NOT MEASUREMENT SENSITIVE

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25 October 1995
SUPERSEDING
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31 December 1992

DEPARTMENT OF DEFENSE STANDARD PRACTICE

ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT (EXCLUDING ELECTRICALLY INITIATED EXPLOSIVE DEVICES)

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FOREWORD

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

2. This standard covers the establishment and implementation of an Electrostatic Discharge (ESD) Control Program for any activity that designs, tests, inspects, services, manufactures, processes, assembles, installs, packages, labels, or otherwise handles electrical or electronic parts, assemblies and equipment susceptible to damage by static electricity. This document provides control program requirements for ESD sensitive (ESDS) items susceptible to damage from discharges of up to 15,999 volts Human Body Model (HBM) Classes 1-3. This standard does not apply to electrically initiated explosive devices or part level design requirements. MIL-HDBK-263 provides additional information relative to the implementation of this standard.

3. Electrostatic charges are generated by the relative motion, physical separation of materials or flow of solids, liquids, or gases. Common sources of ESD include personnel, items made of common plastics, and processing equipment. ESD can damage parts by direct contact with a charged source or by charges induced from electrostatic fields. Examples of ESDS parts are micro-circuits, discrete semiconductors, thick and thin film resistors, hybrid devices and piezoelectric crystals.

4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 03R42, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Purpose. The purpose of this standard is to establish comprehensive requirements for an ESD control program to minimize the effects of ESD on parts, assemblies, and equipment. An effective ESD control program will increase reliability and decrease both maintenance actions and lifetime costs. This standard shall be tailored for various types of acquisitions.

1.2 Scope. This standard defines the performance requirements for an ESD control program for electrical and electronic parts, assemblies, and equipment, susceptible to damage from ESD. Electrically initiated explosive devices and part level design are excluded from these requirements. This standard covers identification, testing, classification, assembly and equipment design criteria, protected areas, handling procedures, training, marking of hardware, protective covering and packaging, and provides for quality assurance requirements, audits and reviews.

1.3 Application. This standard shall apply to Government activities and contractors, subcontractors, suppliers, and vendors. When this standard is applied to Government activities the term "contractor" shall be replaced with "Government activity" as appropriate.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3,4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3,4, and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following standards and handbook form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards

(DoDISS) and supplement thereto, cited in the solicitation(see 6.2).

STANDARDS

MILITARY

MIL-STD-750	-	Test Methods for Semiconductor Devices.
MIL-STD-883	-	Test Methods and Procedures for Microelectronics.
MIL-STD-2073-1	-	DOD Materiel Procedures for Development and Application of Packaging Requirements.
MIL-STD-2073-2	-	Packaging Requirement Codes.

HANDBOOK

MILITARY

MIL-HDBK-263	-	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices). (Metric)

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation(see 6.2).

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

ANSI C63.16-1993 - American National Standard Guide for Electrostatic Discharge Test Methodologies and Criteria for Electronic Equipment

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

F 1166 - Human Engineering Design for Manned Systems, Equipment and Facilities

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

ELECTROSTATIC DISCHARGE (ESD) ASSOCIATION

EOS/ESD-S5.1 - EOS/ESD Association Standard for ESD Sensitivity Testing, Human Body Model (HBM) - Component Level

ESD-S5.2 - ESD Association Standard for ESD Sensitivity Testing, Machine Model (MM) - Component Level

ESD-S5.3 - ESD Association Standard for ESD Sensitivity Testing, Charged Device Model (CDM) - Component Level

(Application for copies should be addressed to the ESD Association, Inc., 7902 Turin Road, Suite 4, Rome, NY 13440-2069.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

RS-471 - Symbol and Label for Electrostatic Sensitive Devices.

(Application for copies should be addressed to the Electronic Industries Association, 2500 Wilson Boulevard, Arlington, VA 22201-3834.)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE STD C62.38-1994 - IEEE Guide on ESD: ESD Withstand Capability Evaluation Methods (for Electronic Equipment Subassemblies)

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 801-2 - (First Edition, 1984) Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements

IEC 801-2 - (Second Edition, 1991-04) Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements

(Application for copies should be addressed to the American National Standard Institute, 1430 Broadway, New York, NY 10018.)

