110. Aircraft testing. The purpose of this test is for the contractor to demonstrate the performance and compatibility of the aircraft as well as its ability to perform its mission.

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APPENDIX E

EMC TRAINING

10. Introduction. All personnel involved in the development, procurement, and operation and maintenance of military equipments making use of the EM spectrum, should be able to apply an awareness of EMC requirements and principles to their tasks. An effective EMC training program established by the manager is essential for developing this awareness and should provide for

- Training of program managers, designers, engineers and technicians in analytical design and production methods and management techniques for achieving the required EMC.
- Training of operational and maintenance personnel in field techniques to recognize degradation of performance due to EM energy and to optimize and maintain for EMC.

A well-implemented training program can be helpful in preventing potential EM problems discovered during the acquisition process. There are some cases where adequate hardware fixes for EM problems are just not available or feasible, either because of the state-of-the-art in EMC technology or because of prohibitive costs. For many of these problems, however, operational procedures can be used to eliminate, or at least to reduce, the severity of the problem. Such operational procedure fixes can include reduction of transmitter power for certain circumstances, avoiding the use of certain frequencies, or use of a different antenna for a communications circuit. These procedures may be discovered to be the only way in which a certain EM problem can be reduced to acceptable limits, yet they may be new to Fleet operators and even in conflict with what has been considered common operating procedure. Proper training is the only way to ensure that the Fleet personnel will use and understand these newly developed techniques.

20. EMC training responsibility. Each military department is responsible within its own organization for ensuring that properly balanced emphasis on EMC is included in formal courses in design, maintenance, and operation of systems and equipments.

The program manager must make arrangements for training and educating all those around him involved in the acquisition process, about the importance of maintaining EMC between the platform and its operational hardware and system-to-system compatibility. A properly developed and maintained training plan for EMC is the program manager's primary tool for ensuring that lack of electromagnetic awareness does not introduce problems which must be later solved at great expense, or worse, lived with by the Operational Fleet.

The program manager is also responsible for ensuring that training requirements related to EMC on the system or equipment under procurement are incorporated into required training plans. For example, EMC training should be included as part of Navy Training Plans (NTPs) which, by OPNAV direction, are required for most new procurements.

30. Incorporate EMC into NTPs. Official guidance for preparation and implementation of NTPs is contained in OPNAVINST 1500.8. This instruction also contains a sample outline of the minimum information to be contained in any NTP.

The program manager is responsible for ensuring that EMC training requirements are addressed in the preliminary stages of the NTP development process. The following objectives should be levied on those support personnel charged with preparation of the NTP:

- Provide information for use in management, planning, and coordination among the various facets of EMC training to allow for conservation of resources, continuity between programs within the acquisition, and maximum training effectiveness.

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- Establish estimated funding requirements for supporting the plans, which are flexible enough to meet anticipated changes arising from changing tactical and technical considerations.

- Include provision for identification and reporting EMC deficiencies and their correction during the life cycle.

- Include provisions for periodically updating EMC training requirements in the NTP to reflect future planning brought about by changes in acquisition milestones.

40. Training of operational and maintenance personnel. Naval personnel who have been trained to be proficient in operation and maintenance of new Navy weapon systems generally lack training in considering problems associated with system EMC.

Sufficient discussion of susceptibility mechanisms should be presented to enable operational personnel to identify the source of any system performance degradation and to eliminate this degradation by proper operating techniques or by requesting assistance from maintenance personnel.

Maintenance personnel should be made aware of system EMC design features and of their responsibility in maintenance actions to insure the continued maximum effectiveness of these design features throughout the system life. EMC is interrelated with reliability,safety, performance, and other system characteristics, and EMC maintenance can and should proceed concurrently with them.

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APPENDIX F

FREQUENCY MANAGEMENT AND CONTROL

10. Introduction. For telecommunications equipment or systems requiring the use of the radio frequency spectrum for surveillance or sensing, telemetry, radio control or the more conventional radio communications circuitry, the availability of adequate spectrum support is a firm prerequisite to successful system operation. Spectrum-related aspects must therefore be given appropriate and timely consideration, in conjunction with other major influences, in the planning, development, procurement and operational phases of radiocommunications systems, if they are to effectively perform their intended functions without causing disruption to or receiving disruption from other radio services.

For telecommunications equipment, electromagnetic spectrum management policy and decisions precipitate from the International Telecommunications Union, through the National Telecommunications and Information Administration (Department of Commerce) and the Department of Defense, to service departments and subordinate commands. The constraints by these organizations are to be accepted as unalterable by the Program Manager.

Spectrum management and EMC policies within DoD are the responsibility of the Assistant Secretary of Defense for Communications, Command, Control and Intelligence. The ASD (C^3I) coordinates the DoD interface with the Interdepartmental Radio Advisory Committee (IRAC) and is responsible for monitoring and reviewing policies, plans, programs, and budgets for telecommunications within the DoD. The ASD (C^3I) is a member of the Defense System Acquisition Review Council (DSARC).

Electromagnetic environmental data and equipment spectral characteristics are collected and stored at the Electromagnetic Compatibility Analysis Center (ECAC), Annapolis, Maryland for use by all agencies of the DoD and can assist in the areas of—

- Spectrum Planning
- Emission and Susceptibility Characteristics Evaluation
- Deployment and Siting Analysis
- Consultation Services

20. Spectral characteristics. To insure that the objectives of the DoD EMC Program are met, requirements are often established for the collection of spectral characteristics data, or spectrum signatures, on certain designated equipments and systems that are designed to emit or respond to electromagnetic energy. The measurements are normally performed when the equipment is in

- Its final configuration or at a time as agreed upon between the contractor and procuring activity
- The configuration it will have in production, even though it may not have been officially accepted

Copies of the spectral characteristics data should be sent to ECAC. It is essential that this data be representative of the electromagnetic emission and susceptibility characteristics as will occur in production equipment and systems. In some cases, it may be desirable to perform partial spectral characteristics measurements on equipment before it reaches production status to assist in frequency allocation determinations or for some other special purpose.

30. Frequency management considerations. There are several actions involved in frequency or spectrum management. Two of these are:

- Frequency allocation
- Frequency assignment

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a. A frequency allocation is involved with the authorization to develop an equipment which operates in a specific frequency band or on a given frequency. DD Form 1494 (Application for Frequency Allocation) is required to be submitted at the experimental, developmental and operational periods of the acquisition cycle. Data on DD 1494s are reviewed for conformance to national and international criteria. Failing to invoke the allocation process on a timely basis can result in difficulties when unacceptable frequencies are blindly chosen in the national or international arena. It may lead to the necessity for denial of spectrum support, undesirable limitation thereof, or the necessity for costly subsequent system having an approved resultant waste of funds and time. The importance of a system having an approved frequency allocation cannot be overemphasized. It not only assures a sponsor protection but may point out deficiencies through the EMC analysis which follows, which can be corrected prior to production.

b. A frequency assignment authorization is given allowing use of a specific frequency or band of frequencies for a particular application. Since the useable frequency spectrum is limited, competition for frequency assignments has necessitated coordination requirements, not only with users in the United States, but with those in all countries. The earlier the submission of a request, the sooner the coordination can be completed and a frequency assignment made available for use. The contractor should be made responsible for providing information necessary for frequency assignment approval before operation in his plant.

Frequency management considerations must be applied early in the conceptual phase of system development, and periodically reviewed throughout the system design. Compatibility is achieved through the application of frequency management procedures. Unless there are frequencies available within the appropriate frequency band (available spectrum) on which the system can operate, there is no point in developing the system. The following principles apply

- EMC requirements should not be developed through trade-offs with other system parameters, such as, reliability, maintainability, cost, and safety. They must be based on mission, scenario.
- In the early phases of research and development, past experience should direct attention to certain components or circuits which are likely trouble areas from an EMC aspect. Design philosophy should thus concentrate on these areas to preclude designing into a box canyon, that is, there is not enough space for shielding or separation, inviting pick-up.
- In the later phases of research and development, the mechanisms by which one subsystem may possibly interfere with another, whether it be conducted on power leads, signal leads or common antenna, or emitted, should be explored to determine which, if any, are of sufficient strength to pose a problem.

Electronic equipment, systems and platforms must be capable of operating in the vicinity of other systems and platforms, without causing or responding to undesirable electromagnetic energy, as well as meeting their specified performance requirements.

Primary factors in achieving the required system EMC are the control of equipment emissions and equipment subsystem susceptibility to ensure that the composite system and its associated subsystems and equipment are not only compatible within themselves, but have a high probability of continuing to operate within acceptable tolerances among other systems and subsystems. The procurement contract should explicitly delineate applicable EMC requirements. The contractor should be made responsible for providing information necessary for frequency assignment applications for approval as necessary, before operation in his plant.

40. Frequency management plan for platform. The program manager for the platform must look at intended emissions, intended receive frequency range and define frequency separation criteria.

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APPENDIX G

CONFIGURATION MANAGEMENT

10. General. Configuration Management is required on all EMC programs, whether in support of new construction or modification or alteration, and should be maintained throughout the life cycle of the platform or system. Although configuration management is ongoing, experience with platforms and systems has pointed out that there often are major variations in the same systems installed in the platform of the same type or class. Despite the efforts expended during the design phase on analytical and modeling techniques, and despite efforts to establish appropriate baseline configurations, in practice, changes are often approved and installed without a thorough evaluation of the EMC impact. Too frequently, these variations result in degraded performance of installed systems.

There is ample evidence that the four key steps of configuration management; for example, identification, control, accounting, and auditing are not being performed to ensure the required EMC on platforms. For example, a primary goal in the design of shipboard topside arrangements is the provision for optimum performance and coverage of guns, launchers, directors, radars, and communication systems, consistent with the mission characteristics. This design goal, difficult to attain during new construction ship design, becomes even more difficult throughout the life of the ship, due to additions and modifications. Improved procedures are required to ensure that proposed changes to existing EMC configurations are analyzed to determine the degree of systems degradation, if any, which would result. This analysis must be conducted in sufficient time to be used in making the decision as to whether or not to accomplish the alteration or modification in question.

Configuration management in an EMC Program should provide for the following.

- Identification. The Product EM Baseline which identifies the EM build to requirements. Once a baseline is established, it can only be changed by an Engineering Change Proposal (ECP) or ship alteration (SHIPALT). Design disclosure documentation, including the detailed design of all EM interfaces, should be required to the lowest level at which the item will be repaired or maintained. Separate work statements that result in the loss of design integrity and configuration traceability should not be used.
- Control. All affected activities should participate in the EM evaluation of proposed changes.
- Accounting. Traceability of EM baselines and changes thereto should be provided.
- Audits. Physical EM configuration audits should be performed using approved drawings and specifications to ensure that the as built EM configuration matches the EM configuration identification.

20. Configuration control process. For proposed changes, deviations, or waivers, the manager must ensure that

- Appropriate EMC analysis is conducted by all interested parties.
- Planning, programming, and contractual documentation provides for EMC requirements, analyses, measurements, test and evaluation.
- All (SHIPALTs, Ordnance Alterations (ORDALTs), ECPs, Field Changes (FCs), and requests for waivers or deviations to contractual requirements are documented by an EMC Impact Statement.
- Ensuring that adequate funding is requested to perform required EMC analyses and measurements, to comply with applicable EMC requirements and instructions, and to resolve existing Fleet EMC problems.

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30. Evaluation of changes. The management approach for the evaluation of changes can be categorized as follows

- For a large number of changes, the review and study of a corporate memory and lessons learned file can provide the basis for predicting that similar installations, under similar circumstances, will not create problems. The management solution should identify these proposed changes quickly, efficiently, and economically.
- Some change-generated problems can readily be prevented, while for others, fixes already exist. For this second category of changes, the management solution should involve coordination to ensure that the right people know the correct facts in a timely manner. To help in understanding the necessity for applying the proper preventive or corrective measures, coordination procedures should provide information on the severity of the problems that may be encountered.
- For a third category of changes, EM problems are so complex, and the predicted interference is so severe, that a comprehensive EMC impact evaluation is required. For these the management solution should involve.
  - Early identification of the risks associated with failure to accomplish an EMC impact evaluation.
  - Which engineering center, laboratory, or facility has the best capability to assume lead responsibilities for the EMC impact evaluation.

40. Required actions. Specific actions required include:

- Maintaining a log of proposed changes, deviations, or waivers, together with the assignment of deadline dates for the preparation of an EMC Impact Statement endorsement.
- Performing an initial engineering evaluation to categorize proposed changes that affect EMC configurations.
- Preparing an EMC Impact Statement endorsement that shall contain information and advice appropriate to the EMC enclosures required for Blocks 34-37 of the Engineering Change Proposal Form, DD Form 1692.
- Arranging for the provision of an advisor to attend Change Control Board meetings to provide assistance in EMC matters.
- Maintaining a record of actions taken, and of their results, for the purposes of adding to, and of updating, the corporate memory and lessons learned file.

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APPENDIX H

EMC CONSIDERATIONS IN PROGRAM DOCUMENTS

10. Introduction. The actions to control adverse EM effects are not isolated events but, when applied properly, form a continuum. Since planning and procurement documents are the logical vehicle for implementing an EMC Program, this appendix discusses the relationship between the pertinent documents and required actions. It is presented in the context of a major system procurement, however, the principles and procedures are applicable to platforms and less than major procurements. To provide an insight into the review process, a set of review guidelines is provided.

20. Mission element need statement - (MENS).

- Justifies the initiation of a new major system.
- Describes the mission area and states the need of the new system in terms of the mission element tasks.
- Assesses the projected threat and the DoD capability for mission accomplishment.
- States the solution constraints and provides a program to explore competitive alternative systems.

20.1 EMC considerations for inclusion in MENS.

- Include EMC considerations as part of the assessment of projected threat.
- State EMC performance in a hostile and friendly EME, and as appropriate, EM safety, EMP, and other EMC requirements.

30. Operational requirement (OR).

- Defines operational problems, required system capabilities, system and target parameters and operational employment.
- States cost objectives.

30.1 EMC considerations for inclusion in OR. The OR must form the basis for the EMC effort during the acquisition process. The general requirement for compatibility with the EM environment must be stated at the onset. In addition, unique goals related to EM effects must be specified, for EMP and HERO and other EM requirements. The target parameters and operational employment must be described sufficiently to permit definition of the anticipated EM environment. It is therefore necessary to review the draft OR to assure that sufficient information is provided. Specifically, the following should be addressed.

- Define EM environment in terms of friendly and hostile EME and project far enough into the future to cover the life span of the proposed system.
- Define target sufficiently to determine EMC considerations.
- State EMC goals for system design and intended operation.

40. Development proposal (DP).

- Presents alternatives or trade-offs to achieve a range of capabilities to satisfy the OR.
- Proposes methods for achieving program objectives, provides program alternatives, cost comparisons and defines tasks.
- Addresses T&E that will be required and contains a Development Plan.

40.1 EMC considerations for inclusion in DP. The DP presents the alternatives and trade-offs to achieve the required operational capability called for in the OR. EMC ramifications for each alternative must be addressed. The DP must define the operational EME, the sensitivity of the alternatives to the EM environment and their impact on the ambient environment. The

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hardening alternatives must be described along with costs and risks. If the level of hardness is a major consideration, then the cost versus effect on the operational capability must be described. Plans for developmental and operational EME effects tests must be given, along with performance criteria and objectives. If special test facilities and equipment are required they should be described and cost estimates given. The DP review is required to ensure that the achievement of operational goals will not be unnecessarily restricted by the EME, that emission from the alternatives will not unacceptably degrade other friendly equipment and that appropriate steps are planned for dealing with high risk areas. Specifically, the following should be addressed.

- Address all EMC factors contained in the OR, including rationale for selection of proposed frequency bands of operations.
- State methods for achieving the specified level of EMC, cost and effectiveness for all design alternatives.
- Project EM environment to cover the proposed system life span.
- State projected EM problems for each alternative. Identify, if any, ordnance and human risk in the proposed environment. Define impact on the EM environment created by the proposed system. Specify risk of failure associated with advancing the state-of-the-art, if required.
- State tests appropriate to demonstrate required EMC. This should include, as appropriate, those specified by MIL-STD-461, MIL-STD-449 and MIL-STD-469, MIL-STD-1605, MIL-E-6051, HERO tests, other development tests, and inter-platform testing, as required.
- Include spectrum support and EMC T&E milestones with other T&E milestones. State resolution dates for any identified EMC risks.

50. Decision coordinating paper (DCP).

- Information contained in the DP is combined with the OR to develop the final approval document (DCP), which is used to obtain approval for the next phase of system acquisition.
- The program manager must request approval to initiate the Demonstration and Validation Phase when competitive exploration of alternative concepts during Program Initiation leads to selected alternatives that warrant system demonstration.
- The information developed previously for the OR and DP form the basis for the DCP.
- The DCP contains sections relating to program issues, objectives, alternatives, risks and the development plan.

50.1 EMC considerations for inclusion in DCP during concept development and validation.

- Each design alternative must specify a method for achieving the required EMC.
- State projected EM problems.
- Specify risk associated with advancing the state-of-the-art, if required to achieve the required EMC.
- State tests planned to demonstrate EMC.
- Project EM environment definition far enough into the future to be compatible with the system being acquired.
- Include spectrum support and EMC T&E milestones with other T&E milestones in the development plan. State resolution dates for any identified EMC risks.

50.2 EMC considerations for inclusion in DCP during full scale development.

- Previous T&E and analysis must be incorporated into the DCP.
- Part of the approval process requires the TEMP or TEP to be updated with the recommended system technical performance specifications prior to the system approval milestone.
- Any EMC risks identified in previous phases for the recommended system will be added to the TEMP or TEP along with risk resolution testing milestones.

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- EMC aspects of PAT&E of initial production and long lead time items must be included in the TEMP or TEP.
- Planned EMC testing to re-evaluate the system after changes during initial production must also be included.

50.3 EMC considerations for inclusion in DCP during production.

- When the PAT&E and OT&E has proceeded to the point when a recommendation can be made to recommend full-scale production, the DCP will be updated with the appropriate test results and recommendations and will be submitted to higher authority for approval to proceed with full-scale production.
- Appropriate EMC parameters will be tested during the PAT&E and OT&E and these test results and their implications will be used to update the DCP.

60. Procurement plan (PP). The procurement plan documents technical business, policy, operational and other procurement considerations portraying milestones to be met in achieving the goals of a specific program over its procurement life cycle. Since a PP is regularly updated, it will reflect changes in objectives or method or procurement. The discussion of program technical risks in the PP must include major EMC risks and potential threats to and from other systems or platforms and describe what efforts are planned or underway to reduce them. There should be a general discussion of EMC including control and reporting plans, predictions, analyses, EM specifications and requirements to be imposed,anticipated EME, design disciplines and quality assurance. The test and evaluation approach should describe DT&E to be required to the contractor, and DT&E and OT&E to be performed by the Government for each major phase. In view of the importance of the issues addressed in the PP it is necessary that the EMC aspects be reviewed to assure that they are realistic, economical and achievable. The PP should also define the minimum criteria for a proposal to be acceptable.

70. Request for proposal (RFP). The RFP advises prospective bidders of the Government needs. The item to be procured is described by the applicable specifications or by a description containing the necessary requirements. Thus, the RFP must delineate the anticipated electromagnetic environment location and configuration, the performance requirements in the environment, tailored requirements for intended and spurious emissions and susceptibility criteria. Also, any EM test, evaluation, analysis, simulation and data required of the contractor such as EMC control and test plans and test reports, and any Government test that the item must pass to be acceptable must be included. The role of the contractor in supporting an EMCAB must be defined, if applicable. Since the RFP will be the basis for the contract the procuring activity must be assured that the item will meet the EMC requirements without resorting to costly contract modifications.

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APPENDIX I

EMC BIBLIOGRAPHY FOR PROGRAM MANAGERS

This appendix provides the program manager responsible for the acquisition of platforms, systems and equipment, with a discrete list of pertinent documents relative to the EMC/EME requirements.

Part I	Directives and Instructions provide the definition of and authority to incorporate the EMC/EME requirements.
Part II	Military Specifications and Standards describe, define and dictate the EMC/EME requirements to be included in the Design Specification.
Part III	Guidance Documents provide assistance to the Program Manager in achieving complete EMC/EME considerations in the procurement/acquisition plan.
Part IV	Matrices of EMC Tasks during life cycle vs. basic EMC documents

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PART I -- DIRECTIVES AND INSTRUCTIONS

DOCUMENT NUMBER	SUBJECT
DoD Directive	
3222.3	DoD Electromagnetic Compatibility Program
C-4600.3	Electronic Counter-Countermeasures (ECCM) Policy
4630.5	Compatibility and Commonality of Equipments for Tactical Command, Control and Communications
4650.1	Management and Use of Radio Frequency Spectrum
SECNAVINST	
2400.20	Management and Use of Radio Frequency Spectrum within the Department of the Navy
2410.1	Electromagnetic Compatibility Program Within the Department of the Navy, Policy Direction
C-3430.2	Department of Navy Policy Concerning Electronic Counter-Countermeasures (ECCM) in Electronic Systems
OPNAVINST	
S3430.1	Joint Electronic Warfare Policy
S3430.4	Navy Electronic Warfare Organization and Policy
2410.11	Procedures for the Processing of Radio Frequency Applications for the Development and Procurement of Electronic Equipment
2410.29	Electromagnetic Compatibility Analysis Center; analytic services and data available from
2410.31	Electromagnetic Compatibility Within the Department of the Navy
C-3430.15	Electronic Warfare Support Measures and Electronic Intelligence Technical Systems
C-3430.18	Reporting Beaconing, Intrusion, Jamming and Interference of Electromagnetic Systems
3811.1	Threat Support to Weapons Systems Selection and Planning
5101.1	Resolution of Electromagnetic Radiation (EMR) Hazard Problems
NAVMATINST	
2410.1	Electromagnetic Environmental Effects (E^3) Policy Within the Naval Material Command
3882.3	Threat Support to Weapons Systems Selection and Planning
3920.4	Navy Combat Survivability Program; Establishment of
5101.1	Electromagnetic Radiation (EMR) Hazard Problems, resolution of
5400.17	Nuclear Weapon Effects Program Technical and Management Responsibilities and Procedures
10380.9	Electromagnetic Environment Considerations in the Life Cycle of Navy Electronic/Electrical Equipment and Systems; implementation of

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PART II -- MILITARY SPECIFICATIONS AND STANDARDS

DOCUMENT NUMBER	TITLE
MIL-B-5087	Bonding, Electrical and Lightning Protection for Aerospace Systems

SCOPE - This specification covers the characteristics, application, and testing of electrical bonding for aerospace systems, as well as bonding for the installation and interconnection of electrical and electronic equipment therein, and lightning protection.

DOCUMENT NUMBER	TITLE
MIL-E-6051	Military Specification - Electromagnetic Compatibility Requirements, Systems (aircraft and associated weapons systems)

SCOPE - This specification outlines the overall electromagnetic compatibility (EME) requirements for aircraft weapons systems installation.

MAJOR OBJECTIVE - Development:

1. Program Plan
2. Control Board
3. System Requirements
4. Control Plan
5. Test Program
6. Acceptance Criteria

DOCUMENT NUMBER	TITLE
MIL-S-6451	Shield, Protective, Aircraft and Missiles

SCOPE - This specification covers protective shields for engine and tailpipe openings of aircraft and missiles.

DOCUMENT NUMBER	TITLE
MIL-E-8881	Enclosure, Electromagnetic Shielding Demountable, Prefabricated General Specification for

SCOPE - This specification covers shielding enclosures which provide specified degrees of attenuation of electromagnetic fields from 100 kilocycles (kc) to 20,000 megacycles (mc) for the purpose of test and alignment of electronic equipments and other related purposes.

DOCUMENT NUMBER	TITLE
MIL-A-9094	Arrester, Lightning, General Specification for Design of

SCOPE - This specification covers the general requirements for aircraft lightning arresters used with radio receiving and transmitting antenna systems.

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DOCUMENT NUMBER	TITLE
MIL-C-11693	General Specification for Radio Frequency Interference Reduction Capacitor, AC and DC, Hermetically sealed in metal cases

SCOPE - This specification covers the general requirements for established reliability (ER) and non-ER capacitors designed for operation with alternating current (ac) and direct current (dc), paper, metallized paper, and metallized plastic dielectric, radio-interference-reduction, feed-through capacitors, hermetically sealed in metal cases for use primarily in broadband radio-interference suppression application.

DOCUMENT NUMBER	TITLE
MIL-E-12889	Capacitors, By-Pass, Radio-Interference Reduction, Paper Dielectric, AC and DC, (Hermetically Sealed in Metallic cases), General Specification for

SCOPE - This specification covers the performance and general material requirements for by-pass, radio-interference-reduction, alternating-current (ac) and direct-current (dc), paper-dielectric capacitors, hermetically sealed in metallic cases, for use primarily in broadband, radio-interference suppression application. In addition, this specification indicates the ambient test conditions within which the capacitors must operate satisfactorily and reliably. These capacitors are suitable for operation over a temperature range of -55° to +85°C.

DOCUMENT NUMBER	TITLE
MIL-F-15733	Filters, Radio Interference, General Specification for

SCOPE - This specification covers the general requirements for current-carrying filters, alternating-current (ac) and direct-current (dc), for use primarily in the reduction of broadband radio interference.

DOCUMENT NUMBER	TITLE
MIL-I-16165	Interference Shielding, Engine Electrical System

SCOPE - This specification covers requirements for interference shielding items and shielded harnesses for engine electrical systems aboard Naval ships, at advance bases, and in the vicinity of electronic installations. It includes the allowable interference limits for such items and the permissible limits for auxiliary devices normally installed on electrical wiring systems associated with these engines.

