14 NAVSEA-S6000-AB-GTP-010

MILITARY SPECIFICATIONS, STANDARDS AND CONTRACT CLAUSES SPECIFYING CONTROLS FOR PROTECTION AGAINST ELECTROSTATIC DISCHARGE.

APPROVED FOR PUBLIC RELEASE,
DISTRIBUTION UNLIMITED

PUBLISHED BY DIRECTION OF THE
COMMANDER, NAVAL SEA SYSTEMS COMMAND

DECEMBER 1978

FOREWORD

This report contains excerpts from military standards, specifications and contract clauses that pertain to the establishment and implementation of ESD controls. This document is in no way an exhaustive list of all military documents specifying ESD controls, but contains those documents commonly imposed on contracts and which explicitly specify or strongly infer the implementation of controls needed for an effective ESD control program. Similar documents not contained herein should be reviewed in similar context.

Users of this report should review the standards and specifications and the applicable revisions listed herein as they apply to a specific contract to determine the ESD control program applicable to that contract.

The Naval Ship Engineering Center welcomes comments and suggestions on the use and improvement of this document. Please direct all comments in writing to: Naval Ship Engineering Center, Code 6181B, Washington, D.C. 20362.

Requests for copies of this document from U.S. Government activities should be forwarded to:

Commanding Officer
Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, Pennsylvania 19120

Requests from industry should be forwarded to the same address via the local U.S. Government representative (e.g., DCASA) or may be purchased directly from the same address, Attn: Code FOIG.

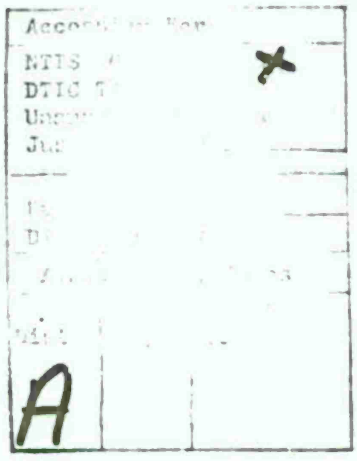


TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

1.0 SCOPE

This document contains excerpts from military standards, specifications and standard contract clauses normally imposed upon equipment contractors and suppliers which generally or specifically require the establishment and implementation of controls for the protection of electronic devices from Electrostatic Discharge (ESD). The standards, specifications and contract clauses listed herein are but a sample of those commonly imposed on equipment suppliers by NAVSEA contracts and is in no way an exhaustive compilation of all contract specifications and clauses requiring ESD controls.

2.0 GENERAL

Many types of electronic components and devices are susceptible to damage due to ESD (commonly referred to as ESD sensitive (ESDS)) at electrostatic voltage levels commonly generated by production, test, operation and maintenance personnel. These components/devices include the following:

- Microwave Semiconductors
- Metal Oxide Semiconductors
- Microcircuits using N+ guard ring construction
- Dielectrically isolated microcircuits
- Lowpower Schottky and Schottky TTL
- ECL Microcircuits
- High input impedance linear microcircuits (Zin $\geq 10^7$ ohms)
- Small signal transistors ($f_T \geq 500$ MHz)
- Low power microcircuits and small signal discrete semiconductors (P $\leq$10 watts @25^{o}C)
- Discrete semiconductors using silicon dioxide to insulate metal paths over active area

- Junction FETS
- Thick and thin film resistors
- Precision ladder networks
- Hybrids using any of the above listed components

Besides the above ESDS components/devices all sub-assemblies, assemblies, equipments, etc. containing these components/devices are ESDS.

In order to protect these ESDS items (components, assemblies, etc.) from damage during fabrication, assembly, test, storage, handling, transportation and maintenance, ESD controls must be established and implemented throughout all phases of production, test, and fleet operation.

The intent of this document is to identify the ESD controls needed to protect ESDS items and the existing contract standards, specifications, and clauses or sections thereof which require that equipment contractors and suppliers establish and implement ESD controls.

3.0 DOCUMENT CONTENT

This document has been organized into five (5) sections:

Section	Content
I	General Specification Requirements. This section covers the standards and specifications containing ESD requirements normally imposed for the establishment of Quality, Reliability, Maintainability, Safety, Logistics Support Programs, the General Ship ESD Specification requirements and ASPR/SPCC packaging and marking of ESDS items.

Section	Content
II	Design Specification Requirements. This section covers the standards and specifications containing ESD requirements normally imposed on contractors who design and develop Navy shipboard and shore electronic equipment.
III	Packaging Specification Requirements. This section covers the commonly imposed packaging and marking requirements for ESDS items normally imposed upon contractors and suppliers of Navy shipboard and shore electronic equipment.
IV	Technical Manual Specification Requirements. This section covers the standards and specifications requiring the inclusion of caution and special maintenance procedures for ESDS items.
V	Drawing Specification Requirements. This section covers the standards and specifications requiring the inclusion of ESD labeling and requirements for drawings and specifications of ESDS items.

REQUIREMENTS FOR ELECTROSTATIC DISCHARGE (ESD) CONTROLS

I General Specification Requirements for the Establishment and Implementation of Electrostatic Discharge (ESD) Controls

General requirements for the establishment and implementation of ESD controls are contained in the following military documents normally contractually imposed upon suppliers of Navy shipboard and shore electronic equipment.

Quality

- MIL-Q-9858A — Military Specification, Quality Program Requirements, 16 December 1963
- MIL-I-45208A — Military Specifications, Inspection System Requirements, 16 December 1963

Reliability

- MIL-STD-785A — Military Standard, Reliability Program for Systems and Equipment, Development and Production, 28 March 1969
- MIL-R-22732C (SHIPS) — Military Specification, Reliability Requirements for Shipboard Electronic Equipments, 12 November 1973

Maintainability

- MIL-STD-470 — Military Standard, Maintainability Program Requirements, 21 March 1966

Safety

- MIL-STD-882 and -882A — Military Standard, System Safety Program for Systems and Equipments: Requirements for, MIL-STD-882 - 15 July 1969; MIL-STD-882A - 28 June 1977

LSA/MEA Requirements

- MIL-M-24365A — Military Specification, Maintenance Engineering Analysis; Establishment of, and Procedures and Formats for Associated Documentation; General Justification for, 20 July 1970
- MIL-STD-1388 — Military Standard, Logistics Support Analysis, 15 October 1973

Procurement Regulations

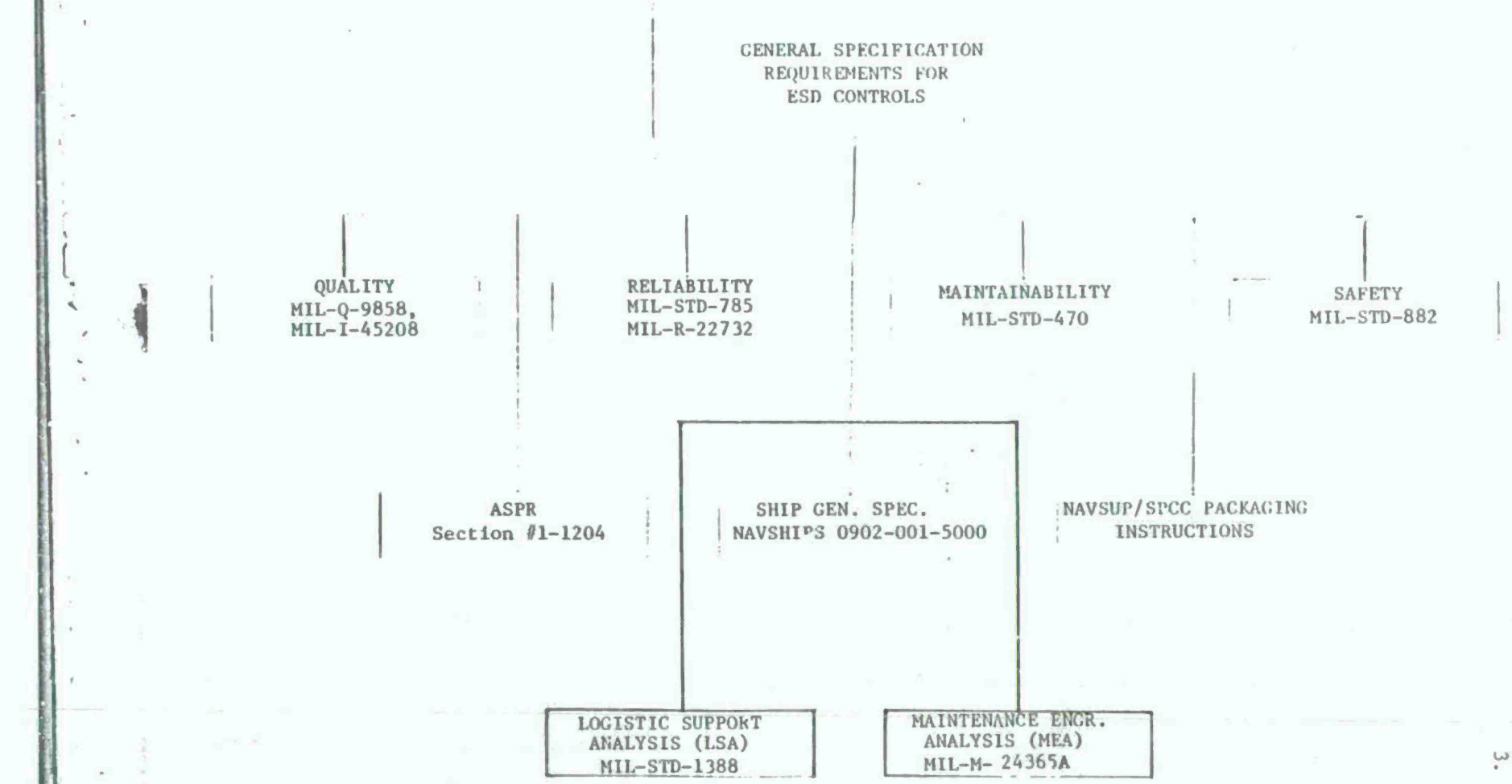
- ASPR #1-1204 — Armed Services Procurement Regulations, Section 1-1204, Packaging and Marking Policies

Ship General Requirements

- NAVSHIPS 0902-001-5000 — General Ship Specification, Section 080g, Packaging, 1 January 1977

Spare Parts/Packaging and Handling Instructions

- NAVSUP/SPCC Std Form 36, Contract Requirement G-64 — 6-64 Packaging Instructions for EM, ES, Magnetic and Radioactivity Protection (Rev 3-78)


GENERAL SPECIFICATION
REQUIREMENTS FOR
ESD CONTROLS
QUALITY
MIL-Q-9858,
MIL-I-45208
RELIABILITY
MIL-STD-785
MIL-R-22732
MAINTAINABILITY
MIL-STD-470
SAFETY
MIL-STD-882
ASPR
Section #1-1204
SHIP GEN. SPEC.
NAVSHIPS 0902-001-5000
NAVSUP/SPCC PACKAGING
INSTRUCTIONS
LOGISTIC SUPPOkT
ANALYSIS (LSA)
MIL-STD-1388
MAINTENANCE ENGR.
ANALYSIS (MEA)
MIL-M- 24365A

A QUALITY ASSURANCE REQUIREMENTS

1. The requirements of MIL-Q-9858A pertinent to the establishment and implementation of ESD controls are:

"3.3 Work Instructions. The quality program shall assure that all work affecting quality (including such things as purchasing, handling, machining, assembling, fabricating, processing, inspection, testing, modification, installation, and any other treatment of product, facilities, standards or equipment from the ordering of materials to dispatch of shipments) shall be prescribed in clear and complete documented instructions of a type appropriate to the circumstances. Such instructions shall provide the criteria for performing the work functions and they shall be compatible with acceptance criteria for workmanship. The instructions are intended also to serve for supervising, inspecting and managing work. The preparation and maintenance of and compliance with work instructions shall be monitored as a function of the quality program."

