

ANSI/ESD STM97.2-2016

# ESD Association Standard Test Method

**ANSI/ESD STM97.2-2016**

*Revision of ANSI/ESD STM97.2-2006*

*For the Protection of Electrostatic  
Discharge Susceptible Items*

*Footwear/Flooring System – Voltage  
Measurement in  
Combination with a Person*



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*An American National Standard  
Approved November 17, 2016*



***ESD Association Standard Test Method for  
the Protection of Electrostatic Discharge  
Susceptible Items -***

***Footwear/Flooring System –  
Voltage Measurement in  
Combination with a Person***

Approved March 18, 2016  
EOS/ESD Association, Inc.



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(This foreword is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

## FOREWORD

This standard test method<sup>1</sup> is intended to provide test methods for measuring the voltage on a person in combination with footwear and floor materials as a system. This standard test method covers all floor materials used to control Electrostatic Discharge (ESD) including floor mats, floor coverings, coatings, paints and floor finishes together with footwear.

This standard test method is limited to defining procedures for measuring the voltage accumulation on personnel in combination with footwear and floor materials. This test method provides data that is relevant in the user's specific environment, application and controlled laboratory conditions.

A common source of electrostatic voltage on a person in a work environment is when a foot separates from the floor while walking. The effect of this generation and accumulation of electrostatic charge can be minimized with appropriate selection of the footwear/floor system.

To effectively control voltage on personnel, floor materials must be used in conjunction with static control footwear. A footwear/flooring system that is conductive enough to discharge a person also may pose a safety hazard. The work performed with these systems often entails the use of tools and test instruments that operate at voltages high enough to cause electrical shock. The presence of a footwear/flooring system tested using the methods described in this document will not guarantee personnel safety.

This document was originally designated ESD STM97.2-1999 and approved on February 7, 1999. ANSI/ESD STM97.2-2006 was a reaffirmation, re-designation of ESD STM97.2-1999 and was approved on February 26, 2006. ANSI/ESD STM97.2-2016 is a revision of ANSI/ESD STM97.2-2006 and was approved on March 18, 2016.

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<sup>1</sup> **ESD Association Standard Test Method (STM):** A definitive procedure for the identification, measurement and evaluation of one or more qualities, characteristics or properties of a material, product, system or process that yield **reproducible test** results.

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## **ESD Association Standard Test Method for the Protection of Electrostatic Discharge Susceptible Items – Footwear/Flooring System – Voltage Measurement in Combination with a Person**

### **1.0 PURPOSE, SCOPE, AND APPLICATION**

#### **1.1 Purpose**

This document provides test methods for the measurement of the voltage on personnel that use a footwear-flooring system where protection of electrostatic discharge (ESD) susceptible items is required.

#### **1.2 Scope**

This document establishes test methods for the measurement of the voltage on a person in combination with floor materials and static control footwear, shoes or other devices.

#### **1.3 Application**

This document provides test methods for voltage measurements of footwear/flooring systems prior to installation or application, and test methods for evaluating and monitoring footwear/flooring systems after installation or application.

Uses in connection with electromagnetic interference (EMI), ordnance, flammables or explosives are excluded along with protection from other sources of damage.

### **2.0 REFERENCED DOCUMENTS**

Unless otherwise specified, the following documents of the latest issue, revision or amendment form a part of this standard to the extent specified herein:

ESD ADV1.0, ESD Association's Glossary of Terms<sup>2</sup>

ESD TR20.20, ESD Handbook<sup>2</sup>

ANSI/ESD STM3.1, Ionization<sup>2</sup>

ANSI/ESD S6.1, Grounding<sup>2</sup>

ANSI/ESD S7.1, Flooring - Resistive Characterization of Materials<sup>2</sup>

ANSI/ESD STM9.1, Footwear – Resistive Characterization<sup>2</sup>

ESD SP9.2, Footwear – Resistive Characterization<sup>2</sup>

ANSI/ESD STM97.1, Floor Materials and Footwear – Resistance Measurement in Combination with a Person<sup>2</sup>

AATCC-138, Shampooing: Washing of Textile Floor Coverings<sup>3</sup>

AATCC 171, Carpets: Cleaning of Hot Water Extraction Method<sup>3</sup>

ANSI/IICRC S100, Standard and Reference Guide for Professional Carpet Cleaning<sup>4</sup>

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<sup>3</sup> American Society of Textile Colorists and Chemists, P.O. Box 12215, Research Triangle Park, NC 27709-2215, 919-549-8141

<sup>4</sup> The Institute of Inspection, Cleaning and Restoration Certification, 2715 E. Mill Plain Blvd, Vancouver, WA 98661, 360-693-5675



### 3.0 DEFINITIONS OF TERMS

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](http://www.esda.org). The following definitions are in addition to those found in ESD ADV 1.0, ESD Association's Glossary of Terms:

**Groundable point, floor material.** A point on the floor material that accommodates an electrical connection from the floor material to an appropriate ground.

