MIL-HDBK-237A
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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NEW PAGE	DATE	SUPERSEDED PAGE	DATE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
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66	16 June 1986	65	2 February 1981
67 - 117	16 June 1986	new	

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 entered. 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.

AMSC N/A FSA EMCS

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Review activities:
Navy - AS, SH, OS, MS, TD

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

User activities:
Navy - MC, YD

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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APPENDICES

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FIGURES

TABLES

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.

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:

- Evaluate TOR for E^3 considerations
- Include E^3 considerations in DOP
- 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.

- 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 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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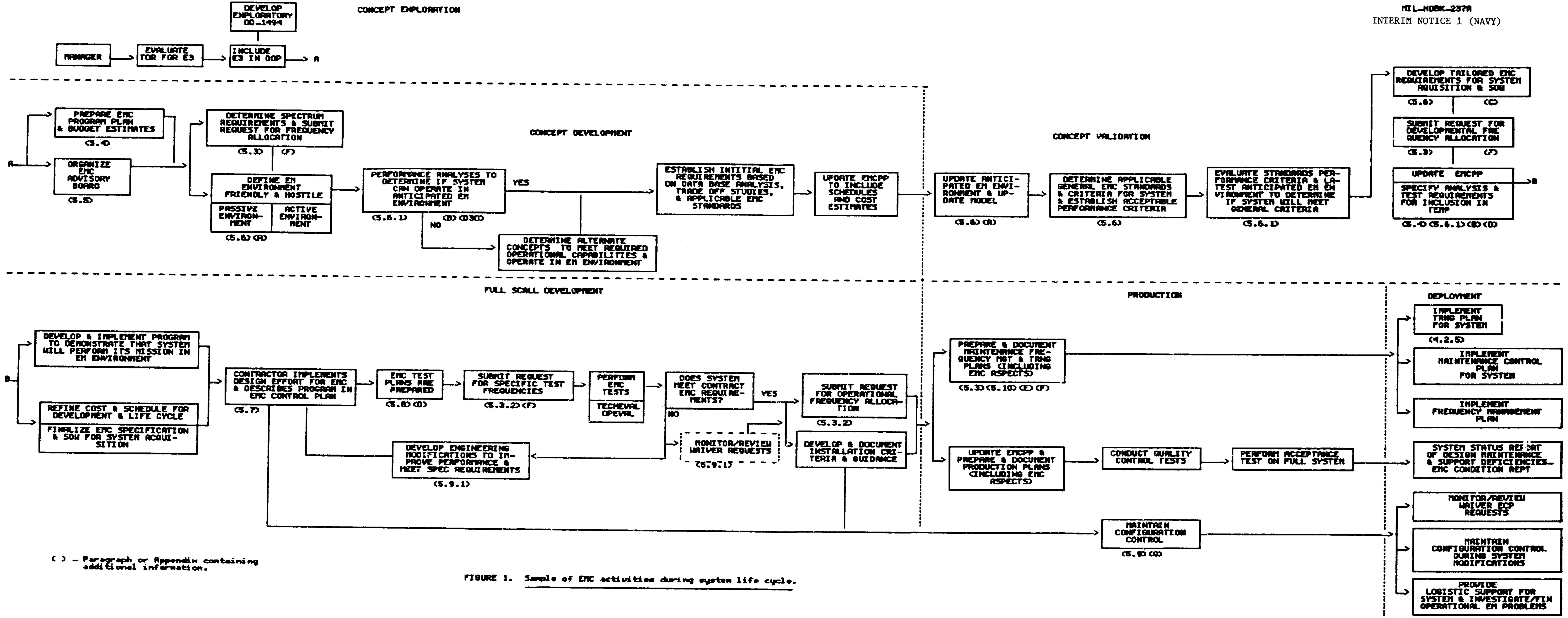

( ) - Paragraph or Appendix containing additional information.

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

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.

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

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.

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.

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.

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).

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.

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 <u>E^3 Coordinator.</u> 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 <u>E^3 Program Funding.</u> 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 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 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.

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.

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;

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 <u>Considerations in Program Documents.</u> 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 <u>Statement-of-Work (SOW).</u> 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 <u>Specifications and Standards.</u> 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

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.

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, 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?

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 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:

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 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.