"3.5 Corrective Action. The quality program shall detect promptly and correct assignable conditions adverse to quality. Design, purchasing, manufacturing, testing or other operations which could result in or have resulted in defective supplies, services, facilities, technical data, standards or other elements of contract performance which could create excessive losses or costs must be identified and changed as a result of the quality program. Corrective action will extend to the performance of all suppliers and vendors and will be responsive to data and product forwarded from users. Corrective action shall include as a minimum:

(a) Analysis of data and examination of product scrapped or reworked to determine extent and causes;

(b) Analysis of trends in processes or performance of work to prevent nonconforming product; and

(c) Introduction of required improvements and corrections, an initial review of the adequacy of such measures and monitoring of the effectiveness of corrective action taken."

"4.1 Drawings, Documentation and Changes."

. . . . .

"With respect to design drawings and design specifications, a procedure shall be maintained that shall provide for the

evaluation of their engineering adequacy and an evaluation of the adequacy of proposed changes. The evaluation shall encompass both the adequacy in relation to standard engineering and design practices and the adequacy with respect to the design and purpose of the product to which the drawing relates.

With respect to supplemental specifications, process instructions, production engineering instructions, industrial engineering instructions and work instructions relating to a particular design, the contractor shall be responsible for a review of their adequacy, currentness and completeness. The quality program must provide complete coverage of all information necessary to produce an article in complete conformity with requirements of the design.

. . . . . "

"6.2 Production Processing and Fabrication. The contractor's quality program must assure that all machining, wiring, batching, shaping and all basic production operations of any type together with all processing and fabricating of any type is accomplished under controlled conditions. Controlled conditions include documented work instructions, adequate production equipment, and any special working environment. Documented work instructions are considered to be the criteria for much of the production, processing and fabrication work. These instructions are the criteria for acceptable or unacceptable "workmanship". The quality program will effectively monitor the issuance of and compliance with all of these work instructions.

Physical examination, measurement or tests of the material or products processed is necessary for each work operation and must also be conducted under controlled conditions. If physical inspection of processed material is impossible or disadvantageous, indirect control by monitoring processing methods, equipment and personnel shall be provided. Both physical inspection and process monitoring shall be provided when control is inadequate without both, or when contract or specification requires both.

Inspection and monitoring of processed material or products shall be accomplished in any suitable systematic manner selected by the contractor. Methods of inspection and monitoring shall be corrected any time their unsuitability with reasonable evidence is demonstrated. Adherence to selected methods.

. . . . .

. . . . .

Certain chemical, metallurgical, biological, sonic, electronic, and radiological processes are of so complex and specialized a nature that much more than the ordinary detailing of work documentation is required. In effect, such processing

may require an entire work specification as contrasted with the normal work operation instructions established in normal plant-wide standard production control issuances such as job operation routing books and the like. For these special processes, the contractors' quality program shall assure that the process control procedures or specifications are adequate and that processing environments and the certifying, inspection, authorization and monitoring of such processes to the special degree necessary for these ultraprecise and super-complex work functions are provided."

"6.4 Handling, Storage and Delivery. The quality program shall provide for adequate work and inspection instructions for handling, storage, preservation, packaging, and shipping to protect the quality of products and prevent damage, loss, deterioration, degradation, or substitution of products. With respect to handling, the quality program shall require and monitor the use of procedures to prevent handling damage to articles. Handling procedures of this type include the use of special crates, boxes, containers, transportation vehicles and any other facilities for materials handling. Means shall be provided for any necessary protection against deterioration or damage to products in storage. Periodic inspection for the prevention and results of such deterioration or damage shall be provided. Products subject to deterioration or corrosion during fabrication or interim storage shall be cleaned and preserved by methods which will protect against such deterioration or corrosion. When necessary, packaging designing and packaging shall include means for accommodating and maintaining critical environments within packages, e.g., moisture content levels, gas pressures. The quality program shall assure that when such packaging environments must be maintained, packages are labled to indicate this condition. . . . In compliance with contractual requirements, the quality program shall include monitoring provisions for protection of the quality of products during transit.

2. The requirements of MIL-I-45208A pertinent to the establishment and implementation of ESD controls are:

"3.2.3 Corrective Action. The contractor shall take prompt action to correct assignable conditions which have resulted or could result in the submission to the Government of supplies and services which do not conform to (1) the quality assurance provisions of the item specification, (2) inspections and tests required by the contract, and (3) other inspections and tests required to substantiate product conformance."

B RELIABILITY PROGRAM REQUIREMENTS

1. The requirements of MIL-STD-785A pertinent to the establishment and implementation of ESD controls are:

> "5.2.5 Reliability Critical Items. . . . The contractor shall establish a program for identification, control, and special handling of critical parts, components, subsystems, or other items from design through final acceptance."
>
> "5.2.6 Effects of Storage, Shelf-Life, Packaging, Transportation, Handling and Maintenance. The reliability program shall include efforts such as test and analysis, or estimation, to determine the effects of storage, shelf-life, packaing, transporation, handling and maintenance on the reliability of the product. This shall include items such as:
> (a) Identification of major or critical characteristics of items which deteriorate with . . . , environmental conditions . . .;
> (b) . . .
> (c) Special procedures for maintenance or restoration."
>
> "5.2.7 Design Reviews. Reviews shall be made at appropriate stages of development and production to evaluate achievement of the reliability requirements. The planned reviews should include, to the extent applicable but not necessarily limited to:
> (1) . . .
> (2) Potential design or production (derived from reliability analyses) problem areas, and control measures necessary to preserve the inherent reliability . . . ."
>
> "5.5 Production Reliability"
>
> "5.5.1 Transition from Development. The reliability program plan shall identify procedures to be utilized during the production of systems and equipments to prevent degradation of reliability. The procedures developed should consider the manufacturing process controls to be applied during production. . . . Control procedures shall be identified which show the control of manufacturing processes and procedures that can affect producr reliability."

2. The requirements of MIL-R-22732C pertinent to the establishment and implementation of ESD controls are:

"3.3.6 Failure modes, effects, and criticality analysis. The contractor shall perform a Failure Modes, Effects, and Criticality Analysis (FME&CA) from the equipment level down to the non-repairable part. The FME&CA shall document all probable modes of failure, symptoms, causes, alleviating factors, expected frequency of occurrence, and their effects on performance and personnel/material safety (hazard levels shall be included as specified in accordance with MIL-STD-882 (see 6.3)) with respect to the overall equipment and each assembly or functional level therein giving proper consideration to all possible alternate modes of operation. The FME&CA shall also include a listing of critical and limited life items, the reasons for criticality, and the expected life. The FME&CA shall be used as a tool for design improvements to eliminate or reduce item criticality, . . . , or increase personnel/material safety. Design improvements shall be documented and included in the FME&CA report.

C MAINTAINABILITY PROGRAM REQUIREMENTS

The requirements of MIL-STD-470 pertinent to the establishment and implementation of ESD controls are:

"5.3 Prepare Inputs to the Detailed Maintenance Concept and Detailed Maintenance Plan. The contractor shall prepare inputs to the maintenance concept and to the detailed system/equipment maintenance plan based upon the broader operational and support concepts and requirements established by the procuring activity. The initial step in the development of the inputs to the plan shall be the development of inputs to a detailed maintenance concept, which shall evolve through repetitive maintainability analysis (see paragraph 5.2) into a detailed maintenance plan for supporting the operation of the system/equipment in the planned operational environment. Typical outputs of the analysis which are included in the maintenance plan are:

(a) . . .
(b) Facilities required.
(c) Support equipment and tools required.
(d) . . . ."

"5.4 Establish Maintainability Design Criteria. . . .
(a) Reduce the complexity of maintenance by:

. . .

(5) Insuring the compatibility among system equipment and facilities."

D SAFETY PROGRAM REQUIREMENTS

The requirements of MIL-STD-882 pertinent to the establishment and implementation of ESD controls are:

(1) MIL-STD-882

"3. DEFINITIONS. The following definitions apply to this standard:
3.1 Safety. Freedom from those conditions that can cause injury or death to personnel, damage to or loss of equipment or property."

"4.2.3 Engineering Development Phase. . . . To provide support to the system engineering program, the system safety engineering activities shall include, but not be limited to the following:

. . .

(d) Participating in technical design and program reviews;

. . .

(h) Reviewing engineering documentation (drawings and specifications)."

"4.2.4 Production Phase. The contractor shall identify critical production techniques, assembly procedures, facilities, testing and inspection requirements which affect system safety. Adequate procedures shall be invoked through the planned, controlled, and scheduled system for quality control and monitoring specified contractually to insure that safety achieved in design is maintained during production. Corrective action shall be taken to eliminate, reduce or control hazards so identified. These corrections shall include necessary changes to engineering documentation. An audit shall be performed to identify any new system safety hazards which may result from the introduction of engineering changes. The impact of such changes on safety shall be evaluated to determine whether the previously established safety level of the system has been maintained; if not, redesign or change procedures shall be initiated to obtain the contracted level of safety."

"4.2.5 Operational Phase (including disposal). The system safety program during the Operational Phase, and subsequent disposal, will include, but not be limited to the following functions:

(a) Operational safety review of system to determine if design, operating and maintenance procedures, and emergency procedures are adequate, based on user experience.

(b) Evaluation of design changes and modifications to operational equipment to insure inherent safety is not degraded.

(c) Continual review of operator and maintenance publication changes to insure that safety requirements, procedures, and cautions are adequate."

"5.2 System Safety Program Plan. . . . shall include but not be limited to:

. . .

(b) Providing specific information showing how the contractor will meet the safety requirements during development and manufacture including the design concepts to be utilized.

. . .

(k) Method of assimilation and dissemination of system requirements to designers and associated personnel to expedite correction of known deficiencies.

. . .

(n) Delineate the safety data and analyses (including GFE) required of and to the integrating and associate contractors.

(o) Identification of special safety studies, research and test data.

(p) Safety data coordination flow."

"5.3 Reviews."