**Hardboard (standard or tempered).** Heavy sheet material of fibers matted and pressed or rolled to form a strong board. (*Masonite*, of the *Masonite Corp.*, or the equivalent, is one of several commonly available board products that will serve the purpose.<sup>5</sup>)

**Static control floor material.** A permanently installed floor material such as tile, carpet, polymer, epoxy or sheet flooring that dissipates static charges by grounding personnel, equipment or other objects contacting the floor material or that controls the generation and accumulation of static charges associated with floor materials.

**Static control floor finish.** A non-permanent coating periodically applied to existing floor surfaces that dissipates static charges by grounding personnel, equipment or other objects contacting the floor finish or that controls the generation and accumulation of static charges associated with floor materials.

**Static control floor mat.** A movable section of material placed over existing flooring that dissipates static charges by grounding personnel, equipment or other objects contacting the mat or that controls the generation and accumulation of static charges associated with floor materials.

**Static control footwear (shoes).** Coverings for the human foot that have properties to control the accumulation of static charge when used in conjunction with a static control floor, floor finish or floor mat.

**Static control footwear (other devices).** Foot grounders, such as foot straps, toe grounders, booties or other electro-mechanical connectors (excluding shoes), which are connected to human feet are intended to control the generation and accumulation of static charge when used in conjunction with a static control floor, floor finish or floor mat.

### 4.0 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 SHOULD BE FOLLOWED.**

**THE RESISTANCE MEASUREMENTS OBTAINED THROUGH THE USE OF THIS TEST METHOD SHALL NOT BE USED TO DETERMINE THE RELATIVE SAFETY OF PERSONNEL EXPOSED TO HIGH AC OR DC VOLTAGES.**

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## 5.0 TEST METHODS

This section describes the test methods for measuring voltage on a person in combination with ESD footwear and flooring materials, both prior to and after installation.

### 5.1 Apparatus Requirements

#### 5.1.1 Hand-Held Electrode

A stainless steel, brass or copper round or tubular stock, approximately 2.5 cm (1 inch) in diameter x 7.5 cm (3 inches) or greater in length, with a banana plug receptacle or screw connector attached to one end of the cylinder.

#### 5.1.2 Environment

A low humidity environment shall be an environment of  $12\% \pm 3\%$  relative humidity and  $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ . Preconditioning of the footwear and flooring samples shall be a period of at least 72 hours.

The humidity indicating instrumentation shall be accurate to  $\pm 3\%$  RH in the operational range.

#### 5.1.3 Voltage Measurement Apparatus

A charged plate monitor or equivalent with input resistance of greater than  $1.0 \times 10^{14}$  ohms and capacitance less than or equal to 20 pF capable of measuring voltages in the ranges of 10 volts up to a minimum of 1000 volts with an accuracy of  $\pm 10\%$  (see ANSI/ESD STM3.1). The monitor shall have an analog or digital output to connect to a recording device.

#### 5.1.4 Recording Device

A chart recorder, scope or data logger such as an analog to digital converter connected to a personal computer. The system time constant shall be not more than 0.2 second.

#### 5.1.5 Specimen Support Material for Floor Material

5.1.6.1 A planar (flat) surface, when used for specimen support, shall have a surface resistivity greater than  $1.0 \times 10^{13}$  ohms/square when measured per ASTM D257 or a surface resistance greater than  $1.0 \times 10^{12}$  ohms when measured per ANSI/ESD STM11.11.

For test methods using 2.27 kg (5 lb), 6.35 cm (2.5 inch) electrodes, an alternate method to verify the properties of the specimen support surface may be used, by measuring the resistance point-to-point of the material with the electrodes spaced at least 15 cm (6 inches) apart (edge-to-edge). A resistance point-to-point of at least one order of magnitude greater than the upper limit of the item being measured is required.

