

Electrostatic Discharge Control Program

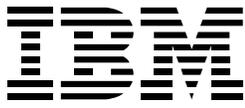
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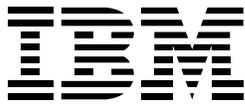
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Introduction

1. Scope

1.1 Abstract

This Standard covers the considerations necessary to design, establish, implement, and maintain an ESD control program for all IBM locations where ESD Sensitive (ESDS) devices are handled. This document covers the minimum elements that are required to establish an effective ESD program. This standard will protect devices with a withstand voltage of 100 volts using a Human Body Model waveform. Devices more sensitive may require additional controls. It is based on the historical experience of both military and commercial organizations as well as IBM's own experience. This document has been written to comply with industry ESD standard - ANSI/ESD S20.20-1999.

The fundamental ESD control principles that form the basis of this document are as follows:

- 1) All conductors in the environment, including personnel, must be bonded electrically either to earth ground or another conducting body (which may be isolated from earth ground) which provides an equal potential balance between all items and personnel. Electrostatic protection can be maintained at a potential above a "zero" voltage ground potential as long as all items in the system are at the same potential.
- 2) Charged nonconductors may potentially damage ESDS devices through a process called "induction." Ionization or other charge reduction techniques may be required if the measured static field exceeds the limits established in this standard.
- 3) Transportation of ESDS items outside an Electrostatic Protected Area (EPA) requires the use of ESD protective packaging.

For the purposes of this Standard, it shall be assumed that all electronic devices are ESD sensitive.

1.2 Objective

This standard covers the minimum ESD requirements for any IBM facility where unprotected ESD Sensitive (ESDS) products are handled. The controls referenced in this document have been selected to ensure that ESD sensitive devices will not be damaged. Additional controls if required shall be documented in the Site (local) ESD Control Program Plan (procedure).

1.3 Application

This Standard applies to all IBM locations and processes where unprotected ESDS products are handled.

1.4 Effective Date

This document takes effect with its publication.

2. Document Administration

2.1 Originating Area and Responsibility

This document was developed and issued by Corporate Standards Project Authority (SPA) for:

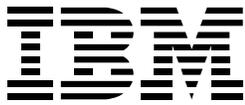
SIRS Code: 082 (Electrostatic Discharge Protection)
Location Code: 980 (Rochester, MN)
Division: ESG
SCRL Group: C2
Page Count: 8

2.2 Authorization

Publication of this document was approved by the standards authorities of all affected operating units.

2.3 Compliance

- Compliance with this document is required by: All Sites.
- Compliance with the requirements of this document will be determined by: Initial - Corporate Certification of each IBM Location.
- Ongoing - Compliance Verification Audits performed by each site.



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2.4 Property Statement

This document is the property of IBM. Its use outside IBM is authorized only for responding to a request for quotation or for the performance of work for IBM. All supplier/vendor questions must be referred to the IBM purchasing department.

3. Related Documentation

3.1 Superseded Documents

C-S 2-0001-702, dated 1991-01.

3.2 Referenced External Standards

ANSI/EOS/ESD S3.1-1991

ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items - Ionization

ANSI/EOS/ESD S6.1-1991

ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items - Grounding

ANSI/ESD S20.20-1999

*ESD Association Standard for the Development of an Electrostatic Discharge Control Program
ESD Association - 7900 Turin Rd. Building 3, Suite 2 - Rome NY 13440-2069 (315) 339-6937*

EOS/ESD S11.11- 1993

ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items - Surface Resistance Measurement of Static Dissipative Planar Materials

ESD S1.1- 1998

ESD Association Standard for the Protection of ESD Susceptible Items - Wrist Straps

ESD S4.1-1997

ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items - Work Surfaces

ESD S7.1- 1994

ESD Association Standard for Protection of Electrostatic Discharge Resistive Characterization of Floor Materials

ESD S9.1-1995

ESD Association Standard for Protection of Electrostatic Discharge Susceptible Items - Footwear - Resistive Characterization

ESD S11.31- 1994

ESD Association Standard for Evaluating the Performance of Electrostatic Discharge Shielding Materials - Bags

ESD STM 2.1-1997

ESD Association Standard Test Method for the Protection of ESD Susceptible Items - Garments

ESD STM 12.1-1997

ESD Association Standard Test Method for the Protection of ESD Susceptible Items - Seating - Resistive Measurement

ESD STM 97.1-1999

ESD Association Standard Test Method for the Protection of ESD Susceptible Items - Floor Material and Footwear - Resistive Measurement in Combination with a Person

ESD STM 97.2-1999

ESD Association Standard Test Method for the Protection of ESD Susceptible Items - Floor Material and Footwear - Voltage Measurement in Combination with a Person

3.3 Referenced IBM Documents

C-S 2-0001-701

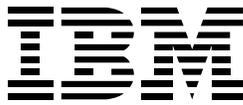
Electrostatic Discharge Protection (ESDP) for Tooling

C-H 2-0001-703

Packaging of Electrostatic Discharge Sensitive Components

3.4 Copyright Permission

Not applicable.