RELIABILITY ANALYSIS CENTER (RAC)

VZAP-95 - Electrostatic Discharge Susceptibility Data 1995

(Application for copies should be addressed to the Reliability Analysis Center, P.O. Box 4700, Rome, NY 13442-4700.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 The definitions of terms not defined herein shall be in accordance with MIL-HDBK-263.

4. GENERAL REQUIREMENTS

4.1 General. Contractors shall establish, implement, and document the ESD control program in accordance with the requirements of this standard. Contractors shall also apply the ESD control program requirements (see 5.1.1) to subcontractors, suppliers, and vendors to provide continuous protection for ESDS parts, assemblies and equipment. Detailed guidance for establishing, implementing, documenting, and auditing the elements of an ESD control program is provided in MIL-HDBK-263.

4.1.1 Tailoring of this standard. This standard, or portions thereof, may not apply to all acquisitions or applications. The contractor shall tailor the ESD control program for the acquisition by selecting the applicable elements of figure 1. The reference numbers in figure 1 are included for ready reference to the appropriate sections of this standard. Figure 1 cannot, and does not take precedence over contractual, delivery order or this standard's requirements. Tailoring is subject to approval by the acquiring activity.

5. DETAILED REQUIREMENTS

5.1 ESD control program plan. The contractor shall prepare an ESD control program plan that addresses each of the elements of the ESD control program shown in the tailoring flow chart depicted in figure 1. The ESD control program plan is the principal document for designing, implementing, and auditing the ESD control program. The goal is a fully implemented and integrated ESD control program that conforms to the quality system requirements.

5.1.1 Subcontractor control. The contractor shall ensure that subcontractors, suppliers and vendors have established and implemented an ESD control program in accordance with the requirements of this standard. Tailoring of this standard for subcontractors, suppliers and vendors shall be the responsibility of the prime contractor (see 4.1.1).