5.1.6.2 For testing of floor materials or mats, mount the floor material on nominal 6.3 mm (0.25 inch) tempered or standard hardboard according to Section 5.2.1. The hardboard must be 1 cm (0.5 inch) larger than the floor sample in all directions.

#### 5.1.6 Specimen Support Material for Floor Finishes

5.1.6.1 Mount floor surface on nominal 6.3 mm (0.25 inch) hardboard according to Sections 5.1.6.1 and 5.2.1 before applying finish. Use conductive adhesive to fasten a minimum sized 5 mm x 15 mm x 0.25 mm (2 inches x 6 inches x 0.01 inch) metallic foil to make contact with the floor finish surface as a groundable point.

5.1.6.2 For testing of floor finishes, use the floor surface to which the finish would be applied. Coat according to the manufacturers' specification.



## 5.2 Product Qualification Testing

### 5.2.1 Floor Specimen Preparation

5.2.1.1 The preferred size of specimen shall be 91 cm x 91 cm (36 inches x 36 inches), although 122 cm x 122 cm (48 inches x 48 inches) may be used. In the case of the larger sample, the 6.3 mm (0.25 inch) hardboard may have to be backed by another nominal 6.3 mm (0.25 inch) thick plywood or hardboard for strength.

5.2.1.2 Mount specimen on support material. Use manufacturer's recommended procedures.

5.2.1.3 Each floor specimen shall have two ground connections that simulate end use grounding methods. Unless the manufacturer's installation instructions require otherwise, the ground connection shall not extend more than 7.5 cm (3 inches) into the specimen.

### 5.2.2 Pre-Conditioning

#### 5.2.2.1 Cleaning of Specimens

##### 5.2.2.1.1 Floor Mats or Other Hard Surface Materials and Footwear

Clean twice following manufacturer's recommendations or clean with a minimum 70% isopropanol-water solution using a clean, low-linting cloth.

##### 5.2.2.1.2 Textile Floor Materials

To remove residual, non-permanent substances, clean according to manufacturer's recommendations. In the absence of such recommendations, clean with standard hot water extraction procedures, such as IICUC S001 or AATCC-171.

##### 5.2.2.1.3 Floor Finishes

Remove any surface contamination by wiping with a clean, dry, low-linting cloth.

#### 5.2.2.2 Environmental Conditioning

After cleaning specimens, place floor material and footwear in a low humidity environment set to relative humidity  $12\% \pm 3\%$  RH and  $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$  and condition the material for 72 hours minimum.

NOTE: Samples must not be removed from this environment until all testing has been completed.

### 5.2.3 Test Procedures for Voltage Measurement

5.2.3.1 Place conditioned floor specimen on floor of test chamber, maintaining a distance of at least 61 cm (2 feet) between walls and all sides of the sample.

5.2.3.2 Connect either groundable points "A" or "B" of the flooring specimen to ground (Figures 1 and 2).

5.2.3.3 Connect voltage measurement apparatus to recording device.

5.2.3.4 Connect hand-held electrode to the voltage measurement apparatus.

5.2.3.5 Wear static control footwear under test (shoes or other devices) on both feet for 10 minutes. Stand on the floor specimen with the left foot at position 5 and the right foot at position 6 (see Figure 1). See Annex A for alternate walking methods.

5.2.3.6 Hold hand-held electrode.



5.2.3.7 Before starting each test, touch ground to remove any charge on your body and check to make sure the instrumentation is also zeroed.

5.2.3.8 Walk on the floor specimen using the walking pattern. With each step, raise foot approximately 7.6 cm (3 inches) from the floor surface. Attempt to maintain feet parallel to floor during test. Do not scuff or drag feet during the test. The pace should be greater than one step per second. Pause for two seconds between each six step test cycles. A minimum of ten test cycles must be performed.

