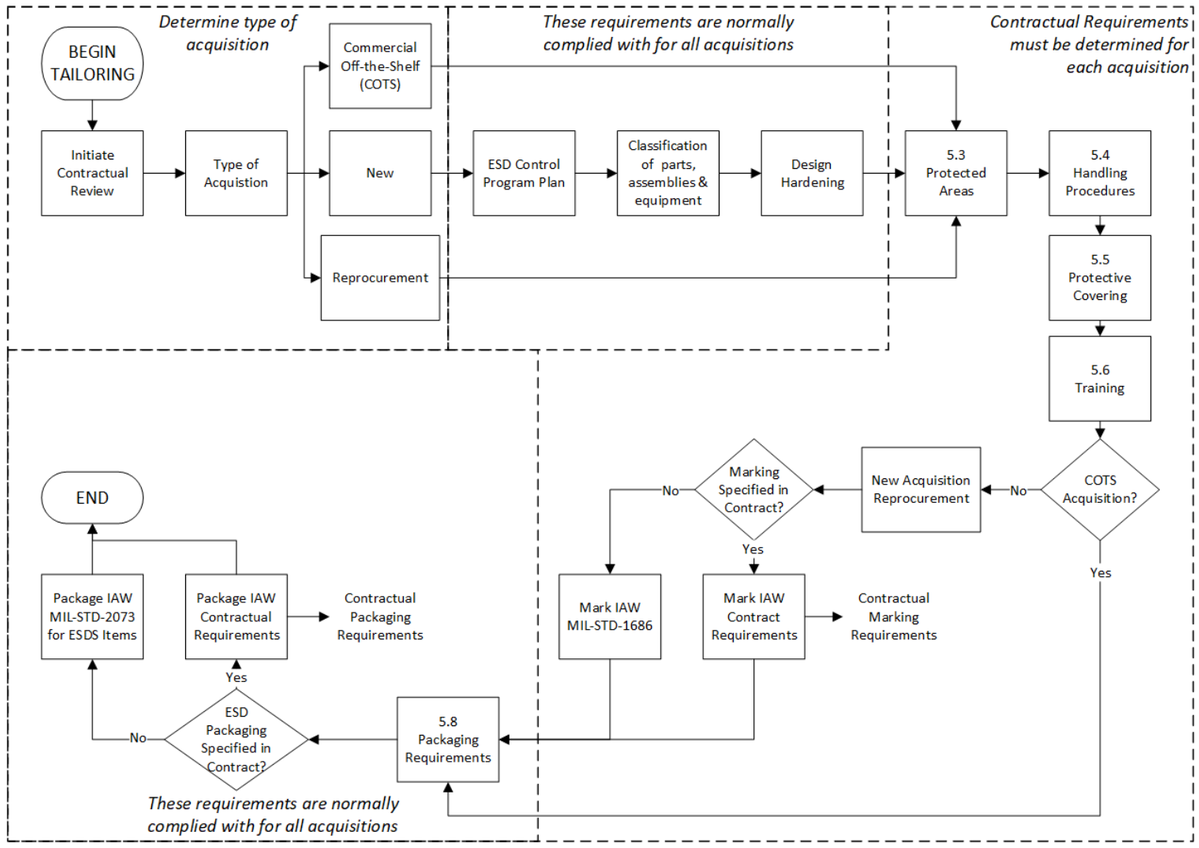
MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
1. SCOPE	1. SCOPE	This column contains copyrighted material used with permission. See https://www.esda.org/standards/ for a complimentary download of ANSI/ESD S20.20-2014.	
1.1 Purpose. The purpose of this standard is to establish the requirements for an ESD control program to minimize the effects of ESD on parts, assemblies, and equipment. An effective ESD control program will increase reliability, decrease maintenance actions and lifetime cost. This standard may be tailored for various types of acquisitions.	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.	**1.0 PURPOSE** The purpose of this standard is to provide administrative and technical requirements for establishing, implementing and maintaining an ESD Control Program (hereafter referred to as the "Program").	*Administrative requirements in ANSI/ESD S20.20 tells the organization how to run its program.*
1.2 Scope. This standard defines the 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 work areas, handling procedures, training, marking of documentation and hardware, protective covering, packaging and marking, and installation for assemblies and equipment. Also included are quality assurance requirements, data requirements, audits and reviews.	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.	**2.0 SCOPE** This document applies to activities that manufacture, process, assemble, install, package, label, service, test, inspect, transport or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 volts HBM, 200 volts CDM, and 35 volts on isolated conductors. Activities that handle items that are susceptible to lower withstand voltages may require additional control elements or adjusted limits. Processes designed to handle items that have an ESD sensitivity to lower withstand voltages can still claim compliance to this standard. This document does not apply to electrically initiated explosive devices, flammable liquids or powders. NOTE: The CDM voltage level as used in this document is based on managing process essential insulators to mitigate induced voltages on devices that could lead to damage. NOTE: Isolated conductors were historically represented by MM.	*Scope of ANSI/ESD S20.20 includes handling of ESDS items. No need for a separate section for handling procedures.* *ANSI/ESD S20.20 identifies the minimum threshold for ESD controls, whereas MIL-STD-1686B & C do not.* *ANSI/ESD S20.20 specifically excludes flammable liquids and powders. MIL-STD-1686B & C do not.*
1.3 Application. This standard **shall** be applied to Government activities and contractors, subcontractors, suppliers, and vendors engaged in any of the functions listed in table I. When this standard is applied to Government activities the term "contractor" **shall** be replaced with "Government activity" as appropriate.	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.		*This paragraph is no longer allowed per MIL-STD-962 and is not applicable for an NGS.* *ANSI/ESD S20.20 uses a generic term, "organization," which covers contractors and Government activities.*
1.3.1 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 functions and elements of table I. Tailoring rationale and data for the acquisition **shall** be included in the ESD control program plan (see 5.1). Tailoring is subject to approval by the acquiring activity.	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.	**6.3 Tailoring** This document, or portions thereof, may not apply to all applications. Tailoring is accomplished by evaluating the applicability of each requirement for the specific application. Upon completion of the evaluation, requirements may be deleted or modified outside the limits of this standard. Tailoring decisions, including rationale and technical justifications, **shall** be documented in the ESD Control Program Plan.	*All these standards allow for tailoring. Tailoring is not a requirement (despite the shall in 1.1 of 1686C) and should only be used when applicable. Tailoring, if used, should be documented and approved by the acquiring activity.*
1.3.1.1 Mission critical or essential equipment. When equipment is designated as mission critical or essential by the acquiring activity (see 6.1), the ESD control program **shall** include class 3 parts, assemblies and equipment.			*Not covered in MIL-STD-1686C.*

TABLE I. ESD control program requirements. (MIL-STD-1686B)