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DOCUMENT NUMBER	TITLE
MIL-F-18327	General Specification for Filters; High Pass, Low Pass, Band Pass, Band Suppression and Dual Functioning

SCOPE - This specification covers the general requirements for passive frequency-selective networks, such as dual functioning, band suppression, band pass, low pass, and high pass (or any combination thereof) electric-wave filters, including those employing electromechanical and piezoelectric elements, for use over the frequency range of 0 to 150 megahertz. Filters covered by this specification are intended for use where operation under various environmental conditions is required. This specification covers filters weighing not more than 50 pounds and requiring root-mean-square test voltage ratings not greater than 5,000 volts.

DOCUMENT NUMBER	TITLE
MIL-E-18639	Enclosure, Electromagnetic Shielding, Knockdown Design

SCOPE - This specification covers shielding enclosures which shall provide stated minimum degrees of attenuation to electromagnetic fields, within the frequency range of 100 kilocycles (kc.) to 10,000 megacycles (mc.), for the purpose of test alignment of electronic equipment and for other related purposes.

DOCUMENT NUMBER	TITLE
MIL-F-25880	Band Pass, Band Suppression Filter

SCOPE - This specification covers the general requirements for one type of band pass, band suppression filter, designated Filter, Band Pass, Band Suppression F-339/A.

DOCUMENT NUMBER	TITLE
MIL-E-47188	Electronic Shielding Material, Application of Encapsulated, Welded Modules, Process Requirements for

SCOPE - This specification establishes the requirements for the application of electronic shielding material to encapsulated modules. Unless otherwise specified on the module part drawing, the encapsulated module shall be sealed with a conformal coating prior to application of the shielding material.

DOCUMENT NUMBER	TITLE
MIL-S-81245	Shield, Rad Haz L/20MM Cartridges Holder, Rad Haz Shield

SCOPE - This specification covers the rad haz shield, hereinafter referred to as shield and the rad haz shield holder, hereinafter referred to as holder. The shield serves as a protective cover for the electric primer of a 20mm MARK 100 series round of ammunition belted in the MARK 2 link.

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DOCUMENT NUMBER	TITLE
MIL-STD-188-124	Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems

SCOPE - This standard establishes the minimum basic requirements and goals for grounding, bonding and shielding of ground-based telecommunications C-E equipment installations, subsystems and facilities including buildings and structures supporting tactical and long haul military communication systems.

DOCUMENT NUMBER	TITLE
MIL-STD-220	Method of Insertion-Loss Measurement for Radio-Frequency Filters

SCOPE - This standard covers a method of measuring, in a 50-ohm system, the insertion loss of feed - through suppression capacitors, and of single- and multiple-circuit, radio-frequency (RF) filters at frequencies up to 1000 megahertz (MHz).

DOCUMENT NUMBER	TITLE
MIL-STD-285	Attenuation Measurements for Enclosures EM Shielding for Electronic Tests Purposes, Method of

SCOPE - This standard covers a method of measuring the attenuation characteristics of electromagnetic shielding enclosures used for electronic test purposes over the frequency range 100 kHz to 10,000 MHz.

DOCUMENT NUMBER	TITLE
MIL-STD-449	Radio Frequency Spectrum Characteristics, Measurement of

SCOPE - This technical standard establishes uniform measurement techniques that are applicable to the determination of the spectral characteristics of radio-frequency transmitters and receivers. The ultimate goal is to ensure the compatibility of present and future systems.

DOCUMENT NUMBER	TITLE
MIL-STD-454	Standard General Requirements for Electronic Equipment

Requirement 1 - Establishes criteria for the design and development of military electronic equipment to promote maximum safety for personnel and equipment.

Requirement 61 - Establishes criteria for electromagnetic interference control.

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DOCUMENT NUMBER	TITLE
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

SCOPE - This standard covers the requirements and test limits for the measurement and determination of the electromagnetic interference characteristics (emission and susceptibility) of electronic, electrical and electromechanical equipment.

MAJOR OBJECTIVE - Define requirements and limits for EMI characteristics.

DOCUMENT NUMBER	TITLE
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of

SCOPE - This standard establishes techniques to be used for the measurement and determination of the electromagnetic interference characteristics (emission and susceptibility) of electrical, electronic, and electromechanical equipment, as required by MIL-STD-461.

MAJOR OBJECTIVE - Measurement techniques for determining EMI characteristics.

DOCUMENT NUMBER	TITLE
MIL-STD-463	Definitions and System of Units, Electromagnetic Interference and Electromagnetic Compatibility

SCOPE - This standard contains general interference definitions, abbreviations, and acronyms. Definitions of abbreviations and terms are limited to statements of meaning as related to this and referenced standards, rather than encyclopedia or textbook discussions. A basic fundamental knowledge of the principles of interference is assumed.

DOCUMENT NUMBER	TITLE
MIL-STD-469	Radar Engineering Design Requirements Electromagnetic Compatibility

SCOPE - The engineering design requirements set forth herein are established to control the spectral characteristics of all new radar systems operating between 100 and 40,000 megahertz (MHz) in an effort to achieve electromagnetic compatibility and to conserve the frequency spectrum available to Military radar systems.

DOCUMENT NUMBER	TITLE
MIL-STD-704	Aircraft Electric Power Characteristics

SCOPE - This standard establishes requirements for conducted electric power characteristics on aircraft at the interface between the electric power system and the input to electric utilization equipment.

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DOCUMENT NUMBER — TITLE

MIL-STD-1310 — Shipboard Bonding and Grounding Methods for EMC and Safety

SCOPE - This standard provides shipboard bonding, grounding and other techniques for electromagnetic compatibility and safety.

DOCUMENT NUMBER — TITLE

MIL-STD-1377 — Effectiveness of Cable, Connector and Weapon Enclosure Shielding and Filters in Precluding Hazards of Electromagnetic Radiation of Ordnance; Measurement of

SCOPE - This standard is intended to provide a weapon developer or designer with the shielding and filter effectiveness test methods for determining whether the particular weapon design requirements have been properly implemented.

DOCUMENT NUMBER — TITLE

MIL-STD-1385 — Preclusion of Ordnance Hazards in Electromagnetic Fields; General Requirements for

SCOPE - This standard establishes the general requirements to preclude hazards resulting from ordnance having electro-explosive devices when exposed to electromagnetic fields. The nominal frequency range covered by this standard is from 10 kHz (10^4 Hz to 40 GHz (4×10^{10} Hz)

DOCUMENT NUMBER — TITLE

MIL-STD-1399 — Interface Standards for Shipboard Systems

SCOPE - This standard establishes interface and environmental requirements for shipboard systems/equipment installations.

Section 300 - Electric Power, Alternating Current (Metric)
Section 408 - EMR Hazards to Personnel and Fuel
Section 409 - EMR Hazards to Ordnance

DOCUMENT NUMBER — TITLE

MIL-STD-1512 — Electroexplosive Subsystems Electrically Initiated Design Requirements and Test Methods

SCOPE - The purpose of this document is to establish uniform design and qualification requirements and test methods for the design, development, and acceptance of all electroexplosive subsystems and component parts.

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DOCUMENT NUMBER	TITLE
MIL-STD-1541 (USAF)	Electromagnetic Compatibility Requirements for Space Systems

SCOPE - This standard establishes the electromagnetic compatibility (EMC) requirements for space systems, including launch vehicles, space vehicles, ground systems, and associated aerospace ground equipment (AGE). It does not apply to facilities which house such items.

DOCUMENT NUMBER	TITLE
MIL-STD-1542 (USAF)	Electromagnetic Compatibility Requirements for Space System Ground Facilities

SCOPE - This standard covers the general EMC and grounding requirements for space system ground facilities. Space system facilities include structures that house electrical/electronic devices or equipment such as service structures, tracking station buildings, satellite control rooms, computer rooms, and spacecraft or booster assembly buildings.

DOCUMENT NUMBER	TITLE
MIL-STD-1574	System Safety Program for Space and Missile Systems

SCOPE - This standard defines the requirements for implementation of system safety programs covering the life cycle of the system. It includes the safety requirements for the following activities/periods: design, development, test, checkout, modification, production, servicing, refurbishing, maintenance, transportation, handling, training, disposal, deployment, and normal and contingency operations. This standard also defines the management and technical tasks and controls required to minimize accident risks caused by human error, environment, deficiency/-inadequacy of design, and component malfunction or interactions.

DOCUMENT NUMBER	TITLE
MIL-STD-1605	Procedures for Conducting a Shipboard Electromagnetic Interference Survey (Surface Ships)

SCOPE - This standard provides detailed procedures for conducting an electromagnetic interference (EMI) survey aboard surface ships. An EMI survey is required for new construction ships and ships receiving overhauls or other major repair work that changes the electromagnetic configuration.

DOCUMENT NUMBER	TITLE
MIL-STD-1658	Shipboard Guided Missile Launching System Safety Requirements, Minimum

SCOPE - This standard establishes the minimum safety requirements for shipboard guided missile launching systems. Special requirements which may be imposed on launching systems handling missiles containing nuclear warheads or liquid fuels other than hydrocarbon fuels are not included.

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DOCUMENT NUMBER	TITLE
AIR-STD-12/19 (ASCC AIR STD)	Electromagnetic Compatibility Test Methods for Aircraft Electrical and Electronic Equipment

OBJECT - To standardize minimum requirements and essential test methods pertaining to Intra-system-Electromagnetic Compatibility of electrical and electronic equipment for use with aerospace systems of the member countries.

DOCUMENT NUMBER	TITLE
ABC-STD-52	Shipboard Electrical Power Characteristics

DOCUMENT NUMBER	TITLE
STANAG 3516	EMC Test Methods for Aerospace Electrical and Electronic Equipment

OBJECT - To establish the minimum requirement and essential test methods pertaining to Intra-system-Electromagnetic compatibility of electrical and electronic equipment for use with aircraft systems.

DOCUMENT NUMBER	TITLE
STANAG 3614 AE	EMC of Installed Equipment in Aircraft

PURPOSE - To ensure that equipment interference control is considered already during development and that interference limits are included in the development specification of equipment.

To warrant compatible operation of the equipment with its electromagnetic interference and its susceptibility in a complex electromagnetic interference environment within a weapons systems.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):

DOCUMENT NUMBER	TITLE
ANSI C95.1	Safety Level of Electromagnetic Radiation with Respect to Personnel

SCOPE - Recommendations are made to prevent possible harmful effects on mankind, resulting from exposure to electromagnetic radiation in the frequency range from 10 MHz to 100 GHz. They apply to all radiation within this frequency range originating from radio stations, radar equipment, and other possible sources of electromagnetic radiation such as used for communication, radio-navigation and industrial and scientific purposes. These recommendations are not intended to apply to the deliberate exposure of patients by or under the direction of practitioners of the healing arts.

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DOCUMENT NUMBER	TITLE
ANSI C95.2	Radio Frequency Radiation Warning Symbol

SCOPE - This standard applies to the design of a symbol for use as a sign intended to warn workers or the public of the presence of biologically hazardous levels of electromagnetic radiation and, in so far as considered desirable, to define specific hazards and provide cautionary information.

It is not the intent of this specification to conflict with or supersede in any fashion the standard ionizing radiation sign as defined in USA Standard Specifications for Industrial Accident Prevention Signs Z35.1-1959.

DOCUMENT NUMBER	TITLE
ANSI C95.3	Techniques and Instrumentation for Measurement of Potentially Hazardous Electromagnetic Radiation at Microwave Frequencies

PURPOSE - Subcommittee I on Techniques, Procedures, and Instrumentation was originally organized on April 7, 1960, to Establish specifications for techniques and instrumentation used in evaluating hazardous radio-frequency radiation.

On January 8, 1963, the intent of the scope was clarified by specific reference to mankind, flammable volatile materials, and explosive devices; thus the purpose was extended to Establish specifications for techniques and instrumentation to be used in evaluating radio-frequency hazards to mankind, flammable volatile materials, and explosive devices.

DOCUMENT NUMBER	TITLE
ANSI C95.4	Safety Guide for the Prevention of RF Radiation Hazard in the Use of Electric Blasting Caps

PURPOSE - This guide is intended to provide a basis for assessing the hazards associated with initiation of commercial electric blasting caps by radio frequency (RF) energy by indicating safe distances from commercial RF sources.

Part I gives basic information of the mechanism of RF initiation and its avoidance.

Part II gives tables of safe distances developed by analytical calculations and supported by numerous field tests. Adherence to these tables will give the blaster a high degree of assurance that his blasting layout should be safe against RF initiation.

Part III gives data on common RF sources.

DOCUMENT NUMBER	TITLE
BUMEDINST 6470.13( )	Microwave and Radio Frequency Health Hazards

PURPOSE - To call attention to potential health hazards associated with exposure to electromagnetic fields in the frequency range of 10 MHz to 100 GHz, to specify maximum exposure levels in terms of external field quantities, to provide guidance for medical surveillance and to specify reporting requirements of microwave overexposure incidents.

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DOCUMENT NUMBER	TITLE
BUMEDINST 6470.14( )	Laser Health Hazards

PURPOSE - To establish a standard for the evaluation of laser hazards and guidance for medical surveillance of persons occupationally exposed to laser radiation.

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PART III -- GUIDANCE DOCUMENTS

MILITARY HANDBOOKS

NUMBER	TITLE
MIL-HDBK-235	Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment, Subsystems and Systems

The intent of this handbook is to provide guidance and establish a uniform approach for the protection of Navy electronics from the adverse affects of the electromagnetic environment. Examples of systems, subsystems and equipments for which this handbook may be applicable are aerospace and weapon systems and associated subsystems, equipments and ordnance.

Provides detailed information and guidance for test and evaluation in the electromagnetic environment·

Part I - General
Parts II & III - Electromagnetic levels - Friendly/Hostile
Part IV - Electromagnetic levels - Army

NUMBER	TITLE
MIL-HDBK-238	Electromagnetic Radiation Hazards

This handbook addresses hazards due to electromagnetic radiation of the non-ionizing type except for the ionizing radiation of X-rays produced incident to operating electronic equipment. Electromagnetic Radiation Hazards (RADHAZ) affect personnel, sensitive electronic devices, explosive and fuels. The present state-of-the-art in the evaluation of existing hazards limits the determination of absolute safe levels at all frequencies.

NUMBER	TITLE
MIL-HDBK-241	Design Guide for EMI Reduction in Power Supplies

This design guide has been developed to provide information relating to methods and techniques that an equipment engineer may use to reduce electromagnetic interference. Information in this handbook is directed particularly to power supplies since experience indicates that they are the major cause of undesired emanations. Many of the basic techniques of reducing EMI in power supplies can also apply to an entire equipment. Use of the methods and techniques herein should enable an equipment engineer to develop a compromise between the various characteristics and disciplines applied to the equipment design. These characteristics include electromagnetic compatibility (EMC), weight, size, cost, reliability, maintainability, temperature, humidity, human engineering, and performance. Use of this handbook should result in an equipment design that is EMC effective with the fewest penalties to other characteristics.

MANUALS

DOCUMENT NUMBER	TITLE
NAVSEA	
0900-LP-058-3010	Shipboard Installation Practices for Electromagnetic Pulse Vulnerability Reduction
0967-LP-316-3010	Instruction Manual for Microwave Radiation Protective Clothing

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0900-LP-005-8000	Technical Manual for Radio Frequency Radiation Hazards - Personnel - Shipboard
0967-LP-317-7010	Radio Frequency Burn Hazards Reduction
OP-5 (Vol. I)	Ammunition and Explosives Ashore
OP-3840	EMC Criteria for Surface Weapons Systems
OD 30393 (1)	Design Principles and Practices for Controlling Hazards of Electromagnetic Radiation to Ordnance (HERO Design Guide)
0967-LP-266-1010	R.F. Compatibility and Electromagnetic Interference Reduction Techniques for Forces Afloat
0967-LP-000-0150	Electronic Installation and Maintenance Book, Electromagnetic Interference Reduction
0967-LP-283-5010	Shipboard Electromagnetic Shielding Practices

DOCUMENT NUMBER	TITLE
NAVSHIPS	
94552	R. F. Shielding of Ship Hatches and Access Doors
NAVSEA/NAVAIR/NAVELEX	
OP3565/16-1-529/0967-LP-624-6010 Vol. I	Technical Manual, Electromagnetic Radio Hazards (U) (Hazards to Personnel, Fuel and Other Flammable Materials) (U)
Vol. II	Technical Manual, Electromagnetic Radio Hazards (U) (Hazards to Classified Ordnance) (U)
NAVAIR	
5335	Electromagnetic Compatibility
AR-29	Frequency Allocation and Equipment Spectrum Signature, Requirements for
AR-43	Electromagnetic Compatibility Advisory Board Requirements for
AR-46	Aeronautical Requirements, HERO, Requirements for HERO Tests, Analyses and Documentation
AR-107	Aeronautical Requirements Navy Aircraft Survivability/ Vulnerability
NAVELEX	
0101, 106	Naval Shore Electronics, Electromagnetic Compatibility And Electromagnetic Radiation Hazards
NAVFAC	
DM4	Design Manual for Electrical Engineers
NAVORD	
OD 44881	Safety and Performance Tests for Qualifications of Explosives

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OD 10773 Safety Principles for Operations Involving Electro-Explosive Devices

Naval Surface Weapons Center, White Oak Laboratory:

a. NSWC/WOL/TR 75-193 EMP Design Guidelines for Naval Ship Systems
b. Engineering Design Guidelines for EMP Hardening of Naval Missiles and Airplanes

Air Force, ASD/ENESS, Wright-Patterson AFB, Ohio 45433 - EW Design Handbook, Vol. IV - ECCM

USAF DH 1-2 General Design Factors
DH 1-4 Electromagnetic Compatibility
DH 1-6 System Safety
DH 2-4 Electronic Warfare
DH 2-7 System Survivability
DH 4-2 Electronic Systems Test and Evaluation

ASSOCIATED DOCUMENTS

NAVAIR AD 1115, Electromagnetic Compatibility Design Guide for Avionics and Related Ground Support Equipment

AD 619666/7, Interference Reduction Guide for Design Engineers Vol. 1 and 2.

NASA SP 3067, Radio Frequency Interference Handbook

AFR 80-23, USAF Electromagnetic Compatibility Program

Rome Air Development Center, Interference Notebook, Vol. 1 - RADC-TR-66-1, Vol. 2 - RADC-7T-66-1

Defense Nuclear Agency:

a. DNA 2114-H, EMP Handbook
   Vol. I - Design (C)
   Vol. II - Analysis and Testing (C)
   Vol. III - Environment and Application (S)
   Vol. IV - Resources (C)
b. DNA 3286-H, DNA EMP Preferred Test Procedures
c. Capabilities of Nuclear Weapons, Defense Nuclear Agency Effects Manual No. 1
d. EMP Awareness Course Notes, DNA-2772T

Electronic Industries Association, Designer's Guide on EMC Bulletins 1-10.

National Fire Protection Association:

a. NFPA 78-1968, Lightning Protection Code
b. NFPA 77-1972, Static Electricity, Recommended Practice on

Society of Automotive Engineers (SAE), Warrendale, Pennsylvania:

AIR 1208 - Bibliography - Lightning and Precipitation Static
AIR 1221 - EMC System Design Requirements
AIR 1509 - EMC Antennas and Antenna Factors and How to Use Them
AIR 1406 - Lightning Protection and Static Electrification
AIR 1394 - Cabling Guidelines for Electromagnetic Compatibility
AIR 1255 - Spectrum Analyzers for EMI Measurements
AIR 1147 - EMI on Aircraft from Jet Engine Charging
AIR 1173 - Test Procedures to Measure the R.F. Shielding Characteristics of EMI Gaskets
AIR 1404 - DC Resistivity vs. R.F. Impedance of EMI Gaskets
AIR 1500 - Bibliography Lossy Filters

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AIR 1423	-	EMC on Gas Turbine Engines for Aircraft Propulsion
AIR 1425	-	Methods of Achieving EMC on Gas Turbine Engines for Self-Propelled Land Vehicles
ARP 935	-	Suggested EMI Control Plan Outline
ARP 936	-	Capacitor, 10 MFD for EMI Measurements
ARP 937	-	Jet Engine Electromagnetic Interference Test Requirements and Test Methods
ARP 958	-	Broadband Electromagnetic Interference Measurement of Antennas, Standard Calibration Requirements and Methods
ARP 1172	-	Filters, Conventional Electromagnetic Interference Reduction, General Specification for
ARP 1481	-	Corrosion Control and Electrical Conductivity in Enclosure Design
J551D	-	Measurement of EMR from a Motor Vehicle or other Combustion-Powered Device (excluding Aircraft)

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Part IV -- Matrices of EMC Tasks

TABLE III. EMC Tasks during concept development and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410 11	OPNAVINST 2410 29	OPNAVINST 2410 31	NAVMATINST 2410.1	NAVMATINST 5101.1	NAVMATINST 10380 9	MIL-E-6051	MIL-STD-451	MIL-STD-463	MIL-STD-469	MIL-STD-1385	MIL-STD-1399	NTIA MANUAL	MIL-HDBK-235	DD FORM 1494	MIL-HDBK-253	MIL-STD-704
PREPARE AND UPDATE EMCPP			X	X					X								
ORGANIZE EMCAB				X			X									X	
DETERMINE SPECTRUM REQUIREMENTS AND SUBMIT REQUEST FOR FREQUENCY ALLOCATION	X		X	X									X		X		
DEFINE EM ENVIRONMENT WHICH MAY BE ENCOUNTERED DURING LIFE CYCLE						X	X				X	X		X		X	X
ANALYZE SYSTEM OR PLATFORM TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM CAN OPERATE IN ANTICIPATED EM ENVIRONMENT		X	X	X	X	X	X							X		X	
ESTABLISH INITIAL EMC REQUIREMENTS FOR SYSTEM OR PLATFORM							X	X		X	X	X	X	X			X

*NOTE: Consult other guidance documents listed in Part III of this appendix as appropriate.

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TABLE IV. EMC tasks during concept validation and basic EMC document (as appropriate)*

EMC TASKS	OPNAVINST 2410 11	OPNAVINST 2410 29	OPNAVINST 2410 31	NAVMATINST 2410 1	NAVMATINST 5101 1	NAVMATINST 10330 9	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	MIL-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-HDBK-235	MIL-HDBK-253	MIL-B-5087	NTIA MANUAL	DD FORM 1423	DD FORM 1664	DD FORM 1494
CONTINUE EMCAB				X			X												X					
REVIEW & UPDATE EM ENVIRONMENT						X	X							X	X		X	X	X					
REFINE ANALYSES TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM CAN SATISFACTORILY OPERATE IN INTENDED EM ENVIRONMENT		X	X	X	X	X	X											X	X					
DEFINE ACCEPTABLE PERFORMANCE CRITERIA FOR SYSTEM OR PLATFORM							X	X		X				X	X		X	X	X		X			
EVALUATE EMC STDs & CRITERIA PREDICTED EM ENVIRONMENT AND ACCEPTABLE PERFORMANCE CRITERIA TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM WILL MEET GENERAL EMC CRITERIA							X	X		X		X		X	X		X	X	X	X	X			
DEVELOP TAILORED EMC REQUIREMENTS FOR ACQUISITION AND CORRESPONDING SOW				X			X	X		X				X	X		X	X	X		X	X	X	
SUBMIT REQUEST FOR DEVELOPMENTAL FREQUENCY ALLOCATION	X		X	X																	X			X
SPECIFY OPERABILITY ANALYSES & TESTING REQUIREMENTS FOR TEMP			X	X			X		X	X	X		X			X								
UPDATE EMCPP				X																				

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate).

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TABLE V. EMC tasks during full scale development and basic EMC documents (as Appropriate)*

EMC TASKS	OPNAVINST 2410 11	OPNAVINST 2410 31	NAVMATINST 2410 1	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	MIL-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-HDBK-235	MIL-HDBK-253	MIL-HDBK-238	MIL-HDBK-241	NTIA MANUAL	DD FORM 1423	DD FORM 1494	DD FORM 1664	MIL-S-5087
CONTINUE EMCAB			X	X												X							
FINALIZE EMC REQUIREMENTS AND SOW FOR ACQUISITION OF PREPRODUCTION MODEL AND REVIEW CONTRACTOR DATA ITEMS INCLUDING EMCCP				X	X		X		X		X	X		X	X	X			X	X		X	
MONITOR/REVIEW WAIVER REQUESTS & ECP's		X	X																X				
DEVELOP & IMPLEMENT COMPREHENSIVE PROGRAM TO DEMONSTRATE BY ANALYSIS, SIMULATION & TEST THAT THE SYSTEM/PLATFORM WILL PERFORM ITS MISSION IN THE ANTICIPATED EM ENVIRONMENT INCLUDE THIS IN TEMP/TEP		X	X	X		X	X	X		X			X		X	X							
SUBMIT REQUEST FOR ASSIGNMENT OF TEST FREQUENCIES	X		X																		X		
DOCUMENT EMC ASPECTS OF MAINTENANCE, PRODUCTION & TRAINING PLANS				X					X								X	X					X
DEVELOP EMC SPECIFICATION REQUIREMENTS FOR PRODUCTION CONTRACT				X	X		X		X		X	X		X	X	X			X	X		X	X
SUBMIT REQUEST FOR OPERATIONAL FREQUENCY ALLOCATION	X		X																X		X		
DEVELOP INSTALLATION CRITERIA & GUIDANCE									X								X						X

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate).