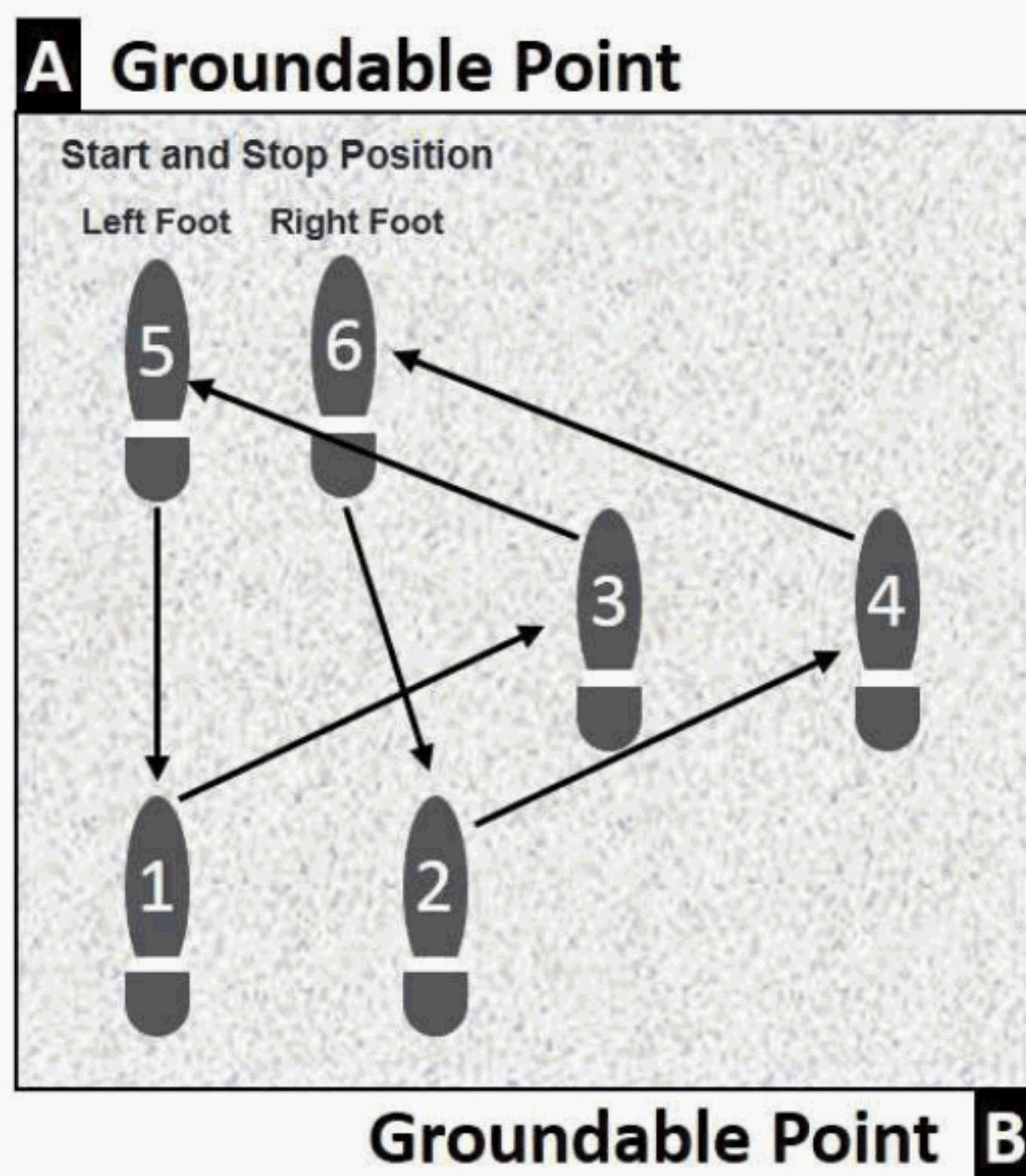
5.2.3.9 Continue walking on the floor specimen until the body voltage recorded on the recording device reaches equilibrium. Use appropriate scales on the charged plate monitor and recording device for optimum resolution.