"5.3.1 Program and Design reviews. Safety shall be an integral part of all program and design reviews held for the system, subsystem, or equipment. System safety program reviews shall be conducted as part of the scheduled overall design and/or program reviews toassess the status of compliance with the overall safety program objectives. This review shall identify any deficiencies of the system with respect to safety and provide guidance for further development which may be required. . . ."

"5.4 System safety criteria and considerations."

"5.4.1 General. System designs and operational procedures developed by each contractor should consider, but not be limited to, the following:

(a) Avoiding, eliminating or reducing significant hazards identified by analysis, design selection, material selection, or substitution. . . .

(b) Controlling and minimizing hazards to personnel, equipment, and material which cannot be avoided or eliminated.

(c) Isolating hazardous substances, components, and operations from other activities, areas, personnel, and incompatible materials.

. . ."

"5.6 System safety precedence. Actions for satisfying safety requirementsin order of precedence are specified below:

(a) Design for minimum hazard. The major effort throughout the design phases shall be to select appropriate safety design features; e.g., fail safe, redundancy.

(b) Safety devices. Known hazards which cannot be eliminated through design selection shall be reduced to an acceptable level through the use of appropriate safety devices.

. . .

(d) Special procedures. Where it is not possible to reduce the magnitude of an existing or potential hazard through design, or the use of safety and warning devices, the contractor shall develop special procedures. Precautionary notations shall be standardized in accordance with the directives of the procuring activity."

"5.7 Design criteria/specifications. When design criteria specified by the procuring activity is proved inadequate in regards to safety, the contractor shall report the deficiency and recommend corrective actions with supporting evidence to the procuring activity."

"5.8 Analyses. Analyses are performed to identify hazardous conditions for the purpose of their elimination or control. Analyses shall be made to examine the system, subsystems, components and their interrelationship to include logistic support, training, maintenance, and operational environments. The analyses shall be accomplished to do the following:

(a) Identify hazards and determine any needed corrective actions.

(b) Determine and evaluate safety considerations in trade-off studies.

(c) Determine and evaluate appropriate safety design requirements.

(d) Determine and evaluate operational, test, and logistic safety requirements.

. . . "

"5.8.2 System hazard analyses."

"5.8.2.1 Preliminary hazard analysis. A preliminary hazard analysis shall be performed as the initial analysis task during the acquisition of a system. This analysis shall be a comprehensive, qualitative study. Such information shall be used in the development of safety criteria to be imposed

in performance or design specifidations. Areas to be considered shall include, but are not limited to the following:

. . .

(c) System environmental constaints.

. . .

(f) Effect of transient current, electrostatic discharges, electromagnetic radiation, and ionizing radiation to or by the system. Design of critical controls to prevent inadvertent activation and employment of electrical interlocks.

. . .

(i) Safe operation and maintenance of the system.

(j) Training and certification pertaining to safe operation and maintenance of the system.

. . .

(r) Protective clothing, equipment or devices.

(s) Lightning and electrostatic protection.

. . . "

"5.8.2.4 Operating hazard analyses. Analyses shall be performed to determine safety requirements for personnel, procedures, and equipment used in installation, maintenance, support, testing, transportation, storage, operations, . . . and training during all phases of intended use as specified in the system requirements. Engineering data, procedures, and instructions developed from the engineering design and initial test programs shall be used in support of this effort. Results of these analyses shall provide the basis for:

(a) Design changes where feasible to eliminate hazards or provide safety devices, and safeguards.

(b) The warning, caution, special inspections and emergency procedures for operating and maintenance instructions including emergency action to minimize personnel injury.

. . .

(d) Special procedures for servicing, handling, storage and transportation."

"5.9 Action on identified hazards. Action shall be taken to eliminate or minimize hazards revealed by analyses or related engineering efforts. Catastrophic and critical hazards shall be eliminated or controlled. If these hazards cannot be eliminated, or controlled to a specified probability of occurrence, the alternative controls will be immediately presented to the responsible procuring activity for resolution. Reporting shall be in accordance with the provisions of the System Safety Program Plan."

"8. TRAINING."

"8.1 Safety Training for Operator and Maintenance Personnel. Safety information on approved methods and procedures will be included in instruction lesson plans and student examinations for the training of system (operator and maintenance) personnel. Protective devices and emergency equipment will be identified and included in training. Safety training aids, exhibits and displays may be used."

"9. EFFECTS OF STORAGE, SHELF-LIFE, PACKAGING, TRANSPORTATION, HANDLING AND MAINTENANCE. The program shall consider, analyze, identify the effects of storage, shelf-life, packaging, transportation, handling and maintenance on the safety of the product. This shall include items such as:

(a) Identification of major or critical characteristics of safety significant items which deteriorate with age, environmental conditions, and other factors.

(b) Procedures for periodic field inspection or tests (including recall for test) of items to establish continuing acceptable levels of performance for parameters under test.

(c) Special safety procedures for maintenance or restoration."

(2) MIL-STD-882A

"3.5 Safety. Freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property."

"4.1 System safety program objectives. The system safety program shall define a systematic approach to ensure that:

. . .

(b) Hazards associated with each system are identified and evaluated, and eliminated or controlled to an acceptable level throughout the entire life cycle of a system.

. . ."

"4.2.1.1 Milestone 0. The system safety effort will support the definition of mission element needs by identifying safety deficiencies in existing or projected capability and by identifying opportunities for system safety to improve mission capability or reduce life cycle costs."

"4.2.1.2 Program initiation phase. System safety tasks applicable to the program initiation phase are those required to evaluate the alternative system concepts under consideration for development and establish the system safety program consistent with the identified mission need and life cycle requirements. System safety tasks will include the following:

(a) Evaluate all material, design features, procedures and operational concepts and environments under consideration which affect safety throughout the life cycle.

(b) Perform a preliminary hazard analysis (PHA) to identify hazards associated with each alternative concept.

. . .

(d) Highlight special areas of safety consideration, such as system limitations, risks, and man-rating requirements.

(e) Review safety and successful designs of similar systems for consideration in alternative concepts.

(f) Define the system safety requirements based on past experience with similar systems.

. . . "

'4.2.2 Demonstration and validation phase. System safety tasks during the demonstration and validation phase will be tailored to programs ranging from extensive study and analyses through hardware development to prototype testing, demonstration and validation. System safety tasks will include the following:

. . .

(c) Identify those technology, design, production, and operational and support (O&S) risks having an impact on safety.

(d) Establish system safety requirements and criteria for verifying that requirements have been met.

(e) Participate in tradeoff studies to reflect the impact on system safety requirements and risk. Recommend system design changes based on these studies to ensure that the optimum degree of safety is achieved consistent with performance and system requirements.

. . . "

"4.2.3 Full-scale engineering development phase. To provide support to the system engineering program, the system safety tasks during the full-scale engineering development phase will include the following:

. . .

(d) Perform or update subsystem, system, and O&S hazard analyses and safety studies concurrent with the design/test

effort to identify design and operating and support hazards. Recommend any required design changes and control procedures.

. . .

(f) Participate in technical design and program reviews and present results of subsystem, system, and O&S hazard analyses.

(g) Identify and evaluate the effects of storage, shelf-life, packaging, transportation, handling, test, operation, and maintenance on the safety of the system and its components.

. . ."

"4.2.4 Production and deployment phase. As part of the ongoing system safety program, the system safety tasks during the production and deployment phase will include the following:

. . .

(b) Identify critical parts and assemblies, production techniques, assembly procedures, facilities, testing, and inspection requirements which may affect safety and will ensure:

(1) Adequate safety provisions are included in the planning and layout of the production line to establish safety control of the system within the production process and operations.

(2) Adequate safety provisions are included in inspections, tests, procedures, and checklists for quality control of the equipment being manufactured so that safety achieved in design is maintained during production.

(3) Production technical manuals or manufacturing procedures contain required warnings, cautions, and special procedures.

. . .

(e) Review warnings, cautions, and special procedures required for safe operation and maintenance.

(f) Review procedures for storage, packaging, handling, and transportation to ensure that safety is maintained.

(g) Review procedures and monitor results of periodic field inspections or tests (including recall-for-tests) to ensure acceptable levels of safety are maintained. This includes identifying major or critical characteristics of safety significant items that deteriorate with age, environmental conditions, or other factors.

. . .

(k) Conduct a safety review of proposed new operating and maintenance procedures, or changes, to ensure that the procedures, warnings, and cautions are adequate and inherent safety is not degraded. These reviews shall be documented as updates to the O&S hazards analyses."

"5.4 System safety requirements. System safety requirements establish design and operational safety criteria for hazard elimination or control and may establish a quantitative value designating the level of system safety."

"5.4.1 General requirements. System designs and operational procedures should consider the following:

. . .

(b) Eliminate or control hazards identified by analyses or related engineering efforts through design solution, material selection, or substitution. Potentially hazardous materials (e.g., propellants, explosives, hydraulic fluids, solvents, lubricants or fuels) shall be selected to provide optimum safety characteristics.

(c) Isolate hazardous substances, components, and operations from other activities, areas, personnel, and incompatible materials.

. . .

(e) Minimize hazards resulting from excessive environmental conditions (e.g., temperature, pressure, noise, toxicity, acceleration and vibration).

. . .

(i) Provide suitable warning and caution notes in assembly, operations, maintenance, and repair instructions, and distinctive markings on hazardous components, equipment, or facilities to ensure personnel and equipment protection. These shall be standardized in accordance with the requirements of the managing activity.

. . . "

"5.4.2 System safety precedence. The order of precedence for satisfying system safety requirements and resolving identified hazards shall be as specified:

(a) Design for minimum hazard. From the first, design to eliminate hazards. If an identified hazard cannot be eliminated, control hazards through design selection.

(b) Safety devices. Hazards that cannot be eliminated or controlled through design selection shall be controlled to an acceptable level through the use of fixed, automatic, or other protective safety design features or devices.

Provisions shall be made for periodic functional checks of safety devices.

. . .

(d) Procedures and training. Where it is possible to eliminate or adequately control a hazard through design selection or use of safety and warning devices, procedures and training shall be used to control the hazard. Procedures may include the use of personal protective equipment. Precautionary notations shall be standardized as specified by the managing activity. Safety critical tasks and activities may require certification of personnel proficiency."

"5.4.4 Action on identified hazard. Action shall be taken to eliminate or minimize hazards revealed by analyses or related engineering efforts. Catastrophic and critical hazards shall be eliminated or controlled. If these hazards cannot be eliminated or controlled to an acceptable level, the alternative controls and recommendations will be immediately presented to the managing activity. Hazard analyses and reports shall provide closed-loop procedures to ensure timely resolution of all identified hazards."

"5.5.1 Analysis type, format and technique. Hazards analyses used in system safety are (a) preliminary hazards analysis (PHA) which is an initial safety assessment of the system, (b) subsystem hazard analysis (SSHA) which provides for hazard identification associated with the functional relationship of components and equipments comprising each subsystem, (c) system hazard analysis (SHA) which provides for hazard identification associated with subsystem interfaces, and (d) operating and support (O&S) hazard analyses which provide for an evaluation of procedural safety. . . ."

"5.5.1.1 Preliminary hazard analysis. . . . The PHA should consider the following for identification of hazards:

. . .