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TABLE VI. EMC tasks during production and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.31	NAVMATINST 2410.1	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	MIL-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-STD-238	MIL-STD-241	MIL-STD-253	MIL-B-5087	DD FORM 1494	NTIA MANUAL
REVIEW CONTRACTOR'S EMC TEST PLAN AND REPORT FOR ACCEPTANCE TESTS				X	X	X	X	X		X	X	X	X	X						
PERFORM SPECIAL EMC TESTS DEFINED IN TEMP				X		X	X	X		X			X							
FINALIZE EMC ASPECTS OF MAINTENANCE - TRAINING PLANS				X					X						X	X	X	X		
DEVELOP & DOCUMENT FREQUENCY MANAGEMENT/USAGE PLAN	X																		X	X
UPDATE EMCPP			X																	
MONITOR/REVIEW WAIVER REQUESTS & ECP's		X	X																	X

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate).

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TABLE VII. EMC tasks during deployment and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.31	NAVMATINST 2410.1	NTIA MANUAL
IMPLEMENT MAINTENANCE AND TRAINING PLANS, INCLUDING EMC ASPECTS				
MAINTAIN CONFIGURATION CONTROL DURING LIFE CYCLE, INCLUDING REVIEWING ECP's		X	X	
IMPLEMENT FREQUENCY MANAGEMENT/USAGE PLAN	X			X
INVESTIGATE AND FIX OPERATIONAL EM PROBLEMS			X	

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate). For the most part, implementation procedures during deployment will be agency dependent.

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☐ MANUFACTURER

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a. Paragraph Number and Wording

b Recommended Wording

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MIL-HDBK-237A
INTERIM NOTICE 1 (NAVY)
16 June 1986

MILITARY HANDBOOK

ELECTROMAGNETIC COMPATIBILITY MANAGEMENT GUIDE FOR PLATFORMS, SYSTEMS AND EQUIPMENT

TO ALL HOLDERS OF MIL-HDBK-237A

1. THE FOLLOWING PAGES OF MIL-HDBK-237A HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
iii	2 February	iii	Reprinted without change
iv	16 June 1981	iv	2 February 1981
v	2 Feburary 1981	v	Reprinted without change
vi	16 June 1986	vi	2 February 1981
vii	16 June 1986	new	
viii	16 June 1986	new	
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65	16 June 1986	64	2 February 1981
66	16 June 1986	65	2 February 1981
67 - 117	16 June 1986	new	

2. Retain this notice and insert before Table of Contents.

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Review activities:
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User activities:
Navy - MC, YD

Preparing activity:
Navy - EC
(Project No. EMCS-N116)

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FOREWORD

The existence of operational problems in the tri-services resulting from the effects of electromagnetic energy has been documented in numerous military exercises and survey reports. These electromagnetic incompatibilities led to mission aborts and costly delays, thereby reducing the operational availability of military platforms, systems and equipments. The severity of military electromagnetic environments (EME), the damaging effects of electromagnetic (EM) problems to personnel, ordnance, fuels, and other equipments, and the degraded equipment performance and security underscore the importance of electromagnetic compatibility (EMC). The incompatibilities are traceable to the following:

Platforms, systems and equipments were not being designed to operate in their intended electromagnetic environment

Deficiencies in management, planning and control of the efforts necessary to achieve EMC including the definition and transfer of responsibilities and information from the Acquisition Program Manager to the Logistics Manager

Experience has shown that the desired degree of EMC can best be achieved by first identifying the operational EM environment and then defining and adhering to proper design, development, test, production and installation requirements and procedures, and continuing with adequate maintenance and support measures throughout the life cycle. EMC must be considered as a principal design parameter with the magnitude, scope and level of the effort tailored to the specific type and mission of the platform, system or equipment and the program phase. Emphasis must be placed on implementing practical requirements and procedures to meet the desired EMC requirements with available resources, while still meeting the intended mission requirements.

To accomplish this, an effective program of EMC management, assessment, engineering and configuration control is required and must be integrated into the overall design and engineering effort from early in the conceptual phase and throughout the life cycle.

Under most circumstances it is impractical to consider after-the-fact fixes. Experience has shown that correction of EM problems after an equipment or system is designed or in operation always involves considerable expense, and yields less than optimum results. For this reason, the Department of Defense (DoD) has required implementation of specific efforts to deal with EMC matters from the early conceptual and design phases, and throughout the life cycle and requires:

Early determination of EMC requirements

Achievement of total system EMC in the operational environment

Attainment of built-in EMC in the design of electronic systems, rather than resorting to after-the-fact remedial measures

Assurance that EMC can, in fact, be achieved; or, if not, duly considered and remitted in favor of overriding operational necessity

Establishment of control procedures to correct EM problems throughout the life cycle

This handbook provides quidance for establishing an effective EMC program throughout the life cycle of platforms, systems and equipments. In addition, it is assumed that the manager has a background which is primarily managerial. Compliance with these guidelines dictates the size of the document. A summary of EMC milestones and tasks is depicted on FIGURE 1. If additional general management information is desired, it is suggested that Naval Ocean Systems Center Technical Document, TD 108 Project Managers Guide, or any other comparable document, be reviewed.

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CONTENTS

APPENDICES

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FIGURES

TABLES

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1. SCOPE

1.1 Scope. This document is intended to provide managers responsible for the design, development and acquisition of DoD platforms, systems and equipments with the guidance necessary to establish an effective program for achieving the desired degree of EMC. The handbook describes the steps which must be taken to ensure that EMC considerations are incorporated during the life cycle to achieve the desired compatibility for the life cycle of the platform, system, or equipment.

1.2 A Applicability. Provisions of this handbook are to be applied by procuring agencies, and by development and operations activities at appropriate times during the life cycle of any platform, system or equipment which emits or which can be susceptible to electromagnetic energy. For example, the handbook is applicable as follows:

a. During acquisition to assure visibility, accountability, and controllability of the EMC effort, as well as its integration into the overall program
b. During the design process to assure a coherent design, management awareness and cost effective tailoring of applicable EMC standards and requirements

It may also be applied by contractors as a guide for establishing and implementing an EMC program during the contract phase.

1.3 Format. To assure early consideration of EMC as well as to provide the necessary continuity achieving and monitoring the required EMC, the guide follows the framework of the life cycle for platforms, systems and equipments. Section 4 describes the overall approach which should be taken during the life cycle for EMC. Section 5 describes specific actions which must be taken by the manager to implement the approach in Section 4. Together these actions describe the steps which must be taken during the life cycle and the responsibilities of the manager for ensuring that his equipment, system, installation or platform is not only compatible within itself (that is, self-compatibility) but has a high probability of continued operation, within acceptable tolerances, with other systems and platforms in its intended EME. The appendices describe in greater detail the various aspects of EMC which are to be implemented by- the manager, and include:

- EME
- Prediction and Analysis
- Tailoring General EMC Standards to EM Operational Requirements
- Checklist for Major EMC TaE Planning Considerations (Navy)
- EMC Training
- Frequency Management and Control
- Configuration Management
- EMC Considerations in Program Documents
- EMC Bibliography for Managers

1.4 Relationship between EME and EMC. The electromagnetic environment in which military platforms. systems and equipments must operate is created by a multitude of sources. Primary contributors are intentional, unintentional, friendly and hostile emitters. Electromagnetic pulses, atmospheric, solar and galactic emissions, lightning, and the like, are other sources. The contribution of each emitter to the environment may be described in terms of its technical characteristics, such as power, modulation, frequency, bandwidth and so forth. Effects depend on the receiver's characteristics, relative locations of emitters and receptors, operational concepts, and so forth. However, it can be concluded that the EME can adversely affect all electronic, electro-optical, electrical and electromechanical equipments and systems, personnel, fuels, and weapons.

1.4.1 Terminology. Various terms have been used to describe the programs established to reduce or prevent adverse effects from electromagnetic energy. These terms include: EMC, EMI, EMV, EMP, ECCM, EM-power, P-static, HERO, EME, E^3, HERF, HERP, and RADHAZ. To avoid confusion the term EMC will be used in this document and encompasses any source of electromagnetic energy and any type of potential victim.

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1.4.2 Intra-system versus inter-system. EM interactions between elements of a system are termed intra-system EMC whereas EM interactions between systems are inter-system EMC. This concept may be extended to platforms by considering EM interactions between equipments and systems on a platform as intra-platform EMC whereas Interactions between the platform and its EM environment or other platforms are considered inter-platform EMC.

* 2. APPLICABLE DOCUMENTS

2.1 Government documents. The following documents, of the Issue listed in the Department of cations and Standards (DoDISS) and its supplements, form a part of this document to the extent specified herein. The date of the applicable DoDISS and supplements thereto shall be as specified in the solicitation.

SPECIFICATIONS

MILITARY

MIL-E-6051	Electromagnetic Compatibility Requirements, Systems (Aircraft And Associated Weapons Systems)

STANDARDS

MIL-STD-449	Radio Frequency Spectrum Characteristics, Measurements Of
MIL-STD-461	Electromagnetic Emission And Susceptibility Requiements For The Control Of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement Of
MIL-STD-463	Definitions And System Of Units, Electromagnetic Interference And Technology
MIL-STD-469	Radar Engineering Design Requirements, Electromagnetic Compatibility
DOD-STD-480	Configuration Control - Engineering Changes, Deviations And Waivers
MIL-STD-1605	Procedures For Conducting A Shipboard Electro-magnetic Interference (EMI) Survey (Surface Ships)
DoD-STD-2169	High Altitude Electromagnetic Pulse (HEMP) Environment (U)

HANDBOOKS

MIL-HDBK-235	Electromagnetic (Radiated) Environment Consider-ations For Design And Procurement Of Electrical And Electronic Equipment, Subsystems And Systems

PUBLICATIONS

INSTRUCTIONS

OPNAVINST 1500.8	Preparation And Implementation Of Navy Training Plans (NTP) In Support Of Hardware And Non-Hardware Oriented Developments
OPNAVINST 2410.11	Procedures For The Processing Of Radio Frequency Applications For The Development And Procurement Of Electronic Equipment
OPNAVINST 3960.10	Test And Evaluation
NAVMATINST 2410.1	Electromagnetic Effects (E^3) Policy Within The Naval Material Command (NMC)

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OTHER

ECAC-CR-83-177	DD Form 1494 Preparation Guide for Navy Frequency Allocations
NTIA MANUAL	Manual Of Regulations And Procedures for Radio Frequency Management

(Copies of specifications, standards, handbooks, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

3.1 Definitions. The definitions included in MIL-STD-463 and MIL-HDBK-235 shall apply.

3.2 Acronyms and abbreviations. The following are EMC related acronyms and abbreviations of terms used in this handbook:

ASEMICAP	Air Systems Electromagnetic Interference Corrective Action Program
CASREP	Casualty Report
CEP	Circular Error Probability
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
CONAR	Commanding Officer's Narrative Report
E^3	Electromagnetic Environment Effects
ECAC	Electromagnetic Compatibility Analysis Center
ECCM	Electronic Counter-Countermeasures
EED	Electro-Explosive Device
EM, em	Electromagnetic
EMC	Electromagnetic Compatibility
EMCAB	Electromagnetic Compatibility Advisory Board
EMICP	Electromagnetic Interference Control Plan
EMCON	Emission Control
EMCPP	Electromagnetic Compatibility Program Plan
EME	Electramagnetic Environment
EMI	Electromagnetic Interference
EMP	Electromagnetic Pulse
EMR	Electromagnetic Radiation
EMV	Electromagnetic Vulnerability
HERE	Hazards of Electromagnetic Radiation to Equipment
HERF	Hazards of Electromagnetic Radiation to Fuels
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
PK	Probability of Kill
P-static	Precipitation Static
RADHAZ	Radiation Hazards to Personnel

4. INCORPORATING EMC DURING PROGRAM LIFE CYCLE

4.1 General. Management and engineering personnel must establish and implement a procedure for integrating EMC into the various phases of the life cycle of platforms, systems and equipments. This approach is required to assure early consideration of EMC as well as to provide the necessary continuity for achieving and maintaining the required EMC. The approach, in the case of a complex system usually includes modeling, analyzing, simulating and testing to determine emission and susceptibility characteristics and operational constraints. Final requirements are postulated by tailoring of general standards to the peculiar characteristics and operational requirements of the item in its individual specification.

* 4.2 Life cycle flow. The principal phases in the life cycle of a major system or platform are generally delineated as.

- Concept Exploration
- Concept Development
- Concept Validation
- Full Scale Development
- Production
- Deployment

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Numerous departmental and agency directives contain the policies which define the activities and decisions made during each phase. A flow diagram depicting an approach designed to integrate an EMC program into the overall acquisition process for major defense systems is shown on FIGURE 1. The relationship between these activities and specific actions required by the manager is presented in other sections and the appendices of this guide. The EMC documents which may be used to assist in carrying out these actions an listed in APPENDIX I. EMC considerations in program documents are contained in Appendix H.

* 4.2.1 Concept exploration. The Tentative Operational Requirement (TOR) must form the basis for the E^3 effort during the acquisition process. The general requirement for compatibility with the EM Environment (EME) must be stated at the beginning and the EME must be defined far enough into the future to cover the life span of the proposed acquisition item. In addition, unique objectives related to EM effects must be specified for all E^3 disciplines. The target parameters and operational employment must be described efficiently to permit definition of the anticipated EME. The Development Options Paper (DOP) presents the alternatives and tradeoffs to achieve the required operational capability called for in the TOR. E^3 ramifications for each alternative must be addressed. The DOP must define the operational EME, the sensitivity of the alternatives to the EME and their impact on the environment. The hardening alternatives must be described along with costs, risks, and the potential effect on the operational capability. Plans for developmental and operational E^3 tests must be given, along with performance criteria. If special test facilities and equipment are required, they should be described and cost estimates given.

* 4.2.1.1 EMC tasks during concept exploration. EMC tasks which should be addressed during this phase of the program are as follows:

- o Evaluate TOR for E^3 considerations
- o Include E^3 considerations in DOP
- o Develop an exploratory frequency application, DD-1494

4.2.1.2 Concept development. During this phase, technical and financial baselines for a development and acquisition program are established. Included are definitions of required operational capability, doctrines and specific material requirements. Critical technical and operational issues will be identified for study and resolution in subsequent phases, whereas performance characteristics are established only in general terms. Outputs of this phase an alternate concepts, established operational schedules and estimated procurement costs. During this phase, (proper consideration of EMC will have a significant impact throughout the life cycle. For example, preliminary selection of operating frequency band modulation and other technical parameters must be consistent with established international and national frequency management policies. Also, an assessment of the ability of a system to perform its function during its life cycle must include a threat analysis using both the friendly and hostile EM environment which may be encountered. These factors must be addressed not only in performing trade-off studies and risk assessments, but also in estimating total program costs.) The culmination of these activities will be the first major design review by the Defense Systems Acquisition Review Council (DSARC I), the program initiation decision.

4.2.1.3 EMC tasks during concept development. EMC tasks which should be addressed during this phase of the program are as follows. is recommended that the program manager either consult with the EMC authority within his activity or designate an EMC Task Manager to support him on EMC matters throughout the program life cycle.

- o Prepare EMC Program Plan (EMCPP) (see 5.4)
- o Budget for EMC effort during program
- o Establish an EMC Advisory Board (EMCAB) (see 5.5)
- o Determine spectrum requirements and submit request for frequency allocation (see 5.3 and APPENDIX F)
- o Define EM environment which may be encountered during life cycle (see 5.6 and Appendices A and C)
- o Perform an analysis to determine if proposed system or platform can operate in the anticipated EM environment (see 5.6 and APPENDIX B)
- o Establish initial EMC requirements for system or platform (see 5.6 and APPENDIX C)
- o Update EMCPP and refine schedules and cost estimates

4.2.2 Concept validation. The primary objective of this phase is the selection of the single concept which will be carried out through full scale development. To accomplish this, the estimates made in the concept development phase must be refined. Areas of risk must be assessed to assure that they have been adequately defined and can be resolved or minimized. Frequently, this phase includes the construction of prototypes to evaluate operational, technical and environmental factors as well as to refine costs. An SOM and RFQ for research and development contract support will be prepared, when required. The studies, analyses and testing are culminated in the second design review DSARC II, where a decision is made as to whether to proceed to full scale development.

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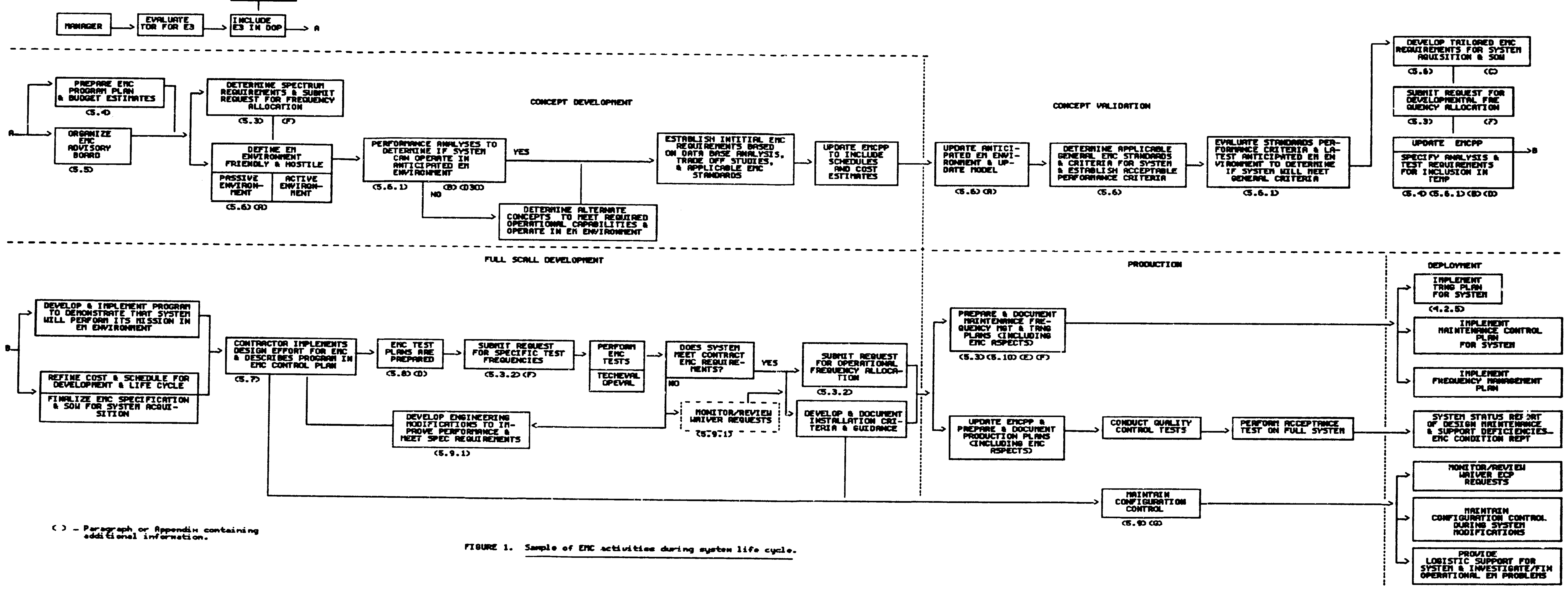

( ) - Paragraph or Appendix containing additional information.

FIGURE 1. Sample of EMC activities during system life cycle.

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4.2.4.1 EMC tasks during production. EMC tasks which should be addressed during this phase of the program are as follows:

- o Review and approve proposed EMC tests and reports for acceptance tests
- o Perform special EMC acceptance tests (see 5.8 and APPENDIX D)
- o Finalize EMC aspects of integrated logistics support (ILS) maintenance and training plans (see 5.11 and APPENDIX E)
- o Develop and document frequency management and usage plan (see 5.3 and APPENDIX F)
- o Update EMCPP and turn it over to the logistics manager
- o Ensure ECPS are reviewed for EMC impact (see 5.9 and APPENDIX G)
- o Include EMC Condition Report in platform status report of design, maintenance and support deficiencies

4.2.5 Deployment. This phase begins with the acceptance of the first operational system or platform and extends until all are phased out of the inventory. There is usually an overlap with the production phase. In-service performance must be monitored by a reliable, established feed-back system to detect, report and correct operational problems. Any modifications, ECPs and overhaul plans must be reviewed in accordance with the program configuration control system.

4.2.5.1 EMC tasks during deployment. EMC tasks which should be addressed during this period are as follows:

- o Implement maintenance, training and frequency management and usage plans including activation of procedures for EM problem reporting and requests for assistance
- o Investigate and fix EM problems as may be reported by a formalized reporting process
- o Maintain configuration control during systems modifications modifications.

ECPs must be reviewed for EMC impact.

* 4.3 Procedural method for addressing EMC. TABLE I and FIGURE 1 summarize the procedures described in 4.2 and provide the program manager with an crderly and coherent approach for addressing EMC involving platforms, equipments and systems. Appendices J, K and L give specific information for Naval Sea Systems Command (NAVSEA) and Space and Naval Warfare Systems Command (SPAWAR) PMs on how to implement the guidance given in this handbook. Appendix M gives information specific to Naval Air Systems Command (NAVAIR) acquisitions. Although the specific design and acquisition procedures may differ depending on whether the procurement is for a platform, system or equipment, the overall approach for ensuring EMC in the end product is essentially the same. In cases where the detailed design and production is done by the contractor, the project manager's major responsibilities in EMC are to define the applicable EMC requirements and monitor the contractor's efforts to comply with the requirements. In cases where the detailed design is done by the procuring activity and a contractor is responsible for production in accordance with Government-furnished information (GFI), the program manager must, in addition to the above, conduct all aspects of the EMC effort, including establishing installation criteria, performing analyses, and so forth. In any case, the program manager may delegate these responsibilities to the EMC authority in his activity or he may establish an EMCAB to provide advice and assistance so that he can carry out the responsibilities, or a combination of both approaches.

4.3.1 Design methodology. Electromagnetic compatibility can be achieved through proper design, development, test and production methods, accepted installation practices and life cycle maintenance and support. To be effective, the design methodology must provide a clearly defined, coherent approach for preventing electromagnetic problems and for achieving the required electromagnetic compatibility. Normally, electromagnetic compatibility will not be attained unless these aspects are emphasized by management in an EMC program established early in the conceptual and design phases of equipment and systems. An example of the methodology for addressing ship EMC is shown in TABLE II. FIGURE 2 illustrates graphically the key elements impacting platform EMC.

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TABLE I. Typical EMC tasks related to the various phases of ship platform design & construction.*

EMC Tasks	Concept Development	Concept Validation	Full Scale Development	Production
• Prepare EMCPP and updates (5.4)				
• Establish EMC advisory board (EMCAB) (5.5)				
• Review plans, programs, and contracts to ensure EMC provisions				
• Apply MIL SPECS & STDs				
• Prepare and update EMC control plan				
• Prepare EMC inputs to TEMP				
• Maintain liaison with acquisition managers of electronic systems, subsystems, and equipments				
• Study EMC impact of all ship alterations (SHIPALTS), ECP's, ordnance alterations (ORDALTS), and requests for waivers				
• Ensure application of EMC predictions techniques in time to influence ship design				
• Support utilization of selected materials where feasible, to achieve interference reduction (e.g., fiber optics)				
• Develop frequency management plan				
• Coordinate application of EMC criteria in EW, EMP, EMV, HERO, and RADHAZ				
• Ensure adequate funding for accomplishment of necessary EMC engineering tasks				

*NOTE: See appendices J and K.

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APPENDIX I
EMC BIBLIOGRAPHY FOR PROGRAM MANAGERS

This appendix provides the program manager responsible for the acquisition of platforms, systems and equipment, with a discrete list of pertinent documents relative to the EMC/EME requirements.

Part I	Directives and Instructions provide the definition of and authority to incorporate the EMC/EME requirements.
Part 11	Military Specifications and Standards describe, define and dictate the EM/EME requirements to be included in the Design Specification.
Part III	Guidance Documents provide assistance to the Program Manager in achieving complete EMC/EME considerations in the procurement/ acquisition plan.
Part IV	Matrices of EMC Tasks during life cycle vs. basic EMC documents

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PART I -- DIRECTIVES AND INSTRUCTIONS

DOCUMENT NUMBER	SUBJECT
DoD Directive	
3222.3	DoD Electromagnetic Compatibility Program
C-4611.3	Electronic Counter-Countermeasures (ECCM) Policy
4631.5	Compatibility and Commonality of Equipments for Tactical Command, Control and Communications
4651.1	Management and Use of Radio Frequency Spectrum
SECNAVINST	
2411.21	Management and Use of Radio Frequency Spectrum within the Department of the Navy
2411.1	Electromagnetic Compatibility Program Within the Department of the Navy, Policy Direction
C-3431.2	Department of Navy Policy Concerning Electronic Counter-Countermeasures (ECCM) in Electronic Systems
OPNAVINST	
S3431.1	Joint Electronic Warfare Policy
S3431.4	Navy Electronic Warfare Organization and Policy
2411.11	Procedures for the Processing of Radio Frequency Applications for the Development and Procurement of Electronic Equipment
2411.29	Electromagnetic Compatibility Analysis Center; analytic services and data available from
2411.31	Electromagnetic Compatibility Within the Department of the Navy
C-3431.15	Electronic Warfare Support Measures and Electronic Intelligence Technical Systems
C-3431.18	Reporting Beaconing, Intrusion, Jamming and Interference of Electromagnetic Systems
3811.1	Threat Support to Weapons Systems Selection and Planning
5111.1	Resolution of Electromagnetic Radiation (EMR) Hazard Problems
* **SPAWARINST**	
2411,4	Electromagnetic Environmental Effects (E^3) Policy Within the Naval Material Command
3882.3	Threat Support to Weapons Systems Selection and Planning
3921.4	Navy Combat Survivability Program; Establishment of
5111.1	Electromagnetic Radiation (EMR) Hazard Problems, resolution of
5411.17	Nuclear Weapon Effects Program Technical and Management Responsibilities and Procedures
11381.9	Electromagnetic Environment Considerations in the Life Cycle of Navy Electronic/Electrical Equipment and Systems; implementation of

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DOCUMENT NUMBER	TITLE
MIL-STD-1541 (USAF)	Electromagnetic Compatibility Requirements for Space Systems

SCOPE - This standard establishes the electromagnetic compatibility (EMC) requirements for space systems, including launch vehicles, space vehicles, ground systems, and associated aerospace ground equipment (AGE). It does not apply to facilities which house such items.