	Elements											
	Sec 5.1	Sec 5.2	Sec 5.3	Sec 5.4	Sec 5.5	Sec 5.6	Sec 5.7	Sec 5.8	Sec 5.9	Sec 5.10	Sec 5.11-5.12	Sec 5.13
Functions	ESD control program plan	Classification	Design protection (Excluding Part Design)	Protected areas	Handling procedures	Protective covering	Training	Marking of hardware	Documentation	Packaging	QA requirements, reviews and audits	Failure analysis
Design	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Production	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Inspection & test	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Storage & shipment	✓			✓	✓	✓	✓	✓	✓	✓	✓	
Installation	✓			✓	✓	✓	✓	✓	✓	✓	✓	
Maintenance & repair	✓			✓	✓	✓	✓	✓	✓	✓	✓	

FIGURE 1. Tailoring flow chart. (MIL-STD-1686C)



MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
2. APPLICABLE DOCUMENTS	2. APPLICABLE DOCUMENTS	**3.0 REFERENCED PUBLICATIONS**	
	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.		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*
2.1 Government documents.	2.2 Government documents.		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*
2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the	2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).	issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).		*Language is obsolete. Per MIL-STD-962, the current language for the last sentence is: "Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract."*
SPECIFICATION - MILITARY			
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.			*Cancelled November 2010 (No superseding document).*
STANDARD - MILITARY	STANDARDS - MILITARY		
	MIL-STD-750 - Test Methods for Semiconductor Devices.		
MIL-STD-785 - Reliability Program for Systems and Equipment Development and Production.			*Cancelled July 1998 (No superseding document).*
	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.		*Cancelled October 1996 (Superseded by MIL-STD-2073-1).*
HANDBOOK - MILITARY	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)	MIL-HDBK-263 - Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices). (Metric)		*Cancelled January 2021 (Superseded by ESD TR20.20).*
(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.)	(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.)		*Obsolete language. Current language per MIL-STD-962 is: "(Copies of these documents are available online at https://quicksearch.dla.mil.)"*
2.2 Non-Government publications. The following document(s) 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).	2.3 Non-Government publications. The following document(s) 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).	Unless otherwise specified, the following documents of the latest issue, revision or amendment form a part of this standard to the extent specified herein: (from 3.0)	*DoD required paragraph per MIL-STD-962.* *Language is obsolete in MIL-STD-1686B & C. Per MIL-STD-962, the current language replacing the last two sentences is: "Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract."*
	AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)		
	ANSI C63.16-1993 - American National Standard Guide for Electrostatic Discharge Test Methodologies and Criteria for Electronic Equipment		*Now IEEE C63.16-2016*
	(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.)		*Copies of IEEE C63.16-2016 are available from https://www.ieee.org/standards/index.html.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
	AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)		*ASTM International*
	F 1166 Human Engineering Design for Manned Systems, Equipment and Facilities		*Current*
	(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)		*Copies of ASTM F1166 are available from https://www.astm.org/Standards/F1166.htm.*
	ELECTROSTATIC DISCHARGE (ESD) ASSOCIATION		
	EOS/ESD-S5.1 - EOS/ESD Association Standard for ESD Sensitivity Testing, Human Body Model (HBM) - Component Level		*Cancelled (Superseded by ANSI/ESDA/JEDEC JS-001)*
	ESD-S5.2 - ESD Association Standard for ESD Sensitivity Testing, Machine Model (MM) - Component Level		*Now ESD SP5.2. MM testing no longer recommended. See ANSI/ESD S20.20, annex B, for more information.*
	ESD-S5.3 - ESD Association Standard for ESD Sensitivity Testing, Charged Device Model (CDM) - Component Level		*Cancelled (Superseded by ANSI/ESDA/JEDEC JS-002)*
		ESD ADV1.0, ESD Association's Glossary of Terms[(2)] ANSI/ESD S1.1, Wrist Straps[(2)] ANSI/ESD STM2.1, Garments[(2)] ANSI/ESD STM3.1, Ionization[(2)] ANSI/ESD SP3.3, Periodic Verification of Air Ionizers[(2)] ANSI/ESD S4.1, Worksurfaces – Resistance Measurements[(2)] ANSI/ESD STM4.2, ESD Protective Worksurfaces – Charge Dissipation Characteristics[(2)] ANSI/ESD S6.1, Grounding[(2)] ANSI/ESD S7.1, Floor Materials – Characterization of Materials[(2)] ANSI/ESD STM9.1, Footwear – Resistive Characterization[(2)] ESD SP9.2, Footwear – Foot Grounders Resistive Characterization[(2)] ANSI/ESD STM12.1, Seating – Resistive Measurement[(2)] ANSI/ESD S13.1, Electrical Soldering/Desoldering Hand Tools[(2)] ESD TR53, Compliance Verification of ESD Protective Equipment and Materials[(2)] ANSI/ESD STM97.1, Floor Materials and Footwear – Resistance Measurement in Combination with a Person[(2)] ANSI/ESD STM97.2, Floor Materials and Footwear – Voltage Measurement in Combination with a Person[(2)] ANSI/ESD S541, Packaging Materials for ESD Sensitive Items[(2)]	

