ESD Association Standard

ANSI/ESD S7.1-2005

ANSI/ESD S7.1-2005
Revision and Redesignation of ANSI/ESD STM7.1-2001

For the Protection of Electrostatic Discharge Susceptible Items

Floor Materials
Characterization of Materials

Electrostatic Discharge Association
7900 Turin Road, Bldg. 3
Rome, NY 13440

An American National Standard
Approved March 10, 2005

Revision and Redesignation of
ANSI/ESD STM7.1-2001

ESD Association Standard for the Protection of Electrostatic Discharge Susceptible Items - Floor Materials – Characterization of Materials

Approved February 13, 2005
ESD Association

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FOREWORD

This Standard is intended to provide test methods for evaluating floor materials used to control electrostatic charges. This standard covers all floor materials including floor mats, floor coverings, coatings, paints, and floor finishes.

This Standard is limited to defining procedures for measuring electrical resistance. Electrical resistance is one property that can be used to evaluate the electrostatic performance of floor materials. However, resistance does not fully characterize these materials. An additional property to be considered in the selection and use of floor materials includes triboelectric charge generation.

A common source of electrostatic charge in a work environment is the separation of foot or caster from the floor, resulting in the generation of electrostatic charge that can accumulate on personnel and equipment. The effect of this generation and accumulation of electrostatic charge can be minimized with appropriate selection or treatment of the floor material.

To effectively control electrostatic charges, floor materials must be used in conjunction with ESD controlled footwear, conductive wheels or casters.

This Standard was originally designated ESD S7.1-1994, and approved on February 27, 1994. The original release was then reaffirmed, redesignated STM7.1-2001, and approved on May 20, 2001. This Standard is a revision and redesignation of ANSI/ESD STM7.1-2001. This Standard was prepared by the 7.0 Flooring Subcommittee. At the time, the 7.0 Flooring Subcommittee had the following members:

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1.0 PURPOSE & SCOPE

1.1 Purpose

This Standard provides test methods for measuring the electrical resistance of floor materials used for the control of electrostatic charge and discharge. The standard provides test methods for the qualification of floor materials prior to their installation or application, as well as test methods for acceptance and monitoring of floor materials after installation or application.

1.2 Scope

This Standard establishes test methods for measuring the electrical resistance of floor materials where protection of ESD susceptible items is required. The resistances considered here are measured from the top of the floor material to its ground connection and from top surface to top surface locations.

This test method tests conductive and dissipative flooring materials.

1.3 Application

Resistance to groundable point measurements on small laboratory samples may be different from resistance to ground measurements performed on large installed areas, especially when evaluating materials such as floor finishes.

This standard relies on resistance measurements utilizing standard instruments to provide a means of evaluating floor materials. Conversely, resistivity is measured by specific equipment and is used to establish an intrinsic material property. Resistivity measurements are not within the scope or purpose of this standard.

Use of this document or the procedures defined herein DO NOT APPLY to facilities where ordnance, flammables, or explosives are stored or handled. For these concerns, refer to ASTM F-150.

2.0 REFERENCES

ESD Association[1],
ESD-ADV1.0-Glossary of Terms

ANSI/ESD S6.1, Standard for Protection of Electrostatic Discharge Susceptible Items-- Grounding

American Society for Testing and Materials,[2]
ASTM D 2240-86, Test for Rubber Property - Durometer Hardness

ASTM D 257-99 Standard Test Methods for DC Resistance or Conductance of Insulating Materials

International Institute of Carpet and Upholstery Certification[3]
IICUC S001-1991, Standard Reference Guide for Professional On-location Cleaning of Installed Textile Floor Covering Materials

American Association of Textile Colorists and Chemists [4]
AATCC-171, Carpets: Cleaning of: Hot Water Extraction Method

3.0 DEFINITIONS

The following definitions shall apply for the purposes of this standard in addition to those specified in the ESD Glossary of Terms.

Acceptance Equipment: An instrument or collection of instruments that meet the criteria of a standard or standard test method and provides a measurement that is repeatable. It may or may not be as accurate as laboratory evaluation equipment. This equipment is typically used to verify materials, devices or procedures under in-use conditions.