DOCUMENT NUMBER	TITLE
MIL-STD-1542 (USAF)	Electromagnetic Compatibility Requirements for Space System Ground Facilities

SCOPE - This standard covers the general EMC and grounding requirements for space system ground facilities. Space system facilities include structures that house electrical/electronic devices or equipment such as service structures, tracking station buildings, satellite control roosm, computer rooms, and spacecraft or booster assembly buildings.

DOCUMENT NUMBER	TITLE
MIL-STD-1574	System Safety Program for Space and Missile Systems

SCOPE - This standard defines the requirements for implementation of system safety programs covering the life cycle of the system. It includes the safety requirements for the following activities/periods: design, development, test, checkout, modification, production, servicing, refurbishing, maintenance, transportation, handling, training, disposal, deployment, and normal and contingency operations. This standard also defines the management and technical tasks and controls required to minimize accident risks caused by human error, environment, deficiency/-inadequacy of design, and component malfunction or interactions.

DOCUMENT NUMBER	TITLE
MIL-STD-1615	Procedures for Conducting a Shipboard Electromagnetic Interference Survey (Surface Ships)

SCOPE - This standard provides detailed procedures for conducting an electromagnetic interference (EMI) survey aboard surface ships. An EMI survey is required for new construction ships and ships receiving overhauls or other major repair work that changes the electromagnetic configuration.

DOCUMENT NUMBER	TITLE
MIL-STD-1658	Shipboard Guided Missile Launching System Safety Requirements, Minimum

SCOPE - This standard establishes the minimum safety requirements for shipboard guided missle launching systems. Special requirements which may be imposed on launching systems handling missiles containing nuclear warheads or liquid fuels other than hydrocarbon fuels are not included.

*DOCUMENT NUMBER	TITLE
DOD-STD-2169	High Altitude Electromagnetic Pulse (HEMP) Environment (U)

SCOPE - This document is classified. Obtain from procuring activity.

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DOCUMENT NUMBER	TITLE
AIR-STD-12/19 (ASCC AIR STD)	Electromagnetic Compatibility Test Methods for Aircraft Electrical and Electronic Equipment

OBJECT - To standardize minimum requirements and essential test methods pertaining to Intra-system-Electromagnetic Compatibility of electrical and electronic equipment for use with aerospace systems of the member countries.

DOCUMENT NUMBER	TITLE
ABC-STD-52	Shipboard Electrical Power Characteristics

DOCUMENT NUMBER	TITLE
STANAG 3516	EMC Test Methods for Aerospace Electrical and Electronic Equipment

OBJECT - To establish the minimum requirement and essential test methods pertaining to Intra-system-Electromagnetic Compatibility of electrical and electronic equipment for use with aircraft systems.

DOCUMENT NUMBER	TITLE
STANAG 3614 AE	EMC of Installed Equipment in Aircraft

PURPOSE - To ensure that equipment interference control is considered already during development and interference limits are included in the development specification of equipment.

To warrant compatible operation of the equipment with its electromagnetic interference and its susceptibility in a complex electromagnetic interference environment within a weapons systems.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

DOCUMENT NUMBER	TITLE
ANSI C95.1	Safety Level of Electromagnetic Radiation with Respect to Personnel

SCOPE - Recommendations are made to prevent possible harmful effects on mankind, resulting from exposure to electromagnetic radiation in the frequency range from 11 MHz to 111 GHz. They apply to all radiation within this frequency range originating from radio stations, radar equipment, and other possible sources of electromagnetic radiation such as used for communication, radio-navigation and industrial and scientific purposes. These recommendations are not intended to apply to the deliberate exposure of patients by or under the direction of practitioners of the healing arts.

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DOCUMENT NUMBER	TITLE
ANSI C95.2	Radio Frequency Radiation Warning Symbol

SCOPE - This standard applies to the design of a symbol for use as a sign intended to warn workers or the public of the presence of biologically hazardous levels of electromagnetic radiation and, in so far as considered desirable, to define specific hazards and provide cautionary information.

It is not the intent of this specification to conflict with or supersede in any fashion the standard ionizing radiation sign as defined in USA Standard Specifications for Industrial Accident Prevention Signs, Z35.1-1959.

DOCUMENT NUMBER	TITLE
ANSI C95.3	Techniques and Instrumentation for Measurement of Potentially Hazardous Electromagnetic Radiation at Microwave Frequencies

PURPOSE - Subcommittee I on Techniques, Procedures, and Instrumentation was originally organized on April 7, 1961, to establish specifications for techniques and instrumentation used in evaluating hazardous radio-frequency radiation.

On January 8, 1963, the intent of the scope was clarified by specific reference to mankind, flammable volatile materials, and explosive devices; thus the purpose was entended to establish specifications for techniques and instrumentation to be used in evaluating radio-frequency hazards to mankind, flammable volatile materials, and explosive devices.

DOCUMENT NUMBER	TITLE
ANSI C95.4	Safety Guide for the Prevention of RF Radiation Hazard in the Use of Electric Blasting Caps

PURPOSE - This guide is intended to provide a basis for assessing the hazards associated with initiation of commercial electric blasting caps by radio frequency (RF) energy by indicating safe distances from commercial RF sources.

Part I gives basic information of the mechanism of RF initiation and its avoidance.

Part II gives tables of safe distances developed by analytical calculations and supported by numerous field tests. Adherence to these tables will give the blaster a high degree of assurance that his blasting layout should be safe against-RF initiation.

Part III gives data on common RF sources.

*DOCUMENT NUMBER	TITLE
OPNAV NOTICE 5111	Personnel protection policy for Exposure to Radio-Frequency Radiation (RFR)

PURPOSE - To call attention to potential health hazards associated with exposure to electromagnetic fields in the frequency range of l1 MHz to l11 GHz, to specify maximum exposure levels in terms of external field quantities, to provide guidance for medical surveillance and to specify reporting requirements of microwave overexposure incidents.

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DOCUMENT NUMBER	TITLE
BUMEDINST 6471.14( )	Laser Health Hazards

PURPOSE - To establish a standard for the evaluation of laser hazards and guidance for medical surveillance of persons occupationally exposed to laser radiation.

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PART IV - MATRICES OF EMC TASKS

TABLE III. EMC TASKS DURING CONCEPT EXPLORATION & BASIC EMC DOCUMENTS (AS APPROPRIATE)*

EMC TASKS	OPNAV/INST. 5000.42 W/CH. 1	SPAWAR INST. 2410.4	
EVALUATE TOR FOR E^3 CONSIDERATIONS	X		
INCLUDE E^3 CONSIDERATIONS IN DOP	X		
DEVELOP AN EXPLORATORY FREQUENCY APPLICATION, DD-1494		X	

*NOTE: Consult other guidance documents listed in Part III of this appendix as appropriate.

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Part IV -- Matrices of EMC Tasks

TABLE IV. EMC Tasks during concept development and basic EMC documents (as appropriate)*

EMC Tasks	OPNAVINST 2410.11	OPNAVINST 2410.29	OPNAVINST 2410.31	NAVMATINST 2410.1	NAVMATINST 5101.1	NAVMATINST 10380.9	MIL-E-6051	MIL-STD-461	MIL-STD-463	MIL-STD-469	MIL-STD-1385	DoD-STD-1399	NTIA MANUAL	MIL-HDBK-235	DD FORM 1494	MIL-HDBK-253	MIL-STD-704
PREPARE AND UPDATE EMCPP			X	X					X								
ORGANIZE EMCAB				X			X									X	
DETERMINE SPECTRUM REQUIREMENTS AND SUBMIT REQUEST FOR FREQUENCY ALLOCATION	X		X	X									X		X		
DEFINE EM ENVIRONMENT WHICH MAY BE ENCOUNTERED DURING LIFE CYCLE						X	X				X	X		X		X	X
ANALYZE SYSTEM OR PLATFORM TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM CAN OPERATE IN ANTICIPATED EM ENVIRONMENT		X	X	X	X	X	X							X		X	
ESTABLISH INITIAL EMC REQUIREMENTS FOR SYSTEM OR PLATFORM							X	X		X	X	X	X	X			X

*NOTE: Consult other guidance documents listed in Part III of this appendix as appropriate

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TABLE V. EMC tasks during concept validation and basic EMC document (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.29	OPNAVINST 2410.31	NAVMATINST 2410.1	NAVMATINST 5101.1	NAVMATINST 10380.9	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	DoD-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-HDBK-235	MIL-HDBK-253	MIL-B-5087	NTIA MANUAL	DD FORM 1423	DD FORM 1664	DD FORM 1494
CONTINUE EMCAB				X			X												X					
REVIEW & UPDATE EM ENVIRONMENT						X	X							X	X		X	X	X					
REFINE ANALYSES TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM CAN SATISFACTORILY OPERATE IN INTENDED EM ENVIRONMENT		X	X	X	X	X	X											X	X					
DEFINE ACCEPTABLE PERFORMANCE CRITERIA FOR SYSTEM OR PLATFORM							X	X		X				X	X		X	X	X		X			
EVALUATE EMC STDs & CRITERIA PREDICTED EM ENVIRONMENT AND ACCEPTABLE PERFORMANCE CRITERIA TO DETERMINE IF PROPOSED SYSTEM OR PLATFORM WILL MEET GENERAL EMC CRITERIA							X	X		X		X		X	X		X	X	X	X	X			
DEVELOP TAILORED EMC REQUIREMENTS FOR ACQUISITION AND CORRESPONDING SOW				X			X	X		X				X	X		X	X	X		X	X	X	
SUBMIT REQUEST FOR DEVELOPMENTAL FREQUENCY ALLOCATION	X		X	X																	X			X
SPECIFY OPERABILITY ANALYSES & TESTING REQUIREMENTS FOR TEMP			X	X			X		X	X	X		X			X								
UPDATE EMCPP				X																				

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate).

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TABLE VI. EMC tasks during full scale development and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.31	NAVMATINST 2410.1	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	MIL-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-HDBK-235	MIL-HDBK-253	MIL-HDBK-238	MIL-HDBK-241	NTIA MANUAL	DD FORM 1423	DD FORM 1494	DD FORM 1664	MIL-B-5087
CONTINUE EMCAB			X	X												X							
FINALIZE EMC REQUIREMENTS AND SOW FOR ACQUISITION OF PREPRODUCTION MODEL AND REVIEW CONTRACTOR DATA ITEMS INCLUDING EMCCP				X	X		X		X		X	X		X	X	X			X	X		X	
MONITOR/REVIEW WAIVER REQUESTS & ECPs		X	X																	X			
DEVELOP & IMPLEMENT COMPREHENSIVE PROGRAM TO DEMONSTRATE BY ANALYSIS. SIMULATION & TEST THAT THE SYSTEM/PLATFORM WILL PERFORM ITS MISSION IN THE ANTICIPATED EM ENVIRONMENT. INCLUDE THIS IN TEMP/TEP		X	X	X		X	X	X		X			X		X	X							
SUBMIT REQUEST FOR ASSIGNMENT OF TEST FREQUENCIES	X		X																		X		
DOCUMENT EMC ASPECTS OF MAINTENANCE. PRODUCTION & TRAINING PLANS				X					X								X	X					X
DEVELOP EMC SPECIFICATION REQUIREMENTS FOR PRODUCTION CONTRACT				X	X		X		X		X	X		X	X	X			X	X		X	X
SUBMIT REQUEST FOR OPERATIONAL FREQUENCY ALLOCATION	X		X																X		X		
DEVELOP INSTALLATION CRITERIA & GUIDANCE									X								X						X

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate).

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TABLE VII. EMC tasks during production and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.31	NAVMATINST 2410.1	MIL-E-6051	MIL-STD-461	MIL-STD-462	MIL-STD-469	MIL-STD-449	MIL-STD-1310	MIL-STD-1377	MIL-STD-1385	MIL-STD-1399	MIL-STD-1605	MIL-STD-704	MIL-STD-238	MIL-STD-241	MIL-STD-253	MIL-B-5087	DD FORM 1494	NTIA MANUAL
REVIEW CONTRACTOR'S EMC TEST PLAN AND REPORT FOR ACCEPTANCE TESTS				X	X	X	X	X		X	X	X	X	X						
PERFORM SPECIAL EMC TESTS DEFINED IN TEMP				X		X	X	X		X			X							
FINALIZE EMC ASPECTS OF MAINTENANCE - TRAINING PLANS				X					X						X	X	X	X		
DEVELOP & DOCUMENT FREQUENCY MANAGEMENT/USAGE PLAN	X																		X	X
UPDATE EMCPP			X																	
MONITOR/REVIEW WAIVER REQUESTS & ECP's		X	X																	X

***NOTE:** **Consult other guidance documents listed in Part III of this appendix (as appropriate).**

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TABLE VIII. EMC tasks during deployment and basic EMC documents (as appropriate)*

EMC TASKS	OPNAVINST 2410.11	OPNAVINST 2410.31	NAVMATINST 2410.1	NTIA MANUAL
IMPLEMENT MAINTENANCE AND TRAINING PLANS, INCLUDING EMC ASPECTS				
MAINTAIN CONFIGURATION CONTROL DURING LIFE CYCLE, INCLUDING REVIEWING ECP's		X	X	
IMPLEMENT FREQUENCY MANAGEMENT/USAGE PLAN	X			X
INVESTIGATE AND FIX OPERATIONAL EM PROBLEMS			X	

*NOTE: Consult other guidance documents listed in Part III of this appendix (as appropriate). For the most part, implementation procedures during deployment will be agency dependent.

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APPENDIX J

APPLICATION GUIDE FOR NAVSEA and SPAWAR ACQUISITIONS

10. Introduction. This appendix provides NAVSEA and SPAWAR program managers (PMs) responsible for the acquisition of ships, systems and equipment with specific information on how to implement the guidance given in this handbook.

20. Ship Acquisition. The delivery of a new ship, with minimal E^3 problems, to the active fleet requires the establishment of an E^3 program covering the entire life cycle of the ship. This program should be started during any feasibility study and continue throughout the preliminary and contract design, and construction phases. Consideration must also be given to maintaining the E^3 integrity of the ship throughout its operational life. This can be accomplished with the use of some or all of the following tasks in accordance with the SHAPM E^3 Control Strategy outlined in Appendix K:

a. Designate an E^3 Coordinator.

b. Obtain adequate funding to conduct an EMC program.

c. Develop and execute an EMC Program Plan (EMCPP).

d. Establish an EMC Advisory Board (EMCAB).

e. Incorporate E^3 requirements in the Top Level Specification (TLS), all Requests for Proposals (RFPs), specifications, and Statements-of-Work, Ship Project Directives, and other related documentation.

f. Develop and execute E^3 Test and Evaluation (T&E) plans for all phases of the acquisition.

g. Develop and execute a training plan to ensure that EMC features are not compromised during use.

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Assistance can be obtained from the appropriate Navy E^3 Program Office in defining and executing the necessary tasks within the command's management framework. Ultimate responsibility for the above tasks rests with the program manager.

20.1 E^3 Coordinator. The Ship Acquisition Program Manager (SHAPM) should designate a qualified person as the E^3 coordinator. The E3 coordinator duties include the following:

a. Coordinate E^3 related efforts in the SHAPM's office.
b. PM's representative to the EMCAB.
c. Coordinate requested information and participation of activities as necessary for EMCAB functions.
Maintain all files and records of the EMCAB and other E^3 material related to the acquisition.

$E^{3=}$ considerations apply in many areas of ship acquisition. The E^3 design, test, installation and training elements should be integrated under the direction of the E^3 Coordinator. This provides a constant coherent exchange of information relative to design changes, test *or* installation problems (anticipated or realized) and training requirements to allow each group to function as participants in the E^3 program rather than separate entities. The currentness of such information made available to the EMCAB through the E^3 Coordinator will allow faster reaction and increased assurance that the EMCAB recommendations will be valid. The E^3 Coordinator will alleviate the day-to-day control effort required of the program manager.

20.2 E^3 Program Funding. The budget for the design, development, production and deployment of the ship should ensure that adequate funding is allocated to support the E^3 program effort required throughout the program. Without adequate planning from the start, the program may have to rely on the use of costly, after-the-fact

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investigative programs with band aid or retrofit fixes to attain some degree of EMC, at the cost of performance.

20.2.1 E^3 Budget. The E^3 budget must consider the costs involved in:

a. Development of the EMCPP
b. Life cycle support of the EMCPP
c. Support of the EMCAB
d. Funding for analysis and prediction effort and procurement of fixes required to resolve potential problems
e. E^3 testing of Government and contractor furnished equipment and of the ship
f. Responsibility and funding for each activity involved in the E3 program (contractor, government laboratories, in-house, field activities)
g. E^3 support in design and installation review
h. Training (in-house, installation and test activities such as shipyard and military)

Assistance in determining the E^3 budget can be obtained from the E3 program office, and by obtaining costs from previous programs of similar scope which fully implemented the E^3 program.

20.3 EMCPP. The effectiveness of any program in terms of time, cost, quality, etc. requires establishment of desired "end-result" technical goals and methods to be employed in achieving these goals. The methods cover program philosophy, policy, management, authority and responsibility of each activity involved in the program. The SHAPM is required by NAVSEA INST 2410.2 to prepare a program plan which describes the overall approach to be employed in achieving EMC during the ship's life cycle. The program plan will define the management organization of the E3 program; establish lines of communication, responsibility, and authority of all involved activities; describe the platform, system, or equipment in terms of intended use, installation and

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anticipated EM environment; establish or define the methods to be used in predicting EM compatibility in the intended environment; establish goals and milestones to be met at each stage of the life cycle; and make provision for updating the program plan to address changing needs or requirements as the acquisition progresses through its life cycles. The EMCPP should meet the requirements of DI-R-7096.

20.4 EMCAB. An EMCAB should be established early in the acquisition process, for ACAT I and II procurements, preferably in the feasibility study phase. The EMCAB will support the SHAPM for all E^3 aspects of the acquisition from ship specification preparation, design review, analysis and prediction, test plan review, test result review, installation, construction, builder's trials, INSURV trials, and the first few years of the ship's operation. To adequately serve this function, all members of the board should have E^3 training or background and, if possible, be recognized authorities in the E^3 community. Membership should be limited to the minimum required to cover all pertinent E^3 disciplines. This will ensure issues can be discussed and resolved without undue delay. All recommendations and findings of the board will be forwarded to the SHAPM, in the manner prescribed in the EMCPP, for final disposition. Typically the EMCAB will include representatives from the following:

a. Ship PM's office (E^3 Coordinator)
b. SPAWAR E^3 office
c. NAVSEA E^3 and Topside Design offices
d. Shipbuilder and Ship Design Agent
e. NAVAIR E^3 office (as required)
f. Others (as required)

20.4.1 Participation. Functional descriptions for the above representatives are as specified in 20.4.1.1 through 20.4.1.6.

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20.4.1.1 Ship Program Manager's Office (E^3 Coordinator). The coordinator provides a direct link between the EMCAB and PM and apprises the EMCAB on contractual conflict or other matters resulting from EMCAB recommendations. The coordinator also reports EMCAB findings and recommendations to the PM. As such, an "early warning" input is provided to the PM of potential problems, anticipated ship modifications or other E^3 related matters.

20.4.1.2 SPAWAR E^3 Office Representative. The SPAWAR representative provides the EMCAB with information and advice on problems encountered and resolutions for SPAWAR systems. Technical expertise is also provided in E^3 related matters.

20.4.1.3 NAVSEA E^3 and Topside Design Office Representatives.
These representatives may serve as EMCAB chairman for NAVSEA ship acquisitions and provide the EMCAB with information and advice from the NAVSEA data bank on problems encountered and corrective actions with similar ship designs, A direct link is also provided to other NAVSEA program offices for information and data needed by the EMCAB for E^3 assessment. These representatives also provide technical expertise in E^3 related matters.

20.4.1.4 NAVAIR E^3 Office Representative. The NAVAIR representative provides the EMCAB with information and advice concerning aircraft systems.

20.4.1.5 Ship Builder and Ship Design Agent. These representatives should be designated E^3 engineers. They provide a direct source of E^3 information relative to problems encountered or anticipated and the contractor's proposed methods of resolution. They provide contractor participation in EMCAB recommendations for changes or modifications. These E^3 engineers may be augmented as necessary by other contractor personnel to provide more detailed design information required by the EMCAB.

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20.4.1.6 Others. Representatives of other SPAWAR, NAVSEA, and NAVAIR offices, laboratories or equipment contractors may be needed on a limited basis to provide information to assist the EMCAB in determination or resolution of E^3 problems. The EMCAB chairman may request participation through the program manager's E^3 coordinator.

20.4.2 Meetings. The EMCAB chairman provides direction to the EMCAB by preparing the agenda for meetings, assigning action items to various members as required and submitting status reports, findings, and recommendations. Meetings should be held at regular intervals, usually once a month, with provision for special meetings to handle urgent issues as they arise. A secretary is necessary to maintain accurate minutes of the EMCAB's discussions and recommended actions. The minutes should contain a description of issues and recommendations for their resolution as well as identification and assignment of action items to each board member with completion target dates. Minutes of meetings should be distributed to all members at least one week prior to the next meeting. A permanent log of action items, problem forms/tracking and status and recommendations should be kept to provide a single source of information relative to the EMCAB's function. For continuity purposes, the secretary should be permanently assigned to the EMCAB.

20.4.3 Responsibilities. The PM is responsible for the preparation of a charter to define the role of the EMCAB. The EMCAB responsibilities may include any or all of the following:

a. Assist in preparation of the EMCPP;
b. Assist in preparing the procurement specification, SOW, TLS, SPD and other similar documentation to ensure proper E^3 content;
c. Assist in identifying and resolving potential E^3 problems that may be identified during the design, development, procurement, and installation phases of the acquisition;

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d. Review the contractor's documentation for content and adequacy;
e. Participate in design reviews;
f. Perform or direct analysis and prediction studies, as required, to assess potential E^3 impact;
g. Serve as a formal adjunct to the procuring activity's configuration control process concerning E^3 matters;
h. Review predicted and reported E^3 problems to determine applicability; direct development of fixes to resolve potential problems;
i. Direct required E^3 tasks and report findings and recommendations via prescribed channels for appropriate action.

20.5 E^3 Considerations in Program Documents. The application of E^3 requirements is essential throughout the ship acquisition process in all key documents such as SOWS, RFPs and specifications related to E^3 tests, evaulations, analyses, simulations and control. Appendix H is amplified as follows in sub-paragraphs 20.5.1 through 20.5.3.

20.5.1 Statement-of-Work (SOW). The SOW should establish and define the contractor's full EMC obligations. It should require the preparation of EMI control plans and special EMC analyses. The development of the EMC Control Plan, participation on the EMCAB and support of design reviews should also be specified.

20.5.2 Specifications and Standards. The applicable E^3 specifications and standards should be tailored to the ship and its systems and equipments. Documents which are the most frequently used are: MIL-STD 1310, DOD-STD-1399, MIL-STD-461 and MIL-STD-1605. Additional requirements such as EMP may need to be specified. EMP requirements are contained in

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DOD-STD-2169, MIL-STD-461 and MIL-STD-1310. The ultimate objective of the E^3 requirements is to achieve compatibility of all systems in the ship environment.

20.5.3 Request for Proposal (RFP). The Request for Proposal (RFP) is the document used to describe the type of services, systems, equipments, etc. to be purchased by the Navy. It is the document available to bidders who may be interested in responding to the RFP. It is important that the RFP be as explicit as possible in the E^3 area in defining what is required of the successful bidder. The RFP must not be vague in defining requirements, nor in the case of feasibility studies must it be so restrictive as to preclude technological advances or innovative approaches by the contractors. The program manager responsible for preparing the RFP should have available the program charter, JMSNS, OR, and NDCP to ensure that the contents and requirements of the RFP do not change, alter or deviate from that which was approved. The RFP for ship acquisition should require bidders to discuss the following, where applicable:

a. EMC organization.
b. Qualifications and experience.
c. Past E^3 performance.
d. Test facilities.
e. How E^3 effort will be integrated.
f. Design approaches.
g. E^3 testing.
h. Tailoring of specifications & standards.
i. Subcontractor control.
j. GFE.
k. Off-the-shelf.

20.5.3.1 Proposal Evaluation Considerations. In the evaluation of the E portion of a contractor's proposal for a system acquisition, consideration should be given the company's E^3 background and personnel as well as the proposal response. Weighting factors must be established for each element of the corporate experience and proposal response in the Source Selection Plan.

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20.5.3.1.1 Company Related.

a. Definition of EMC organization. Is there a clearly functional EMC group in the company organizational structure? Who heads this group and what is his authority? How does this group relate to other groups in the company such as design, production, test, etc.?

b. Qualifications and experience of EMC personnel. Does the training and experience of the proposed EMC personnel satisfy the key personnel requirements of the RFP? Do the personnel have degrees and at what level? How much E^3 experience does each individual have and in what areas: EMI, RADHAZ, HERO, EMP? Was this experience in design, production, test, etc.? Have the proposed PM and other key personnel attended E^3 awareness training?

c. Past E^3 performance record. Does the corporate history show substantial E^3 effort on past military or civilian contracts? Was this in the EMI, RADHAZ, HERO, or EMP areas? Does this effort satisfy the RFP E^3 requirements?

d. Test facilities and equipment. Does the company possess adequate test facilities and equipment such as shielded enclosures, spectrum analyzers, EMI meters, power amplifiers, antennas or other specialized equipment necessary to support the RFP E^3 test requirements?