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
	(Application for copies should be addressed to the ESD Association, Inc., 7902 Turin Road, Suite 4, Rome, NY 13440-2069.)	[2] ESD Association, 7900 Turin Road, Bldg. 3, Ste. 2, Rome, NY 13440-2069, 315-339-6937	*(Copies of ESDA documents are available online at https://www.esda.org/standards/.)*
ELECTRONIC INDUSTRIES ASSOCIATION (EIA)	ELECTRONIC INDUSTRIES ASSOCIATION (EIA)		*Defunct organization.*
RS-471 - Symbol and Label for Electrostatic Sensitive Devices.	RS-471 - Symbol and Label for Electrostatic Sensitive Devices.		*Now JESD471*
(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street NW, Washington, DC 20006.)	(Application for copies should be addressed to the Electronic Industries Association, 2500 Wilson Boulevard, Arlington, VA 22201-3834.)		*Copies of JESD471 are available from https://www.jedec.org/.*
	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)		*Withdrawn January 2005*
	(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		*Now IEC 61000-4-2 Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.*
	IEC 801-2 - (Second Edition, 1991-04) Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements		*Now IEC 61000-4-2*
	(Application for copies should be addressed to the American National Standard Institute, 1430 Broadway, New York, NY 10018.)		*Copies of IEC 61000-4-2 are available from https://webstore.iec.ch/publication/4189.*
	RELIABILITY ANALYSIS CENTER (RAC)		*The RAC is closed.*
	VZAP-95 - Electrostatic Discharge Susceptibility Data 1995		*Document is no longer available. RAC VZAP-95 data is at least 25 years old and its current validity is unknown.*
	(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.)	(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.)		*Not required per MIL-STD-962.*
2.3 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.	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.		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
3. DEFINITIONS	3. DEFINITIONS	**4.0 DEFINITIONS**	
3.1 The definitions of terms not defined herein **shall** be in accordance with MIL-HDBK-263.	3.1 The definitions of terms not defined herein **shall** be in accordance with MIL-HDBK-263.	The terms used in the body of this document are in accordance with the definitions found in ESD ADV1.0, ESD Association's Glossary of Terms available for complimentary download at www.esda.org.	*MIL-HDBK-263 has been cancelled. ESD ADV1.0 has current ESD definitions. See https://www.esda.org/standards/ for a complimentary download of ESD ADV1.0.*
		5.0 PERSONNEL SAFETY The procedures and equipment described in this document may expose personnel to hazardous electrical conditions. Users of this document are responsible for selecting equipment that complies with applicable laws, regulatory codes and both external and internal policy. Users are cautioned that this document cannot replace or supersede any requirements for personnel safety. Ground fault circuit interrupters (GFCI) and other safety protection **should** be considered wherever personnel might come into contact with electrical sources. Electrical hazard reduction practices **should** be exercised and proper grounding instructions for equipment **shall** be followed. The resistance measurements obtained through the use of these test methods **shall** not be used to determine the relative safety of personnel exposed to high AC or DC voltages.	*MIL-STD-1686B and MIL-STD-1686C don't identify personnel safety requirements in any form.*
4. GENERAL REQUIREMENTS	4. GENERAL REQUIREMENTS	**6.0 ESD CONTROL PROGRAM**	
4.1 General. Contractors **shall** establish, implement, and document the ESD control program in accordance with the requirements of this standard. The applicable control program functions and elements of table I **shall** also be applied to subcontractors, suppliers, and vendors to provide continuous protection for ESDS parts, assemblies and equipment. Detailed guidelines for establishing, implementing, and documenting the elements of an ESD control program are provided in MIL-HDBK-263.	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.	**6.1 ESD Control Program Requirements** The Program **shall** include both administrative and technical requirements as described herein. The Program **shall** document the lowest level(s) of device ESD sensitivity that can be handled. The Organization **shall** establish, document, implement, maintain and verify the compliance of the Program in accordance with the requirements of this document.	*Administrative requirements tells the organization how to run its program.* *The technical requirements of an ESD control program are in ANSI/ESD S20.20.* *MIL-HDBK-263 cancelled. ESD TR20.20 has current guidance.*
		6.2 ESD Control Program Manager or Coordinator An ESD Control Program Manager or Coordinator **shall** be assigned by the Organization to verify the compliance of the Program in accordance with the requirements of this document.	*This tells the organization how to run its program.*
4.2 Deliverable data. Deliverable data prepared in accordance with the requirements of sections 5 and 6 of this standard and identified on the DD Form 1423, Contract Data Requirements List (CDRL), **shall** be prepared in accordance with the instructions in the applicable Data Item Description (DID) , DD Form 1664, (see 6.2) and approved by the acquiring activity.			*This section in MIL-STD-1686B addresses data requirements that should have been in 6.2.* *Not included in MIL-STD-1686C. No DIDs or other data deliverables are identified.*
5. DETAILED REQUIREMENTS	5. DETAILED REQUIREMENTS		