(c) Environmental constraints including the normal operating environments (e.g., drop, shock, extreme temperatures, noise and health hazards, fire, electrostatic discharge, lightning, X-ray, electromagnetic radiation, and laser radiation).

(d) Operating, test, maintenance and emergency procedures (e.g., human error analysis of operator functions, tasks, and requirements; effect of environmental factors such as

equipment layout and lighting requirements on human performance; life support requirements and their safety implications in manned systems; crash safety; egress, rescue, survival, and salvage).

(e) Facilities, support equipment, and training (e.g., provisions for storage, assembly, checkout, prooftesting of hazardous systems/assemblies which may include toxic, flammable, explosive, corrosive or cryogenic fluids; electrical power sources; training and certification pertaining to safe operation and maintenance).

. . . "

"5.5.1.4 Operating and support hazard analyses. Operating and support (O&S) hazard analyses shall be performed to identify and control hazards and determine safety requirements for personnel, procedures, and equipment used in production, installation, maintenance, testing, modification, transportation, storage, operation, emergency escape, egress, rescue, training, and disposal during all phases of intended use as specified in the system requirements. The O&S hazard analyses begun in the demonstration and validation phase should be oriented to development and operational testing. As the life cycle proceeds to production and deployment, O&S problems should be included. The analyses will also address hazards to the system that may be induced by maintenance personnel. Engineering data, procedures, and instructions developed from the engineering design and initial test programs should be used in support of this effort. Results of these analyses should provide the basis for:

(a) Identifying a hazardous time period and actions required to minimize risk during this time.

(b) Design changes to eliminate and control hazards.

(c) Identifying requirements for safety devices and equipment and required maintenance procedures to detect their functional failure.

(d) Warnings, cautions, and special and emergency procedures for operating and maintenance.

(e) Special procedures for handling, storage, transportation, maintenance, and modification."

"5.8 Training. Approved safety procedures shall be included in instruction lesson plans and student examinations for the training of engineering, technician, operating and maintenance personnel. Safety and warning devices, personal protective equipment, and emergency equipment shall be identified."

"5.9 Audit program. Techniques and procedures shall be implemented to ensure that the objectives and requirements of the system safety program are being accomplished. Procedures shall also be included for ensuring adequate on-the-job safety surveillance during system installation, checkout, maintenance, and modification activities."

E LSA/MEA REQUIREMENTS

The requirements of MIL-STD-1388-1, -2 and MIL-M-24365A pertinent to the establishment and implementation of ESD controls are:

(1) MIL-STD-1388-1

"5.8.13.6 Safety Factors. The System Safety Program, implemented in accordance with MIL-STD-882, provides hazard analysis data as inputs to the LSA for consideration in support system engineering and provisioning. Examples of data provided from the Preliminary, Subsystem, and System Hazard Analyses are Hazard Level Categories; fail safe design provisions; effects of storage, shelf-life, packaging, transportation, handling and maintenance on item safety; hazards to personnel and equipment; and impacts on personnel training and training material."

"5.8.13.7 Packaging, Handling, Storage and Transportability (PHST) Factors. The PHST Program, established in accordance with MIL-STD-1367, provides a wide variety of LSA input data. Examples include impacts of system/equipment distribution and delivery analysis on PHST; special storage and stowage requirements, to include impacts on facilities; packaging selection criteria based on operational and support concepts; requirements for reusable containers and their degree of reusability; provisioning data for PHST equipment; PHST maintenance concepts and procedures; and PHST operator and maintenance personnel requirements."

(2) MIL-STD-1388-2

"Safety Hazard Level Code: I N F - "

"In conjunction with a specific Task Code, identifies existing or potential conditions where personnel error, environment, design characteristics, procedural deficiencies, or subsystem or component failure or malfunction may cause personnel injury or system damage or loss. This code provides a qualitative measure of hazards stated in relative terms. See MIL-STD-882 for definitions of the four Hazard Level Categories and their respective codes."

(3) MIL-M-24365A

"3.2.1 MLA item selection criteria. In general, an MEA shall be performed for each functional system, equipment, unit, assembly, or subassembly which requires preventive or corrective maintenance, and the continued operation of which is essential to the successful performance of one or more mission-related functions or to the successful completion of the mission itself. The criticality, essentiality, and maintenance or logistic significance of items in functional systems, equipment, units, or assemblies, shall in general, determine the priority sequence in which MEA's shall be prepared for such items. A list of items recommended for MEA application shall be prepared by the contractor and submitted to the procuring activity for approval (see 3.4). Unless otherwise specified (see 6.2), selection criteria for contractor-furnished and government-furnished items shall be as follows:

. . .

(d) Other items considered to warrant separate analyses, such as items meeting the following criteria:

(1) Reliability. Items with reliability characteristics which generate unusual maintenance, or those items which have an established service life, or time phased replacement.

(2) Special handling, adjustment, or checking. Items which require special handling procedures, critical adjustment techniques, or periodic checks to determine performance.

. . . "

"3.2.2.2 Reliability interface. Reliability interface with MEA shall include failure frequency, failure modes and effects analysis, test results, design tradeoff decisions, and any other reliability dictated actions affecting support analysis. . . ."

"6.3 Logistic concepts and parameters. The logistic concepts and parameters specified (see 6.2) should include, when applicable, the following:

(a) Mission and operational concepts and parameters. Collectively, mission and operational concepts and parameters may be described and referred to as "Plan for Use." Examples of such concepts and parameters include the following:

. . .

(5) Operational environment(s).

(b) Maintenance concepts. Maintenance concepts will be the planned or envisioned methods that will be employed to sustain the weapon system or equipment at a defined level of readiness or in a specified condition in support of the operational requirement. A partial listing of possible elements of a maintenance concept is as follows:

. . .

(4) Compatibility with existing support capability (range and depth).

. . .

(9) Location and environmental considerations of existing facilities."

"30.2.4 Maintenance requirement and task analysis, worksheet IV. Worksheet IV utilizes worksheets II and III as input data. This worksheet identifies all maintenance requirements and associated factors (that is, utilization factor, frequency of maintenance, and so forth) necessary to achieve the objectives and constraints of the contents of worksheets II and III and the item being analyzed. All support requirements necessary to fulfill maintenance requirements identified are developed on this worksheet and consist of skill levels, number of personnel, elapsed time, manhours, maintenance requirement card (MRC) and technical manual numbers, maintenance repair parts and quantity, support equipment, facility, training, and safety requirements. The maintenance requirement is further analyzed in sequential maintenance tasks wherein the preventive or corrective maintenance action is described in detail sufficient to satisfactorily complete the maintenance requirement. Subsequent worksheets of theMEA derive information from the basic analysis recorded on worksheet IV and in general, collate and summarize this basic data."

"30.2.6 Support equipment summary sheet, worksheet VI. Worksheet VI summarizes by maintenance level the recommended support equipment required to accomplish the maintenance requirements identified on worksheet IV; and identifies the category of support equipment (for example, tools, test equipment, special support equipment, packaging, handling, and so forth).

F ASPR GENERAL PROVISIONS

The requirements of ASPR Section 1-1204 pertinent to the establishment and implementation of ESD controls are:

"1-1204 Packaging and Marking Policies.

(a) All Department of Defense supplies, materials, and equipment shall be afforded the degree of packaging (preservation and packing) required to prevent deterioration and damages due to the hazards of shipment, handling and storage.

(b) Appropriate packaging and marking requirements shall be included in procurement documents.

(1) When a commodity specification is used for procurement, the required military packaging level or commercial packaging reference contained in that specification shall also be stated in the procurement document.

(2) When a commodity specification is not used, the procurement document shall include or reference either a process specification or standard; a detailed packaging requirement for each applicable military packaging level; or a requirement for commercial packaging.

(3) The exception in 1-1202(b)(iii) to the use of mandatory specifications extends to packaging specifications.

(c) Marking requirements.

(1) MIL-STD-129, "Marking for Shipment and Storage," together with any appropriate additional marking requirements, shall be specified in procurement documents for the marking of military packaged items.

(2) FED-STD-NO. 356, "Commercial Packaging of Supplies and Equipment", together with any appropriate additional marking requirements, shall be specified in procurement documents for the marking of commercially packaged items.

(3) For items having shelf-life limitations, marking requirements shall include:

(i) dating or other maximum allowable age or shelf-life limitations as specified by the contractor or manufacturer; and

(ii) any temperature, humidity, or other required storage conditions.

(d) Item and destination information furnished by the requiring activity shall be used by the contracting officer in determining appropriate military packaging levels or commercial packaging references and marking requirements. Maximum practicable use shall be made of packaging specialists in the development and establishment of individual procurement packaging and marking requirements and the evaluation of contractors' estimates or charges for such services.

(e) Reports and recommendations furnished by the contract administration office on DD Form 2025, "Packaging Change Recommendation/Approval" shall be acted upon promptly by the procuring contracting officer as provided for by the form.

G SHIP GENERAL SPECIFICATION

The requirements of NAVSHIPS 0902-001-5000 pertinent to the establishment and implementation of ESD controls are:

"Section 080g

65 Solid state components such as diodes, transistors, integrated circuits, and equipment containing such parts which can be damaged as a result of static electricity or electromagnetic force,
70 shall be preserved-packaged in flexible barrier material meeting the requirements of either Mil Spec, MIL-B-131 or Mil Spec. MIL-B-81705."

H NAVSUP/SPCC INSTRUCTIONS

The requirements of NAVSUP/SPCC Std Form 36, Contract Requirement G-64 pertinent to the establishment and implementation of ESD controls are:

"G-64 PACKAGING INSTRUCTIONS FOR ELECTROMAGNETIC, ELECTROSTATIC, MAGNETIC AND RADIOACTIVITY PROTECTION (REV 3-78)

1. When the packaging requirements code (MIL-STD-726) and/or the method of packaging does not specify protection for items adversely effected by electromagnetic, electrostatic, magnetic or radioactive field forces, one or more of the following protective packaging and marking requirements apply unless the item construction provides such protection.

(a) Electromagnetic Protection. . . .

(b) Electrostatic Protection. Items adversely effected by electrostatic forces shall be wrapped in electrostatic free barrier material conforming to MIL-B-81705 or unit packaged in bags conforming to MIL-B-117, Type 1, Class A, Style 2 or Type I, Class F, Style 1 prior to application of other authorized or specified packaging materials.

Exception: The wrap is not required when the item is cushioned with PPP-C-1842, Type II, Style A or B, or PPP-C-795 cushioning material certified as meeting the static electricity test requirements of PPP-C-1842, Type III, Style A or B or other cushioning materials certified as being equal to or exceeding the static electricity test requirements of PPP-C-1842, Type III, Style A or B.

Alternate: As an alternate to the above, electrostatic-free pouches conforming to MIL-P-81997, Type I or II or other pouches certified to be equal to or exceeding the requirements of MIL-P-81997, Type I or II may be used prior to application of other authorized or specified packaging materials.