5.2.3.10 Perform three tests per sample.

5.2.3.11 Record all data and the test conditions.

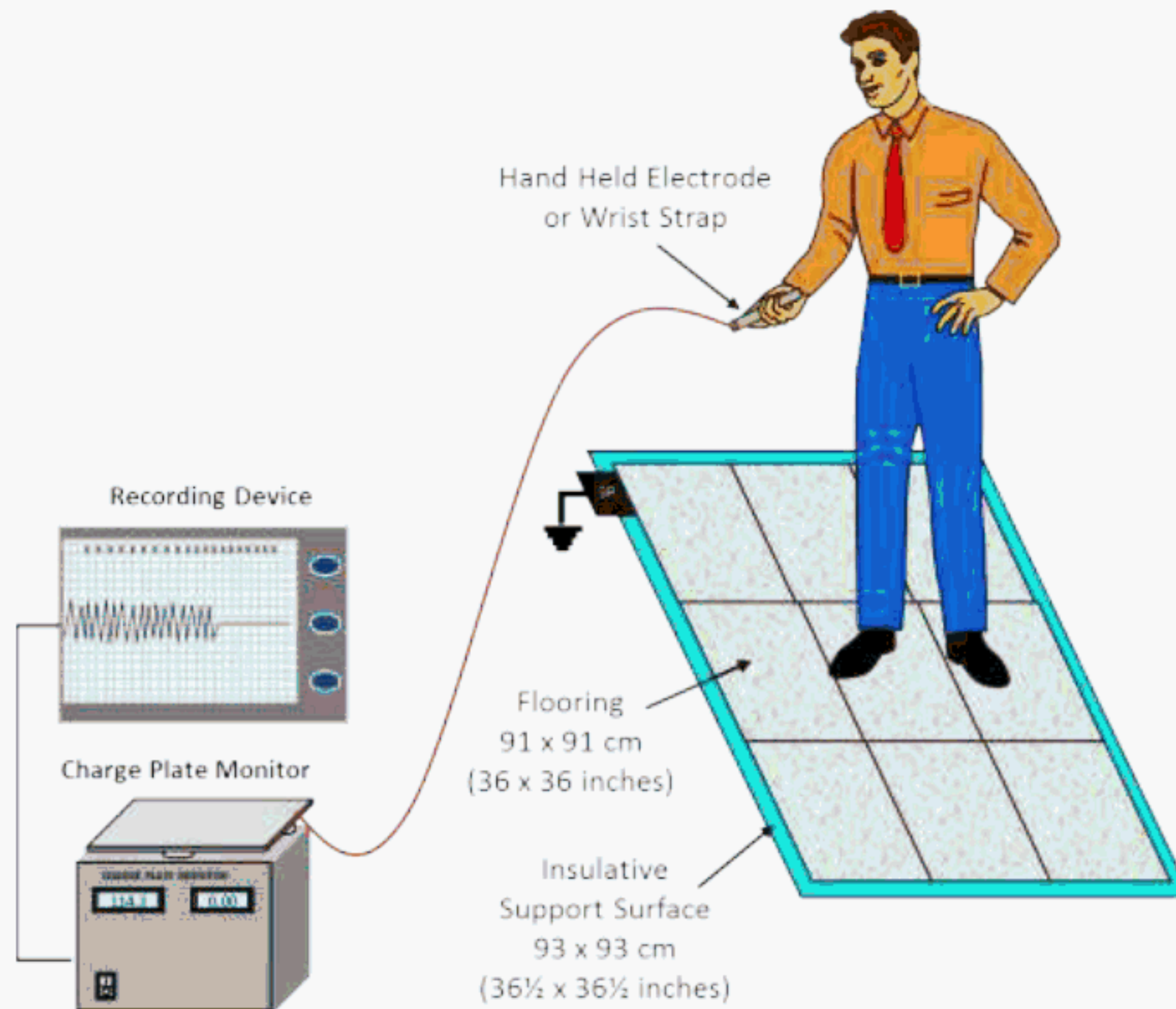
5.2.3.12 At a minimum, report the nine highest voltages; that is, the three highest voltages for each of the three tests regardless of polarity. See Annex B for sample test records.

5.2.3.13 Repeat testing at other environmental conditions as required for specific applications.



*Figure 1: Description of Walking Pattern*





*Figure 2: Diagram Showing Electrical Connections for the Footwear/Flooring System Walking Test*

#### **5.2.4 Reporting of Test Results**

Report test parameters using the sample table in Annex B1. Report the temperature and relative humidity, date of testing, type and identity of footwear, composition of shoe sole, identity of floor, name of test subject and test equipment used. Using the sample table in Annex B2, report test results in volts for the nine voltages measured. Summarize test data in the same table by reporting minimum, maximum, and mean of the absolute values obtained.

### **5.3 Test Procedures – Installed or Applied Material Testing**

#### **5.3.1 Test Procedures for Voltage Measurements for Installed or Applied Material**

Perform five tests per floor material or a minimum of five tests for every 460 square meters (5,000 square feet) of floor material, whichever is greater. Record the three highest readings for each test. A minimum of three of the five tests should be conducted in those areas that are subject to wear, have evidence of chemical or water spillage, or are visibly dirty. Test for voltage on a person in accordance with Section 5.2.3. See Annex B3 for sample test records.