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
5.1 ESD control program plan. An ESD control program plan that addresses each of the applicable functions and elements of table I (see 1.3.1) **shall** be prepared and submitted for approval in accordance with the data ordering document included in the contract or order (see 6.2).	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.	**7.1 ESD Control Program Plan** The Organization **shall** prepare an ESD Control Program Plan that addresses each of the requirements of the Program. Those requirements include: • Training • Product Qualification • Compliance Verification • Grounding / Equipotential Bonding Systems • Personnel Grounding • ESD Protected Area (EPA) Requirements • Packaging Systems • Marking The ESD Control Program Plan is the principal document for implementing and verifying the Program. The goal is a fully implemented and integrated Program that conforms to internal quality system requirements. The ESD Control Program Plan **shall** apply to all applicable facets of the Organization's work.	*An ESD control program plan is a data requirement. Per MIL-STD-962, section 4.3, "Data can only be required in the contract." Requiring an ESD Control Program Plan is programmatic decision.* *Neither MIL-STD-1686B or MIL-STD-1686C address the requirements for:* • *Product qualification* • *Compliance verification* • *Grounding / equipotential bonding systems* • *Personnel grounding* • *Personnel safety* *in an ESD control program plan.*
		8.0 ESD CONTROL PROGRAM PLAN TECHNICAL REQUIREMENTS Sections 8.1 to 8.5 describe the key technical requirements used in the development of an ESD Control Program. The required limits are based on the test methods or standards listed in each table. The Compliance Verification Plan **shall** document the methods used to verify the limits.	*ESD control program technical requirements are not in either MIL-STD-1686B or MIL-STD-1686C.*
		8.1 Grounding / Equipotential Bonding Systems Grounding / Equipotential Bonding Systems **shall** be used to ensure that ESDS items, personnel and any other conductors that come into contact with ESDS items (e.g., mobile equipment) are at the same electrical potential. An implementing process **shall** be selected from Table 1.	*Grounding / equipotential bonding system requirements are not in either MIL-STD-1686B or MIL-STD-1686C.*
		Table 1. Grounding / Equipotential Bonding Requirements	
		8.2 Personnel Grounding All personnel **shall** be bonded or electrically connected to the grounding / equipotential bonding system when handling ESDS items. The personnel grounding method(s) **shall** be selected from Table 2. When personnel are seated at ESD protective workstations, they **shall** be connected to the grounding / equipotential bonding system via a wrist strap. For standing operations, personnel **shall** be grounded via a wrist strap or by a footwear/flooring system meeting the requirements of Table 2. When garments are used to achieve personnel grounding, it **shall** be documented in the ESD Control Program Plan. The garment **shall** have electrical continuity from one sleeve to the other and **must** also meet the wrist strap resistance requirements defined in Table 2 and the groundable static control garment system in Table 3.	*Personnel grounding requirements are not in either MIL-STD-1686B or MIL-STD-1686C.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
		Table 2. Personnel Grounding Requirement	
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 1.3.1).	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).		*This is a contractual matter and does not belong in a standard.*
5.2 Classification of ESDS parts, assemblies and equipment. The contractor **shall** identify each ESDS part, assembly and equipment applicable to the contract as class 1 or 2. ESDS classification data **shall** be used to ensure compliance with the requirements of 5.1, 5.3, 5.4, 5.5 and 5.9. Identification and classification of class 3 items **shall** be required for mission critical or essential parts, assemblies and equipment (see 1.3.2.1).	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.		*MIL-STD-1686C introduced three defined models: the Human Body Model (HBM), Machine Model (MM), and Charged Device Model (CDM) to characterize the ESD susceptibility of a part.* *MIL-STD-1686B used HBM exclusively, but never the term HBM.* *MIL-STD-1686C never specifies when to use CDM or MM* *MM testing no longer recommended. See ANSI/ESD S20.20, annex B, for more information.* *Neither ANSI/ESD S20.20, ANSI/ESDA/JEDEC JS-001, nor ANSI/ESDA/JEDEC JS-002 require ESDS classification of parts, assemblies or equipment.*
	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 3. HBM ESD Component Classification Levels** (from ANSI/ESDA/JEDEC JS-001) Classification / Voltage Range (V) 0Z: < 50 0A: 50 to < 125 0B: 125 to < 250 1A: 250 to < 500 1B: 500 to < 1000 1C: 1000 to < 2000 2: 2000 to < 4000 3A: 4000 to < 8000 3B: ≥ 8000	*Table 3 from ANSI/ESDA/JEDEC JS-001 tracks with section 5.2.1 from MIL-STD 1686B and table I from MIL-STD 1686C.*
	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 CDM: EOS/ESD-S5.3 MM: EOS/ESD-S5.2 † Order changed from the original.	**Table 4. ESD Susceptibility Test References for Devices** (from annex B*) ESD Model / ESD Standards and Methods for… HBM: ANSI/ESDA/JEDEC JS-001; MIL-STD-883 method 3015; MIL-STD-750 method 1020; MIL-PRF-19500; MIL-PRF-38535 CDM: ANSI/ESDA/JEDEC JS-002; JEDEC JESD22-C101	*ANSI/ESDA/JEDEC JS-001 supersedes EOS/ESD-S5.1* *ANSI/ESDA/JEDEC JS-002 supersedes EOS/ESD-S5.3*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
		MM (For Information Only) | ANSI/ESD STM5.2 JEDEC JESD22-A115 * Annex B is not part of ANSI/ESD S20.20-2014	*ESD SP5.2 supersedes EOS/ESD-S5.2 and ANSI/ESD STM5.2*
5.2.1 Sensitivity classification.	5.2.1 Part ESD sensitivity classes and classification.		
Class 1: Susceptible to damage from ESD voltages greater than 0 to 1,999 volts as determined in accordance with 5.2.1.1.	See table I, HBM class 1.		*ANSI/ESDA/JEDEC JS-001 table 3 has classes 0 and 1 (with subclasses) that cover 0 to < 2000 V.*
Class 2: Susceptible to damage from ESD voltages of 2,000 to 3,999 volts as determined in accordance with 5.2.1.1.	See table I, HBM class 2.		*ANSI/ESDA/JEDEC JS-001 table 3 has class 2 that covers 2000 to < 4000 V.*
Class 3: Susceptible to damage from ESD voltages of 4,000 to 15,999 volts as determined in accordance with 5.2.1.1.	See table I, HBM class 3.		*ANSI/ESDA/JEDEC JS-001 table 3 has class 3 (with subclasses) that covers 4000 to 16000+ V.*
NOTES: The classification voltage ranges defined above include both positive and negative polarities. For the purpose of this standard, parts, assemblies and equipment susceptible to ESD voltages of 16,000 volts or higher are considered non-ESD sensitive.			*Class 3B from ANSI/ESDA/JEDEC JS-001 table 3 is ≥ 8000 V.*
5.2.1.1 Parts. ESD sensitivity classification for parts **shall** be determined as follows:	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) ESD sensitivity as specified in the applicable part specification, or (b) ESD sensitivity in accordance with appendix A test data contained in the Reliability Analysis Center (RAC) ESD Sensitive Items List (ESDSIL), or	(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.		*RAC VZAP-95 data is at least 25 years old and its current validity is unknown.*
(c) Classified in accordance with appendix B, or			*Data in appendix B is 29 years old and does not reflect the updated HBM classification system of ANSI/ESDA/JEDEC JS-001 table 3.*
(d) When specified, or at the option of the contractor when not specified, determine sensitivity by test (see appendix A). ESD sensitivity test data reporting **shall** be in accordance with the data ordering document included in the contract or order (see 6.2).	(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 [EOS/ESD-S5.1, MIL-STD-883 method 3015, and MIL-STD-750 method 1020] listed in table II may be considered to be equivalent. The preferred test method is EOS/ESD-S5.1.		*ANSI/ESDA/JEDEC JS-001 supersedes EOS/ESD-S5.1 (which superseded appendix A) and is the preferred test method.*
Classification method/rationale **shall** be documented in the ESD control program plan. When a part is less sensitive than indicated in appendix B it **shall** be reclassified in accordance with 5.2.1.1 (a), (b) or (d).		Excerpt from 6.1, ESD Control Program Requirements: "The Program **shall** document the lowest level(s) of device ESD sensitivity that can be handled."	

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
	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.		*No requirement. Use of MM ESD sensitivity is at the discretion of the contractor. MM testing no longer recommended. See ANSI/ESD S20.20, annex B, for more information.*
	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.		*No requirement. Use of CDM ESD sensitivity is at the discretion of the contractor.*
5.2.1.2 Assemblies and equipment. Assembly and equipment ESD sensitivity classification **shall** be based upon the part sensitivity classification of the parts used in the assembly or equipment. When assemblies or equipment incorporate protective methods to meet the design protection requirements of 5.3, the assembly or equipment is classified at the design hardened voltage protection level. Guidance relating to the definition of the terms assembly and equipment will be provided by the acquiring activity upon request.	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.		*No requirement. Went from a **shall** in MIL-STD-1686B to a **should** in MIL-STD-1686C. Requiring assembly or equipment hardening is a programmatic decision.* *Beyond the scope of ANSI/ESD S20.20.*
5.3 Design protection. The minimum requirements for ESD design hardening of assemblies and equipment, at the assembly or equipment inputs, outputs, and interface connection points **shall** be:	TABLE III. ESD assembly/equipment design hardening goals.		*Went from a **shall** in MIL-STD-1686B to a **should** in MIL-STD-1686C.* *Beyond the scope of ANSI/ESD S20.20.*
Assemblies - 2,000 volts			*Voltage level should be a programmatic decision.*
Equipment - 4,000 volts			*Voltage level should be a programmatic decision.*
NOTE: Inputs, outputs and interface connection points are those points where the assembly or equipment is electrically connected to items external to the assembly or equipment.			

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.