In addition to the standard markings required by MIL-STD-129 and elsewhere in this instruction, order or contract, the MIL-STD-129 markings for sensitive electronic items apply except as follows: The MIL-STD-129 sensitive electronic device caution label (2" x 2") specified for intermediate packages shall beused for unit packages in lieu of the sensitive electronic device symbol when available marking space permits its use. Also, additional special caution markings shall be placed on all unit, intermediate and shipping containers adjacent to the MIL-STD-129 sensitive electronic device caution label as follows:

Marking with a legend of an attention-attracting color easily readable to normal or corrected vision at a visual inspection distance of three feet stating the following legend text:

"CAUTION - ELECTROSTATIC SENSITIVE DEVICE: Do not remove antistatic protection except in protected areas. See NAVSEA OD 46363 for protective measures for testing or handling this item."

Note: Handling during packaging of electrostatic sensitive items shall be accomplished in accordance with the requirements of NAVSEA OD 46363. Copies of NAVSEA OD 46363 can be obtained from Naval Ship Engineering Center, Code 6181B, Washington, D.C. 20362. Phone number: Commercial 202-692-6423, autovon 222-6423.

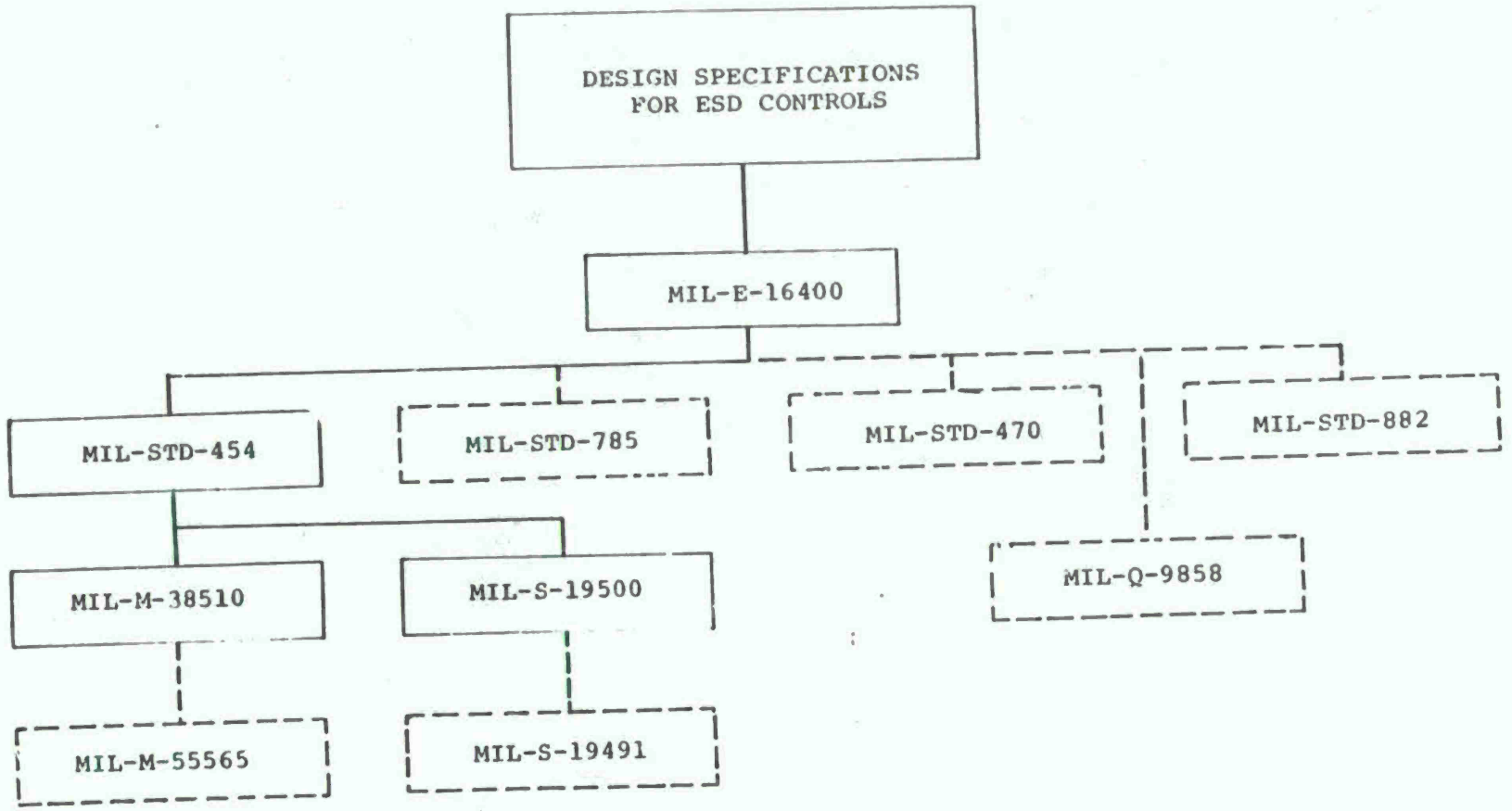
(c) Electromagnetic and Electrostatic Protection: When the item requires electromagnetic protection and is electrostatic sensitive, the requirements of both paragraphs 1.a and 1.b of this instruction apply. Electrostatic free bags, wraps and cushioning shall always be applied to electrostatic sensitive items prior to application of other authorized or specified packaging materials."

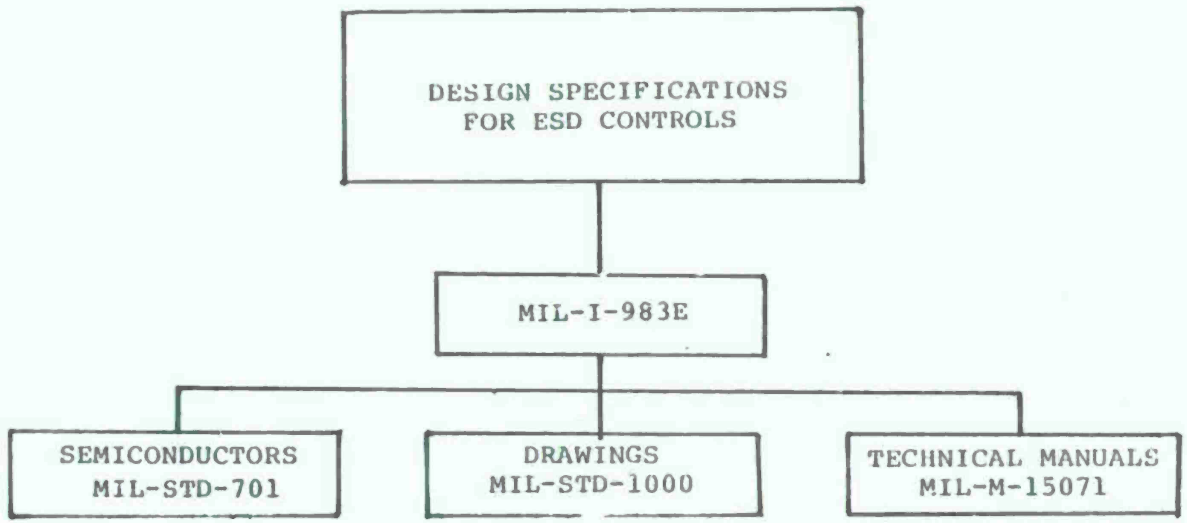
REQUIREMENTS FOR ELECTROSTATIC
DISCHARGE (ESD) CONTROLS

II Design Specification Requirements for the Establishment and Implementation of Electrostatic Discharge (ESD) Controls

Design requirements for the establishment and implementation of ESD controls are contained in the following military documents normally contractually imposed upon suppliers of Navy shipboard and shore electronic equipment.

• MIL-E-16400G	Military Specification, Electronic, Interior Communications and Navigation Equipments, Naval Ship and Shore, General Specifications for, 24 December 1974
• MIL-E-454E	Military Standard, Standard General Requirements for Electronic Equipment, 1 March 1976
• MIL-M-38510C & D	Military Specification, Microcircuits, General Specifications for, "C" - 1 March 1976; "D" - 31 August 1977
• MIL-S-19500E & F	Military Specification, Semiconductor Devices, General Specification for, "E" - 1 April 1968; "F" - 15 December 1977
• MIL-I-983E	Military Specification, Interior Communication Equipment, Naval Shipboard; Basic Design Requirements for, 15 August 1966, including Amendment -1, 22 December 1967


DESIGN SPECIFICATIONS FOR ESD CONTROLS
MIL-E-16400
MIL-STD-454
MIL-STD-785
MIL-STD-470
MIL-STD-882
MIL-M-38510
MIL-S-19500
MIL-Q-9858
MIL-M-55565
MIL-S-19491


DESIGN SPECIFICATIONS
FOR ESD CONTROLS
MIL-I-983E
SEMICONDUCTORS
MIL-STD-701
DRAWINGS
MIL-STD-1000
TECHNICAL MANUALS
MIL-M-15071

A MIL-E-16400G (dtd 24 December 1974)

"3.4.8.20 Microelectronic devices. The selection and application of microelectronic devices shall conform to requirement 64 of MIL-STD-454."

"3.4.8.27 Semiconductor devices. The selection and application of semiconductor devices shall conform to requirement 30 of MIL-STD-454."

"3.10 System Safety program. When specified in the individual equipment specification (see 6.2.1), the contractor shall develop and maintain an effective system safety program that is planned and integrated into all phases of design, production, and testing of the equipment. The system safety program shall provide a disciplined approach to identify hazards and prescribe corrective actions in a timely cost effective manner. The system safety program tasks shall be specified in a formal plan (System Safety Program Plan). The plan shall include requirements to be imposed on each subcontractor to assure compatibility with the system safety program for the equipment. MIL-STD-882 shall be used as a guidance for preparing the System Safety Program Plan (SSPP) as specified (see 6.2.2)."

"3.10.3 Design review. Safety shall be an integral part of all design reviews held for all the equipment, subsystems, and parts. The contractor shall conduct system safety program reviews. Where possible, the system safety program reviews shall be conducted as part of the overall program review to assess the status of compliance with the overall safety objectives. This review shall identify any deficiencies of the system with respect to safety and provide guidance for further analysis or design effort which may be required. Qualified contractor system safety personnel shall attend these design reviews. The command or agency concerned shall be notified prior to each system safety program review, to permit participation by a representative of the command or agency concerned. A summary of the safety design review shall be prepared as specified (see 6.2.2)."

"3.10.4 System safety criteria and considerations. The equipment design and operational procedures developed by the contractor shall consider, but not be limited to the following:
(a) Avoiding, eliminating, or reducing identified hazards by analysis, design selection, material selection, or substitution.

(b) Controlling and minimizing hazards to personnel, equipment, and material which cannot be avoided or eliminated.

(c) Isolating hazardous substances, parts, and operations from other activities, areas, personnel, and incompatible materials.