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Requirements

4. External Standards

The ESD Association Standards listed in Section 3.2 on page 2 provide the industry recognized test method for testing ESD controls. These are the test methods that have been and are presently used within IBM.

5. Safety Regulations

All site safety and local country regulations applicable to handling and testing of ESD-sensitive parts shall be observed.

6. Electrostatic Discharge (ESD) Event

ESD is sudden transfer of charge between two objects at different electrical potentials. Static charge is generated by contact and separation of two materials or flow of liquids, solids, or gases. Common sources of ESD include personnel, items of plain plastic, furniture, processing equipment, and so on. ESD can damage parts by direct contact with a charged source or from charges induced by an electrostatic field. ESD can cause catastrophic, latent, and upset failures. **Catastrophic failures** are when a device has been exposed to ESD and it no longer is functional. **Latent failure** is a failure that occurs in time as a result of an earlier ESD event to that device. **Upset failures** are when the normal operation is interrupted due to ESD causing the system, tester, and so on, to be restarted. No damage to any device is encountered by this type of failure.

7. ESD Control Program

Each IBM location that handles ESDS products shall establish, document, and verify the effectiveness of the local ESD program. This shall be accomplished by implementing the requirements of this Standard in addition to documenting the unique aspects of the local ESD Program.

The ESD Control Program is divided into three main topic areas:

- 1) ESD Control Program Administrative Elements - Required
- 2) ESD Control Program Technical Elements - Required

- 3) Optional ESD Control Program Technical Elements

A single ESD control program cannot be mandated for all applications (manufacturing, test, field, and so on). *“Tailoring” is accomplished by evaluating the applicability of each requirement for the specific application. Upon completion of the evaluation, requirements may be added, modified, or deleted. Tailoring decision(s), including rationale, shall be documented and approved by the SPA for ESDP.*

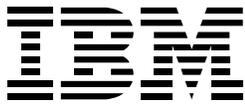
7.1 ESD Control Program Administrative Elements (Required Section)

7.1.1 ESD Control Program Plan. Each location shall prepare a plan that addresses each of the elements of the ESD Control Program. The ESD Control Program Plan (site procedure) is the principle document for implementing and verifying local compliance with this Standard. The Plan shall address the requirements as described herein and applies to all applicable facets of the local Organization. The local ESD Control Program plan must be reviewed and approved by the Corporate SPA for ESDP. A copy of the program plan must be on file with the SPA as well.

As part of the local ESD program plan, an ESD Coordinator is required for each IBM location. The local ESD Coordinator shall have the following responsibilities.

- 1) Develop and implement the local ESD program.
- 2) Coordinate the Compliance Verification audits and subsequent reports.
- 3) Act as a local consultant for any ESD related issues.

7.1.2 Training Plan. Initial and recurrent ESD training shall be provided to all personnel who handle or otherwise come into contact with any ESDS items. Records for both initial and refresher training shall be kept for a minimum period of 24 months. The location of the training records shall be documented in the local ESD Control Program Plan.



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7.1.2.1 Initial Training. All IBM personnel who handle or come into contact with ESD products shall receive instruction concerning the local IBM ESD Handling Procedures. The instruction can be in the form of either a class with an instructor or an approved, computer based training program that addresses all of the elements of the local ESD program as well as an awareness of basic ESD principles. The training shall be conducted before any personnel handles ESDS products without direct supervision. An objective evaluation technique to ensure employee comprehension should be given to all employees that handle ESD sensitive Products.

7.1.2.2 Refresher Training. All IBM personnel who handle or come into contact with ESDS products shall receive refresher training. The frequency of the training shall be defined but not to exceed 24 months. The course can be in the form of a class with an instructor or an approved computer based training program that addresses all of the elements of the local ESD program as well as an awareness of basic ESD principles. Basic ESD principles shall also be included in the refresher course. An objective evaluation technique to ensure employee comprehension should be given to all employees that handle ESD sensitive products.

7.1.3 Compliance Verification Plan. Each IBM location shall establish a Compliance Verification Plan. The purpose of the plan is to ensure that the location is in compliance with the requirements that are set out in the Local ESD Program. The Verification Plan shall consist of documented audits as well as the individual Technical Element Verification Checks. The frequency of the checks should be based on the element's usage, its durability and the associated risk of failure. Test equipment capable of accurately measuring the desired parameters shall be used.

The local ESD Coordinator will determine the Technical Element Verification check frequency. Documented audits shall be performed, at a minimum, on a quarterly basis.