20.5.3.1.2 Proposal Response Related.

a. Integration of E^3 effort with other proposal information. Is E^3 integrated into all phases of the RFP response including design, analysis and prediction, prototype testing,

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production testing, maintenance and operation? Is E^3 addressed in the training or supporting documentation required by the RFP?

b. Design approach. What measures in the ship design are incorporated to prevent EMI? Some examples are: antenna arrangement, shielding, filtering, cable selection and routing, bonding and grounding. Has the design been adequately analyzed from an E^3 standpoint?

c. E^3 testing. Does the E^3 test plan satisfy the RFP? requirements for testing the first ship of the class? Has consideration been given to testing during the construction cycle to ensure that the original EMI design features have not been degraded?

d. Understanding E^3 specifications. Does the resonse indicate a clear understanding of the E^3 related specifications? Is any tailoring of the specifications indicated together with appropriate justification? Are there any indicated exemptions to the specifications with attendant justifications?

e. Subcontractor control. How will the E^3 requirements be passed on to subcontractors? Will they be tailored and on what basis? What E^3 documentation will be required from the subcontractors and how will their EMI control designs be monitored? Are the proposed subcontractors responsive to the RFP E^3 requirements and who will perform the required T&E?

f. Government furnished equipment (GFE). How does the contractor address GFE? Does he plan to test GFE or require test data for his analysis and prediction efforts? What assumptions have been clearly stated?

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g. Off-the-shelf equipment. Is the use of off-the-shelf equipment proposed? Can qualification through similarity be fully justified? What modifications must be made to incorporate the E^3 requirements?

30. Electronic and Electrical Systems or Equipment Acquisitions. For electronic and electrical systems or equipment acquisitions, an E^3 program covering the entire life cycle of the acquisition should be initiated. Such a program is described in Appendix L including the establishment of an EMCAB as described in paragraph 20.4. Tasks required for systems and equipment acquisitions are described in the paragraphs that follow.

30.1 Frequency Allocation. The PM is responsible for the initiation of research, development and/or procurement of electronic systems or equipment and must submit an Application for Frequency Allocation (DD Form 1494) in triplicate to his command's frequency allocation coordinator in accordance with the applicable instruction. This requirement is not applicable for electrical equipment. Assistance in completing DD Form 1494 may be obtained from the Command Frequency Allocation Coordinator and by following "DD Form 1494 Preparation Guide for Navy Frequency Allocations", ECAC-CR-83-077.
Without an approved frequency allocation, the PM technically has no authority to obtain a system or equipment either through development or purchase of an off-the-shelf commercial equipment. Normally, an application for frequency allocation will be submitted four times corresponding to the stages of life cycle management of a system or equipment. The requirements for each stage are explained in 30.1.1 through 30.1.4.

30.1.1 Stage 1. The "conceptual" or "concept development" stage. A conceptual allocation is required prior to releasing funds for studies or assembling "proof-of-concept" test beds. Little more than the system purpose, the planned frequency range, and planned system power are

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required to be completed. It is highly desirable, however, that any other planned or estimated details concerning the equipment be entered on the DD Form 1494. Where information has not been determined, the entry "NAvail" or "Not Available" should be made. "Unknown" or "Unk" should be used to indicate that information is not and will not be determined.

30.1.2 Stage 2. The "experimental" or "concept validation" stage. An experimental allocation is required prior to the release of funds for building a radiating test model or assignment of a frequency for experimental usage. This includes, but is not restricted to, units that will be tested within the laboratory. Estimated and calculated data can be used for nearly all the blocks on the DD Form 1494.

30.1.3 Stage 3. The "advanced development" or "full scale development" stage. Prior to contracting for engineering development models, a stage three allocation must be filled in with measured data. Where measured data is not available, calculated data must be used. Any entries of "NAvail" must be accompanied by the reason for the nonavailability.

30.1.4 Stage 4. The "operational" or "production and deployment" stage. Prior to contracting for production units, an operational frequency allocation is mandatory. All blocks of the DD Form 1494 containing technical characteristics should contain measured data. Calculated data is generally unacceptable at this stage.

30.1.5 Commercial Off-the-Shelf Equipment. All commercial off-the-shelf equipment whose RF characteristics have been modified, falls into this stage of allocation. Even if the equipment is being used within an experimental or developmental system, it is operational equipment by definition, because of its off-the-shelf status (for example, an off-the-shelf telemetry system used during development of a missile). Submittal of more than one request for frequency allocation (DD Form 1494) may be required if:

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a. The system has more than one distinct RF component. (Refer to ECAC-CR-83-077 for example and guidance.)

b. Proposals from two or more contractors are being evaluated and are different in frequency usage. The technical characteristics for each approval allocation should be written into the respective contract specification.

Modifications to operational systems require a new request or a notice-to-holders depending on the extent of the modification. Each request for frequency allocation will take six to nine months for approval. To avoid costly delays in the life cycle stages from concept to deployment, it is important that frequency allocation requests be submitted at the earliest possible date in order to have approval for the next stage of development.

30.2 E^3 Considerations in Program Documents. The application of EMC requirements is essential throughout the acquisition process in all key documents such as, DPs, SOWS, RFPs, specifications, and documents related to EMC tests, evaluations, analyses, simulation, and control. Appendix H is amplified as follows in subparagraphs 30.2.1 through 30.2.1.6.

30.2.1 E^3 Requirements. The following paragraphs describe the E^3 requirements for the various documents in the acquisition cycle.

30.2.1.1 Development Proposal (DP). The EMC ramifications, including EM problems, cost, and effectiveness, for each alternative system considered must be addressed. All EMC factors contained in the OR must be addressed, including the rationale for the selection of proposed frequency bands of operation. The methods for achieving the specified level of EMC must be described. If they are state-of-the-art, then the specified level of EMC must be estimated. Dates for resolution of identified risks must be stated. The impact on the EM environment by the proposed system must be defined. Tests required to demonstrate EMC

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should be identified. These should include, as appropriate, those specified by MIL-STD-461, DOD-STD-1399, MIL-STD-469, MIL-STD-1605, MIL-E-6051, HERO tests, other development and inter-platform tests, as required. Include spectrum support and EMC T&E milestones.

30.2.1.2 Decision Coordinating Paper (DCP). The information contained in the OR and DP is used to develop the DCP. During the various phases of the development of the system, the DCP should be updated to reflect information obtained from analysis and T&E. EMC aspects of Production Acceptance Test and Evaluation (PAT&E) of initial production and long-lead time items must be included in the TEMP or TEP.

30.2.1.3 Acquisition Plan/Acquisition Strategy. The plan should contain a general discussion of EMC including control and reporting plans, predictions, analysis, E^3 specifications and requirements to be imposed, anticipated EME, design disciplines and quality assurance. The EMC aspects should be realistic, economical, and achievable.

30.2.1.4 Requests for Proposal (RFP). The RFP must specify the performance of the electrical or electronic equipment or system in the anticipated EME. It should include tailored requirements for intended and spurious emissions and susceptibility criteria. MIL-HDBK-235 is a useful document for determining environmental levels. The RFP should include EM tests, evaluations, analyses, simulations, and data required of the contractor, such as EMC control plans, EMC test plans, and EMC test reports. Contractor support of the EMCAB must be defined.

30.2.1.5 Statement of Work (SOW). The SOW should establish and define the contractor’s full EMC obligations for the electrical or electronic equipment being procured. It should describe the intent and content of EMI control plans, special EMC analysis and documentation, and include tailoring requirements for EMC. The development of the EMCPP, participation on the EMCAB and support of design reviews should be specified.

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30.2.1.6 Specifications and Standards. The applicable specifications and standards should be tailored to the equipment and the environment in which it will be operated. Documents which are the most frequently used are: MIL-STD-461, MIL-STD-462, MIL-STD-469, and MIL-HDBK-235. Additional requirements such as EMP, lightning, RADHAZ, HERO and filtering may need to be specified. The ultimate objective of the E^3 requirements is to achieve compatibility of the system in its operational environment.

30.3 E^3 Tasks during Life-Cycle Phases. OPNAVINST 5000.42 establishes four phases as the life cycle for an acquisition:

a. Conceptual or exploratory research phase
b. Validation or advanced development phase
c. Full scale development phase
d. Production phase

This handbook separates the production phase into another stage of life cycle by listing deployment as a separate entity. The PM must decide after careful review of the program, if it is in the best interest of the government to prepare a separate SOW for the production phase (one for production and one for deployment). For purposes of discussion of E^3 tasks during life cycle, it is assumed that five SOWS will be prepared. SPAWAR and NAVSEA PMs should refer to Appendix L and NAVAIR PMs should refer to Appendix M for additional guidance.

30.3.1 Conceptual or Exploratory Research Phase. During this phase, technological advances, environment, operational requirements, time element, and cost are all to be considered and tradeoff analyses conducted to produce a viable program to achieve realistic military objectives. E^3 considerations during this phase should include:

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a. Establishing and defining contractor effort.
b. Defining contractor participation in the EMCAB.
c. Defining contractor effort in establishing initial EMC requirements.
d. Defining contractor effort in performing predictive analysis to determine if the system can meet its operational requirements in the intended environment.
e. Contractor effort in initial E^3 management and milestone programs.

30.3.2 Validation or Advanced Development Phase. The SOW for this phase will be more explicit in defining the contractor effort. E^3 tasks to be included in the SOW are:

a. Continuation of contractor effort on the EMCAB.
b. Review of the anticipated EME and update as necessary.
c. Evaluation of E^3 specifications and standards and contractors recommendations for changes.
d. Contractor analysis of system performance in the revised EME considering recommended changes to specifications and standards.
e. Contractor effort in development and update of the test and evaluation master plan.
f. Contractor effort in updating the EMCPP.
g. Contractor effort in E^3 management and scheduling.

30.3.3 Full Scale Development Phase. The SOW for this phase is based on the premise that the acquisition is viable and that the results will justify continuing to the production and deployment phases. E^3 contents of the SOW become more definitive and are structured to provide the necessary inputs for the production and deployment. Contractor E^3

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efforts in the full scale development phase SOW should include:

a. Continuation of EMCAB support.
b. Revision and update of EMCPP to reflect modifications of system design, operational requirements, and EME.
c. Finalization of the EMC environment.
d. Revision of the TEMP.
e. Development of a test and evaluation plan and management structure to support the TEMP.
f. Analysis and simulation program to predict potential EMC problems in the intended environment.
g. Finalization of specifications, production E^3 management plan, and scheduling.
h. Development of E^3 training plan.
i. E^3 considerations in installation changes and technical manuals.

30.3.4 <u>Production Phase.</u> During the production phase, the SOW should reflect those E^3 areas which are not covered in the production contract. Those areas requiring contractor effort are:

a. Continue EMCAB support.
b. Finalization of EMCPP.
c. Finalization of E^3 training plans.
d. Finalize installation drawings and procedures for E^3.
e. Finalize test and evaluation plan for installation check out and total platform testing.
f. E^3 support necessary during installation and initial deployment.

30.3.5 <u>Deployment.</u> Following the acceptance of the first operational system, the PM must decide if continued contractor's

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support is necessary. If necessary, the SOW should define the areas of support. They may include any or all of the following:

a. Implementation of in-service E^3 training.
b. Procedures for reporting and resolution of E^3 problems.
c. E^3 configuration control.
d. Review and revision of maintenance and system usage for EMI control.

30.4 Test and Evaluation (T&E). T&E is the method by which system performance objectives are demonstrated at each phase of the acquisition life cycle prior to advancing to the next phase of the life cycle. An integral part of the T&E process is E^3. Early definition of the intended environment and the design features of the acquisition to cope with the environment are essential.

30.4.1 Test and Evaluation Master Plan (TEMP). The TEMP is the major test planning document. It is required for ACAT I, ACAT II, and ACAT III acquisitions. Requirement for ACAT IV is decided by CNO. The TEMP is prepared by the developing agency in cooperation with COMOPTEVFOR and is revised annually to reflect significant results achieved and changes in plans and milestones. The TEMP is reviewed prior to the decision to advance the acquisition to the next life cycle phase. The TEMP does not necessarily include all facets of E^3, (EMP, ESD, HERP, HERO, Lightning, etc.) but should identify those which can alter or impair the design requirements of the system being acquired and should demonstrate that adequate testing and evaluation are being planned to minimize these effects.

30.4.2 Test and Evaluation Plan (TEP). The TEP is in essence a subsection of the TEMP. The objective for performance and decision milestones must be consistent with the TEMP. For acquisitions not requiring a TEMP, the TEP must serve the same purpose with adequate T&E to support the acquisition from concept through deployment and

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operational testing. The driving consideration must be the ability of the equipment or system to perform its function in its intended installation location without impairment by the EME. The acquisition also must not alter the EME in any manner which causes degradation of performance of any other equipment or system installed on the platform or working in consort with the platform. This requires careful definition of the EME as the source of EMI which would cause degradation of the acquisitions' performance. The TEP (or TEMP for large acquisitions) must be structured to test for and achieve the desired degree of immunity from the EME. Conversely, the T&E program must also determine and control the contributions to the EME by the system being acquired. Appendix D of this handbook provides a comprehensive guideline for incorporating E^3 into the TEP orTEMP. Further assistance can be obtained from each Command's E^3 office. Appendix D also provides a T&E list for planning considerations and their inter-relationships.

30.5 Training Plan. The PM is responsible for ensuring that the personnel involved in acquisition and operation are properly trained in all aspects of the E^3 design, installation, maintenance and operational features of the system. To achieve this, a comprehensive training plan must be formulated early in the life cycle process and revised as system design and operational requirements are finalized.

30.5.1 Navy Training Plans (NTPs). Formalized NTPs are required for most new Navy procurements. The NTP prepared for the system operation and maintenance should have the E^3 aspects of design, operation and maintenance features incorporated into it. Guidance for preparation and implementation of NTPs is contained in OPNAVINST 1500.8.

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30.5.2 Factory Training. Factory training will be done to ensure that the E^3 integrity of the system is not compromised where formalized NTPs do not exist. This training should be structured to provide the Navy operators and maintenance personnel the required E^3 information, techniques and practices necessary for proper operation of the system. Additionally, the installation and test personnel must be made aware of the E^3 features incorporated into the system. The training should cover the grounding, cabling, and shielding requirements for the installation technicians and the design, operation, and maintenance features for the test engineers.

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APPENDIX K

SHAPM STRATEGY FOR ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E^3) CONTROL

10. Introduction. The Electromagnetic Effects (E^3) Control Strategy has been specifically prepared in the context of a ship acquisition project. At present, there is little planning guidance available to get a Ship Acquisition Project Manager (SHAPM) started, in terms of "what" and "when" for these initiatives. Filling this need is the purpose of this appendix. The SHAPM E^3 Control Strategy was developed in the general context of surface combatants where problems are typically more pervasive and severe than in submarines or in auxiliaries. The management breadth and the principal oversight elements are the same for all, but scope and priorities of technical execution will differ among the three categories. The proposed strategy is contained in Table VIII. Essential elements of this strategy are:

a. An earlier start to E^3 control planning.

b. Early quantitative and qualitative analyses of the degrading effects of shipboard EM systems to allow time for remedial action before the design is frozen.

c. Defined Gate Criteria to provide E^3 check points (and stop points if necessary) as the ship design moves from one phase to the next.

Factors that are highly significant to the form and contents of the strategy are:

d. Current E^3 directives and conventional EMC engineering practices do not encompass the primary E^3 design requirements necessary in modern naval ship design and specification.

e. Current E^3 directives are predicated upon a different, that is, "aerospace," acquisition process than is employed for ships. If the current directives are applied literally, they will result in an E^3 control effort that is too little and too late.

f. The strategy described herein requires going beyond current practices for design, engineering, and specifications, and in some areas will push technical feasibility limits.

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20. Nature of Technical Problem. E^3 control in the ship acquisition process comprises two distinct, sequential kinds of technical pursuits. The first is system design, heavily involved with naval architecture, to achieve in the ship system design the condition that is broadly specified as a requirement for EMC. The second is the engineering to maintain EMC, that is, preserve EMC attained in the basic ship system design and prevent emergence of new criteria incompatibility and interference conditions. Current E^3/EMC directives relate primarily to the second kind, which is highly equipment oriented. This appendix is designed to cover system design and specification requisites for achieving ship level EMC in the first place as well as then transitioning into conventional EMC practices.

20.1 Identifying the Problems. Numerous EM incompatibility and potential interference conditions exist among the EM suite and electronic technology candidates at the start of any modern ship design. Those conditions must be identified and either overcome or markedly mitigated during the ship design process if the SHAPM is to deliver the mission capabilities that are specified and represent the Navy's investment purpose in the ship acquisition. Resolving EM incompatibilities is most practical during Preliminary Design, and becomes virtually settled by the end of Contract Design. E^3 control requirements must compete with other primary design drivers in those early design phases. Sophisticated EM predictive analyses are prerequisites to quantifying adequately the trade-offs between design alternatives and E^3 degradations of mission capabilities. Because system design flexibility decreases with each succeeding phase of acquisition, true design correction of E^3 problems is virtually ruled out once into Detail Design. "Fixes" then most commonly take the form of selective mission performance cancellation, which reduce return on acquisition investment, so as to suppress the trouble symptoms.

20.2 Integration of E^3 Into Ship Design and Acquisition Processes. E^3 is a very broad term that encompasses a wide variety of phenomena. It has been broken down into many subcategories with no clear correlation or relationship to ship design and acquisition processes. It will be necessary to integrate all the E^3 disciplines during project E^3

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control planning. From an overall design and engineering perspective, E^3 control execution is shaped by the following:

a. The topside design must address both basic incompatibility conditions caused by primary environmental sources that are intentional and necessary emissions, and also dangers to personnel, fuel and ordnance caused by electromagnetic radiation. The incompatibilities are primarily addressed by the interaction of EM engineering and Naval architecture, and by antenna arrangement.

b. Sensitive electronics within the hull and deck-house must be shielded from the intense topside EM environment. Making the skin of the ship an effective EM shield is increasingly critical in surface ships because of the proliferating use of microelectronics in mechanical system controls. Each penetration (stack, hatch, ventilation opening, cable, and so forth) must be engineered and specified as necessary to ensure that resultant internal environment does not exceed invoked equipment design levels.

c. Internal EM interference conditions are primarily caused by unintentional emissions and responses. Control of these EM interference conditions is highly dependent on specification enforcement. Attempts at cost saving by relaxing specifications may result in expensive remedial measures later in the ship's life cycle.

30. Nature of Procedural Problem. While this handbook is consistent with current official E^3 directives and guidance, it will lead to an E^3 control program that is more comprehensive than existing ship E^3 control programs that have been previously patterned literally on those directives. The reason for the increased comprehensiveness is that ship acquisition employs a different acquisition methodology than equipments or systems. For E^3 control purposes, a more comprehensive approach is required for consistency with ship acquisition methodology.

30.1 System Acquisition Methodology. For most system acquisitions a "prime" contractor performs both Full Scale Engineering Development and Production. In this situation the prime, contractor is responsible for:

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a. Total system design, engineering, and production specification, including all subsystems.

b. System production.

c. Accountability for demonstrating total system performance as contractually specified.

Under these contractor responsibilities the government project responsibilities are only to ensure that each prime contract overtly and clearly addresses E^3 as an included dimension of total system performance, and that the prime contractor develops an effective plan for carrying out top-down system E^3 control.

30.2 Ship Acquisition Methodology. Ship acquisition does not employ prime system contractors with the above span of design, engineering, and specification control. Trying to apply the same generic approach, results in E^3 control efforts that are inadequate in scope and too late to deal with basic system problems. Inadequacy results from reliance on shipbuilders for overall E^3 control and relating E^3 control to ship specifications. Lateness results from treating formal E^3 control as part of the lead ship contract. Ship acquisitions require overt E^3 control from the beginning of ship design and GFE developments, relating E^3 trade-offs to top level measures of mission performance and operability, allocation of integrated E^3 control requirements to ship and all GFE specifications, enforcement of E^3 control requirements throughout GFE developments and lead ship detail design and construction, and assuring delivery of required mission capabilities. In those terms it becomes obvious that top level and comprehensive E^3 control can only be executed in and by the Navy, since it is inseparable from total ship system design and specification control. All the elements of E^3 control as previously carried on will be involved, but they will be at the third and lower levels of control, as well as starting much later. The strategy offered in this appendix satisfies the above requirements, given acceptance of the argument that E^3 control is a direct technical accountability, as well as a management accountability, of the Navy. Technical execution of E^3 control, as postulated herein, cannot be contracted out across the board.

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30.3 Technical Feasibility. Few of the design and engineering pursuits required by the proposed E^3 Control Strategy can be carried out with complete scientific rigor. Ships are built to have predictable stability and seakeeping qualities without fully accepted or even fully usable mathematical formulations for the seaway. The SHAPM should be concerned with the practical businesses of engineering and specification for production. The real questions are: (1) can potential EM incompatibility and interference conditions be predictively detected, and (2) can they be detected soon enough to permit basic design remedies to be considered? "Yes" is the answer to (1) in virtually all cases. The answer to (2) is not so straight forward. Basic design remedies are generally limited to Preliminary Design and, the first half of Contract Design. When concurrent GFE developments are involved, complete data for design trade-offs may not be readily available in that time frame. In most cases, nonetheless, it will be most advantageous to carry out corrective design trade-offs, using available data, while meaningful design options are still available. Once into the lead ship contract, corrective measures are usually severely constrained as to technical scope, hence effectiveness, as well as being very costly.

40. SHAMP E^3 Control Strategy. SHAPM E^3 Control Strategy is graphically presented on Table VIII. The following paragraphs provide a description of the strategy.

40.1 Overview. The overall objective of the SHAPM E^3 Control Strategy is to minimize the degradations of ship mission performance due to the electromagnetic environment. Included in this objective is minimization of operability restrictions due to hazards to personnel, fuels, and ordnance. To accomplish this objective the SHAPM must ensure that early and thorough E^3 control planning is implemented, because the resolution of EM problems is very time critical in the early design phases.

40.2 Acquisition Management Objectives. The listed objectives are intended to define the basic elements of the E^3 control plan. The objectives are separated and grouped into the basic acquisition phases Design and Production. Distinction between the two is that the objectives

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for the Design phases apply to basic Navy functions in management and technical direction of ship and major subsystem design, whereas the objectives for the Production phases pertain to contractor responsibilities and Navy oversight of them.

40.2.1 Design Phases. The first two objectives involve the basic design of the ship. E^3 control must enter into the trade-offs for sizing and configuring the ship to be successful. The second pair of objectives apply to how the ship design is specified - how mission performance is specified as the delivery object, and how the ship and its subsystems are specified for production. Accordingly, these four objectives relate directly to top level ship and major subsystem design requirements. Implementing these objectives requires effort and persistence and depends upon dedicated senior project personnel directly supervising E^3 control planning for the Design phases.

40.2.2 Production Phases. These objectives represent extensions of existing practices rather than new requirements. Two critical premises are new, however, and deserve emphasis in planning: The first premise is that the integration of ship and subsystem specifications for E^3 control oversight requirements are to carry over from the Design phases into detailed ship-subsystem interface specifications for Production. The second premise is that E^3 control functions are to be positive and complete, rather than reactive and by exception. Universal and consistent contractual implementation of standards and specifications for E^3 throughout ship, subsystem, and equipment is essential, something that cannot be counted on to happen automatically.

40.3 Gate Criteria. Gate Criteria are intended to be specific tests of whether to proceed into the next phase on the basis of E^3 control progress. Technical activities and processes are the casual considerations for all Gate Criteria. The basic management strategy involved in having Gate Criteria is to reserve to the SHAPM direct and positive control of transitions between acquisition phases on the basis of specific E^3 control achievements. The Gate Criteria on Table VIII do not comprise exhaustive measures of E^3 control. Also, it is not intended that the SHAPM should limit project-level oversight to the given

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criteria. Each Gate Criterion at a given transition point should be demonstrated to be satisfied. If not, the appropriate course of action is to hold the project in the prior phase until it is satisfied. Forging ahead arbitrarily not only injects excessive risk into following E^3 control activities, but it usually results in settling design and engineering options that are essential to correcting the E^3 conditions being addressed by the lagging E^3 control activities. Where Gate Criteria are planning functions, the criticality is associated with the time phasing of key activities in the following phase. Critical leadtime citations below are directly related to this consideration. In all cases, Gate Criteria do not have valid work-arounds. Proceeding without first satisfying a criterion will involve high risk to E^3 control objectives.

40.4 Critical Leadtime Elements. The items identified represent high risk elements in E^3 control planning, because they involve exceptionally long leadtimes for preparatory activities, similar to technical tool development and data acquisition. Unless they are planned accordingly, critical process windows or project milestones will almost certainly be missed.

40.4.1 E^3 Control Planning. E^3 control planning is not obviously a critical leadtime item, since it would appear to be a continuing, progressive process throughout the acquisition project. The controlling consideration is that with the start of Contract Design, at the latest, the total project breaks out into many concurrent and loosely coupled activities of GFE development, ship design, and support engineering. Unless E^3 control planning is in place ahead of this breakout, it will never catch up with the activities expansion.