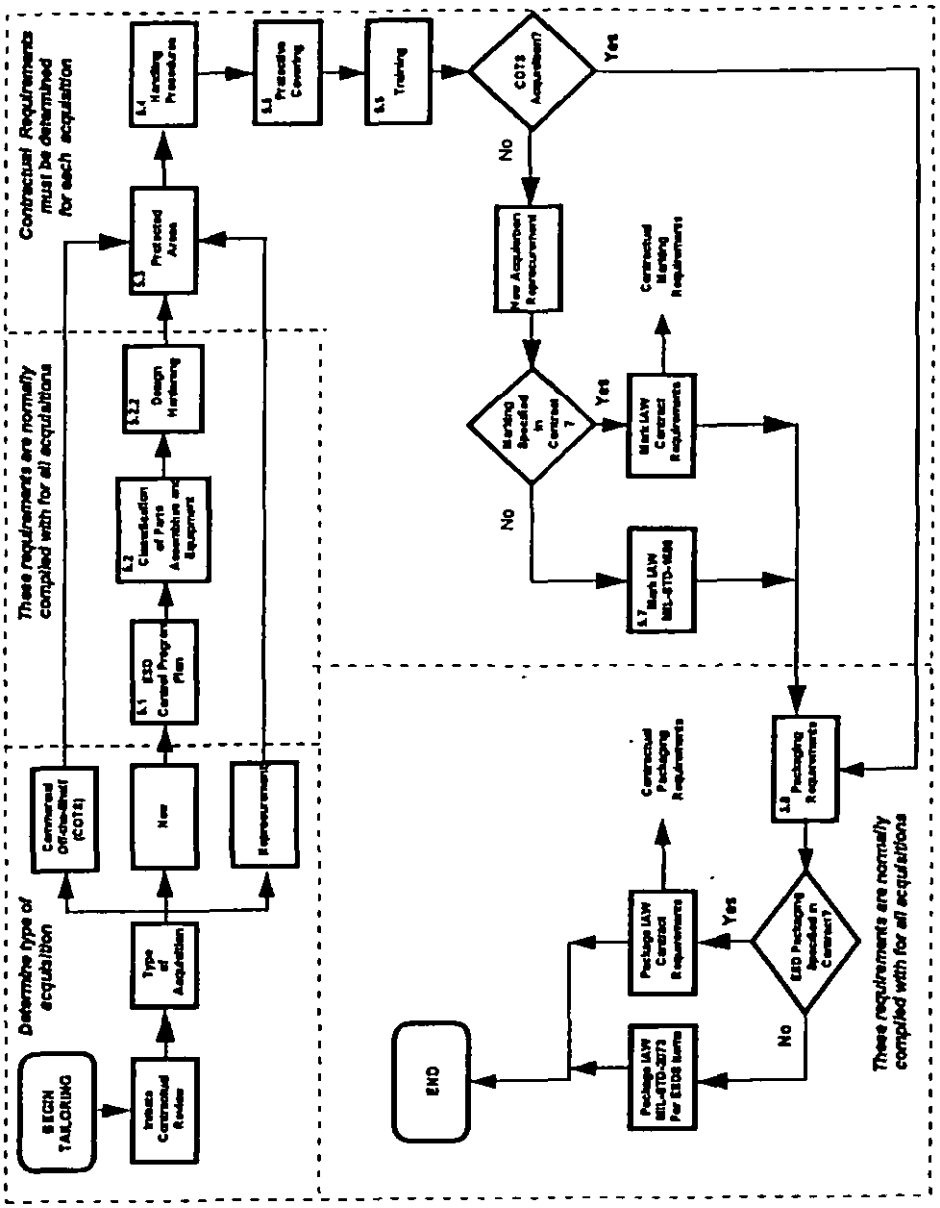

FIGURE 1. Tailoring Flow Chart

5.2 Classification of ESDS parts, assemblies and equipment. ESDS classification data shall be used to ensure that the ESD control program (see 5.1), design hardening (see 5.2.2), protected areas (see 5.3), and handling procedures (see 5.4) provide the requisite levels of ESD protection in accordance with the requirements of this standard. Full characterization of the ESD susceptibility of a part is accomplished by classification to three defined models: the Human Body Model (HBM), Machine Model (MM), and Charged Device Model (CDM). The HBM, MM, and CDM sensitivity classification of parts shall be in accordance with tables I and II. The HBM, MM, and CDM voltage levels do not correlate with each other.

TABLE I. Classes of ESDS parts.

ESD MODEL	ESD CLASS (VOLTAGE RANGE)
HBM	1 (>0V-1,999V)
	2 (2,000V-3,999V)
	3 (4,000V-15,999V)
MM	M1 (0V-100V)
	M2 (101V-200V)
	M3 (201V-400V)
	M4 (401V-800V)
	M5 (> 800V)
CDM	C1 (0V-124V)
	C2 (125V-249V)
	C3 (250V-499V)
	C4 (500V-999V)
	C5 (1,000V-1,499V)
	C6 (1,500V-2,999V)
	C7 (≥ 3,000V)

NOTE: The above Classes may be divided into subclasses.

TABLE II. ESD test standards/methods for classification of ESDS parts.

ESD MODEL	ESD TEST STANDARD/METHOD
HBM	EOS/ESD-S5.1 MIL-STD-883 Method 3015 MIL-STD-750 Method 1020
MM	ESD-S5.2
CDM	ESD-S5.3

5.2.1 Part ESD sensitivity classes and classification.

5.2.1.1 HBM sensitivity classification. The principal source of ESD damage is the human body, as modeled by the HBM standards. HBM ESD sensitivity classification of parts shall be determined as follows:

(a) At the discretion of the contractor, all parts shall be considered as HBM ESD sensitive. In this case, all parts may be classified as falling in the HBM Class 1-3 voltage ranges and included in the ESD control program. If the contractor has definitive data for the specific part (RAC VZAP-95 data, Qualified Products List (QPL), Qualified Manufacturer List (QML), or manufacturers' data sheets), indicating it is not within HBM Classes 1-3, ESD controls are not required for that part.

(b) At the discretion of the contractor, precise HBM ESD sensitivity data, in accordance with the HBM test methods specified in tables I and II may be used to classify all parts. The three HBM test methods listed in table II may be considered to be equivalent. The preferred test method is EOS/ESD-S5.1.

5.2.1.2 MM sensitivity classification. The prime source of damage for the MM is a charged machine or device. MM ESD sensitivity classification for parts should be determined by, and at the discretion of, the contractor. The contractor shall consider the applicability of MM ESD part sensitivity data based upon the type of work performed.