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[1]ESD Association, 7900 Turin Road, Bldg 3, Rome, NY 13440-2069, 315-339-6937
[2]American Society for Testing and Materials (ASTM), 100 Bar Harbour Dr., West Conshohocken, PA 19428.
[3]International Institute of Carpet and Upholstery Certification 2715 E. Mill Blvd., Vancouver, WA 98661, 206-693-5675
[4] AATCC, P.O. Box 12215, Research Triangle Park, N.C. 27709-2215, 919-549-8141

Compliance Verification (Periodic Testing) Equipment: An instrument or collection of instruments that provide an indication or measurement. It may or may not be repeatable or accurate. This equipment is typically used for indications of pass or fail.

Conductive Flooring Material: A floor material that has a resistance to ground of less than 1.0 x 10^6 ohms.

Dissipative Floor Material: Floor material that has a resistance to ground between 1.0 x 10^6 and 1.0 x 10^9 ohms.

Groundable Point, Floor Material: A point on the floor material that is intended to accommodate an electrical connection from the floor material to an appropriate electrical ground.

Laboratory Evaluation Equipment: An instrument or collection of instruments that meet the criteria of a standard or standard test method that provides a measurement that is accurate and repeatable. This equipment is typically used to qualify materials, devices or procedures prior to acceptance and under controlled conditions.

Point-to-Point Resistance: The resistance in ohms measured between two electrodes placed on any surface.

Resistance to Ground: The resistance in ohms measured between a single electrode placed on a surface and ground.

Resistance to Groundable Point: The resistance in ohms measured between a single electrode placed on a surface and a groundable point.

Static Control Floor: A permanently installed floor material such as tile, carpet, polymer, epoxy, or sheet flooring that controls static charges on personnel, equipment, or other objects contacting the floor material.

Static Control Floor Finish: A non-permanent coating periodically applied to floor surfaces that controls static charges on personnel, equipment, or other objects contacting the floor material.

Static Control Floor Mat: A movable island of material placed over existing flooring that controls static charges by grounding personnel, equipment, or other objects contacting the floor material. Static control floor mats may be checked either resistance to ground or point to point resistance. Conductive floor mats may be tested point to ground. A current limiting resistor may be used to connect the mat to ground. This may cause the readings to exceed 1.0 x 10^6 ohms.

4.0 PERSONNEL SAFETY

4.1 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 external and internal policy. Users are cautioned that this document cannot replace or supersede any requirements for personnel safety.

4.2 Ground Fault Circuit Interrupters (GFCI) and other safety protection should be considered wherever personnel might come in contact with electrical sources.

4.3 Electrical hazard reduction practices should be exercised and proper grounding instructions for equipment must be followed.

5.0 EQUIPMENT AND MATERIALS

5.1 Equipment Requirements

5.1.1 Resistance Measuring Meters

5.1.1.1 The instrumentation may consist of either a power supply and current meter (ammeter), or an integrated instrument that combines these functions.

5.1.1.1.1 Use of Laboratory Evaluation Meters: The meter(s) shall have an output voltage, while under load, of 10 volts (± 5%) for measurements less than 1.0 x 10^6 ohms and 100 volts (± 5%) for measurements of 1.0x10^6 ohms and above. The meter must be capable of making measurements from 2.0 x 10^3 ohms (± 10% accuracy) to 1.0 x 10^{10} ohms (± 10% accuracy).

5.1.1.1.2 Use of Acceptance Meters: The meter shall have an open circuit voltage of 10 volts (± 10%) for measurements less than $1.0x10^6$ ohms and 100 volts (±10%) for measurements of $1.0x10^6$ ohms and above. The meter must be capable of making measurements from 2.0×10^3 ohms (± 20% accuracy) to $1.0x10^{10}$ ohms (± 20% accuracy).

5.1.1.1.3 Use of Compliance Verification Meters: The output voltage for compliance verification meters (e.g., under load or open circuit) may vary from laboratory or acceptance testing meters. Outputs from these meters must be correlated to the acceptance testing meter or the laboratory testing meter before use. The meter must be capable of making measurements one order of magnitude below the lowest expected resistance measurement and one order of magnitude above the highest expected resistance measurement.

Technical note: Both test leads should be capable of being isolated from ground. AC line powered resistance measuring devices may give erroneous results due to undefined ground paths. Battery powered equipment is recommended.