40.4.2 Topside Naval Architecture. Perhaps the most difficult leadtime element to satisfy is that associated with topside naval architecture. Topside E^3 trade-off studies can be lengthy, relative to the rapid pace of Preliminary Design. Thus a significant schedule reservation must be made for them, or E^3 control considerations on ship sizing and topside arrangements will be overtaken by less important, but shorter time scale, factors. The necessary data and analytical tools must be made ready ahead of time, to keep pace with Preliminary Design.

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40.5 Frequency Spectrum Utilization. Intensive and increased frequency spectrum utilization is one of the primary reasons E^3 has become a compelling consideration in modern naval ship design. The resultant effect is the "EM environment" that is much alluded to but never physically characterized. While development of better analytical methods is required to describe shipboard EM environments, frequency spectrum utilization can be physically described sufficiently to be very useful for technical and project management purposes. EM characteristics of all transmitters and receivers planned and being alternatively considered for a ship can be synthesized into a total representation which would identify areas of concern. A limited form, combining transmitter fundamentals and receiver operating bands, is sometimes employed for frequency management purposes. Spurious outputs and out-of-band susceptibilities could be added, along with output power levels and component sensitivities, to express the employment density of the spectrum for the ship being designed. The individual input component characteristics required for this synthesis are well known to EM suite component developers. As hardware development progresses, predictions can be improved, and then be replaced by measured data. A Frequency Spectrum Utilization chart provides the vehicle for describing the overall E^3 control problem at the ship or project level. It identifies potential interactions of the hardware elements of the ship, highlights potential conflict areas, and demonstrates the dependencies on naval architecture in overcoming intrinsic incompatibilities.

40.6 Mission Performance. One of the most significant decisions in directing the planning and execution of E^3 control will be determinations of the performance measures to be employed as the evaluation yardsticks for E^3. During the Design phases these measures will be the basis for design trade-offs. At the end of contract design, they become the measures of return on acquisition investment in delivered ships. At the end of construction they become the bases for "Engineered Standards" that apply for acceptance trials. "Engineered Standards" is a term invoked by the President, Board of Inspection and Survey, to apply to ship performance measures for Acceptance Trials. The term has general applicability, but was invoked originally in the specific context of EM degradations to mission performance. "Engineered Standards" are

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quantitative measures that are predictive of system performance under specified conditions of the operating environment. they must, of course, be totally consistent with mission performance measures, as discussed above. The two sets are not identical, because Engineered Standards are developed to correlate directly with test requirements and test conditions of Acceptance Trials, whereas mission performance measures will usually be predicated upon more complex and stressful scenarios. Suitable and adequate performance measures for E^3 control are not normally available nor will documentation requirements, such as the TLR and TLS, give definitive guidance in this respect. Depending on the type of ship, the SHAPM may be able to determine some of the top level performance measures as a result of platform mission requirements. It will be found, however, that E^3 control will depend upon integrating the various types and levels of specifications employed in ship acquisition to a much higher degree than is normally done. Connecting high level mission performance degradations to low level EM causes will often encompass a long, multi-path specification trail. Also, unwanted EM influences are not necessarily confined to the logical functional chains that normally govern specification interfacing. For instance, an HF transmitter can degrade things that have nothing to do with communications, with the coupling mechanisms between cause and effect having no functional relationship to either. Much of these exceptional specification integration requirements will become evident through mission performance analyses. It will be found-that one result will be to emphasize major subsystem levels of specifications, e.g., communications, weapons control, propulsion control. This follows from the fact that most mission performance measures relate to major subsystem functions. One critical area of specification for which there are no normal lead-ins or prompts is that of EM coupling paths and mechanisms. These simply have to be searched out and evaluated by people assigned specifically to the task. One essential purpose of these specifications is to make the skin of the ship an effective shield between the intense topside EM environment and the sensitive electronics within the hull. Every penetration of the hull must be engineered and specified to prevent inward penetration of significant EM energy.

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TABLE IX

TITLE: SHAPM E3 CONTROL STRATEGY

EMC CONTROL STRATEGY GOALS: Eliminate EM Incompatibilities That Degrade required Mission Capabilities. Eliminate EM Effects That Produce Unsafe Conditions For Personnel, Equipment, Fuel Or Ordnance

ACQUISITION MANAGEMENT OBJECTIVES

DESIGN

* EMPLOY NAVAL ARCHITECTURE TO MAXIMUM ADVANTAGE
  - TO CIRCUMVENT EM ENCOMPATIBILITIES
  - TO PRECLUDE RADHAZ EXPOSURES
* MINIMIZE LOSSES OF MISSION CAPABILITIES TO E3 BY
  - PURSUING DESIGN OPTIONS TO ELIMINATE EM INCOMPATIBILITY AND INTERFERENCE CONDITIONS WHERE FEASIBLE
  - ALLOCATING BY DESIGN ON MISSION PRIORITY BASIS, DEGRADING EFFECTS THAT ARE NOT REMOVABLE
* SPECIFY MISSION PERFORMANCE FOR REAL EM SYSTEM ENVIRONMENT VICE IDEAL/INDEPENDENT EQUIPMENT CONDITIONS
* ESTABLISH AND IMPLEMENT TOP-DOWN SPECIFICATION STRUCTURE
  - PROVIDING EFFECTS TRACEABILITY FROM E3 SOURCES TO MISSION PERFORMANCE DEGRADATIONS
  - INTERFACING GFE AND SHIP SPECIFICATIONS

PRODUCTION

* TAILOR CONTRACTORS DESIGN/ENGINEERING TO SPECIFIC E3 REQUIREMENTS DISCRIMINATING BETWEEN
  - SHIP AREAS/SUBSYSTEMS FOR WHICH E3 STANDARDS AND GENERAL SPECIFICATIONS WILL PROVIDE SUFFICIENT PROTECTION AND
  - SHIP AREAS/SUBSYSTEMS FOR WHICH SPECIAL DESIGN AND ENGINEERING MEASURES WILL BE REQUIRED
* CORRECT TO DEGREE FEASIBLE NEWLY DETECTED EM INCOMPATIBILITY AND INTERFERENCE CONDITIONS
* MAINTAIN POSITIVE OVERSIGHT ON COMPLIANCE WITH E3 REQUIREMENTS IN SHIP AND EQUIPMENT SPECIFICATIONS
* INSURE THAT DEVELOPMENT AND PRODUCTION ACCEPTANCE TESTS ARE FULLY EFFECTIVE AS TO DEMONSTRATION OF E3 REQUIREMENTS
* CONDUCT ACCEPTANCE TRIALS ON BASIS OF "ENGINEERED STANDARDS" THAT QUANTITATIVELY CHARACTERIZE EM DEGRADATION EFFECTS

PROJECT PHASE: FEASIBILITY STUDIES — (1) — PRELIMINARY DESIGN — (2) — CONTRACT DESIGN — (3) — DETAIL DESIGN — (4) — CONSTRUCTION — (5) — ACCEPTANCE — (6) — SERVICE LIFE

GATE CRITERIA

Gate criteria	1	2	3	4	5	6
OVERALL E3	Basis for scoping EMC in selected ship design(s) - EM spectrum utilization - EM suite incompatibilities - architectural constraints E3 control planning staffed, started, and directed.	Topside architecture and antenna arrangement firm. EM effects on mission performance analyzed sufficiently to assure that potential problems are known and judged resolvable. E3 control plan structured vertically to interface ship, major subsystems equipments.	Mission performance specified quantitatively: - for EM degradation vs ideal equipment specifications - for operational restrictions (mechanized and operational) E3 control is structured to define interfaces with/among all production contracts - Navy-contractor interactions defined - test requirements defined	Mission performance predictions interated on basis of DT&E and production test data. Ship installation test for E3 conditions specified and approved.	"Engineered Standards" developed as basis of Acceptance Trials Ship installation test for E3 conditions documented and correlated with Engineered Standards	E3 PMS Requirements Mission Capabilities USERS Manual Frequency Management Plan Saftey 'Cut-out' Criteria Configuration Status Accounting As Built Topside Configuration Drawing
RADHAZ (PERSONNEL) (FUEL) (ORDNANCE)		RADHAZ limits not violated with selected topside architecture and antenna arrangement	Power Densities predicted for all RADHAZ exposure sites as basis for specification limits	RADHAZ level predictions iterated on basis of Detail Design, with design release conditional thereon	RADHAZ power density contours mapped on basis of measurements around all exposure areas	
INTERNAL EMI		EMI susceptibilities of candidate subsystem technologies evaluated versus predicted EM environments	Hull Penetrations specified to assure external EM environment transmissions do not exceed invoked MIL-STD-461 limits	EM environment predicted for vicinity of each susceptible sub system o Detail Design Data o Subsystem Production Specifications	Subsystem testing based upon realistic E3 conditions and EM source levels	

CRITICAL LEADTIME ELEMENTS

EMC CONTROL PLANNING
- E3 CONTROL PLAN COMPLETED →

EQUIPMENT ACQUISITION
- DATA ON EM SUITE COMPONENTS →
- ACCESS TO GFE DEVELOPMENT SPECS TO DETERMINE E3 INCORPORATION REQUIREMENTS →
- E3 ECP DEVELOPMENT AND PROCESSING →

SHIP DESIGN
- SCHEDULE RESERVATION IN NAVAL ARCHITECTURE FOR TOPSIDE E3 TRADE-OFF STUDIES →
- DETERMINATION OF HULL PENETRATION SPECIFICATION REQUIREMENTS →

TEST AND TRIALS
- E3 TEST REQUIREMENTS →
- E3 CONDITION TESTING OPPORTUNITIES →

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APPENDIX L

ACQUISITION E^3 CONTROL STRATEGY FOR SHIPBOARD ITEMS

10. Introduction. The E^3 Control Strategy (AECS) is described in this appendix to provide an overview for Participating Managers (PARMs), Acquisition Managers, Engineers, and Logisticians (AMs/AEs/ALs), and other managerial personnel on the newly initiated E^3 control methodology being applied to the acquisition of shipboard items. AECS for shipboard items is an essential counterpart methodology to the SHAPM E^3 Control Strategy described in Appendix K for the acquisition of new ships. Simply stated, the purpose of both methodologies is to ensure that newly constructed naval ships join the Fleet in a condition enabling them to obtain the maximum effective performance from an electromagnetically compatible family of weapon subsystems comprising the ship system. The overall effort continues throughout the life cycles of both ship and each acquisition item so that the condition of electromagnetic compatibility (EMC) will be sustained.

10.1 Applicability. In this appendix the focus is placed on the AECS and its application to shipboard items. Should the SHAPM strategy never be fully implemented, AECS can nevertheless make a contribution of some significance in realizing the purpose sought.

10.2 Elements of AECS. Table IX is a fold-out chart depicting the AECS. A more detailed discussion of the methodology precedes it in the text. The essential elements of AECS are:

a. An earlier initiation of E^3 Control planning (with correspondingly earlier preparation of E^3 program plans) than has been commonly effected.

b. A greater emphasis on electromagnetic (EM) engineering for designs compatible with the electromagnetic environments (EME) in which they will exist.

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c. Early quantitative and qualitative analyses of performance and degradation of performance due to EMI in the shipboard environment, in order that time is available for corrective action before ultimate design is frozen.

d. Defined gates with their criteria as E^3 Control check and decision points as the development is initiated and, in turn, moves from phase to phase of the development cycle. Little new terminology has been created for AECS.

e. "Gate," an adaptation from the logic field, is as stated above.

f. "Item," in accordance with MIL-STD-280, is a non-specific used to denote any product, including subsystem, parts, sets, assemblies, etc. It is used in this text to avoid the confusion where one project's "system" is another's "group" or "subsystem." An acquisition item is then the hardware product being developed and acquired under a project, regardless of level.

g. "System," when used at all herein, shall be understood to mean the ship itself.

h. "At a higher level of design..." is a phrase used to express the application of an acquisition item and the mutual E^3 impact of the item with group, sub-system, and finally, the ship as the overall system.

20. <u>The Management Problem.</u> More often than not, the E^3 problems which occur during the life cycle of a hardware item can be traced to the early stages of the item's development. In these stages, it can be shown that the planning of E^3 Control requirements for the project was late, inadequate, or nonexistent, and that the design understanding of the potential EM environment in which the item was to operate was overly optimistic. Finally, the EMI testing, as the last real chance to discover and foreclose E^3 problems, will be found to have been inadequate, or, in the press of acquisition process, "the results ignored and later overlooked.

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the AECS seeks to remedy this situation by opening an effective dialogue between the AM of the acquisition item and the E^3 community, at the earliest posible point in a project's life. The vehicle for starting this dialogue will be a program plan draft in accordance with Data Item Description (DID) DI-R-7096 initiated by the Command's E^3 Group or PM augmented with project-peculiar data by the AM, and finally approved. This document becomes the cornerstone of the AM's E^3 Control planning, and the change in the method of creating it has been purposely made. Shifting the greater load in formulating the basic E^3 program plan away from the AM is intended to relieve him of this project burden, while at the same time ensuring that a source of value in formulating E^3 Control requirements is available to him with a timeliness supporting, rather than impeding his project's progress. With the dialogue initiated, subsequent exchanges of information will most often occur via a variety of documents. The judgement of these documents shall be on the degree to which E^3 Control requirements relevant to the project are adequately served.

20.1 Gating. The application of AECS to the acquisition process and the development cycle is accomplished by a technique called "gating." For each gate, a set of one or more E^3 Control criteria is established, and fulfillment of all relevant criteria is mandatory. The satisfaction of all criteria opens the gate for advancement of a project; failure to fulfill any of the criteria may delay the project until satisfactory measures to correct the problem are completed. When it is apparent that a gate must remain closed, the manager concerned is to be advised of the problem, the measures necessary to correct it and, as appropriate, the assistance available to insure early resolution. Continuing non-resolution of a problem, as the time for an Acquisition Review approaches, will cause the problem to become an issue before the Command's Acquisition Review Board (ARB).

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AECS is implemented recognizing that E^3 Control is one of many concerns governing a project. The closure of a gate shall be based upon sound engineering reasoning, setting forth the risks involved in permitting further advancement of the project without prerequisite corrective action, and raising the final decision on the gate to a level of responsibility commensurate with the risk accepted.

30. The Technical Problem. It is often necessary to accept some isolation between the design of a platform and the design of the component items which will be placed on it. When this occurs, however, the process of top-down system engineering (TDSE) is degraded; the system designer is no longer able to exercise full control over both platform and component designs. When, in addition, the time frame for each design, platform and component item, are essentially non-concurrent, true TDSE is precluded, and the process becomes one of ad hoc integration. The performance of an individual item may be maximized, but the trade-off involved will work at possibly a a great disadvantage to other co-located items.

30.1 Equipment Selection. The design of ship electronic component items is, for the most part, conducted in isolation of any specific ship's configuration. The selection of items to comprise the ship's master equipment list (MEL) is accomplished often with little consideration other than that the list should comprise the latest available item supporting each generic requirement. In development of new items, the engineering, within regulations for the use of the spectrum, is accomplished to secure advantage from specific characteristics of the operating frequency selected. At the same time, the shared uses permitted in or near the chosen frequency band and their potential incompatibilities are too often ignored or too quickly judged resolvable. Reliance is placed on standardized installation measures and simple compliance with EMC and EMI standards which characterize an item as acceptable if unintentional emissions are below one arbitrary level, and susceptibilities are higher than another. These generalizations

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could be expanded and refined at length, but without significant impact on root causes of, and potential solutions for EM problems. However isolated the designer of an electronic item is from the ultimate ship's system, his hardware will ultimately reside in a real EM environment, and it is possible to postulate a reasonable estimate of that environment upon which to base useful engineering calculations. So informed, the engineer may apply EMC/EMI standards in a rational process rather than a cookbook exercise, and it will become apparent to him that tailoring by enhancing standard threshold levels is, at times, as necessary as relaxations.

30.2 EM Interface. With a better understanding of the EM environment, the designer will appreciate that EM engineering interface measures at installation are no less important than the self-compatibility measures taken internally for the component design. With the recognition that EM interface criteria are as essential as those of physical form and fit, the communication gap between platform and component designers will begin to close. Taken to its logical end, interface criteria should support the calculation of performance degradation for interference levels encountered. Not all of the effort discussed above is readily accomplished at this time. The approach of AECS to the technical problem is evolutionary. What can be done today will be done more effectively, applying existing techniques and standards on a reasoned engineering basis rather than by rote. Some actions, until now regarded as pro forma, will face review against new criteria, such as where alternatives exist, a frequency allocation request will not gain approval merely because that portion of the spectrum was used earlier and the regulations permit such use. The E^3 impact from and to the EM environment must also support approval. Electromagnetic engineering efforts which need to be done, but which are currently beyond realization, will become prime AECS goals, to be identified, planned, developed and implemented. Whenever possible, gate criteria will be restated in terms requiring assessment based on hard engineering

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analysis. As enhanced tools and techniques are available, they will suplant methods used today.

40. Acquisition E^3 Control Strategy (AECS).

40.1 Periods and Phases. The overall development cycle for acquisition programs is defined, characterized, and regulated into phases with milestone points and threshold criteria, by "RDT&E/Acquisition Procedures," OPNAVINST 5000.42B. A program initiation period and three phases are identified by this directive. The AECS has been developed and characterized in six compatible periods and phases which overlay those of the development cycle, the variance in numbers of phases between the two being accommodated as follows:

a. The program initiation period of the development cycle is broken into two consecutive periods by the AECS, Concept Exploration and Concept Development. Program initiation ends at Milestone I approval.

b. The Demonstration and Validation and the Full Scale Development phases for both the development cycle and AECS are identical, and terminate with Milestone II and III approval respectively.

c. The Production and Deployment phase of the development cycle is characterized in AECS by two phases, the Production phase, and the Deployment phase. The junction between the two AECS phases occurs at approval of Production Acceptance Testing & Evaluation (PAT&E), usually a first article inspection.

The phasing is shown in the foldout chart Table IX. Where the vertical lines of the AECS phase boundaries coincide with acquisition milestones, double lines are shown. Coincident boundaries are also marked by a small circle enclosing the Acquisition Review Board number corresponding to the milestone number.

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40.2 Objectives, Gate Criteria, and Key Documents. For each AECS period and phase, a set of objectives has been defined and, supporting their accomplishment, a set of gate criteria established. Gate criteria should be considered in the context of the gate objectives to be fully understood. The objectives are generalized as appropriate to the period or phase. The gate criteria place specific demands upon the planning for an acquisition item and upon the acquisition item itself. The numbers in each criterion block on the chart relate for identification to the documents tabulated in the Key Documents List, Table X. For a gate criterion, a Key Document may serve either or both of the following purposes: it provides a source of direction, guidance, or information necessary to the preparation of other Key Documents, or it represents the output from EM engineering efforts, to be submitted for review and approval.

40.3 Timing and Gate Control. The necessity to show a large amount of information in Table IX results in showing all gate criteria stacked vertically at each gate or phase boundary. This might suggest that the satisfactions of all criteria can or do occur at the same time. This is not true, and, indeed, the satisfaction of some criteria will be prerequisite to that for others. Gate criteria may be satisfied in any order appropriate where no dependency exists. In a chain dependency, all gate criteria having an unresolved prerequisite criteria, remain unresolved. The satisfaction or resolution of all E^3 criteria relevant to a project for a given development gate is MANDATORY. Development projects failing to satisfy one or more E^3 control criteria may not obtain approval to proceed beyond ARB review and, as appropriate to their Acquisition category (ACAT), to higher level reviews (CEB, NSARC/DSARC) pertinent to Milestone approval. A majority of the requirements and actions necessary for AECS gate criteria are, at present, no different than those which have been routine in the past. A careful examination of

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the remaining criteria, however, will reveal a significant departure in requirements. These criteria will necessitate new approaches to the incorporation of E^3 control measures into the design process, and in certain cases, the use of new engineering tools. It should become obvious that early and careful E^3 Control planning and resolution of precursor criteria actions are essential to smooth flow of the entire development.

40.4 Performance Assessment. In the past, EMC and EMI have been accepted as conditions which existed in some degree and were quantified in terms of susceptibility and emission levels. Efforts to relate these conditions to a higher level of design were limited usually to comparison of the source level of an interference generating item to the potential victim item’s level of “hardness” (susceptibility). The concept of AECS and the SHAPM strategy are intended to support more demanding statements of impact, quantified in terms of performance and performance degradation. E^3 Protective Margin Analyses (PMA) will occur earlier in the development phase, in the earliest design estimates. It is necessary for the AM/AE to present PMA estimates as an integral part of his Development Options Paper (DOP), for each option proposed. Subsequently, in Phase I, as the design for the option selected and approved progresses, and test data on the Advance Development Model (ADM) becomes available, revised PMA verifying and refining the earlier work will be required. In the follow-on phases with the Engineering Development Model (EDM), prototypes, Service Test Models, and finally the production item, interest increasingly centers on application of the item in its ultimate environment. The central E^3 issue becomes performance, i.e., performance degradation in the presence of interference. The initially implemented AECS process, therefore, attempts to fill this need. The capability to accomplish this process becomes functions of the availability of refined data concerning the intended EME and engineering tools enabling performance of the calculations. AECS will demand these efforts to a degree consistent with the availability of these data and tools.

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40.5 AECS Development Cycle Overview.

40.5.1 AECS Concept Exploration (CE) Period. This initial period, having a gate with only a single criterion, will be used and described in some detail as an example with which to understand better the presentation of Table IX. In this period the AM/AE will study the Tentative Operational Requirement (TOR, Key Dec. No. 1) as a source of direction and information. The TOR should provide EMC considerations as the earliest statement of the projected EME; other aspects of the TOR will imply additional E^3 considerations and the TOR may also address spectrum utilization. The AM/AE will then prepare two documents: an Exploratory Frequency Allocation (DD-1494, Key Dec. No. 2) and a DOP (Key Dec. No. 3). The first item is a new one and should not be confused with the DD-1494 in Concept Development (CD) gate criterion CD-1 (the CD-1 DD-1494 is the one formerly submitted as the first DD-1494). The new initial DD-1494 must adhere to approved national and international spectrum engineering criteria but may disregard TOR spectrum guidance when technically justifiable; within this framework, it shall propose the best operating frequency for the intended item under the conditions of the EME and known and projected uses of the adjacent spectrum. This DD-1494 is for advance coordination purposes and will not be forwarded beyond the SYSCOM level. It will be reviewed and approved for planning purposes only by the Command's E^3 office. The options in the DOP shall be drafted on the basis of frequencies contained in the DD-1494. Key Document No. 2 is thus a precursor for No. 3. Concurrence in the proposed DOP satisfies the final portion of the Gate CE-1 criterion.

40.5.2 AECS Concept Development (CD) Period. At this point the AM/AE has an approved Operational Requirement (OR), but not an approved project. The immediate goal is achievement of Milestone I approval. Inspection of the CD Gate criteria will reveal the listing of the EMCPP (Key Dec. No. 8) in each criterion. The actual review of this document in its initial iteration is associated primarily with criterion CD-2. It must also be recognized as a source document providing planning guidance, direction, and information for each of the other criteria, and is,

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therefore, a precursor for each. As discussed in paragraph 20 earlier, the preparation of the EMCPP is, henceforth, to be accomplished differently and uniquely. A standard plan following the requirements of DI-R-7096 must be tailored to the project based on project-peculiar data supplied by the AM. Early contact with the Command's E^3 office by the AM is necessary to commence the formulation of this plan. For projects following the classic development cycle pattern, the submission of Key Document No. 2 and later No. 3 would accomplish this. For other projects initiating in later stages of the Development Cycle, early contact for development of an EMCPP is clearly an important step. The EMCPP is not waived, only rescheduled. The Navy Decision Coordinating Paper (NDCP) will present a refinement of the DOP option(s) incorporated in the OPNAV Operational Requirement (OR). The NDCP will present refined estimated PMA results for E^3 Control. The technical package items, specification, SOW, and CDRL for CD-3 will be those used for the contract under the Development and Validation (DV) phase. A Test and Evaluation Master Plan (TEMP, Key Doc. No. 12) appears under CD-3. There has always been a Milestone I requirement for the first iteration of a TEMP at this point in a project's life. CD-3 underscores the need that this document be developed now.

40.5.3 AECS Demonstration and Validation (DV) Phase (Project Phase I). In this phase, the first E^3 Control data based on actual performance and characteristics exhibited by hardware through ADM adherence to the MIL-STD-461 requirements becomes available. Shortly thereafter, in the reports of Development Test and Evaluation (DT&E, DT-I) and Operational Test and Evaluation (OT&E, OT-I), its performance in a real EME will become known. The E^3 Control criteria in the phase are highly interrelated. The EMCPP continues to be a source and driver for other documents and requires early updating. The contractor's EMI Control Plan (EMICP, Key Dec. No. 20) must receive early review and approval in order to be an effective influence on ADM design work, and to support the MIL-STD-462 test plan. Should the acquisition item be a radar device, the timely preparation and approval of an EMC Control Plan (EMCCP) under

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MIL-STD-469 is also necessary for the same reason. The results of tests may generate a loop condition in work flow until redesign and fixes enable the ADM to meet requirements. Test results will serve DV-2, not only to prove the design concept and give the basis for the first real assessment of the item at high levels of integration, they will also be prime drivers for DV-3 and DV-4 criteria. The criterion of DV-3 addresses the technical package for the follow-on phase, Full Scale Development (FSD). Lessons learned during the DV Phase will indicate the refinements and tailoring needed for new specifi- cations. As the Milestone II review approaches, a new TEMP edition will be required. The results of MIL-STD-461, DT-I, and OT-I testing serve DV-4, to crystallize critical E^3 Control test issues and identify areas requiring additional and special tests. These issues will carry through TECHEVAL and OPEVAL. Central to the DV Phase is the issue of cost effectiveness on a life cycle basis. When addressing this issue, attendant E^3 Control measures and risks and their projected life cycle cost must be factored in the overall cost assessment for each development alternative still under consideration.