Audit findings shall be documented and all corrective actions verified. The audit reports shall be issued to the appropriate location management. The local ESD Coordinator is responsible for tracking audit results

and initiating corrective actions when negative trends are identified.

7.2 ESD Control Program Technical Elements (Required Section)

There are certain Critical ESD Program items that each IBM site that handles ESDS products shall implement and document as part of the local ESD Control Program Plan.

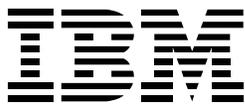
7.2.1 Grounding. Grounding/bonding systems shall be used to ensure that ESDS products, personnel and any other conductors (such as, mobile equipment) are at the same electrical potential. AC equipment ground is the preferred choice for electrical Ground. Where multiple ESD control items are used together (such as, ESD floor mat, ESD work surface and an overhead shelf) the Common Point Ground system as described in ANSI/EOS/ESD S6.1 shall be used.

If a facility utilizes an existing earth grounding rod system, the grounding rods shall be bonded to the AC electrical ground system.

In the event that electrical ground is NOT available, it is permissible to establish an ESD safe environment by bonding all of the process elements (work surface, personnel, floor mat and so on) to a common point. This action will ensure that the ESD control elements, personnel, and the ESDS product are at the same electrical potential. In the situation where electrical bonding is used, the resistance between all bonded elements shall be less than 1×10^9 ohms.

7.2.2 Personnel Grounding. All personnel (when handling ESDS products) shall be electrically connected to AC ground via either a wrist strap system or through a combination of ESD flooring and ESD Footwear. All personnel that handle ESDS products while seated shall be connected to ground via a wrist strap system.

Note: If heel straps are used in the process as a means to ground the employee, it must be noted that the charge generation on the person's body can be as high as 600 volts when walking. Due to this type of voltage being generated, heel straps will not be allowed to be used when carrying any electronic product that is not in the proper ESD packaging.



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7.2.3 Protected Area. Handling of ESD sensitive parts, assemblies, and equipment without ESD protective covers or packaging shall only be performed in an ESD protected area (EPA) or at an ESD protective workstation.

7.2.3.1 Signs. For EPAs, caution signs indicating the boundaries of the EPA shall be posted and clearly visible to personnel prior to entry to the protected area. Any person that enters the EPA shall comply with the local ESD control guidelines.

Exception: The only exception to this requirement involves maintenance or contractor personnel that are exposed to hazardous electrical voltages.

7.2.3.2 Static Generators. The following requirements apply to the presence of static generators within an ESD protected area or at an individual workstation.

- 1) Nonessential insulators (such as, Plastics, personal items) shall be removed from any process where ESDS devices are handled.
- 2) Any process essential insulators may remain at any process step where ESDS devices are handled as long as the measured static fields from these items does not exceed 2,000 volts. If the measured static field exceeds 2,000 volts these items should be kept a minimum distance of 30 cm (12 inches) from the ESD sensitive Product. If it is not possible to meet the minimum distance requirement air ionization may be required. The site ESD Coordinator should determine whether or not the charged source poses a threat to ESDS products at this process step and take appropriate action.

Guidance: The accurate measurement of static fields requires that the person making the measurement be 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. Most meters also require that the object being measured has a minimum dimension in order to get an accurate reading.

7.2.4 Packaging. When ESDS parts are not in a EPA they shall be enclosed in ESD protective packaging for protection from triboelectric charge, direct contact with charged objects, and electrostatic fields. ESD-sensitive items may be removed from ESD protective packaging only by personnel using appropriate ESD static control measures as noted in this standard and only at a ESD protected workstation using appropriate personnel measures, or using an ESD Static Control Field Kit.

Guidance: The following rules should be considered when selecting ESD protective packaging for uncovered ESDS products:

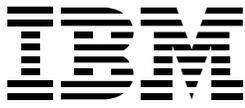
- 1) Within a totally controlled EPA (grounded employees/conductive flooring, and so on) the ESDS products may be hand carried (as long as the peak body voltage does not exceed 100 volts), but when stored place in a electrostatic discharge (ESD) shielding bag or conductive container.
- 2) When transporting between ESD protective workstations where personnel are NOT grounded by use of ESD shoes and conductive flooring, use electrostatic discharge (ESD) shielding bags or conductive containers.
- 3) For shipments between IBM locations, to field locations, distribution centers, from subcontractors (vendors), to the customer use electrostatic discharge (ESD) shielding bags or conductive containers.

All ESDS parts shipped and labeled as ESD sensitive as outlined in C-H 2-0001-703. Only IBM Approved ESD shielding bags and materials can be used. See ESDP Intranet Web page for listing of materials - <http://w3.rchland.ibm.com/projects/esdp/>.