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
5.3.1 Assemblies. Design hardening of assemblies **shall** be determined as follows:	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.		*Went from a **shall** in MIL-STD-1686B to a **should** in MIL-STD-1686C.* *No longer a requirement.*
(a) Assemblies containing only parts susceptible to damage from ESD voltages of 2,000 volts or greater **shall** be considered compliant with 5.3, or			
(b) Assemblies containing protective methods providing protection to ESD voltages of 2,000 volts or greater as determined by analytical techniques subject to the approval of the acquiring activity **shall** be considered compliant with 5.3, or			*IEEE STD C62.38-1994 withdrawn*
(c) When specified, or at the option of the contractor when not specified, compliance with 5.3 **shall** be demonstrated by Appendix C test. Appendix C testing is a destructive test.			*IEC 61000-4-2 supersedes IEC 801-2 (which superseded appendix C) and is the preferred test method.*
	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.		*IEEE STD C62.38-1994 withdrawn* *IEC 801-2 superseded by IEC 61000-4-2* *ANSI C63.16-1993 superseded by IEEE C63.16-2016*
5.3.2 Equipment. Design hardening of equipment **shall** be determined as follows:	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 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).		*Went from a **shall** in MIL-STD-1686B to a **should** in MIL-STD-1686C.* *No longer a requirement.*
(a) Equipment containing only parts and assemblies susceptible to damage from ESD voltages of 4,000 volts or greater **shall** be considered compliant with 5.3, or			
(b) Equipment containing protective methods providing protection to ESD voltages of 4,000 volts or greater as determined by analytical techniques subject to the approval of the acquiring activity **shall** be considered compliant to 5. 3, or			*ANSI C63.16-1993 superseded by IEEE C63.16-2016.*
(c) When specified or at the option of the contractor when not specified, compliance with 5.3-**shall** be demonstrated by Appendix C test. Appendix C testing is a destructive test.			*IEC 61000-4-2 supersedes IEC 801-2 (which superseded appendix C) and is the preferred test method.*
	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		*No requirement.* *ANSI C63.16-1993 superseded by IEEE C63.16-2016.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
	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).		
5.4 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 detailed ESD protective handling procedures (see 5.5). If there are practical considerations which preclude handling in the protected areas, detailed alternative handling precautions and procedures **shall** be prepared and utilized in the unprotected areas. Electrostatic voltages in areas where class 1, class 2 and (as specified in accordance with the requirements of 1.3.2.1) class 3 parts, assemblies and equipment are handled without protective covering or packaging **shall** be maintained below the lowest voltage sensitivity level of these items as determined in accordance with 5.2.1.1.	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.	**8.3 ESD Protected Areas (EPAs)** Handling of ESDS items, parts, assemblies and equipment without ESD protective covering or packaging **shall** be performed while in an EPA. The EPA **shall** have clearly identified boundaries. NOTE: An EPA can consist of a single workstation, entire room, building or other designated area. Access to the EPA **shall** be limited to personnel who have completed appropriate ESD training. Untrained individuals **shall** be escorted by trained personnel while in an EPA. An EPA **shall** be established wherever ESDS items are handled. However, there are many different ways to establish ESD controls within an EPA. Table 3 lists some optional ESD control items which can be used to control static electricity. For those ESD control items that are selected for use in the ESD Control Program, the required limits and test methods for those items become mandatory.	
		8.3.1 Insulators All nonessential insulators such as coffee cups, food wrappers and personal items **shall** be removed from the EPA. The ESD program **shall** include a plan for handling process-required insulators in order to mitigate field-induced CDM damage. If the field measured on the process required insulator is greater than 2000 volts/inch and the process required insulator is less than 30 cm (12 inches) from the ESDS item, steps **shall** be taken to either: (a) Separate the required insulator from the ESDS item by a distance of greater than 30 cm (12 inches); or (b) Use ionization or other charge mitigating techniques to neutralize the charge. If the field measured on the process required insulator is greater than 125 volts/inch and the process required insulator is less than 2.5 cm (1 inch) from the ESDS item, steps **shall** be taken to either: (a) Separate the required insulator from the ESDS item by a distance of greater than 2.5 cm (1 inch); or (b) Use ionization or other charge mitigating techniques to neutralize the charge.	*These requirements are not in either MIL-STD-1686B or MIL-STD-1686C.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
		NOTE: The accurate measurement of electrostatic fields requires that the person making the measurement is familiar with the operation of the measuring equipment. Most hand held meters require that the reading be taken at a fixed distance from the object. They also normally specify that the object has a minimum dimension of fixed size in order to obtain an accurate reading.	
		8.3.2 Isolated Conductors When establishing an ESD Control Plan, if a conductor that comes into contact with an ESDS item cannot be grounded or equipotentially bonded, then the process **must** ensure that the difference in potential between the conductor and the contact of the ESDS item is less than 35 volts. This can be accomplished by measuring the ESDS item and the conductor by using a non-contact electrostatic voltmeter or a high impedance contact electrostatic voltmeter.	*This requirement is not in either MIL-STD-1686B or MIL-STD-1686C.*
		Table 3. EPA ESD Control Items	
5.5 Handling procedures. ESD protective handling procedures **shall** be developed, 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, tested, packaged or handled. Handling procedures **shall** be prepared and submitted for approval in accordance with the data ordering document included in the contract or order (see 6.2).	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.		*Handling procedures is not a separate section in ANSI/ESD S20.20. See 2.0 Scope, which identified that ANSI/ESD S20.20 covers "electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges."*
5.5.1 Equipment level installation and storage. For equipment level installation and storage functions only, the following additional installation procedures **shall** apply: (a) Where storage is required prior to installation, the ESD protective covering or packaging **shall** be maintained intact. (b) ESD protective covering or caps on external equipment cabinet terminals, interconnecting cables, and connector assemblies **shall** not be removed until just prior to installation. (c) Prior to engaging a de-energized connector and cable with a mating receptacle connected to an ESDS item, the connector pins and the cable shield (connector outer shell) **shall** be grounded to discharge any electrostatic potentials. Interconnecting cables terminated on one end to an ESDS item **shall** be handled as an ESDS item in accordance with 5.5.			*Not included in MIL-STD-1686C.*
5.6 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 5.10. Guidance related to protective covering is provided in MIL-HDBK-263.	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.		*Protective covering is not a separate section in ANSI/ESD S20.20. Section 8.4, Packaging, covers most protective covering requirements. Other protective covering requirements are in ANSI/ESD S541.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
5.7 Training. Recurrent ESD training **shall** be provided to all personnel who perform or supervise any of the applicable functions or elements listed in table I. Personnel training records **shall** be made available to the acquiring activity or its designated representative for on-site review upon request (see 6.2).	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.	**7.2 Training Plan** Initial and recurrent ESD awareness and prevention training **shall** be provided to all personnel who handle or otherwise come into contact with any ESD sensitive (ESDS) items. Initial training **shall** be provided before personnel handle ESDS items. The type and frequency of ESD training for personnel **shall** be defined in the Training Plan. The Training Plan **shall** include a requirement for maintaining employee training records and **shall** document where the records are stored. Training methods and the use of specific techniques are at the Organization's discretion. The training plan **shall** include the methods used by the Organization to verify trainee comprehension and training adequacy.	*A Training Plan is a data requirement. Per MIL-STD-962, section 4.3, "Data can only be required in the contract." Requiring a Training Plan is programmatic decision.*
5.8 Marking of hardware. Unless otherwise specified (see 6.1), marking **shall** be as follows.	5.7 Marking of hardware. Marking **shall** be as specified in the following:	**8.5 Marking** ESDS items, system or packaging marking **shall** be in accordance with customer contracts, purchase orders, drawing or other documentation. When the contract, purchase order, drawing or other documentation does not define ESDS items, system or packaging marking, the Organization, in developing the ESD Control Program Plan, **shall** consider the need for marking. If it is determined that marking is required, it **shall** be documented as part of the ESD Control Program Plan.	*Marking requirements for ANSI/ESD S20.20 are contractually driven. The contractor may define marking requirements when such requirements are not in the contract or the technical data.*
5.8.1 Parts. ESDS parts **shall** be marked with the EIA RS-471 symbol as illustrated on figure 1.			*MIL-STD-1285 identifies ESDS marking requirements for electrical and electronic parts.* *JESD471 superseded EIA RS-471.*
5.8.2 Assemblies. ESDS assemblies **shall** be marked with the EIA RS-471 symbol as illustrated on figure 1. 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.	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.		*???* *JESD471 superseded EIA RS-471.*
FIGURE 1. (RS-471) Electrostatic discharge symbol.	FIGURE 2. (RS-471) Electrostatic discharge symbol.		*JESD471 superseded EIA RS-471.*
5.8.3 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 ESDS symbol: CAUTION CONTAINS PARTS AND ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD)	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.		*MIL-STD-130 identifies ESDS marking requirements for military equipment.* *JESD471 superseded EIA RS-471.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
5.8.3.1 External equipment terminals. The EIA RS-471 symbol **shall** be applied on the exterior of the equipment cabinet adjacent to external terminals connected internally to ESDS parts and assemblies.			*Not included in MIL-STD-1686C.* *JESD471 superseded EIA RS-471.*
5.9 Documentation.			
5.9.1 Deliverables. Deliverable documentation **shall** identify class 1, 2 and (as specified in accordance with the requirements of 1.3.2.1) class 3 parts, assemblies, equipment, and connectors, test points and terminals connected to ESDS parts and assemblies collectively as ESDS. Additionally, the above documentation **shall** include or refer to documented ESD protective procedures.			*Contractual matter. Not included in MIL-STD-1686C.*
5.9.2 Non-deliverables. Non-deliverable documentation used by the contractor for implementation of an ESD control program **should** identify class 1, 2 and (as specified in accordance with the requirements of 1.3.2.1) class 3 parts, assemblies and equipment collectively as ESDS. At the contractor's option, exact classification data may be included in lieu of collective identification. Documentation, as appropriate, **should** include or incorporate by reference, documented ESD protective procedures.			*No requirement.*
5.10 Packaging. Unless otherwise specified (see 6.1), ESD protective packaging **shall** be in accordance with MIL-E-17555 for ESDS items. In addition, ESD protective caps **shall** be used on equipment external connectors that are connected to ESDS parts and assemblies within the equipment.	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, K8 or KS for ESDS items.	**8.4 Packaging** The organization **shall** define ESD protective packaging requirements, both inside and outside the EPA per ANSI/ESD S541 or in accordance with the contract, purchase order, drawing or other documentation necessary to meet customer requirements. NOTE: When ESDS items are placed on packaging materials and the ESDS items have work being performed on them, then the packaging materials become worksurfaces. The worksurface requirements for resistance to ground apply.	*MIL-STD-2073-1 is the DoD standard for packaging including ESD.*
5.11 Quality assurance requirements. Quality assurance requirements **shall** be established to periodically verify conformance to this standard and the approved ESD control plan. These requirements **shall** include periodic monitoring and auditing of ESD requirements invoked on subcontractors, suppliers, and vendors.			
5.11.1 Preparation of internal quality records. The contractor **shall** prepare and maintain internal records of each periodic quality evaluation performed to ensure compliance with the approved ESD control program plan. These records **shall** identify the date of the evaluation, evaluation participants, items or activities reviewed, objectives of the evaluation, all detected problems, and any recommendations and corrective actions resulting from the evaluation.			
5.11.2 Internal quality reporting. The contractor **shall** prepare periodic internal reports that provide to contractor management the results and recommendations from the quality evaluations			