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:

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 <u>Validation or Advanced Development Phase.</u> 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 <u>Full Scale Development Phase.</u> 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

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 Production Phase. 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 Deployment. Following the acceptance of the first operational system, the PM must decide if continued contractor's 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 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 <u>Training Plan.</u> 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 <u>Navy Training Plans (NTPs).</u> 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.

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.

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.

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

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. <u>Nature of Procedural Problem.</u> 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 <u>System Acquisition Methodology.</u> For most system acquisitions a "prime" contractor performs both Full Scale Engineering Development and Production. In this situation the prime, contractor is responsible for:

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.

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 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 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.

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 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.

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		PRODUCTION	
* EMPLOY NAVAL ARCHTECTURE 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	* 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

	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 ACQUISTION: 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 → ←

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.

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.

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).

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 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 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.

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 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.

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, 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 <u>AECS Demonstration and Validation (DV) Phase (Project Phase I).</u> 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

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 <u>AECS Full Scale Development (FSD) Phase (Project Phase II).</u> 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 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 AECS in the Production Phase. 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.

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

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.

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

TABLE XI

ACQUISITION E^3 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.

TABLE XII

ACQUISITION E^3 CONTROL STRATEGY: KEY DOCUMENTS IDENTIFICATION LIST

No.	Document
1	TOR
2	DD-1494, Exploratory Statement
3	DOP
4	DD-1494, D&V Allocation
5	Acquisition Strategy
6	Acquisition Plan
7	NDCP/DCP/SCP for Milestone I
8	Government EMCPP
9	Technical Description/Spec. for D&V Phase
10	SOW for D&V Phase
11	CDRL for D&V Phase
12	TEMP, initial version
13	DD-1494, FSD Allocation
14	Gov. EMCPP, D&V Rev.
15	Specification for FSD Phase
16	SOW for FSD Phase
17	CDRL for FSD Phase
18	TEMP update revision for Milestone II
19	RFP/IFB for D&V Phase
20	EMICP(461)/EMCCP(469), D&V Phase
21	Test Plans (461/469), D&V Phase
22	Test Reports (461/469), D&V Phase
23#	ECPs, Deviations, & Waivers; any phase, D&V+
24*	NTP, D&V or FSD Phase
25*	ILSP, D&V or FSD Phase
26	DT-II Test, (FSD Phase)
27	DT-I Reports, (D&V Phase)
28	OT-II Test Plans, (FSD Phase)
29	OT-I Reports (D&V Phase)
30	DD-1494, PRD Allocation
31	Gov. EMCPP, FSD Rev.
32	Specification for PRD Phase

No.	Document
33	SOW for PRD Phase
34	CDRL for PRD Phase
35	TEMP, final approved version
36	RFP/IFB for FSD Phase
37	EMICP(461)/EMCCP(469), FSD Phase
38	Test Plans (461/469), FSD Phase
39	Test Reports(461/469), FSD Phase
40	TECHEVAL Test Plans, FSD Phase
41	DT-II Reports (FSD Phase)
42	OPEVAL Test Plans (FSD Phase)
43	OT-II Reports (FSD Phase)
44	TECHEVAL Test Report (FSD Phase)
45	OPEVAL Reports (FSD Phase)
46	Maintenance Req'm't. Cards(MRC) work sheets
47	Installtn. Control Dwgs(ICD), Prelim. (FSD)
48	Technical Manuals, ms Copy for Review
49#$	SHIPALT Proposal; any & all, any phase, FSD+
50#$	Field Change; any & all, any phase, FSD+
51*	SPD, Part II; FSD & PRD
52*	OLSS, when occurring, FSD and out
53	DD-1494, Operational Authorization
54	Gov. EMCPP, P&D Revision
55	RFP/IFB, PRD Phase
56	EMICP(461)/EMCCP(469), PRD Phase(If required)
57	Test Plans (461/469), PRD Phase
58	Test Reports(461/469), PRD Phase
59	NTP, approved version
60	ILSP, approved version
61#	FOT&E Report, PRD & DPL Phases
62*	ICD's, Revision prelim., PRD or DPL
63*	Tech. Manuals, Rev./Change Pgs., ms copy
64*	MRC's, 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.

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.

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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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)* ☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: ______
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