5.2.1.3 CDM sensitivity classification. The prime source of damage for the CDM is the rapid discharge of a charged part. This ESD event is totally part-dependent. CDM ESD sensitivity classification for parts should be determined by, and at the discretion of, the contractor. The contractor shall consider the applicability of CDM ESD part sensitivity data based upon the type of work performed.

5.2.2 Assembly/equipment classification and design hardening. When an assembly or equipment incorporates protective circuitry or techniques to meet the minimum design hardening requirements of this standard, the assembly or equipment is classified at the design-hardened ESD withstand voltage level. Classification of assemblies or equipment meeting the design hardening requirements (see table III) should be based upon analytical techniques, or actual test as specified in 5.2.2.1 through 5.2.2.3.

5.2.2.1 Direct contact, non-operating assembly, 2,000 V body/finger or hand/metal HBM tests. This model can be used to verify that assemblies will not be damaged during non-operating conditions, by direct contact (2,000 V body/finger or hand/metal HBM) to input, output, and interface connections. This threat occurs during the maintenance process when assemblies are handled without their associated cables and connectors attached. This threat applies to all types of assemblies. The test for this model should consist of three positive and three negative pulses at 2,000 V body/finger or hand/metal HBM, applied to each input, output, and interface connection of the assembly. The recommended test method for this model is IEEE STD C62.38-1994 (see table IV) that provides guidance to determine which of the two ESD test methods (body/finger or hand/metal) is appropriate for a specific assembly.

5.2.2.2 Direct contact, operating equipment, 4,000 V hand/metal HBM test. This model can be used to verify that operating equipment will not be damaged (or non-recoverable faults will not be injected), by direct contact (4,000 V hand/metal HBM) to operator accessible points and exposed surface areas during the normal maintenance process. This threat is limited to equipments subject to operator adjustments or maintenance activities during operation. The test for this model should consist of multiple pulses (the number is statistically based, in accordance with ANSI C63.16-1993) at 4,000 V hand/metal HBM, applied to each operator-accessible control and to the

TABLE III. ESD assembly/equipment design hardening goals.

Test Type	ESD Model	Test Locations	Functional Level	ESD Hardening Requirement
Direct contact, Non-operating	Body/Finger or Hand/Metal HBM	Inputs, outputs and interface connections (1)	All assemblies	2,000 volts
Direct contact, Operating	Hand/ Metal HBM	Operator accessible controls and the center of each plane surface	Field-maintained equipment	4,000 volts
Indirect contact, Operating	Furniture Model	Horizontal Coupling Plane (HCP) or Vertical Coupling Plane (VCP) (2)	Digital office equipment	4,000 volts

NOTES: (1) Inputs, outputs and interface connection points are those points where the assembly is electrically connected to items external to it.

(2) The HCP (or VCP) is a horizontal (or vertical) metal plate that is capacitively coupled to the equipment, to which pulses are applied to simulate discharges to objects adjacent to the equipment.

center of each exposed plane surface of the equipment. The recommended test methods are either ANSI C63.16-1993 or IEC 801-2 (See Table IV).

TABLE IV. ESD test standards/methods for hardening of ESDS assembly/equipment.

ESD MODEL	ESD TEST STANDARD/METHOD
Body/Finger or Hand/Metal HBM	IEEE STD C62.38-1994 (Assembly)
Hand/Metal HBM	IEC 801-2[1] ANSI C63.16-1993 (Equipment)
Furniture Model	ANSI C63.16-1993 (Equipment)
Note: [1] IEC 801-2 (First Edition, 1984) and IEC 801-2 (Second edition 1991-04) are both in current use.	

5.2.2.3 Indirect contact, operating equipment, 4,000 V furniture model test. This model can be used to verify that operating digital equipment in an office environment will not be damaged (or non-recoverable faults will not be injected), by indirect contact (4,000 V Furniture Model) during normal activities performed within the proximity of the equipment. This threat applies to all digital equipment in an office environment but is especially important for NDI(Non-Developmental Item)/COTS (Commercial-Off-The-Shelf) equipment. The test for this model should consist of multiple pulses (the number is statistically based, in accordance with ANSI C63.16-1993) using the 4,000 V Furniture Model, applied to a Horizontal Coupling Plane (HCP) or a Vertical Coupling Plane (VCP). The HCP is preferred. The recommended test method is in ANSI C63.16-1993 (See table IV).