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
specified herein. The quality evaluation reports **should** identify the activities performed, all detected problems, necessary remedial action, identified trends in the problems reported, and recommended changes to improve quality.			
5.12 Formal reviews and audits. The contractor **shall** evaluate the planning and preparation performed for each formal review and audit in 5.12.1 and 5.12.2 to ensure that all required documentation **will** be available and ready for Government review. The acquiring activity reserves the right to perform audits and to review documentation specified herein as required to determine conformance to the requirements specified in this standard. The contractor's scheduled design and program reviews **shall** include ESD control program requirements. The acquiring activity or designated representatives **shall** be accorded the option to attend such reviews. The minutes of these reviews and audits **will** be made available at the contractor's facility upon request.	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.		*Went from a **shall** in MIL-STD-1686B to a **should** in MIL-STD-1686C.* *No longer a requirement.*
5.12.1 Design reviews. Design decisions relating to the ESD control program **shall** be presented at design reviews and **shall** include the following: (a) Identification of class 1, 2 and (as specified in accordance with 1.3.2.1) class 3 parts, assemblies and equipment and ESDS external terminals (see 5.2.1 and 5.9). (b) Results of classification circuit analysis for assemblies and equipment when applicable (see 5.3.2). (c) Protective circuitry for assemblies (see 5.3.1) and equipment connectors, terminals and test points (see 5.3.2). (d) Marking of documentation including incorporation of protective handling procedures (see 5.9). (e) Marking of hardware (see 5.8). (f) Problem areas relevant to meeting the requirements of this standard and proposed corrective actions including tradeoffs and analysis. (g) Part selection, classification method and rationale.			
5.12.2 Program reviews. Progress **shall** be assessed by the review of: (a) ESD control program plan implementation (see 4.1). (b) General design, construction and maintenance requirements for protected areas (see 5.4). (c) Protective procedures used-to control the handling of ESDS parts, assemblies and equipment (see 5.5).			