. . . "

"3.10.5 System safety precedence. Actions for satisfying safety requirements in order of precedence are specified hereinafter. However, a lower level action shall not be taken unless the higher level action is not possible or practical:

(a) Design for minimum hazard
(b) Safety devices
(c) Warning devices
(d) Special procedures"

"3.10.6 System safety check list. A system safety check list shall be prepared as specified (see 6.2.2). The system safety check list is a formal means of providing assurance that all required and identified safety requirements that minimize, control or eliminate hazards have been incorporated in the system orequipment design and as-built hardware and verified by review, test, or other method approved by the command or agency concerned."

"3.10.7 Safety analyses. Safety analyses shall be performed to identify hazardous conditions for the purpose of their elimination or control. Analyses shall be made to examine the equipment, subsystems, parts and their interrelationship to include logistic support, training, maintenance and operational environments."

"3.10.8 Conceptual safety analysis (CSA). As an initial effort, a CSA shall be performed for the system. This analysis shall be a comprehensive, qualitative study. Areas to be considered shall include, but are not limited to the following:

(a) System environmental constraints.
(b) Compatibility of materials.
. . .
(d) Safe operation and maintenance of the system.
(e) Training and certification pertaining to safe operation and maintenance of the system.
. . .
(i) Protective clothing, equipment, or devices."

"3.10.9 Design safety analysis (DSA). The contractor shall conduct a design safety analysis for the equipment. This shall be an expansion of the conceptual safety analysis. It shall be performed to determine from a safety consideration, the functional and interface relationships of parts and equipment comprising the system."

"3.10.10 Functional safety analyses. Analyses shall be performed to identify activities or operations which can, by their inherent nature, lead to a situation containing a potential for injury to personnel or damage to equipment. The areas of the analyses shall include but not be limited to the following:

(a) Specific safety installation requirements.
(b) Specific safety testing requirements.
(c) Specific operating requirements.
(d) Specific safety supervision.
(e) Specific safety handling requirements.
(f) Safety training requirements.

CSA, DSA, engineering data, procedures, and instructions developed from the engineering design shall be used in support of this effort."

B MIL-STD-454E (dtd 1 March 1976)

(1) Requirement 30, Semiconductor Devices

"5. Electrostatic sensitive parts. Certain types of semiconductor devices are susceptible to electrostatic discharge damage. Appropriate discharge procedures should be observed prior to handling these parts, and design selections of desired devices should include a consideration of the effectiveness of the input or other protective elements included in the device design."

(2) Requirement 64, Microelectronic Devices

"7. Electrostatic sensitive parts. Certain types of integrated circuits are susceptible to electrostatic discharge damage. Appropriate discharge procedures shall be observed when handling, storing or testing these parts and design selections of desired devices should include a consideration of the effectiveness of the input or other protective elements included in the device design."

C MIL-M-38510

(1) MIL-M-38510C (dtd 1 March 1976)

"5.1 Preservation - Packaging and packing. Microcircuits shall be prepared for delivery in accordance with preservation - packaging and packing conforming to Level A, B or C requirements of MIL-M-55565 unless otherwise specified in the procurement document (see 6.1(e))."

(2) MIL-M-38510D (dtd 31 August 1977)

"5.1 Preservation - packaging and packing. Microcircuits shall be prepared for delivery in accordance with preservation - packaging and packing conforming to level A, B or C requirements of MIL-M-55565 unless otherwise specified in the procurement document (see 6.1(e)). In addition, microcircuits which require electrostatic protection shall either:
(a) be packaged in individual carriers with a maximum resistivity of 100kΩ - cm, or
(b) be fully enclosed in an antistatic material with sufficient permanent conductivity on all surfaces to permit controlled bleed-off of static charges and of sufficient resistivity ($1 \times 10^{12}\Omega$ - cm minimum) to prevent the introduction of electronic charges from the external environment."

"APPENDIX F. Requirements for the preparation of device specifications or drawings.
30.1 Individual item requirements. The device specification or drawing shall cover the items listed in a through p below:
. . .
(p) Electrostatic Sensitivity."

(3) MIL-M-38510 DETAILED SPEC (Typical requirements for ESD ICs).

"5. PACKAGING."

"5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-M-38510. The devices covered by this specification require electrostatic protection."

"6.7 Handling. MOS devices must be handled with certain precautions to avoid damage due to accumulation to static charge. Input protective devices have been designed in the chip to minimize the effect of this static build-up. However, the following handling practices are recommended:

(a) Devices should be handled on benches with conductive and grounded surface.

(b) Ground test equipment and tools.

(c) Do not handle devices by the leads.

(d) Store devices in conductive foam or carriers.

(e) Avoid use of plastic, rubber, or silk in MOS areas.

(f) Maintain relative humidity above 50 percent, if practical."

D MIL-S-19500

(1) MIL-S-19500E (dtd 1 April 1968)

"3.7.2 Marking on initial container. All of the marking specified in 3.7.1, except polarity, shall appear on the carton, box, plastic envelope, and so forth, used as the initial protection or wrapping for delivery. Marking shall be in conformance with MIL-STD-129."

"5.1 Preparation for delivery. Semiconductor devices shall be prepared for delivery in accordance with MIL-S-19491 or as specified in the contract or order."

(2) MIL-S-19500F (dtd 15 December 1977)

"5.1 Packaging requirements. The requirements for the packaging of semiconductor devices shall be in accordance with MIL-S-19491."

"3.6.2 Requirements for semiconductor devices. All semiconductor devices to be used shall be in accordance with the provisions of MIL-STD-701."

(Note: MIL-STD-701 lists where available TX devices. TX devices must meet the requirements of MIL-S-19500).

"3.8.3.1 Design. The equipment design construction and shielding (particularly of wiring and contacts) shall be such as to:
(a) Shield amplifier input circuits and low level contacts from the effects of stray electromagnetic and electrostatic fields."

"3.9.1 Drawings - general. Drawings shall conform to MIL-STD-1000 . . ."

"3.9.3.6 Assembly Drawings. Assembly drawings shall be drawn for each unit and for each assembly. The following information shall be included on the assembly drawings:
. . .
(c) Appropriate notes to cover any special methods of assembly, special treatments . . ."

"3.9.7 Manuals"

"3.9.7.1 General. Manuals shall be in accordance with MIL-M-15071."

"3.9.8.1 Special Tools. Whenever special tools are necessary for proper service maintenance of any shipboard system, a complete set shall be furnished each ship by the contractor."

REQUIREMENTS FOR ELECTROSTATIC
DISCHARGE (ESD) CONTROLS

III Packaging Specification Requirements for Electrostatic Discharge Sensitive (ESDS) Items

Packaging requirements for ESDS items are contained in the following military and aerospace documents normally contractually imposed upon suppliers of Navy shipboard and shore electronic equipment.

- MIL-S-19491E — Military Specification; Semiconductor Devices, Packaging of, 1 March 1977
- MIL-M-55565A — Military Specification, Microcircuits, Preparation for Delivery of, 13 August 1973
- MIL-STD-1475 — Military Standard, Contamination Control Technology, Packaging Protection of Precision Cleaned Material, 14 February 1974
- MS 90363 — Military Standard, Box, Fiberboard, With Cushioning for Special, Minimum Cube Storage and Limited Reuse Application, 22 June 1977
- NAS 853 — National Aerospace Standard, Field Force, Protection For, Rev 1
- --- — NAVSEC Contract - Sample Boilerplate for Packaging Requirements


PACKAGING REQUIREMENTS FOR ESDS ITEMS
MIL-S-19491 (Semiconductors)
MIL-M-55565 (Microcircuits)
MIL-STD-1475
MS 90363
NAS 853
NAVSEA CONTRACT CLAUSE (Packaging).

A MIL-S-19491E (dtd 1 March 1977)

"3.1.4.1 Electrostatic (ES) protection. Electrostatic protection may be accomplished by enclosing the semiconductor devices in initial wraps or bags fabricated from barrier material conforming to MIL-B-81705. Other materials which have a sufficient and permanent conductivity on all surfaces to permit controlled bleed-off of static charges to ground without producing a spark may also be used, provided the surface resistivity does not exceed 1×10^{12} ohms when tested in accordance with ASTM D257. Conductive materials may be applied to the leads to protect these devices from body or transient charges that may be encountered on removal from the unit packages. Electrostatic protection is mandatory for all microwave diodes, insulated gate field effect transistors, metal insulated and metal oxide semiconductors, and semiconductor devices not otherwise named which operate at a frequency above 1 gigahertz."

"3.2.1.4.1 Semiconductor devices. Semiconductor devices shall be individually packaged in accordance with submethod IA-8 or MIL-P-116. Barrier material conforming to MIL-B-81705, Type I, may be used for semiconductor devices requiring electrostatic or electromagnetic protection. Other barrier materials may also be used provided that the electrostatic, electromagnetic and water-vaporproof requirements of MIL-B-81705, Type I are met (see 3.1.4.1 and 3.1.4.2). Bags or envelopes made from these barrier materials shall be fabricated in accordance with MIL-B-117."

"3.4.2.1 Field force marking. The term "ES/EM SHIELDED" shall be marked in accordance with the special marking provisions of MIL-STD-129 on all unit packages meeting the electrostatic and electromagnetic protection requirements of this specification (see 3.1.4.1 and 3.1.4.2). Other types of field force protection provided, whether individually or in combination, shall be similarly marked on the unit package (see 3.1.4.1 through 3.1.4.4)."

B MIL-M-55565A (dtd 13 August 1973)

"3.1.2.1 Electrostatic (ES) protection. Electrostatic protection shall be accomplished by enclosing the microcircuits in initial wraps or bags fabricated from barrier material

conforming to MIL-B-81705. Other materials which have a sufficient and permanent conductivity on all surfaces to permit controlled bleed-off of static charges to ground without producing a spark may also be used provided the surface resistivity does not exceed 1×10^{12} ohms when tested in accordance with ASTM D257."

"3.2.1.4 Unit packaging. Unless otherwise specified (see 6.2), microcircuits shall be individually packaged in accordance with submethod IA-8 of MIL-P-116 using barrier material conforming to MIL-B-81705."

"3.4 Marking. In addition to any special marking required by the contract or purchase order (see 6.2), each unit package and intermediate and exterior container shall be marked in accordance with MIL-STD-129. The complete military or supplier's part number, as applicable, shall be marked on all unit and intermediate packages in accordance with the identification marking provisions of MIL-STD-129. The term "ES EM SHIELDED" shall be marked in accordance with the special marking provisions of MIL-STD-129 on all unit packages meeting the electrostatic and electromagnetic protection requirements of this specification (see 3.1.2.1 and 3.1.2.2). Other types of field force protection provided, whether individually or in combination, shall be similarly marked on the unit package (see 3.1.2.1 through 3.1.2.4). The additional unit package marking specified in MIL-M-38510 for microcircuits procured to that specification shall be applied in accordance with the special marking provisions of MIL-STD-129. When specified (see 6.2), the marking of domestic shipments for civil agencies shall be in accordance with Fed. Std. No. 123."

C MIL-STD-1475 (dtd 14 Feb 1974)

"6.2 Secondary packaging for field force protection. When hardware is identified on its drawing as being susceptible to damage from electrostatic, electromagnetic, magnetic, or radioactive field forces, protection shall be provided per NAS 853."