#### **5.3.2 Reporting of Test Results**

Report test parameters using the sample table in Annex B1. Report temperature and relative humidity, date of testing, type and identity of footwear, composition of shoe sole, identity of floor, name of test subject and test equipment used. Select the three highest readings for each of the five tests. Report test results in volts for the 15 voltages measured, using the sample table in Annex B3. Summarize test data in the same table by reporting minimum, maximum, and mean of the absolute values obtained. Include a diagram showing approximate test locations and ground connections used.

## **6.0 OTHER CONSIDERATIONS**

**6.1** The footwear/flooring system should be monitored to assure that proper maintenance procedures are being followed.

**6.2** The data obtained under this standard should be analyzed by the end user in a manner consistent with the footwear/flooring system specifications for the materials being tested.

**6.3** For further selection considerations, refer to the ESD Handbook (ESD TR20.20).

**6.4** Complete characterization of the footwear/floor system should include the measurement of the resistance of the floor (ANSI/ESD STM7.1), resistance characterization of the footwear (ANSI/ESD STM9.1), and the resistance of the Footwear/Flooring System measured using ANSI/ESD STM97.1. Perform all tests at the following environmental conditions:  $12\% \pm 3\%$  RH and  $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .



(This annex is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

## **ANNEX A (INFORMATIVE) - ALTERNATE METHODS OF WALKING**

There are many ways one could choose to walk. The walking pattern described here simulates forward, backward and crossover movements typical of workers in a number of disciplines. However, other methods of walking are acceptable assuming that they simulate user actual patterns. For example, a simple box step can be used as in AATCC-134 or a longer forward and backward step pattern on a 2 foot x 8 foot pallet as described in the Bellcore work. The user of this test method should choose a step pattern typical of the majority of the workers within your organization.

(This annex is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

**ANNEX B1 (INFORMATIVE) - SAMPLE FOOTWEAR/FLOORING SYSTEMS TEST RECORD**

<b>Test Date</b>	
<b>Temperature</b>	
<b>Relative Humidity</b>	
<b>Description of Floor Specimen</b>	
Manufacturer	
Type (Hard or Soft Tile, Carpet, etc.)	
Material (Vinyl, Rubber, etc.)	
Substrate Material	
<b>Description of Footwear</b>	
Manufacturer	
Type of Footwear	
Composition of Soles	
<b>Description of Test Hardware</b>	
Charged Plate Monitor: Manufacturer and Description:	
Graphical Recording Device: Manufacturer and Description	
<b>Optional Information</b>	
Name of Test Subject	

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(This annex is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

**ANNEX B2 (INFORMATIVE) - CHARGE GENERATION VOLTAGE, SECTION 5.2**

(Use Figures 1 and 2 for reference.)

Measurement Number	Peak Voltage (Volts) (Record Polarity)
1	
2	
3	
4	
5	
6	
7	
8	
9	
Minimum Absolute Value	
Maximum Absolute Value	
Mean Absolute Value	



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**ANNEX B3 (INFORMATIVE) - CHARGE GENERATION VOLTAGE ON AN INSTALLED FLOOR, SECTION 5.3**

(Use Figures 1 and 2 for reference.)

NOTE: Make at least five sets of measurements per 460 square meters (5,000 square feet). Do at least three measurements in those areas that are subject to wear or that have chemical or water spillage or that are visibly dirty.

<b>Measurement Number</b>	<b>Peak Voltage (Volts) (Record Polarity)</b>
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
Minimum Absolute Value	
Maximum Absolute Value	
Mean Absolute Value	

(This annex is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

#### **ANNEX C (INFORMATIVE) - BIBLIOGRAPHY**

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(This annex is not part of ESD Association Standard Test Method ANSI/ESD STM97.2-2016)

**ANNEX D (INFORMATIVE) – REVISION HISTORY FOR ANSI/ESD STM97.2-2016**

General – Changed document title and all reference phrases to footwear/flooring.

Section 5.1.1 - Updated the description of the Hand Held Electrode to the new boiler plate description.

Section 5.1.3 - Under charge plated add “Up” to the sentence.

Section 5.1.6.2 - Changed the last sentence from “Coat a definite amount according to the manufacture’s specification.” To “Coat according to the manufacturer’s specification.”

Section 5.2.2.2 - Removed “preset” and “the prescribed” from the sentence and added “12% ± 3% RH” to the sentence. Also, changed “± 1°C” to “± 3°C”.