5.3 Protected areas. Handling of ESDS parts, assemblies and equipment without ESD protective covering or packaging shall be performed in ESD protected areas in accordance with ESD protective handling procedures (see 5.4). If there are practical considerations which preclude handling in the protected areas, alternative handling precautions and procedures shall be prepared and utilized in the unprotected areas. Electrostatic voltages and charges generated in areas where ESDS parts, assemblies and equipment are handled without protective covering or packaging shall be minimized to the lowest practicable level.

5.4 Handling procedures. ESD protective handling procedures shall be established, documented, and implemented. Handling procedures shall include, as applicable, ESD damage prevention procedures to be used in all areas where ESDS items are manually or machine processed.

5.5 Protective covering. When not being worked on or when outside protected areas, ESDS parts and assemblies shall be enclosed in ESD protective covering or packaging. Protective packaging of ESDS items shall be in accordance with 5.8. Guidance related to protective covering is provided in MIL-HDBK-263.

5.6 Training. Periodic and recurrent ESD training shall be provided to all personnel who perform or supervise any of the work associated with ESDS items. Training may be classroom training, on the job instruction, or a combination of both.

5.7 Marking of hardware. Marking shall be as specified in the following:

5.7.1 Assemblies. ESDS assemblies shall be marked with the EIA RS-471 symbol as illustrated in figure 2. The symbol shall be located in a position readily visible to personnel when the assembly is incorporated in its next higher assembly. When physical size or orientation of the assembly precludes compliance with this requirement, alternative marking procedures shall be developed and implemented only with prior concurrence by the acquiring activity.

(RS-471)

FIGURE 2. Electrostatic discharge symbol.

5.7.2 Equipment. Equipment containing ESDS parts and assemblies shall be marked with the EIA RS-471 symbol. The symbol shall be located on the exterior surface of the equipment and readily visible to personnel prior to gaining access to ESDS parts and assemblies within the equipment. The following ESD caution statement should be placed adjacent to the RS-471 symbol:

"CAUTION
CONTAINS PARTS AND
ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY
ELECTROSTATIC DISCHARGE (ESD)."

The symbol and caution statement shall conform to the labeling requirements of ASTM F 1166.

5.8 Packaging. ESD protective packaging will be in accordance with the contract or purchase order for ESDS items. If ESD protective packaging is not specified in the contract or purchase order, requirements for packaging will be in accordance with MIL-STD-2073 codes GX, JK, JW, KB or KE for ESDS items.

5.9 Quality assurance reviews and audits. The contractor should address ESD control in the planning and preparation performed for quality assurance reviews and audits to ensure that these consistently address ESD control. The contractor's scheduled design, program reviews and audits should include ESD control program requirements.

5.10 Failure analysis. Failure analysis, when performed, should consider ESD related failure modes and effects as part of the failure analysis.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. This document provides requirements for establishing, documenting and implementing an ESD control program. For those contracts incorporating DOD-STD-1686 of 2 May 1980, the companion document was DOD-HDBK-263 of 2 May 1980. For those contracts incorporating MIL-STD-1686A of 8 August 1988, the companion document was MIL-HDBK-263A of 22 February 1991. For those contracts incorporating MIL-STD-1686B of 31 December 1992,

the companion document was MIL-HDBK-263B of 31 July 1994. There is no military handbook yet for this version of MIL-STD-1686C.

6.2 Issue of DoDISS. When this standard is used in acquisition, the applicable issue of the DoDISS must be cited in the solicitation (see 2.1 and 2.2).

6.3 Subject term (key word) listing.

Charged device model
Classification, parts, assemblies, equipment
Human body model
Machine model
Protected areas
Protective covering
Static Electricity

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
Army -ER
Navy - SH
Air Force - 17

Review activities:
Army - AT, CR, MI, SM
Navy - AS, EC, OS, SA
Air Force - 11, 15, 19, 99

Preparing activity:
Navy - SH
(Project RELI-0075)