"6.2.1 Electrostatic protection. Electrostatic protection shall be provided by a bag or wrap fabricated from an identifiably colored homogeneous antistatic plastic film having sufficient conductivity on all surfaces to permit controlled bleed-off of static charges to ground, without the production of a spark. Cushioning materials used with electrostatic sensitive devices shall also be homogeneously antistatic and noncorrosive."

D MS 90363 (22 June 1977)

"2. The following wrap requirements apply as applicable:
(a) Items which may be adversely affected by electrostatic force building shall be wrapped in anti-static material conforming to MIL-B-81705 and secured with pressure sensitive tape prior to application of other packaging materials.
Exception: The wrap is not required when the item is cushioned with PPP-C-1842, Type III in accordance with Paragraph 3.
(b) Items coated with a preservative shall be wrapped with barrier material conforming to MIL-B-22191, Type II and secured with pressure sensitive tape."

E NAS 853 (National Aerospace Standard - Packaging Standard - Rev 1)

"3.0 REQUIREMENTS"

"3.1 General"

"3.1.1 Field Force Protection as described herein shall be supplemented by preservation, packaging, packing, and marking for shipment and storage as required by NAS 850, or NAS detail packaging standards."

"3.1.2 Each item shall be individually enclosed in materials capable of providing adequate protection against field forces as described herein."

"3.1.3 Electrostatic Protection - Shall be provided by a bag/wrap or containers fabricated from an antistatic plastic film including laminates having sufficient conductivity on all surfaces to permit controlled bleed-off of static charges to ground without the production of a spark. Cushioning materials used with electrostatic-sensitive devices shall also be antistatic and noncorrosive. The materials shall have the maximum surface resistivity of 1×10^{12} ohms when tested per ASTM D257-66."

"4.0 QUALITY ASSURANCE"

"4.1 Packages which do not conform to these requirements are subject to rejection and return to supplier at his expense."

F SAMPLE NAVSEC CONTRACT CLAUSES (PACKAGING)

"Electrostatic protection. Item(s) adversely affected by electrostatic field forces shall be provided an initial wrap of material conforming to MIL-B-81705, Type II, or cushioned in material conforming to PPP-C-1842, Type III, Style A or B, and unit packaged in heat-sealed bags conforming to MIL-B-117, Type I, Class F, Style 1. Alternatively, recloseable cushioned pouches conforming to MIL-P-81997, Type I or II may be used in lieu of the initial wrap or cushioning. Non-corrosive conductive material(s) shall be applied to all exposed leads and connector pins to maintain a common potential. This is to protect the item(s) from electrostatic charge(s) that may be encountered during handling or while near strong electrostatic fields."

"Packaging material. Packaging materials currently covered by title, scope, or intended use under Government specification(s), but modified as electrostatic-free material(s), or newly developed electrostatic-free packaging material(s) not covered by a Government packaging material specification(s) are encouraged for use. Use of such modified or newly developed electrostatic-free packaging material(s) will be permitted subject to the contracting officer's determination that: (a) the physical properties of such material(s) are equal to or better than similar constructed material(s) covered under a required Government packaging material specification and, (b) that such materials satisfy the electrostatic decay rate requirement of MIL-B-81705. The material manufacturer/supplier or contractor shall furnish to the Government Inspector for review documented proof of conformance to the requirements specified herein, certified by an acceptable testing laboratory. Upon submission for acceptance, copies of the contractor's documented proof shall be forwarded to the procurement contracting officer (PCO) packaging activity. The decision of the contracting officer shall be final as to the acceptability or non-acceptability of the packaging material and that decision shall not be subject to review under the disputes clause of the contract. When such materials are acceptable, unit packaging shall be in accordance with the procedures for electrostatic protection."

"Marking. In addition to the markings required by MIL-STD-129 and the contract or order, the MIL-STD-129 markings for sensitive electronic items shall apply except as follows: The sensitive electronic device caution label, 2" x 2" or less, specified for intermediate packages shall be used for unit packages in lieu of the device symbol. In addition, special caution markings shall be placed on all unit and intermediate (interior) packages and shipping containers. Electrostatic sensitive item caution markings may be placed adjacent to the MIL-STD-129 sensitive electronic device caution label. Caution markings shall be as follows:

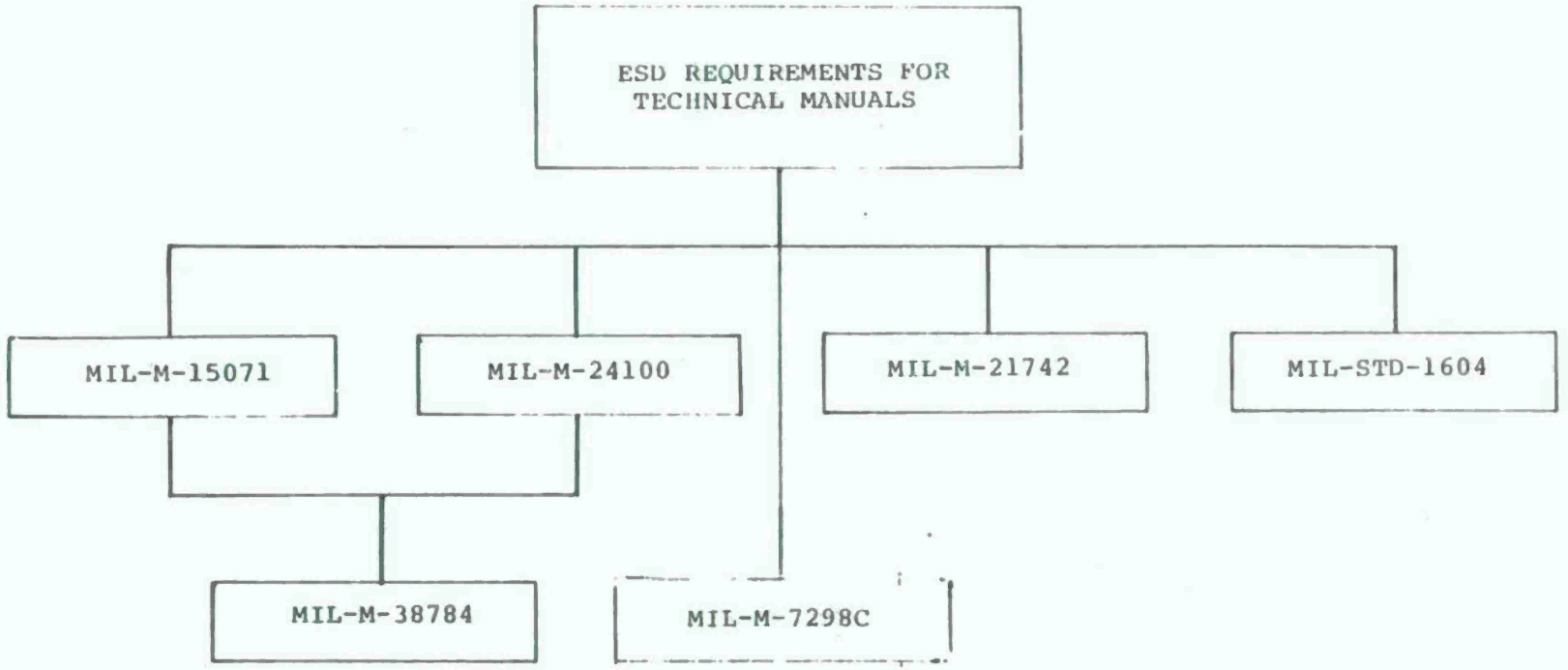
> "CAUTION -- ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See MIL-HDBK-XXX(NAVY) for protective handling or testing measures for this item."

REQUIREMENTS FOR ELECTROSTATIC
DISCHARGE (ESD) CONTROLS

IV Technical Manual Requirements for the Inclusion of ESD Caution and Control Procedures in Technical Overhaul and Maintenance Manuals

Requirements for the inclusion of caution and ESD control procedures in Technical Manuals are contained in the following military documents normally contractually imposed upon suppliers of Navy shipboard and shore electronic equipment.

- MIL-M-15071G — Military Specification, Manuals, Technical; Equipment and Systems, Content Requirements for, 1 August 1969
- MIL-M-24100B — Military Specification, Manuals, Technical: Functionally Oriented Maintenance Manuals (FOMM) for Equipment and Systems, 2 January 1974
- MIL-M-38784A — Military Specification, Manuals, Technical: General Style and Format Requirements, 1 January 1975
- MIL-M-21742A — Military Specifications, Manuals, Technical: Overhaul Electronic and Interior Communications Equipment: Content Requirements for, 5 February 1971
- MIL-STD-1604(OS) — Military Standard, Technical and Maintenance, Overhaul and Repair Standards, Preparation of, 28 September 1973
- MIL-M-7298C — Military Specification Manuals, Technical: Commercial Equipment, 1 November 1970


ESD REQUIREMENTS FOR TECHNICAL MANUALS
MIL-M-15071
MIL-M-24100
MIL-M-21742
MIL-STD-1604
MIL-M-38784
MIL-M-7298C

A MIL-M-15071G (NAVY)

"3.5.4.3.1 Method of Presentation . . .
. . .
(b) Initial Safety requirements (action, inspections and reference to emergency turn-off procedures).
. . .
(i) Procedures that can be hazardous to personnel or equipment shall be emphasized by WARNINGS or CAPTIONS placed prior to the specific step involving the possible hazard."

"3.5.8 Chapter 6, Corrective Maintenance. This chapter shall contain instructions required to adjust and align the equipment, remove, reinstall, and align all repairable parts, modules, subassemblies, and assemblies. The instructions shall identify the actions to be taken, safety precautions to be observed, tools, parts, materials and test equipment required; . . ."

"3.6.3 Chapter 2, Safety Precautions. Chapter 2 shall describe the hazards associated with system operation and maintenance. . . ."

"3.6.3.4.2 Maintenance Safety Summary. A maintenance safety summary shall emphasize the proper use of controls, describe the hazards to maintenance personnel, potential damage to the equipment and recommended precautions."

B MIL-M-24100B

"3.2.11 Safety Summary (CG, MC, N). A safety summary in accordance with MIL-M-38784 shall be prepared for each volume/part and shall be included in the front matter."

"3.4.1.2 Section 2. Safety precautions. Section 2 shall describe the hazards associated with system operation and maintenance. To permit wide and unrestricted use, Section 2 should contain only unclassified information."

"3.4.1.2.1 Introduction. This introduction shall be directed at system supervisory personnel, and shall include the following:
(a) Purpose, scope and organization of the system safety instructions.
(b) Basic safety concepts.
(c) Basic responsibilities for safety."

"3.4.1.2.4 System hazards and precautions. Include descriptions of system hazards and precautions, addressed to system personnel and referenced to particular system equipments. The descriptions shall be organized to be consistent with the operation of the system. The descriptions shall supplement and extend equipment safety instructions to the system level, by warning of potential hazards that can be caused during operation or maintenance."