40.5.4 AECS Full Scale Development (FSD) Phase (Project Phase II). During the FSD Phase the concerns of E^3 Control center on ensuring that any late DT and OT report information from the DV Phase, and similar early information from testing in this phase are factored into the EDM design. The FSD specification, having been of necessity issued earlier, can be modified through the design review process by appropriate Engineering Change Proposals (ECP) not later than the Critical Design Review. The time sensitivity of all changes in this stage is high, and the pressure to adhere to schedule for the EDM is strong. Nevertheless, the omission of an E^3 Control design measure that becomes mandatory following EMC/EMI testing, may result in invalidating other tests already completed because of physical changes needed also. Because a large number of acquisition projects are, in fact, redevelopment actions, they are initiated at the FSD stage and will forego the conceptual period and the DV Phase. From the AECS standpoint, the EMC/EMI history of the

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old item being redeveloped becomes the principle source of true EME conditions that the new item will face. In accordance with SPAWAR INST 2410.4, the elimination of any previous EMC and EMI deficiencies are considered as a mandatory redevelopment objective for the item at the levels of the current edition of MIL-STD-461. Previous relaxations must be examined in setting redevelopment EMC/EMI specifications but will not receive pro forma acceptance. The historical baseline EME observed in shipboard applications and enhanced objectives become cornerstones of a new EMCPP, due well in advance of a technical package* for review, if project milestones are to be achieved. In addition to the central concerns of E^3 Control discussed above, certain other measures are appropriate to the FSD phase in order that the life cycle of an item shall be adequately supported. These efforts are directed at the inclusion of directive and informational EMC and EMI material in installation control drawings (ICD), technical manuals, and maintenance requirements documents. Unlike the well-established requirements for EMC data in ICDs, technical manuals and maintenance requirements cards have in the past been silent on design features and parts and material selection made expressly to avoid EMI or ensure EMC. The incorporation of such information is the logical extension of E^3 Control as a part of the service life effort.

40.5.5 <u>AECS in the Production Phase.</u> It will be recalled that AECS splits the development phase, Production and Deployment, into two phases bearing as titles those individual terms. In the first of these, the paramount issue is that the demonstrated EMC and EMI baseline of an AFP EDM be translated to a repeatable production model with no loss of EM quality. The Production Phase also extends its interest to additional supporting actions similar to those initiated during FSD. The trend of these actions will now take two courses: those supporting specific shipboard applications and those pertaining to service life generally.

*For redevelopment starting in FSD, these are DV-3 Key Documents which along with certain of the DV-4 documents, must be prepared on a catch-up basis.

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The latter category includes the preservation and updating of EMC/EMI information in technical documentation attendant to ECPS and Field Changes. The former and more significant category concerns Ship Alterations (ShipAlts) and application to new construction. At present, the role of AM/AE becomes minimal after delivery of a compatible product whose susceptibilities and emissions are fully and accurately documented. When and as AECS is capable of providing more sophisticated tools with which to refine and project the applied EM performance in a quantified EME, this role may be enlarged as appropriate.

40.5.6 AECS Deployment Phase. The efforts in this phase extend similar actions for the support of the service life of an item, following delivery, which were begun in the Production Phase. Additional application of the item to new platforms remains a potential on-going action throughout the service life of the item.

50. Summary. AECS is a method adopted to ensure that ships of the Fleet are able to obtain the maximum effective performance from an electromagnetically compatible family of weapon subsystems in each ship system. The AECS effort continues throughout the life-cycle of each item. The thrust of AECS is two-fold in nature: It is, firstly, issue-oriented, requiring an early initiation of dialogue between the AM and the E^3 cognizant office. The dialogue, once begun, continues via a series of Key Documents, currently little different than those prior to the advent of AECS. Document reviews focus on the accomplishment of project E^3 Control requirements as supported by each document rather than the document as an end in itself. The review process incorporates periodic gating decisions corresponding to Development Cycle phases, to forestall and resolve EMC and EMI problems at the earliest and least costly point of project life. Secondly, AECS is an evolutionary effort seeking to enhance the process of ensuring and achieving EMC in the application and integration of hardware items aboard ships. This aspect seeks to identify and implement better methods of analysis to quantify

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and express item performance in the presence of interference. The end sought is realistic and reliable projection of E^3 before actual installation begins, so that the delay and cost of trial, error, and redevelopment are avoided. AECS is thus intended to be a growth program. The gating phases of AECS evaluation are tailored to compliment the DoD and Navy Development Cycle and the acquisition process. The formulation of AECS emphasizes a minimum of impact on the AM's project burden, provided that his E^3 Control requirements planning has been thorough and timely. At the same time, a specific burden has been placed on the E^3 reviewer. He must at all times retain a clear perspective of a project's overall E^3 Control needs, and make his judgments accordingly. The gating philosophy is intended to demand early achievement of E^3 Control requirements when the cost is reasonable and the expenditure of time minimal, and to consolidate and maintain these achievements through the Development Cycle. AECS continues to influence the acquisition item throughout its life cycle to ensure that its basic compatibility is maintained, and, as necessary, enhanced.

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TABLE X

TITLE	ACQUISITION E^3 CONTROL STRATEGY FOR SHIPBOARD ITEMS					
E^3 CONTROL STRATEGY GOAL	**Eliminate Degradation of Operational Capabilities by EM Incompatibilities**					
ACQUISITION MANAGEMENT OBJECTIVES	> ESTIMATED PERFORMANCE FOR PROJECTED EM ENVIRONMENT VS EXISTING SPECTRUM UTILIZATION: - MAXIMIZE THE EMPLOYABILITY OF THE EM SPECTRUM	> EMPLOY SYSTEM ENGINEERING TO MAXIMUM ADVANTAGE - TO CIRCUMVENT EM INCOMPATIBILITIES - TO PRECLUDE RADHAZ EXPOSURES > MINIMIZE LOSSES OF PERFORMANCE DUE TO E^3 BY: - PURSUING DESIGN OPTIONS TO ELIMINATE EM INCOMPATIBILITY AND INTERFERENCE CONDITIONS WHERE FEASIBLE - ASSESSING EM COMPATIBILITY OF ACQUISITION ITEM AT NEXT HIGHER LEVEL OF DESIGN	> SPECIFY PERFORMANCE FOR PROJECTED EM ENVIRONMENT VICE GENERAL CONDITIONS > IDENTIFY AND IMPLEMENT TOP-DOWN SPECIFICATION STRUCTURE: - PROVIDING TRACEABILITY FOR E^3 DESIGN REQUIREMENTS IN SPECIFICATION AND ACQUISITION DOCUMENTS - IMPLEMENTING E^3 INSTALLATION REQUIREMENTS IN CFE AND GFE SPECIFICATIONS FOR E^3 CONTROL - TAILOR E^3 CONTROL REQUIREMENTS IN TECHNICAL SPECIFICATIONS, BASED ON REQUIRED PERFORMANCE AND INTENDED INSTALLATION	> REFINE E^3 CONTROL REQUIREMENTS IN TECHNICAL SPECIFICATIONS, BASED ON DT & E AND OT & E RESULTS > CORRECT TO DEGREE FEASIBLE NEWLY DETECTED EM INCOMPATIBILITIES AND RADHAZ CONDITIONS > ENSURE THAT APPROVAL FOR PRODUCTION IS NOT GRANTED WITHOUT DEMONSTRATION OF ACCEPTABLE E^3 PERFORMANCE	> ENSURE COMPLIANCE WITH E^3 REQUIREMENTS IN ACQUISITION ITEM SPECIFICATIONS > ENSURE THAT PRODUCTION ACCEPTANCE TESTS DEMONSTRATE COMPLIANCE WITH E^3 DESIGN REQUIREMENTS	> MAINTAIN INTEGRITY OF E^3 REQUIREMENTS THROUGHOUT ACQUISITION ITEM LIFE CYCLE
PROJECT PHASE	CONCEPT EXPLORATION	CONCEPT DEVELOPMENT (ARB I)	DEMONSTRATION & VALIDATION (ARB II)	FULL SCALE DEVELOPMENT (ARB III)	PRODUCTION & (DLV)	DEPLOYMENT **Delivery & Service Life**
GATE CRITERIA	CE-1 ASSESS RISKS & TRADE-OFFS AND DEVELOP EXPLORATORY FREQUENCY ALLOCATION (1,2,3)	CD-1 E^3 RISKS DEFINED FOR ALTERNATE DESIGNS: - EM SPECTRUM UTILIZATION - EM INCOMPATIBILITIES WITH PROJECTED ENVIRONMENT/APPLICATION - POTENTIAL E^3 PROBLEMS ARE KNOWN AND JUDGED RESOLVABLE (4,7,8) CD-2 E^3 CONTROL PROGRAM PLANNED INCLUDING: - FUNDING SOURCE - SUPPORT PERSONNEL - METHODOLOGY & MILESTONES - INTERFACE COMPATIBILITY WITH NEXT HIGHER LEVEL OF DESIGN (5,6,8) CD-3 E^3 CRITICAL TEST ISSUES ESTABLISHED (8,12) CD-4 E^3 DESIGN REQUIREMENTS DEFINED FOR DEMONSTRATION & VALIDATION PHASE (8,9,10,11)	DV-1 E^3 LOGISTICS ISSUES AND REQUIREMENTS HAVE BEEN DEFINED (19,24,25) DV-2 ACQUISITION ITEM PERFORMANCE QUANTIFIED, DEMONSTRATED, & EVALUATED: - FOR EM DEGRADATION - FOR OPERATIONAL RESTRICTIONS - FOR INTERFACE COMPATIBILITY WITH NEXT HIGHER LEVEL OF DESIGN (13,19,20,21,22,27,29) DV-3 E^3 DESIGN REQUIREMENTS DEFINED FOR FULL SCALE DEVELOPMENT PHASE (14,15,16,17,19,23) DV-4 CRITICAL TEST ISSUES AND REQUIREMENTS HAVE BEEN DEFINED (18,19,20,21,26,27,28,29)	FSD-1 E^3 INSTALLATION, MAINTENANCE, & LOGISTIC REQUIREMENTS IDENTIFIED (24,25,36,37,46,47,48,49,52) FSD-2 E^3 CONSIDERATIONS INCORPORATED INTO CONFIGURATION CONTROL ACTION (23,36,37,50,51) FSD-3 PERFORMANCE AND SPECIFICATION REQUIREMENTS VALIDATED, BASED ON ENGINEERING DEVELOPMENT MODEL TEST REPORT AND TECHEVAL/OPEVAL (26,28,30,35,36,37,38,39,40,41,42,43,44,45) FSD-4 E^3 CONTROL REQUIREMENTS DEFINED FOR PRODUCTION PHASE (31,32,33,34)	P-1 E^3 LOGISTICS REQUIREMENTS INCORPORATED INTO LOGISTICS SYSTEM DOCUMENTATION (52,59,60,64,) P-2 E^3 CONFIGURATION CONTROL ESTABLISHED FOR SERVICE LIFE (23,49,50,51,55,62,63) P-3 PRODUCTION ACCEPTANCE TEST & EVALUATION (PAT&E) COMPLIANCE WITH E^3 CONTROL REQUIREMENTS DEMONSTRATED (55,56,57,58,61) P-4 COGNIZANT ACTIVITIES PROVIDED FINAL ACQUISITION ITEM E^3 DATA INCLUDING: - OPERATIONAL FREQUENCY ALLOCATIONS - FREQUENCY MANAGEMENT RESTRICTIONS - EXPECTED MISSION CAPABILITIES - EXPECTED PERFORMANCE AT THE NEXT HIGHER LEVEL OF DESIGN (53,54)	D-1 E^3 CONFIGURATION MANAGEMENT MAINTAINED DURING SERVICE LIFE (23,49,50,52,61,62,63,64)

Note: Nos. in gate blocks refer to Key Documents List. Underlined nos. are Service Life items

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TABLE XI

ACQUISITION E³ CONTROL STRATEGY: KEY DOCUMENT PHASE & DIRECTIVE LIST

KEY DOCUMENT	DOCUMENT NUMBER PHASE						GOVERNING DIRECTIVE
	CE	CD	D&V	FSD	PRD	DPL	
TOR	1						OPNAVINST 5000.42B w/ch1
DD-1494	2	4	13	30	53		NAVELEXINST 2410.3
DOP	3						OPNAVINST 5000.42B w/ch1
ACQUISITION STRATEGY		5					NAVELEXINST 5000.15
ACQUISITION PLAN		6					NAVELEXINST 4200.6D; 4200.8H; 5000.15
NDCP/DCP/SCP		7					NAVELEXINST 5000.12
GOVERNMENT EMCPP		8	14	31	54		NAVELEXINST 2410.3
TECHNICAL DESCRIPTION/ SPECIFICATION		9	15	32			NAVELEXINST 4120.3C w/ch1; 4120.12 w/ch3; 5420.10B
SOW		10	16	33			NAVELEXINST 4120.10C
CDRL		11	17	34			NAVELEXINST 5040.4B w/ch1
TEMP		12	18	35			NAVELEXINST 3960.3B; 3960.4
RFP/IFB			19	36	55		NAVELEXINST 4200.8H; 4200.21A
EMICP(461)/EMCCP(469)			20	37	56		DI-R-7061, DI-R-2056, MIL-HDBK-237A
TEST PLANS (461/469)			21	38	57		DI-R-7063, MIL-STD-461B; DI-R-2055, MIL-STD-469
TEST REPORT (461/469)			22	39	58		DI-R-7062; MIL-STD-461B; DI-R-2057, MIL-STD-469
ECPs, DEVIATIONS, & WAIVERS			23#	23#	23#	23#	NAVELEXINST 4130.1 w/ch2
NTP			24*	24*	59		NAVELEXINST 1500.3
ILSP			25*	25*	60		NAVELEXINST 4000.10A
DT-II & TECHEVAL TEST PLANS			26	26/40			TEMP
DT-I & II REPORTS			27	41			NAVELEXINST 3960.3B
OT-II & OPEVAL TEST PLANS			28	28/42			TEMP
OT-I & II REPORTS			29	43			NAVELEXINST 3960.3B
TECHEVAL TEST REPORT				44			NAVELEXINST 3960.3B
OPEVAL & FOT&E REPORTS				45	61#	61#	NAVELEXINST 3960.3B
MAINTENANCE REQ'M'T. CARD(MRC) WORK SHEETS				46			NAVELEXINST 4700.4A w/ch1
INSTALL. CONTROL DWGS.				47	62*	62*	UDI-E-22193; MIL-D-23140B
TECHNICAL MANUALS				48	63*	63*	NAVELEXINST 5600.7
SHIPALT PROPOSAL				49#$	49#$	49#	NAVSEA TECH SPEC 9090-400
FIELD CHANGE				50#$	50#$	50#	NAVELEXINST 4130.9A w/ch1; 4720.5
SPD, PART II				51*	51*		NAVSEA/SHAPM
OLSS				52*	52*	52*	NAVELEXINST 4000.10A
MRC's					64*	64*	NAVELEXINST 4700.4A w/ch1

May be multiple occurrances; each evaluated when occurring.
* Evaluated one time in earliest phase available.
$ Service Life items; considered as Deployment Phase (DPL) regardless how early occurring.

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TABLE XII

ACQUISITION E^3 CONTROL STRATEGY: KEY DOCUMENTS IDENTIFICATION LIST

No.	Document	No.	Document
1	TOR	33	SOW for PRD Phase
2	DD-1494, Exploratory Statement	34	CDRL for PRD Phase
3	DOP	35	TEMP, final approved version
		36	RFP/IFB for FSD Phase
4	DD-1494, D&V Allocation	37	EMICP(461)/EMCCP(469), FSD Phase
5	Acquisition Strategy	38	Test Plans (461/469), FSD Phase
6	Acquisition Plan	39	Test Reports(461/469), FSD Phase
7	NDCP/DCP/SCP for Milestone I	40	TECHEVAL Test Plans, FSD Phase
8	Government EMCPP	41	DT-II Reports (FSD Phase)
9	Technical Description/Spec. for D&V Phase	42	OPEVAL Test Plans (FSD Phase)
10	SOW for D&V Phase	43	OT-II Reports (FSD Phase)
11	CDRL for D&V Phase	44	TECHEVAL Test Report (FSD Phase)
12	TEMP, initial version	45	OPEVAL Reports (FSD Phase)
		46	Maintenance Req'm't. Cards(MRC) work sheets
13	DD-1494, FSD Allocation	47	Installtn. Control Dwgs(ICD), Prelim. (FSD)
14	Gov. EMCPP, D&V Rev.	48	Technical Manuals, ms Copy for Review
15	Specification for FSD Phase	49#$	SHIPALT Proposal; any & all, any phase, FSD+
16	SOW for FSD Phase	50#$	Field Change; any & all, any phase, FSD+
17	CDRL for FSD Phase	51*	SPD, Part II; FSD & PRD
18	TEMP update revision for Milestone II	52*	OLSS, when occurring, FSD and out
19	RFP/IFB for D&V Phase		
20	EMICP(461)/EMCCP(469), D&V Phase	53	DD-1494, Operational Authorization
21	Test Plans (461/469), D&V Phase	54	Gov. EMCPP, P&D Revision
22	Test Reports (461/469), D&V Phase	55	RFP/IFB, PRD Phase
23#	ECPs, Deviations, & Waivers; any phase, D&V+	56	EMICP(461)/EMCCP(469), PRD Phase(If required)
24*	NTP, D&V or FSD Phase	57	Test Plans (461/469), PRD Phase
25*	ILSP, D&V or FSD Phase	58	Test Reports(461/469), PRD Phase
26	DT-II Test, (FSD Phase)	59	NTP, approved version
27	DT-I Reports, (D&V Phase)	60	ILSP, approved version
28	OT-II Test Plans, (FSD Phase)	61#	FOT&E Report, PRD & DPL Phases
29	OT-I Reports (D&V Phase)	62*	ICD's, Revision prelim., PRD or DPL
		63*	Tech. Manuals, Rev./Change Pgs., ms copy
30	DD-1494, PRD Allocation		
31	Gov. EMCPP, FSD Rev.	64*	MRC's, PRD Phase
32	Specification for PRD Phase		

\# May be multiple occurrances; each evaluated when occurring.
* Evaluated one time in earliest phase available.
$ Service Life items; considered as Deployment Phase (DPL) regardless how early occurring.

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MIL-HDBK-237A
INTERIM NOTICE 1 (NAVY)

APPENDIX M

APPLICATION GUIDE FOR NAVAIR ACQUISITIONS

NAVAIR program managers should refer to NAVAIRINST 2410.1, which defines NAVAIR policy for establishing an effective EMC program throughout the life cycle of platforms, systems and equipment.

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INSTRUCTION: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvement. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about paricular problem areas such as wording which required interpretation, was too rigid, restrictive. looss, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-HDBK-237A Interim Notice 1	ELECTROMAGNETIC COMPATIBILITY MANAGEMENT GUIDE FOR PLATFORMS, SYSTEMS AND EQUIPMENT

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: ______

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

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NOTICE OF CHANGE

NOT MEASUREMENT SENSITIVE

MIL-HDBK-237A
NOTICE 2 (NAVY)
February 14, 1992

ELECTROMAGNETIC COMPATIBILITY MANAGEMENT GUIDE FOR PLATFORMS, SYSTEMS AND EQUIPMENTS

TO ALL HOLDERS OF MIL-HDBK-237A

1. The following pages of MIL-HDBK-237A have been revised and supersede the pages listed:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
v	16 Jun 1986	v	REPRINTED WITHOUT CHANGE
vi	20 Jan 1992	vi	16 Jun 1986
vii	16 Jun 1986	vii	REPRINTED WITHOUT CHANGE
viii	20 Jan 1992	viii	16 Jun 1986
ix/x	20 Jan 1992	ix/x	16 Jun 1986
41	20 Jan 1992	41	2 Feb 1981
42	20 Jan 1992	42	2 Feb 1981
43	20 Jan 1992	43	2 Feb 1981
44	20 Jan 1992	44	2 Feb 1981
119-125	20 Jan 1992	NEW	N/A

2. Retain this notice and insert before Table of Contents.

3* Holders of MIL-HDBK-237A will verify that page changes and additions indicated above have been attached. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military handbook is completely revised.

4. Changes from previous issue. The margins of Notice 2 change pages are marked with vertical lines to indicate where changes (additions, modifications, corrections) from the previous issue were made. This is done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content of the basic issue and Notice 1 irrespective of marginal notations.

Review Activities:
Navy - AS, SH, OS, TD

User Activities:
Navy - YD

Preparing Activity:
Navy - EC
(Project No. N132)

AMSC N/A

AREA EMCS

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FIGURES

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APPENDIX H
E^3 CONSIDERATIONS IN PROGRAM DOCUMENTS

10. INTRODUCTION The actions to control adverse EM effects are not isolated events but, when applied properly, form a continuum. Since planning and procurement documents are the logical vehicle for implementing an E^3 program, this appendix discusses the relationship between the pertinent documents and required actions. It is presented in the context of a major system procurement; however, the principles and procedures are applicable to platforms and less than major procurements. To provide an insight into the review process, a set of review guidelines is provided.

20. MISSION NEED STATEMENT (MNS).

- Identifies Mission Area and describes new system function in the mission area.
- Describes the threat and shortfalls of existing systems to meet the threat.
- State solution constraints and provides a program for consideration of alternative systems.

20.1 E^3 CONSIDERATIONS FOR INCLUSION IN MNS.

- State EMC performance in a hostile and friendly EME.
- Identify EMP survivability requirements and, as may be appropriate, other EMC requirements.

30. TOP LEVEL WARFARE REQUIREMENTS (TLWR).

- Establishes the capabilities required to execute the mission area and provides the basis for all Tentative Operational Requirements.

30.1 E^3 CONSIDERATIONS FOR INCLUSION IN TLWR.

- Spectrum management and consideration.
- Performance requirements in friendly and hostile EME.
- EMP Survivability requirements.
- Other unique top level EMC requirements, ie RADHAZ, HERO, HERF, lightning.

TENTATIVE OPERATIONAL REQUIREMENT (TOR).

- Describes overall mission area, type of system required and concept of operation.
- Describes threat and emphasizes threat trend.
- Identifies shortcomings of existing systems.
- Outlines key capabilities desired and acceptable performance levels.
- Provides life cycle (RDT&E through 5 year deployment) cost estimates.
- Identifies platforms which will employ the system.
- Describes ILS considerations.
- Discusses related developments and interfacing system requirements.

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40.1 E^3 CONSIDERATIONS FOR INCLUSION IN TOR.

- General assessments of the anticipated EME.
- Discussion of potential enemy jamming threat and ECCM requirements to achieve mission capability.
- Identify E3 deficiencies in existing systems.
- Provide for E^3 planning and frequency spectrum management. Identify significant impact to EME and provide trade off considerations.
- Identify E^3 program funding requirements throughout life cycle of the system.
- Provides for E^3 related training and ILS support.
- Identifies EMP survivability requirement and potential RADHAZ concerns.

50. OPERATIONAL REQUIREMENT (OR).

- Defines operational problems, required system capabilities, system and target parameters and operational employment.
- States cost objectives.

50.1 E^3 CONSIDERATIONS FOR INCLUSION IN OR. The OR must form the basis for the EMC effort during the acquisition process. The general requirement for compatibility with the EM environment must be stated at the onset. In addition, unique goals related to EM effects must be specified for EMP and HERO and other EM requirements. The target parameters and operational employment must be described sufficiently to permit definition of the anticipated EM environment. It is therefore necessary to review the draft OR to assure that sufficient information is provided. Specifically, the following should be addressed.

- Define EM environment in terms of friendly and hostile emitters and project far enough into the future to cover the life span of the proposed system.
- Define target sufficiently to determine EMC considerations.
- State EMC goals for system design and intended operation.

60. DEVELOPMENT OPTIONS PAPER (DOP).

- Presents alternatives or trade-offs to achieve a range of capabilities to satisfy the OR.
- Proposes methods for achieving program objectives, provides program alternatives, cost comparisons and defines tasks.
- Addresses T&E that will be required and contains a Development Plan.

60.1 E^3 CONSIDERATION FOR INCLUSION IN DOP. The DOP presents the alternatives and trade-offs to achieve the required operational capability called for in the OR. EMC ramifications for each alternative must be addressed. The DOP must define the operational EME, the sensitivity of the alternatives to the EM environment and their impact on the ambient environment. The hardening alternatives must be described along with costs and risks. If the level of hardness is a major consideration, then the cost versus effect on the operational capability must be described. Plans for developmental and operational EME effects tests must be given, along with performance criteria and objectives. If special test facilities and equipment are required, they should be described and cost estimates given. The DOP review is required to ensure that the achievement of operational goals will not be unnecessarily restricted by the EME, that emission from the alternatives will not unacceptably degrade other friendly equipment and that

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appropriate steps are planned for dealing with high risk areas. Specifically, the following should be addressed:

- Address all EMC factors contained in the OR, including rationale for selection of proposed frequency bands of operation.
- State methods for achieving the specified level of EMC, cost and effectiveness for all design alternatives.
- Project EM environment to cover the proposed system life span.
- State projected EM problems for each alternative. Identify, if any, ordnance and human risk in the proposed environment. Define impact on the EM environment created by the state-of-the-art, if required.
- State tests appropriate to demonstrate required EMC. This should include, as appropriate, those specified by MIL-STD-461, MIL-STD-449 and MIL-STD-469, MIL-STD-1605, MIL-E-6051, HERO tests, other development tests, and inter-platform testing, as required.
- Include spectrum support and EMC T&E milestones with other T&E milestones. State resolution dates for any identified EMC risks.