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
(d) Quality assurance methods and procedures for monitoring the continued effectiveness of protected areas (see 5.11). (e) Quality assurance methods and procedures for performing audits of the ESD control program (see 5.11.and 5.12). (f) Contractor recurrent training program (see 5.7). (g) Protective covering and packaging of ESDS parts, assemblies and equipment (see 5.6 and 5.10). (h) Problem areas in meeting the requirements of this standard and proposed corrective actions including tradeoffs and analysis.			
5.13 Failure analysis. When MIL-STD-785, Task 104 or Task 301 is invoked by the data ordering document included in the contract or order, the failure analysis **shall** include as a factor, ESD related failure modes an effects analysis, and recommendations for corrective action.	5.10 Failure analysis. Failure analysis, when performed, **should** consider ESD related failure modes and effects as part of the failure analysis.		*No requirement. Failure analysis is a programmatic decision.*
6. NOTES	6. NOTES		
	(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*
	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.		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*
6.1 Implementation guidance. When this standard is invoked, the following **should** be specified: (a) If marking of hardware is other than specified (see 5.8). (b) If packaging is other than specified (see 5.10). (c) Whether equipment is mission critical or mission essential (see 1.3.2.1). (d) Whether part, assembly or equipment testing is required (see 5.2.1.1(d), 5.3.1(c) and 5.3.2(c)).			*Now "Acquisition requirements", paragraph 6.2, per MIL-STD-962. Not applicable for an NGS.*
6.2 Data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below **shall** be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the			*The DIDs were not included in MIL-STD-1686C. Section is no longer applicable.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
approved CDRL incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.475-1 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below **shall** be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.			
DI-RELI-80669 Electrostatic discharge control program plan (refer to 5.1)			*Cancelled January 2021*
DI-RELI-80670 Reporting results of electrostatic discharge sensitivity tests of electrical and electronic parts (refer to 5.2.1.1(d), Appendix A 40.1.1)			*Cancelled January 2021*
DI-RELI-80671 Handling procedures for electrostatic discharge sensitive items (refer to 5.5 and 5.7)			*Cancelled January 2021*
(Data item descriptions related to this standard, and identified in section 6 **will** be approved and listed as such in DoD 5010.12-L, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions **should** be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)			
		7.3 Product Qualification Plan A Product Qualification Plan **shall** be established to ensure that the ESD control items that have been selected meet the requirements in the plan. The test methods and required limits are located in the product qualification columns in Tables 2 and 3. Product qualification is normally conducted during the initial selection of ESD control items. Any of the following methods can be used: product specification review, independent laboratory evaluation or internal laboratory evaluation. For ESD control items that were installed by the Organization before the adoption of this standard, on-going compliance verification records can be used as evidence of product qualification.	*A Product Qualification Plan is a data requirement. Per MIL-STD-962, section 4.3, "Data can only be required in the contract." Requiring a Product Qualification Plan is programmatic decision.*
		7.4 Compliance Verification Plan A Compliance Verification Plan **shall** be established to ensure the Organization's fulfillment of the technical requirements of the ESD Control Program Plan. Measurements **shall** be conducted in accordance with a Compliance Verification Plan that identifies the technical requirements to be verified, the measurement limits and the frequency at which those verifications occur. The Compliance Verification Plan **shall** document the test methods and equipment used for making the measurements. If the test methods used by the Organization differ from any of the standards referenced in this document, then there **must** be a tailoring statement that is documented as part of the ESD Control Program Plan. Compliance verification records **shall** be established and maintained to provide evidence of conformity to the technical requirements. The test equipment selected **shall** be capable of making the measurements defined in the Compliance Verification Plan.	*A Compliance Verification Plan is a data requirement. Per MIL-STD-962, section 4.3, "Data can only be required in the contract." Requiring a Compliance Verification Plan is programmatic decision.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
	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).		*Obsolete section.*
6.3 Subject term (key word) listing. Electrical Electronic parts Electrostatic Electrostatic discharge (ESD) Electrostatic discharge sensitive (ESDS) ESD control program	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		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*
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.	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.		*DoD required paragraph per MIL-STD-962. Not applicable for an NGS.*

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
APPENDIX A - CLASSIFICATION TESTING			*MIL-STD-1686C replaces appendix A with EOS/ESD-S5.1 as the preferred test method for HBM ESD sensitivity (see table II). EOS/ESD-S5.1 has been superseded by ANSI/ESDA/JEDEC JS-001.*
10. GENERAL REQUIREMENTS			
10.1 General. This appendix establishes the criteria and procedure for identifying class 1, 2 and 3 parts by test (see 5.2.1.1(d)).			
20. REFERENCED DOCUMENTS			
STANDARDS - MILITARY			
MIL-STD-750 - Test Methods for Semiconductor Devices.			*Remains a valid test method*
MIL-STD-883 - Test Methods and Procedures for Microelectronics			
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)			*Cancelled January 2021 (Superseded ESD TR20.20).*
(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.)			
30. DEFINITIONS			
Definitions **shall** comply with this standard and MIL-HDBK-263.			*MIL-HDBK-263 has been cancelled. ESD ADV1.0 has current definitions.*
40. PART APPLICABILITY REQUIREMENTS			
40.1 General. ESD classification of a part by test (see 5.2.1.1(d)) **shall** be as specified herein. The acquiring activity **shall** be notified of the schedule for testing and **shall** have the right to witness the testing and review the test data. Classification testing of a part **shall** be considered as destructive testing. Tested parts **shall** not be used in deliverable hardware.			
40.1.1 Classification test reports. Classification test reporting **shall** be in accordance with the data ordering document included in the contract or order (see 6.2).			
50. DETAIL REQUIREMENTS			
50.1 Test procedure. Electrostatic discharge sensitivity classification testing **shall** be as specified in 50.1.1 and 50.1.2.			

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
50.1.1 Test method for microcircuits. Microcircuits **shall** be tested and classified using the test procedure and pin combinations in accordance with MIL-STD-883, method 3015.			
50.1.2 Test method for discrete semiconductor devices. Discrete semiconductor devices **shall** be tested and classified using the test procedure and pin combinations in accordance with MIL-STD-750, method 1020.			
50.1.3 Test method for all other parts. All other parts **shall** be tested and classified using the test procedures specified in MIL-STD-883, test method 3015 and the pin combinations specified in table II unless specified by the applicable part specification.			
TABLE II. Pin combinations for all other parts. Resistors: Terminal (+) to terminal (-) Diodes: Anode (+) to cathode (-); Anode (-) to cathode (+) Transistors: Emitter to base (1); Base to collector (1) MOS FETs and JFETs: Gate to source (1); Gate to drain (1) (1) Both polarity (+) to (-) and (-) to (+).			