"3.4.1.2.4.2 Maintenance safety summary. A maintenance safety summary shall emphasize the proper use of controls, describe the hazards to maintenance personnel, potential damage to the equipment, and recommended precautions."

"3.4.1.2.4.3 Hazardous components. Identify and briefly describe the hazardous components including radioactive devices and elements used with the system and summarize the general precautions for such components. The description of a hazardous component shall include brief statements as to the purpose, manner of functioning, nature of built-in safety devices, and nature of the hazardous element; it shall also indicate the relative sensitivity of the component to mechanical shock, vibration, electromagnetic and radioactive radiation, and electrostatic discharges."

"3.4.1.2.5 Warnings, cautions, notes. Warnings, cautions, and note blocks shall be included on applicable pages, as prescribed in MIL-M-38784.

C MIL-M-38784A (dtd 1 January 1975)

"3.3.9 Warnings, cautions and notes. Unless otherwise specified in the technical content specification, warnings and cautions shall precede the text but follow paragraph headings to which they apply. Notes may precede or follow applicable text, depending upon the material to be highlighted. Warnings, cautions, and notes shall not contain lettered or numbered procedural steps nor shall the headings be numbered. When a warning, caution, or note consists of two or more paragraphs the heading WARNING, CAUTION, NOTE, shall not be repeated above each paragraph. If it is necessary to precede a paragraph by both a warning and a note, or a caution and a note, etc., warnings shall precede cautions, which in turn shall precede notes. Figure 12 illustrates the styles. Warnings, cautions,

and notes shall be short, concise and used only to emphasize important or critical data. Warnings and cautions may be worded positively or negatively and shall state the hazard and result or reason, unless obvious. Following are the definitions of warning, caution, and note:

WARNING: An operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury or death of personnel.

CAUTION: An operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE: An essential operating or maintenance procedure, condition, or statement, which must be highlighted."

D MIL-M-21742A (dtd 5 February 1971)

"3.5.1.4 Special overhaul facility requirements. A detailed description shall be provided for special overhaul facility requirements which are unique to the item(s) covered in the manual. The following represents the specific information required; however, it is not to be construed as preventing the addition of such information necessary to properly identify the peculiar facility requirements. The description shall include the following:

(a) Access requirements.

(b) Vibration/shock/acoustic level that will influence the facility or equipment environment.

(c) Temperature and humidity extremes (high and low) that must be provided for the equipment or facility.

(d) Forced ventilation/air changes required from the facility.

(e) Heat rejection rate requirements.

(f) Contamination level imposed by the equipment.

(g) Electro-magnetic interference/compatibility requirements.

(h) Hazard/safety requirements.

(i) Other special environment requirements such as clean rooms, shielded enclosures, etc.

(j) Water and gas service in terms of pressures, flow rates, etc.

(k) Electric power requirements.

(l) Ground requirements.

(m) Mounting provisions for location and controlling dimensions for support equipment and work bench space.

(n) Special handling requirements necessary to handle or move equipment."

"3.5.2.2.1 Disassembly illustrations. Illustrations shall be utilized to show the sequence of disassembly and shall contain a listing of part identification data by item number, zone, noun name, quantity, and reference designation (see figure 4). The sequence of disassembly described in the text shall identify the individual part(s) by the item number shown on the illustration. Illustrations shall also be provided for procedures requiring the use of any special tools, fixtures, or jigs during disassembly."

"3.5.2.3 Section III - Cleaning and examination. This section shall describe the process and methods of cleaning and examination to be performed on each disassembled item."

"3.5.2.3.1 Cleaning. Cleaning instructions shall include the following:

. . .

(f) Post cleaning preservation and handling instructions.

(g) Cautions or warnings to be observed to protect personnel and equipment."

"3.5.2.4 Section IV - Repair and replacement. This section shall include instructions necessary for the repair and replacement of damaged or deteriorated items. The instructions shall identify the action to be accomplished, safety precautions to be observed, special tools, jigs, fixtures, parts, and material required, and step-by-step instructions with supporting illustrations to accomplish the task. When overhaul procedures involve restoration, procedures and parts employed shall be in conformance with MIL-R-24358. For critical procedures the instructions shall indicate in tabular form, the following types of information:

(a) Spring tensions, measured in grams or ounces, as appropriate.

(b) Pressure between contacts when closed, measured in grams or ounces, as appropriate.

(c) Clearance between contacts in open position.

(d) Correct method of installing brushes in rotating machinery, including brush pressure.

(e) Limits to which commutators may be turned on a lathe, including pertinent dimension after cut has been taken.

(f) Specify whether insulating material between commutator segments should be undercut (specify limits) or remain flush with the segments.

(g) List of mandatory replacement items (gaskets, seals, washers, etc.).

(h) Dimensional information with tolerances, clearances, maximum boltdown torques, and in-place balancing levels of mechanical items.

(i) Caution or warnings which must be observed to protect personnel and equipment.

"3.5.2.5 Section V - Reassembly. This section shall include instructions and supporting illustrations necessary for the reassembly of the overhauled item. The use of any special tools, jigs, fixtures, or test equipment shall be specified. . . ."

E MIL-STD-1604(OS) (dtd 28 September 1973)

"3.2 Safety Precautions and Notes. Warnings, Cautions and Notes shall be used to place emphasis on any condition potentially hazardous to personnel or equipment or to highlight an important instruction."

"3.2.1 Warnings and Cautions. Warnings and Cautions shall appear immediately prior to the procedural step giving the specific instructions or precautions necessary to prevent injury to personnel or damage to equipment. Warnings and Cautions have the following significance:

WARNING: An examining or testing procedure or practice which must be observed or risk either loss of life or injury to personnel.

CAUTION: An examining or testing procedure which must be followed or risk damage to or destruction of the equipment."

"3.2.2 Notes. Notes may be used where necessary to highlight an examining or testing procedure or a condition. Notes may, as appropriate, precede or follow the procedure to be highlighted."

F MIL-M-7298C

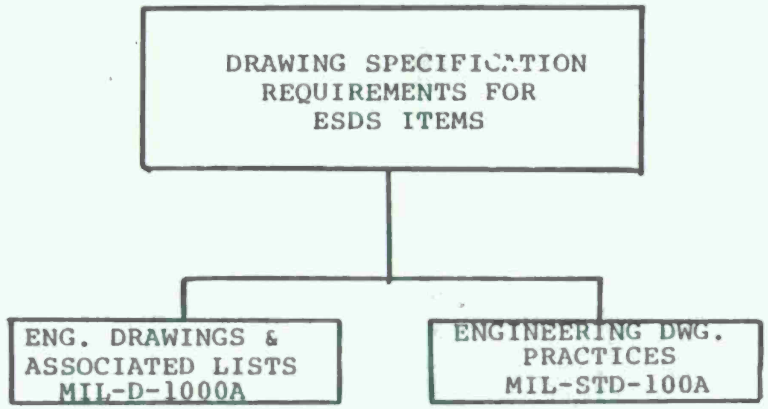
"3.1.2.10 Caution and warning notes. (All) "Caution" notes shall indicate any condition or practices which, if not strictly observed or remedied, could result in damage to, or destruction of the equipment. "Warning" notes shall indicate any conditions or practices which if not strictly observed, could result in personal injury or possible loss of life."

"3.2.2.1.2 Safety precautions. (All) When the procuring activity so requests, safety precautions shall be listed on a separate "front matter" page.

V Drawing Specification Requirements for Electrostatic Discharge Sensitive (ESDS) Items

Drawing requirements for ESDS items are contained in the following military documents normally contractually imposed upon suppliers of Navy shipboard and shore electronic equipment.

- MIL-STD-100A — Military Standard, Engineering Drawing Practices, 1 October 1967
- MIL-D-1000A — Military Specifications, Drawings, Engineering and Associated, 15 October 1975


DRAWING SPECIFICATION
REQUIREMENTS FOR
ESDS ITEMS
ENG. DRAWINGS &
ASSOCIATED LISTS
MIL-D-1000A
ENGINEERING DWG.
PRACTICES
MIL-STD-100A

A MIL-STD-100A

"1-302.16 Identification of Materials, processes and protective treatment. Materials, processes and protective treatment necessary to meet the design requirements of an item shall be identified on the drawing or parts list by reference to applicable specification(s) . . ."

"2-101.2 Detail Drawing. . . ."

"2-101.2.1.1 Requirements. A monodetail drawing shall define all features of the part depicted, including, as applicable, configuration, dimensions, tolerances, materials, mandatory processes, surface finish, protective coating, symbols, etc. Documents required to supplement the detail drawing in stating end product requirements for the part shall be prescribed by notes or tables on the drawing."

"2-101.4.2.1 Requirements. A specification control drawing shall disclose as applicable, configuration, dimensions of envelope, mounting and mating dimensions, interface dimensional characteristics, and limits thereto. In addition, as necessary, inspection and acceptance test requirements, performance, reliability, maintainability, environmental and other functional requirements, to insure identification and adequate reprocurement of an interchangeable item. If an electrical or electronic (or other engineering) circuit is involved, a schematic, connection or other appropriate diagramatic disclosure shall be included on the drawing (or referenced thereon), thereby providing sufficient information for making external connections."

"2-101.4.6 Interface control drawing. . . ."

"2-101.4.6.1 Requirements. An interface control drawing shall delineate, as necessary, (a) configuration and all interface dimensional data applicable to the envelope, mounting and mating of the items; (b) complete interface engineering requirements, such as mechanical, electrical, electronic, hydraulic, pneumatic, optical, etc., which affect the physical or functional characteristics of co-functioning items; and (c) any other characteristics which cannot be changed without affecting system design criteria. Interface drawings may be categorized as mechanical, electrical, interconnections, configuration and installation, operational sequency requirements, system switching, etc., as necessary. The notation INTERFACE CONTROL DRAWING shall be shown, adjacent to the title block."

B MIL-D-1000A

"3.3.3 Level 3 Production"

"3.3.3.1 Engineering drawing types (see 3.5) shall include details of unique processes when essential to design and manufacture; details of performance ratings; dimensional and tolerance data; critical manufacturing assembly sequences; toleranced input and output parameters; schematics; mechanical and electrical connections; physical characteristics, including form and finish; details of material identification; inspection, test and evaluation criteria; necessary calibration information; and quality control data. Unless otherwise specified, a specification (see 3.6), or a control drawing(s) as defined in MIL-STD-100, shall be prepared for:
. . . ."

"6.4 Intended use. The intended use for each level is as follows:"

"6.4.4 Other use. The ultimate use(s) for which delivered engineering data may be found suitable is restricted only by the applied and accepted rights legends thereon. Therefore, Government personnel developing a solicitation will be taking these ultimate uses into consideration whether or not the uses are stated or implied by the contract or order."

"6.4.4.1 For instance, engineering data may be used for:
(a) Logistic support
. . .
(f) Performing maintenance on the item, including overhaul."

"6.4.4.2 The above is not a complete listing. However, all listed items plan towards reducing the resources expended by the DoD."