5.1.2 Electrodes

Two cylindrical 2.27 kg ± 0.06 kg (5 pound ± 2 oz.) electrodes with a diameter of 63.5 mm ± 0.25 mm (2.5 inches ± 0.1 inches) each having contact of electrically conductive material with a Shore-A (IRHD) durometer hardness between 50-70. The resistance between two electrodes placed on a metallic surface should be less than 1,000 ohms when measured at 10 volts or less.

Technical note: Because there is a range allowed in the rubber shore hardness. The hardness of the conductive rubber may affect the reading. Be aware that the shore hardness of the rubber increases over time.

6.0 TEST PROCEDURES

6.1 Laboratory Evaluations

For all laboratory evaluations the meter specified in 5.1.1.1.1 shall be used.

6.1.1 Environment

6.1.1.1 Low Humidity Environment
An environment with a relative humidity of 12% ±3% and a temperature of 23^0 C ± 3^0C.

6.1.1.2 Moderate Humidity Environment
An environment with a relative humidity of 50% ±2% and a temperature of 23^0 C ± 3^0C.

6.1.2 Materials

6.1.2.1 Support Material
Support material shall be 6 mm (0.25") tempered hardboard. The surface shall have a resistance of greater than 1.0×10^{13} ohms when measured per ASTM D-257.

6.1.2.2 Specimen
Size of specimen shall be 305 mm by 610 mm (12 inches x 24 inches) minimum. If the installed product has seams, then the test sample must include a seam.

6.1.2.2.1 If the specimen is a floor finish or similar product, it may require alternative substrates to accommodate this testing procedure. If required, mount the manufacturer's recommended substrate material, according to the manufacturer's instructions, to the support material as described in 6.1.2.1.

6.1.3 Specimen Preparation

6.1.3.1 Mount floor surface specimens on the defined support material, using manufacturer's recommendations. If the specimen under test is a floor finish, apply or coat to the recommended substrate according to the manufacturer's specification.

6.1.3.2 Number of specimens shall be a minimum of 5, labeled from 1 to 5.

6.1.3.3 Each sample shall have two ground connections that simulate end use grounding methods.

6.1.4 Pre-conditioning

6.1.4.1 Cleaning of specimens

6.1.4.1.1 Flooring, Mats, or Other Hard Surface Materials: follow manufacturer's instructions.

6.1.4.1.2 Carpet or Similar Textile Materials: Clean with standard hot water extraction cleaning procedures such as those described in IICUC S001-1991 or AATCC-171 and AATCC-138.

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

6.1.5 Humidity Conditioning: After cleaning the specimens, allow sufficient time for them to dry. Place the specimens in the low humidity environment (see 6.1.1.1) for 72 hours minimum. Perform the tests in 6.1.6 and 6.1.7. At the conclusion of the low humidity testing place the samples into the moderate humidity environment (see 6.1.1.2) for 72 hours minimum and then repeat the tests in 6.1.6 and 6.1.7.

6.1.6 Resistance to Groundable Point
(Refer to Figure 1)

6.1.6.1 Clean electrode with a minimum 70% isopropanol-water solution using a clean, low-linting cloth. Allow electrode to air dry.

6.1.6.2 Connect one lead of the meter to groundable point A and the other lead to the electrode.

6.1.6.3 Set meter to 10 VDC. Place electrode at position 1.

6.1.6.4 Apply test voltage and record the resistance after the measurement has stabilized or after 15 seconds has elapsed. If the reading is higher than 1.0×10^6 ohms, set the meter to 100 VDC and record that reading.

6.1.6.5 Remove test voltage and remove electrode from surface.

6.1.6.6 Repeat measuring sequence for electrode positions 2 through 6 using groundable point A.

6.1.6.7 Repeat measuring sequence for electrode positions 1 through 6 using groundable point B.

6.1.6.8 Repeat measuring sequence 6.1.6.1 to 6.1.6.7 for all specimens.

6.1.7 Resistance Point- to-Point
(Refer to Figure 2)

6.1.7.1 Clean electrodes with a minimum 70% isopropanol-water solution using a clean, low-linting cloth. Allow electrode to air dry.

6.1.7.2 Connect the leads of the meter to the electrodes.

6.1.7.3 Set meter to 10 VDC. Place one electrode at position A and the other electrode at position 1.

6.1.7.4 Apply test voltage and record the resistance after the measurement has stabilized or after 15 seconds has elapsed. If the reading is higher than 1.0×10^6 ohms set the meter to 100 VDC and record that reading.