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
APPENDIX B - ESDS PARTS			*Appendix B does not reflect the changes to the ESD sensitivity levels over the past 29 years. Nor does it reflect the addition of class 0 and the inclusion of subclasses shown in ANSI/ESDA/JEDEC JS-001 table 3.*
10. GENERAL REQUIREMENTS			
10.1 General. This appendix identifies the class 1, 2 and 3 parts by part type applicable to the ESD control program requirements of this standard.			
20. REFERENCED DOCUMENTS			
Not applicable.			
30. DEFINITIONS			
The definitions of terms not defined herein **shall** be in accordance with MIL-HDBK-263.			*MIL-HDBK-263 has been cancelled. ESD ADV1.0 has current definitions.*
40. PART APPLICABILITY REQUIREMENTS			
40.1 Application. The ESDS parts applicable to this standard are listed in table III. These parts are classified by part types and sensitivity ranges.			
50. DETAIL REQUIREMENTS			
50.1 Class 1, 2 and 3 parts. Table III identifies class 1, 2 and 3 part types (see 5.2). Classifications presented are based upon available test data and reports on representative parts of a given part type. Differences in part design, fabrication techniques, or protective circuitry may result in the sensitivity of a part being outside the range specified in table III.			
50.2 Part type classification. Appendix A test data, when available, **shall** supersede table III part type classification.			

TABLE III. List of ESDS parts by part type.

Class 1: Sensitivity range of 0 to 1,999 volts

Part type
Microwave devices (Schottky barrier diodes, point contact diodes, and other detector diodes >1 GHz)
Discrete MOSFET devices
Surface acoustic wave (SAW) device
Junction field effect transistors (JFETs)
Charged coupled devices (CCDs)
Precision voltage regulator diodes (line or load voltage regulation < 0.5 percent)
Operational amplifiers (OP AMPs)
Thin film resistors

Integrated circuits
Hybrids utilizing class 1 parts
Very high speed integrated circuits (VHSIC)
Silicon controlled rectifiers(SCRs) with I_o, < 0.175 amp at 100°C ambient

TABLE III. List of ESDS parts by part type - Continued.

Class 2: Sensitivity range of 2 ,000 to 3,999 volts

Part type
Devices or microcircuits when identified by appendix test data as class 2: Discrete MOSFET devices JFETs Operational amplifiers (OP AMPs) Integrated circuits (ICs) Very high speed integrated circuits (VHSIC)
Precision resistor networks (type RZ)
Hybrids utilizing class 2 parts
Low power bipolar transistors, P_T, ≤ 100 milliwatts with I_o, < 100 milliamps

TABLE III. List of ESDS parts by part type - Continued.

Class 3: Sensitivity range of 4 ,000 to 15,999 volts

Part type
Devices or microcircuits when identified by appendix test data as class 3: Discrete MOSFET devices JFETs Operational amplifiers (OP AMPs) Integrated circuits (ICs) Very high speed integrated circuits (VHSIC)
All other microcircuits not included in class 1 or class 2
Small signal diodes with power <1 watt or I_o, < 1 amp
General purpose silicon rectifiers
SCRs with I, > 0.175 amp
Low power bipolar transistors with 350 milliwatts > P_T > 100 milliwatts and 400 milliamps > I_o, > 100 milliamps
Optoelectronic devices (LEDs, phototransistors, opto couplers)
Resistor chips
Hybrids utilizing class3 parts
Piezoelectric crystals

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
APPENDIX C - ESD SUSCEPTIBILITY TESTING OF ASSEMBLIES AND EQUIPMENT			*MIL-STD-1686C replaces appendix C with IEC 801-2 as the preferred test method (see table IV). IEC 801-2 has been superseded by IEC 61000-4-2.*
10. GENERAL REQUIREMENTS			
10.1 General. This appendix establishes the criteria and procedures for ESD testing of assemblies at 2,000 volts and equipment at 4,000 volts (see 5.3).			
20. REFERENCED DOCUMENTS			
STANDARD - MILITARY			
MIL-STD-883 - Test Methods and Procedures for Microelectronics			
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)			*Cancelled January 2021 (Superseded by ESD TR20.20).*
(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.)			
30. DEFINITIONS			
Definitions **shall** comply with this standard and MIL-HDBK-263.			*MIL-HDBK-263 has been cancelled. ESD ADV1.0 has current definitions.*
40. ASSEMBLY/EQUIPMENT TEST APPLICABILITY REQUIREMENTS			
40.1 General. ESD susceptibility testing of assemblies or equipment (see 5.3.1(c), 5.3.2(c)) **shall** be as specified herein. The acquiring activity **shall** be notified of the schedule for testing and have the right to witness the testing and review the test data. Testing of assemblies or equipment **shall** be considered destructive testing. Tested assemblies or equipment **shall** not be used in deliverable hardware.			
50. DETAIL REQUIREMENTS			
50.1 ESD simulator requirements. Testing **shall** be performed with an apparatus that meets the circuit and waveform verification requirements inclusive of all necessary cables, probes, etc., of MIL-STD-883, method 3015.			
50.2 Waveform verification. The current waveform of the ESD pulse **shall** be verified per MIL-STD-883, method 3015, at the output of the ESD simulator and recorded. The output of the			

MIL-STD-1686B	MIL-STD-1686C	ANSI/ESD S20.20-2014 ©	*Comments*
simulator is inclusive of all cables, probes and other devices used to deliver the waveform to the assembly or equipment under test.			
50.3 Assembly or equipment ESD contact points. All assembly or equipment inputs, outputs, and interface connection points.			
50.4 Test set-up. All connectors **will** be disconnected. Terminal B of the method 3015 ESD classification test circuit **shall** be connected to the assembly or equipment ground. Terminal A **shall** be connected to each connection point under test.			
50.5 Test voltages.			
50.5.1 Assembly. Set the simulator charging voltage Vs to 2,000 volts.			
50.5.2 Equipment. Set the simulator charging voltage Vs to 4,000 volts.			
50.6 Test conditions. Each assembly or equipment **shall** be stabilized for 24 hours at room temperature prior to and during testing.			
50.7 Test procedures. The assembly or equipment **shall** be tested prior to start of the test to ensure it meets all applicable performance requirements. Each connection point of the assembly or equipment **shall** be individually and sequentially connected to the test simulator and subjected to three positive 2,000 (for assemblies) or 4 ,000 (for equipment) volt pulses, respectively. A minimum 3 second delay **shall** separate the pulses. This procedure **shall** be repeated with three negative voltage pulses. Upon completion of the assembly or equipment ESD test, the assembly or equipment **shall** again be tested to ensure it meets all applicable performance requirements.			
50.8 Failure criteria. The assembly or equipment **shall** be determined to have failed the test if it fails to meet any of its applicable performance requirements subsequent to ESD testing.			