7.3 ESD Control Program Technical Elements

Sections 7.1 and 7.2 outline the mandatory requirements for an ESD Control Program. There are however many control elements that can be used to meet the requirements in the sections listed above. Table 1 lists the required technical elements along with various options (where applicable).

When a "Required Technical Element" has only a single option listed in the "Optional Technical Element" Column of Table 1, that option must be

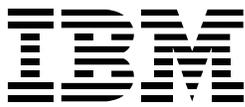


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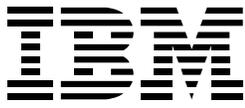
implemented using the required limits and the referenced test method. For “Required Technical Elements” that have several associated “Optional Technical Elements” the ESD Coordinator can select the option(s) that best fit the local manufacturing

processes. The selected options must be included in the Local ESD Program Plan and both the required limits and the referenced documents from Table 1 must be used.

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Table 1.			
Required Elements	Optional Elements	IBM Required Limits	Reference Documents
Grounding / Bonding	AC Ground	NA	ANSI/EOS/ESD S6.1
	Equipotential Bonding	$<1.0 \times 10^9$ ohms	NA
Personnel Ground	Wrist Strap System		
	Seated Operations(1)	$<3.5 \times 10^7$ ohms	ESD S1.1
	Standing Operations	$<3.5 \times 10^7$ ohms	ESD S1.1
	Flooring / Footwear System with Person	$<3.5 \times 10^7$ ohms or <100 volts	ESD STM 97.1 ESD STM 97.2
Protected Area	Work Surfaces (2)	$<1.0 \times 10^9$ ohms	ESD S4.1
	Wrist Strap Cord	$0.8 - 1.2 \times 10^6$ ohms	ESD S1.1
	Footwear (3)	$<1.0 \times 10^9$ ohms	ESD S9.1
	Flooring (4)	$<1. \times 10^6$ ohms	ESD S7.1
	Humidity Control(7)	$>30\%$	NA
	ESD Garments (5)	$<1.0 \times 10^9$ ohms	ESD STM 2.1
	Storage Shelves (6)	$<1.0 \times 10^9$ ohms	ESD S4.1
	Seating	$<1.0 \times 10^9$ ohms	ESD STM 12.1
	Carts - Mobile Equipment (2)	$<1.0 \times 10^9$ ohms	ESD S4.1
	Ionization	$<+/- 50$ volts (Offset Voltage)	ANSI/EOS/ESD S3.1
	Heel Straps	$<1.0 \times 10^7$ ohms	ESD S1.1
Packaging		C-H 2-0001-703	
Packaging	Dissipative	$>1.0 \times 10^4$ ohms - $<1.0 \times 10^{11}$ ohms	EOS/ESD S11.11
	Conductive	$<1.0 \times 10^4$ ohms	EOS/ESD S11.11
	Electrostatic Discharge Shielding	<25 nanojoules	ESD S11.31
Tooling & Fixtures		C-S 2-0001-701 (8)	



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Notes:

- 1) All personnel that handle ESDS products while seated shall be connected to ground via a wrist strap system.
- 2) The required limit for a work surface refers to "Resistance to Ground" per the referenced standard.
- 3) The referenced test method is to be used to assist in the selection of ESD footwear for POSSIBLE use. Any footwear that meets the resistance requirement for this "Optional Technical Element" must also meet ONE of the flooring/footwear System requirements.
- 4) The use of an ESD floor is an optional technical element. When used, the resistance to ground of flooring system must be less than 1×10^6 ohms. For any new IBM flooring installations, only Conductive floors may be purchased. A conductive floor has a resistance to ground of less than 1×10^6 ohms. For IBM locations that have already installed dissipative ESD floor systems, they may continued to be used to ground personnel as long as the maximum body voltage limits of 100 volts are maintained per ESD STM 97.2.
- 5) The technical limit for this Optional Element refers to "sleeve to sleeve" resistance per the referenced test method. To aid in contamination control, a noncharge generating, charge shielding, or static dissipative outer garment may be required. Their function, when and how the garments are to be used shall be specified in local procedures. **WARNING:** Garments may lose static dissipative capabilities after repeated laundering.
- 6) This limit applies only when storage shelves are used to store unprotected ESDS products.
- 7) Temperature and humidity control is an effective aid in controlling the amount of static build-up on parts, equipment, and personnel. An adequate level of relative humidity in work areas is desirable as long as it does not result in accelerating rust formation or result in printed circuit board delamination during wave solder. It should be recognized that establishing a temperature and humidity control for an operating area alone is NOT adequate. ESD protective measures **MUST** be utilized. A temperature and humidity recorder should be employed to provide a continuous record of the Conditions. If the humidity drops below established values, Plant Engineering or the appropriate function and/or the ESD authority should be notified.
- 8) IBM Corporate Standard C-S 2-0001-701 shall be referenced and/or used for control of static on tools and fixtures.