6.1.7.5 Remove test voltage.

6.1.7.6 Repeat measuring sequence for electrode positions 2 through 6 with the other electrode remaining at position A.

6.1.7.7 Repeat measuring sequence for electrode positions 1 through 6 using electrode position B.

6.1.7.8 Repeat measuring sequence 6.1.7.1 to 6.1.7.7 for all specimens.

6.2 Installed or Applied Material

Either of the meters described in sections 5.1.1.1.1 or 5.1.1.1.2 may be used to measure installed or applied materials for the purposes of acceptance testing. In case of dispute or disagreement the meter described in section 5.1.1.1.1 (Laboratory Evaluation meter) shall be used.

Any of the meters described in section 5.1.1.1.1, 5.1.1.1.2 or 5.1.1.1.3 may be used to measure floor materials as part of an on-going compliance verification plan.

Technical note: Both test leads should be capable of being isolated from ground. AC line powered resistance measuring devices may give erroneous

results due to undefined ground paths. Battery powered equipment is recommended.

6.2.1 Resistance to Ground

6.2.1.1 Clean electrode with a minimum 70% isopropanol-water solution using a clean, low-linting cloth. Allow electrode to air dry.

6.2.1.2 As part of acceptance testing, new floors, mats, and floor finishes shall be cleaned per manufacturer's recommendations before testing for resistance.

6.2.1.2.1 When testing existing floors, mats and floor finishes as part of an on-going compliance verification plan, the materials shall not be cleaned prior to testing for resistance.

`Technical Note: If the resistance readings obtained are out of specification, it is permissible to clean the floor material to determine the cause of the out of specification condition.

6.2.1.3 Perform tests at ambient humidity.

6.2.1.4 Connect one lead of the meter to ground (Ground is defined in ANSI/ESD S6.1), and the other lead to the electrode.

6.2.1.4.1 Set the meter to 10 VDC. Place electrode on the surface of the material being tested. (If the floor is known to be greater than $1.0x10^6$ use 100 VDC).

6.2.1.4.2 Apply the test voltage and record the resistance after the measurement has stabilized or after 15 seconds has elapsed. If the reading is higher than 1.0×10^6 ohms set the meter to 100 VDC and record that reading.

6.2.1.4.3 Remove test voltage and remove electrode from the surface.

6.2.1.4.4 Repeat entire procedure repositioning the electrode.

6.2.1.4.5 Perform a minimum of five tests per contiguous floor surface material or a minimum of five tests per 500 sq meters (5,000 square feet) of floor material, whichever is greater. A minimum of three of the five tests should be conducted in those areas that are subject to wear or that have chemical or water spillage or that are visibly dirty. When testing Static Control Floor Mats perform a minimum of 1 test per 2 square meters (21.53 square feet).

6.2.2 Resistance Point-to-Point

6.2.2.1 Clean electrodes with a minimum 70% isopropanol-water solution using a clean, low-linting cloth. Allow electrode to air dry.

6.2.2.2 As part of acceptance testing, new floors, mats, and floor finishes shall be cleaned per manufacturer's recommendations before testing for resistance.

6.2.2.2.1 When testing existing floors, mats and floor finishes as part of an on-going compliance verification plan, the materials shall not be cleaned prior to testing for resistance.

Technical Note: If the resistance readings obtained are out of specification, is permissible to clean the floor material to determine the cause of the out of specification condition.

6.2.2.3 Perform tests at ambient humidity.

6.2.2.4 Connect the leads of the meter to the electrodes.

6.2.2.5 Set meter to 10 VDC. Place electrodes one meter (approximately three feet) apart on the surface of the material being tested. (If the floor is known to be greater than 1.0×10^6 ohms, use 100 VDC.)

6.2.2.6 Apply test voltage and record the resistance after the measurement has stabilized or after 15 seconds has elapsed. Remove test voltage and remove the electrodes from the surface. If the reading is higher than 1.0×10^6 ohms set the meter to 100 VDC and record that reading.

6.2.2.7 Perform a minimum of five tests (in different locations) per contiguous floor surface material or a minimum of five tests per 500 sq meters (approximately 5,000 square feet) of floor material, whichever is greater. A minimum of three of the five tests should be conducted in those areas that are subject to wear or that have chemical or water spillage or that are visibly dirty. When testing Static Control Floor Mats perform a minimum of 1 test per 2 square meters (21.53 sq ft).