70. DECISION COORDINATION PAPER (DCP).

- Information contained in the DOP is combined with the OR to develop the final approval document (DCP), which is used to obtain approval for the next phase of system acquisition.
- The program manager must request approval to initiate the Demonstration and Validation Phase when competitive exploration of alternative concepts during Program Initiation leads to selected alternatives that warrant system demonstration.
- The information developed previously for the OR and DOP form the basis for the DCP.
- The DCP contains sections relating to program issues, objectives, alternatives, risks and the development plan.

70.1 E^3 CONSIDERATIONS FOR INCLUSION IN DCP DURING CONCEPT DEVELOPMENT AND VALIDATION.

- Each design alternative must specify a method for achieving the required EMC.
- State projected EM problems.
- Specify risk associated with advancing the state-of-the-art, if required to achieve the required EMC.
- State tests planned to demonstrate EMC.
- Project EM environment definition far enough into the future to be compatible with the system being acquired.
- Include spectrum support and EMC T&E milestones with other T&E milestones in the development plan. State resolution dates for any identified EMC risks.

70.2 E^3 CONSIDERATIONS FOR INCLUSION IN DCP DURING FULL SCALE DEVELOPMENT.

- Previous T&E and analysis must be incorporated into the DCP.
- Part of the approval process requires the TEMP or TEP to be updated with the recommended system technical performance specifications prior to the system approval milestone.
- Any EMC risks identified in previous phases for the recommended system will be added to the TEMP or TEP along with risk resolution testing milestones.
- EMC aspects of PAT&E of initial production and long lead time items must be included in the TEMP or TEP.
- Planned EMC testing to revaluate the system after changes during initial production must also be included.

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70.3 E^3 CONSIDERATIONS FOR INCLUSION IN DCP DURING PRODUCTION.

- When the PAT&E and OT&E has proceeded to the point of recommendation of full-scale production, the DCP will be updated with the appropriate test results and recommendations. The DCP will then be submitted to higher authority for approval to proceed with full-scale production.
- Appropriate EMC parameters will be tested during the PAT&E and OT&E and these test results and their implications will be used to update the DCP.

80. PROCUREMENT PLAN (PP). The procurement plan documents technical business, policy, operations and other procurement considerations portraying milestones to be met in achieving the goals of a specific program over its procurement life cycle. Since a PP is regularly updated, it will reflect changes in objectives or method of procurement. The discussion of program technical risks in the PP must include major EMC risks and potential threats to and from other systems or platforms and describe what efforts are planned or underway to reduce them. There should be a general discussion of EMC including control and reporting plans, predictions, analyses, EM specifications and requirements to be imposed, anticipated EME, design disciplines and quality assurance. The test and evaluation approach should describe DT&E to be required by the contractor, and DT&E and OT&E to be performed by the Government for each major phase. In view of the importance of the issues addressed in the PP it is necessary that the EMC aspects be reviewed to assure that they are realistic, economical and achievable. The PP should also define the minimum criteria for a proposal to be acceptable.

90. REQUEST FOR PROPOSAL (RFP). The RFP advises prospective bidders of the Government needs. The item to be procured is described by the applicable specifications or by a description containing the necessary requirements. Thus, the RFP must delineate the anticipated electromagnetic environment location and configuration, the performance requirements in the environment, tailored requirements for intended and spurious emissions and susceptibility criteria. Also, any EM test, evaluation, analysis, simulation and data required of the contractor such as EMC control and test plans and test reports, and any Government test that the item must pass to be acceptable must be included. The role of the contractor in supporting an EMCAB must be defined, if applicable. Since the RFP will be the basis for the contract, the procuring activity must be assured that the item will meet the EMC requirements without resorting to costly contract modifications.

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APPENDIX M
APPLICATION GUIDE FOR NAVAIR ACQUISITIONS

NAVAIR program managers should refer to NAVAIRINST 2410.1, which defines NAVAIR policy for establishing an effective EMC program throughout the life cycle of platforms, systems and equipment.

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APPENDIX N
WARFARE SYSTEMS E^3 CONTROL STRATEGY

10. INTRODUCTION. The Warfare Systems E3 Control Strategy (WSECS) is described in this appendix to provide the PARMs (Participating Managers), Program Managers and other acquisition personnel with an overview of the E^3 acquisition methodology currently employed by NAVSEA and SPAWAR. This methodology is not intended to supplant the processes described in detail in Appendices J, K & L. It is to be utilized in conjunction with these methods so that E^3 is addressed at the early conceptional stages of acquisition. WSECS is not unlike the AECS described in Appendix L in that it applies a gate control technique to process through the acquisition stages. WSECS is directed toward achieving EMC through the issuance of Control Interface Drawings. These drawings identify and characterize the intentional signals and allowable degradation.

10.1 APPLICABILITY. The WSECS process is applicable to all warfare systems acquisitions by the Navy. Implementation of this process provides positive E^3 control of the acquisition by establishing prerequisites which must be met at each phase of the life-cycle.

10.2 ELEMENTS OF THE WSECS. Table XIII is a fold-out chart depicting the WSECS. A detailed explanation of the process is contained in the text proceeding the chart. The basic elements of WSECS are:

- Establish the performance envelope: Define at the concept initiation phase the degree of mission capability required and the electromagnetic environment in which the system will operate.
- Define and control all interfaces between warfare systems elements: Issue control interface drawings defining each interface of the warfare systems in terms of intentional signal, conducted emissions and conducted susceptibility.
- Verify compliance: Establish through performance specifications, installation control drawings and test and evaluation requirements that E^3 compliance has been met.

20. WSECS METHOD. The WSECS applies a positive-control methodology of gating for E^3 control. The process for identification, refinement, and approval of warfare systems requirements and the subsequent research, development, and acquisition process are gated in a time-phased basis corresponding to the major decision points during the acquisition life-cycle. Each requirement and subsequent action becomes a part of a continuous evaluation to monitor the extent and adequacy of the E^3 control effort. WSECS provides one or more objectives applicable to each specific phase of the life-cycle and provides for documentation evaluating the achievement of the objectives. As a result of this process, at each decision point during the life-cycle WSECS is ready to present an E^3 position concerning an item and the merits of permitting the acquisition to proceed.

30. WARFARE SYSTEMS E^3 CONTROL STRATEGY (WSECS). OPNAVINST 5000.42C "RDT&E Acquisition procedures" establishes phases, milestones and threshold criteria for Navy acquisitions. The WSECS method is an adaptation of this requirement which provides E^3 control requirements at the acquisition initiation and establishes definitive requirements at each warfare systems interface. This control is achieved by requiring that E^3 related key documentation exists at each phase of the life-cycle. This key documentation provides the basis for determining the E^3 impact, problems to be resolved, problem resolution, and verification of the effectiveness of E^3 controls.

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30.1 KEY DOCUMENTS. For the purpose of WSECS it is unimportant that information be supplied by any particular document, only that it becomes available on a timely basis in a suitable form. In the development of WSECS a survey of normally available or required documentation resulted in the identification of the key documents presented in Table XIII. Many of these are E^3 documents, which predated the formulation of WSECS, and have been subjected to formal document reviews. Others are required as part of the acquisition cycles and contain E^3 information needed for the WSECS decision making process. It is important to note that WSECS reviews of key documentation is for the purpose of extracting desired E^3 information and does not concern the form or format of the document.

30.2 ISSUES. The identification and resolution of WSECS issues must be an iterative process since each phase of acquisition dictates a new set of problems and concerns. In the concept initiation phase, it may suffice to broadly describe the intended operational EME. But as the acquisition progresses, the issues must be more definitive and the resolution be structured into procurement documentation and test and evaluation plans. It is by this method that potential E^3 problems are highlighted and performance degradation of the warfare system and its interface system is avoided. The issues of each phase of acquisition are discussed in more detail in this appendix as related to the phases of acquisition.

30.3 GATE CLOSURE. When it is apparent from available information that the direction of the requirement or project does not support the resolution of critical E^3 issues, the WSECS process denies opening the gate for the next phase of procurement until satisfactory resolution by the project office is achieved. Should resolution not be forth-coming, it is inherent in the WSECS process to formulate the issues for a higher level of authority to review for resolution.

40.0 WSECS PHASES

40.1 THE CONCEPT INITIATION (CI) PHASE. Prepared by the Warfare Requirements Board (WRB) at the OPNAV level, TLWRS will ultimately cover each of the five Warfare Mission Areas in iterative, dynamic documents. The advent of a new or revised version of each TLWR (KDN-1) signals the initiation of the RP cycle. When received by SPAWAR, a TLWR is reviewed and assessed with regard to the current architecture, which serves as a baseline and a guide. The architecture directs the search for requirement solutions in approved and preferred technological fields and dictates ranges and limits of capabilities on and among platforms. There is a bilateral relationship between a TLWR and the architecture, and, in the second part, the architecture is itself reevaluated. In this action, the trends noted in recent TLWRS and the advent of new technologies are evaluated and appropriately factored into architectural revisions. The E^3 cognizant office provides the Warfare Systems Architect (WSA) with technical support in both of these evaluations, providing review comments on the TLWR for the Architectural Options (AO) paper (KDN-2) and on the architecture itself, as appropriate. The WSA prepares the actual response to the OPNAV WRB. From the mission viewpoint, the TLWR document addresses only capability concepts, i.e., requirements as ideas. The principal E^3 considerations that have potential as suitable input are those concerning use of the spectrum and frequency management. The nature of the TLWR may suggest additional areas of interest.

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40.2 THE CONCEPT EXPLORATION (CE) PHASE. On the basis of the approved TLWRs and the architecture adopted, the WRB prepares and issues TORS. Multiple TORS (KDN-5) may result from any particular TLWR, and various TORS, rather than having equal status, may share hierarchical relationships among themselves. TORS are general statements of need and carry a demand to propose alternate solutions. The TORS, as OPNAV documents, are reviewed for information and understanding rather than with criticism. The review serves to determine the necessity for, and the character of the supporting guidance that it may be necessary to provide with a TOR on its way to the cognizant systems command. When generated, the guidance takes the form of a KD described as Development Option Paper (DOP) Guidance, KDN-6. While the OPNAVINST 5000.42 series provides for E^3 control guidance (as EMC guidance) in TORS, the perception of the guidance may vary widely. The document prepared by the systems command in response to a TOR is the DOP, KDN-7. The DOP is the first document which may place the Warfare System community into an adversarial role with a systems command project office. As with any option in which electromagnetic (EM) energy plays a significant part, it is necessary for the DOP to address appropriate E^3 control considerations, particularly if the effects are not relatively constant, uniform considerations for all options. Depending upon the nature and degree of the EMC deficiency, alternative approaches can be employed:

a. The DOP may be rejected and returned for revision to the systems command in order to overcome the E^3 deficiencies noted. Since this method adds further delay for a document responding to a TOR that is probably 12 to 18 months old already, it should be used only in the most unsatisfactory cases.

b. The DOP may be endorsed and forwarded to CNO with comments covering the E^3 deficiencies, and with a copy to the systems command. The SYSCOM can then provide supplementary data addressing the endorsement at an early date.

The last KD for the CE Phase is the DD Form 1494 application for a frequency allocation, Stage 1 (Conceptual), and is designated KDN-8. Each DOP alternative which proposes to transmit or receive EM energy needs an application, except that the same type of transmission or reception for multiple alternatives may be covered by a single application. No application is necessary if there is no transmission or reception of EM energy. There is, of course, no actual hardware at this stage, and KDN-8 serves as a “heads up” alerting mechanism. More specifically, the KDN-8 is a pre-project inquiry to elicit potential, but unsuspected, spectrum utilization problems. The application should be prepared and forwarded, as soon as possible, for any alternative in a draft DOP that requires use of the spectrum. When the KDN-8 DD Form 1494 is required, no DOP should be forwarded to CNO until the attendant KDN-8 has been processed and forwarded for approval. A DOP proposing alternatives whose spectrum utilization would suggest a serious potential for interference, may be held until necessary KDN-8 applications are received for processing.

Nominally, the CE phase ends with the transition of Milestone O. The WSECS and RD&A processes are not, however, locked to one-another at this time, and the WSECS gate may open ahead of actual Milestone O approval.

40.3 THE CONCEPT EXPLORATION/DEFINITION (CED) PHASE.

a. The CED Phase has another DD Form 1494 application requirement (KDN-10), for a Stage #2 (Experimental) frequency allocation. This allocation serves to confirm and expand upon the earlier Conceptual request. It covers the Advanced Development Model (ADM) hardware which is to be built and tested during Phase I (Concept Demonstration/Validation) of the RD&A process. Where

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there is no novelty in the spectrum utilization posed in the application, the Stage #1 (conceptual) type, KDN-8, may be combined with the Stage #2, KDN-10. Although WSECS calls for this application to be submitted prior to Milestone I, a prudent Project Manager (PM) will submit it even earlier if possible. Until the appropriate frequency allocation application has received CNO approval, under OPNAVINST 2400.20E, funds may not be obligated on a contract for an ADM, even though Milestone I approval may have been granted to initiate a project. DD Form 1494 applications may take in excess of six months for approval.

b. The WRB, after reviewing a DOP submission and arriving at a favorable decision, issues an Operational Requirement (OR) based on preferred option(s) . This is KDN-11 and is tantamount to the issuance of project approval for small items in Acquisition Categories (ACATs) III & IV. The OR is a refined presentation of the favored option, is established as a KD for its directive value and forms the basis of the Navy Decision Coordinating Paper (NDCP) to be used to approve the new project formally. The review of the OR also forms the basis for the Warfare Systems Performance Specification (WSPS). The output of the review should be placed in the form of Design Guidance for the WSPS.

c. Two additional KDs are used during the CED Phases: the Systems Specifications (KDN-12) and the Item Specifications (KDN-13).

(1) KDN-12, when available, sets the level of E control direction in a system project. This may be readily apparent, e.g., with an aircraft item as the system, where the requirements of MIL-E-6051 are invoked. In other platform types for which there is no system-level E^3 standard control as yet, the task of E^3 control assessment and allocation may require extended reading. For proper system E^3 control to result, downward direction and allocation of requirements must be implemented from the systems level, establishing interfaces, specifying isolation, filtering, levels, EM practices, etc. A system may not be limited to a single platform; while this may complicate the project, the system considerations stated earlier still apply. Regardless of the intra- or inter-platform nature of the system, the basic requirements stated in the CED Phase form the foundation necessary for successful E^3 control in later development phases. E^3 control measures that are necessary only in lower indentures, but fundamental to system E^3 control effectiveness, must be directed by the system specification.

(2) Where the project is of lesser scope than that of an entire platform and the project item is normally considered at the unit, group, or set level, an Item Specification is prepared. The Item Specification is the ADM Specification; i.e., it is the specification that will be used during Phase I on a contract for the ADM hardware. To facilitate contract award, following Milestone I approval, the specification must have been prepared, coordinated, revised, and approved at an earlier time during the CED Phase. This provides an early opportunity for WSECS to determine how fully the project will follow E^3 control guidance given earlier. Because the ADM is not a MIL-specified item, however, it is not reasonable to expect or demand a full range of MIL-STD-461 requirements and MIL-STD-462 tests for this technology-demonstration hardware. Should the ADM represent integration of previously developed hardware, in whole or in part, the use of which will remain unchanged in the Engineering Development Model (EDM), a requirement in the specification, to use components qualified to MIL-STD-461, would be essential.

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d. Where hierarchical requirements exists, specifications will similarly exist on multiple levels. For this reason, KDN-12 is established in Table XIII, as a separate item from KDN-13. In the event that two levels exist simultaneously for a given requirement, the lowest will always be identified as KDN-13 and each of the others will be identified as KDN-12.

e. The Test & Evaluation Master Plan (TEMP), as KDN-14 in its first iteration, is required for the Milestone I review. The TEMP is a particularly significant document prepared by the project office, which establishes the criteria as well as extent and schedule for project operational evaluation. For review considerations, the TEMP should state E^3 control evaluation criteria for operational effectiveness and operational suitability.

f. KDN-15 is assigned to the Warfare Systems Performance Specification (WSPS). The WSPS is based on the evaluation of the OR (KDN-11). From each of several major technical disciplines of which E^3 is a representative member, input in the form of Design Guidance is supplied. The input is based on the parochial interest of the discipline. The WSPS provides the broad system synthesis of these guidance inputs.

40.4 THE CONCEPT DEMONSTRATION/VALIDATION (CDV) PHASE. Most active of all phases for WSECS, CDV is a particularly important time for the Warfare Systems Engineer (WSE). For each project formally begun by OR, the WSE must at this time prepare, coordinate, negotiate, revise, and issue two more major documents as in follow-on to the WSPS.

a. The Warfare Systems Test Specification (WSTS) and the Warfare Systems Control Interface Drawing (WSCID) are KDNs 21 and 22 respectively. Using these documents, the WSE applies and disseminates additional Warfare System Architecture and Engineering requirements. For the WSCID, the minor supporting documents, Notice of Change (NOC) and Proposed NOC (PNOC), serve the purpose indicated by their names. (This is actually a single document; the PNOC becomes the NOC upon approval.) The WSTS, KDN-21, has no formal instructions issued for its preparation as yet. It may be anticipated, however, that it will specify the verification requirements and methods for corresponding WSPS requirements. The first generation of WSCID documents (KDN-22), in complying with SPAWARINST 9000.1, appear to be addressing only hardwire conducting interfaces. For this form of porting, the CE- and CS- requirements of MIL-STD-461 are appropriate limits for all undesired signal (noise) energy present. A PNOC is evaluated with the WSCID to which it is applicable; the acceptability of the PNOC is commented accordingly. A resulting NOC becomes part of the WSCID affected. The WSPS precursor to the above two KDs is ordinarily issued prior to Milestone I, i.e., before the CDV Phase. Should it have been delayed into CDV, KDN-20 is assigned, and its review is performed as needed. The Design Guidance for the WSPS would have been developed during the OR review in the CED Phase.

b. Three document forms common to the previous phase have counterpart types during the CDV phase. A DD Form 1494 application for the Stage #3 (Developmental) Frequency Allocation is KDN-17. This KD is to be received prior to Milestone II, and its approval must be secured before the EDM contract may be awarded in Phase II. The Full Scale Development (FSD) Specification (KDN-18) which will cover the device EDM, is written during the CDV phase prior to, and in preparation for, Milestone II. The FSD Specification is of particular importance since requirements seen necessary during D&V, incorporated and proven during test and evaluation (T&E), and later given approval for full-rate production (AFP), are those that will continue into the Production and Initial Deployment Phase. The EDM is the proper candidate for full MIL-STD-461 qualification. Finally, the second iteration of the TEMP is designated as KDN-19, and is required for Milestone

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II also. E^3 control criteria should be updated based on the project experience of the CDV phase and as appropriate for KDNs 20, 21, and 22 and as previously described.

Finally CDV phase KDs include two report types: KDN-23 covers any EMI, EMC, or IMI test reports for any standards (MIL-STD-461, MIL-STD-469, etc.), and KDN-24 covers T&E reports whether for DT-I or OT-I. Unlike KDN-16 through 22, however, KDN-23 and -24 are processed to support a new role for SPAWAR. In the new role, SPAWAR acts for E^3 only as a monitor. Information obtained from these KDs is channeled into project evaluations, but no directive action is taken with regard to the project or other offices. This limited monitoring role, begun during CDV, will expand during FSD to almost 100% monitoring.

40.5 THE FULL SCALE DEVELOPMENT (FSD) PHASE). With the approval at Milestone II, the item moves into the FSD Phase. As indicated in 40.4, the SPAWAR role shifts in FSD from that of advocate and arbiter for Warfare Systems Architecture & Engineering, into a passive role which monitors compliance by the project office. A residual directive role remains for E^3 in FSD in regard to two of the KD types:

a. As Milestone III is approached, the final iteration of the TEMP, KDN-28, is prepared, offering one last opportunity to improve or correct the E^3 control criteria for T&E.

b. The final frequency allocation application is to be made prior to the Milestone III review. This is KDN-26, the Stage #4 (operational) request.

c. Lastly, three additional documents are monitored to determine the degree to which the project office is adhering to guidance. These are the Item Specifications (KDN-27) for Production, Test Report (KDN-31) which covers EMC/EMI/IMI reports, surveys, incidents, etc. (MIL-STD-461, -462, -469, -1605, etc.), and the DT-II and OT-II test reports, both grouped together as KDN-32. These sources are reviewed in support of the command monitoring functional responsibility only. No routine report or evaluation is made to other offices.

40.6 THE PRODUCTION & INITIAL DEPLOYMENT (PID) PHASE. The PID Phase starts when a project has been approved for full rate production (AFP). This authorization occurs concurrently with Milestone III (at times with IIIB) approval. The role of SPAWAR continues to be that of monitor, observing projects to assess the degree of compliance with previous guidance. Only two KDs are listed for this phase, EMI Test Reports, KDN-34, and OT-II or III Test Reports, KDN-35, although other sources may be found useful, however. As in the previous phase (FSD), no routine evaluation reports are made. WSECS establishes its own milestone in the absence of a formal one in the RD&A cycle. This is the Production Acceptance Test & Evaluation (PAT&E) for the production contract, the PAT&E reports of which are KDN-35.

40.7 THE OPERATIONS SUPPORT (OPS) PHASE. As the item becomes a common capability in the resources of the Fleet units making up the force, no specific documents are designated to be monitored; KDN-37, however~ is assigned to cover any type of EMI or EMC deficiency report. Documents of opportunity which may provide information regarding an EMI problem include major Fleet exercise reports, casualty reports (CASREPS), or any other documents which address the existence of an EMI condition. Additional OT-III reports are covered by KDN-38. The OPS Phase has one unique feature: the gate condition for any project is routinely regarded as open. Should an EMI condition emerge, the gate then closes until the unsatisfactory condition is removed. In theory, multiple EMI problems might occur within a particular

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force. Should this be the case, several documents would report conditions pertaining to these several problems. The OPS Phase Gate would remain closed until each of the problems was resolved separately.

50.0 USING WSECS IN THE NON-CLASSIC REAL WORLD. The WSECS process is presented in 40.1 through 40.7, as it might be manifested ideally by the various KDs. The series of KDs from Table XIII emerge in time sequence to provide appropriate information for decisions. Do not be surprised, however, if the revelation of information is less orderly in the real world. Nevertheless, keep it clearly in mind that the degree of issue resolution remains the fundamental product to be sought by each KD evaluation.

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Table XIII

SYSTEM	WARFARE SYSTEMS E³ CONTROL STRATEGY (WSECS)						
GOAL	Performance of Warfare Systems, Integrated at Force Level, is Undegraded by Electromagnetic Interference						
MANAGEMENT OBJECTIVES	Establish E³ considerations in the architecture appropriate to the TLWR context.	The potential impact of the EME on options has been addressed.	The projected performance of the developmental option in the potential EME has been established.	Systems E³ performance and testing requirements specified for militarized developments. Systems E³ interface criteria established.	Conformance/adherence of system EDM to E³ control requirements has been demonstrated.	Conformance/adherence of a system production model (PDM) to E³ control requirements approved for the EDM has been approved.	The application of the product item among warfare systems in fleet acrhitecture has not generated adverse problems.
PHASE	CONCEPT INITIATION (0)	CONCEPT EXPLORATION (0)	CONCEPT EXPLORATION/ DEFINITION (I)	CONCEPT DEMONSTRATION/ VALIDATION (II)	FULL SCALE DEVELOPMENT (III)	PRODUCTION & INITIAL DEPLOYMENT (AT&E)	OPERATIONS SUPPORT (IV) (V)
GATE ISSUES	- Does the architecture specifically address the E³ family in a manner appropriate to the requirement level stated?	- To the degree practical, have the potential degrading effects of E3 on the corresponding statements of performance been reflected in the presentation of each option?	- As practical, is the projected performance reflected as a function of the EME present? - Have tentative testing/E³ criteria been developed for E³ program planning?	- From the demonstrated performance, have the overall range of E³ performance requirements necessary been identified? - Have acceptable trade-off limitations for E³ designs control measures been established?	- Has the minimum level of information necessary for an adequate degree of monitoring been available? - Has the information available shown that the EDM incorporates the essential E³ control requirements?	- Has the minimum level of information necessary for an adequate degree of monitoring been available? - Has the information available shown that the PDM replicates the E³ control capabilities of the EDM as approved?	- Has information available shown that the PDM is electromagnetically successful?
APPLICABLE KEY DOCUMENT NUMBERS	KDN: 1, 2, 3	KDN: 4, 5, 6, 7, 8	KDN: 9, 10, 11, 12, 13, 14, 15	KDN: 16, 17, 18, 19, 20, 21, 22, 23, 24	KDN: 25, 26, 27, 28, 29, 30, 31, 32	KDN: 33, 34, 35	KDN: 36, 37, 38

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
1	TLWR
2	AOP
3	OTHER

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
4	OTHER
5	TOR
6	DOPG
7	DOP
8	DD 1494c

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
9	OTHER
10	DD1494c
11	OR
12	SSPEC
13	ASPEC
14	TEMP
15	WSPS

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
16	OTHER
17	DD 1494d
18	ESPEC
19	TEMP
20	WSPS
21	WSTS
22	WSCID
23	EMIRPT
24	TERPT

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
25	OTHER
26	DD 1494e
27	PSPEC
28	TEMP
29	WSTS
30	WSCID
31	EMIRPT
32	TERPT

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
33	OTHER
34	EMIRPT
35	TERPT

KEY DOCUMENT NUMBER (KDN)	KEY DOCUMENT
36	OTHER
37	EMIRPT
38	TERPT