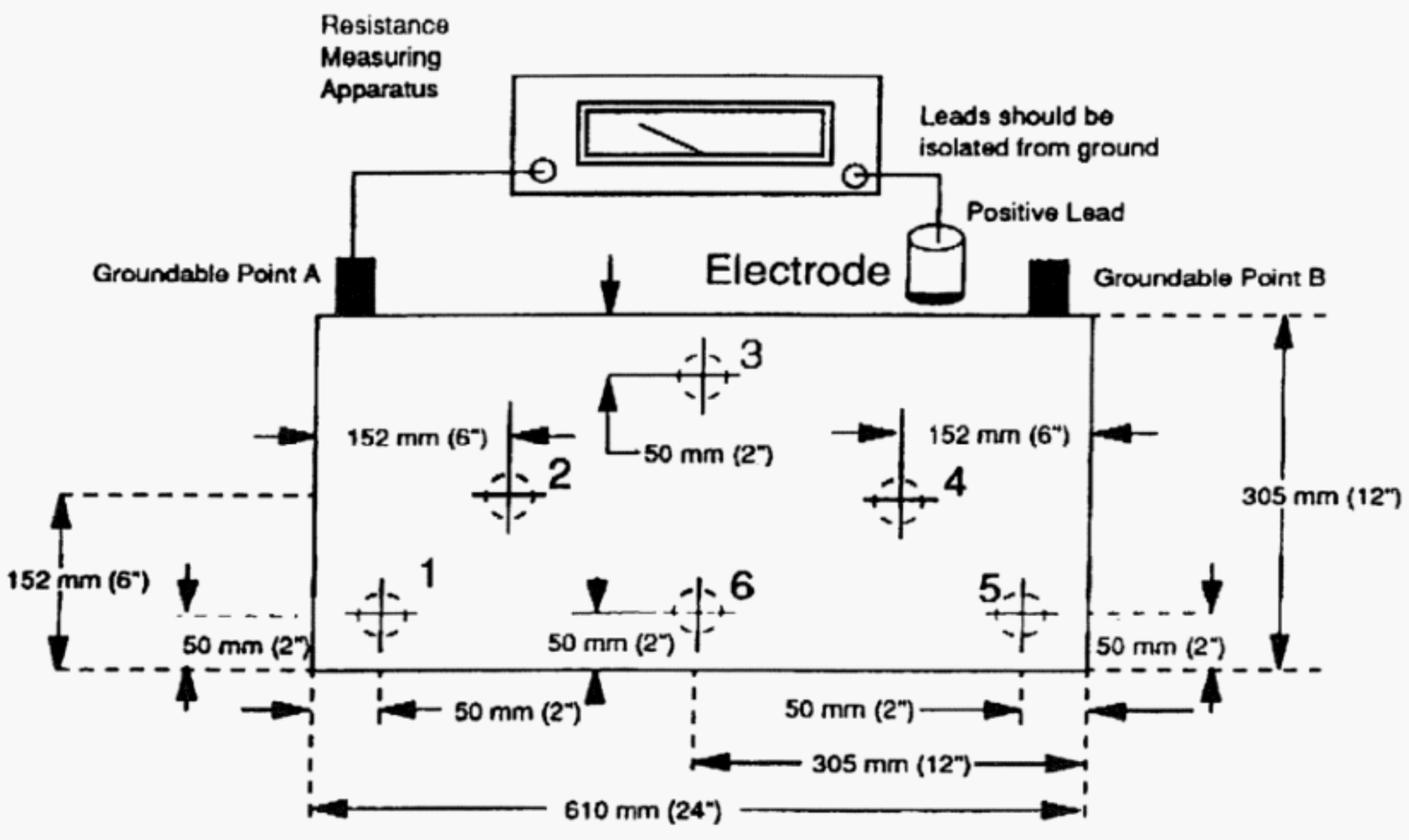
6.3 Reporting of Test Results

6.3.1 Report all values in ohms for resistance to groundable point and for resistance point-to-point. Also report test voltage, test date, temperature and relative humidity at time of testing, actual duration of conditioning, test equipment used, and specimen substrate to which the sample is applied. Summarize the test data by reporting the minimum, maximum, mean, and median values obtained.

6.3.2 For the applied or installed results include a diagram showing approximate electrode positions and ground connections used.

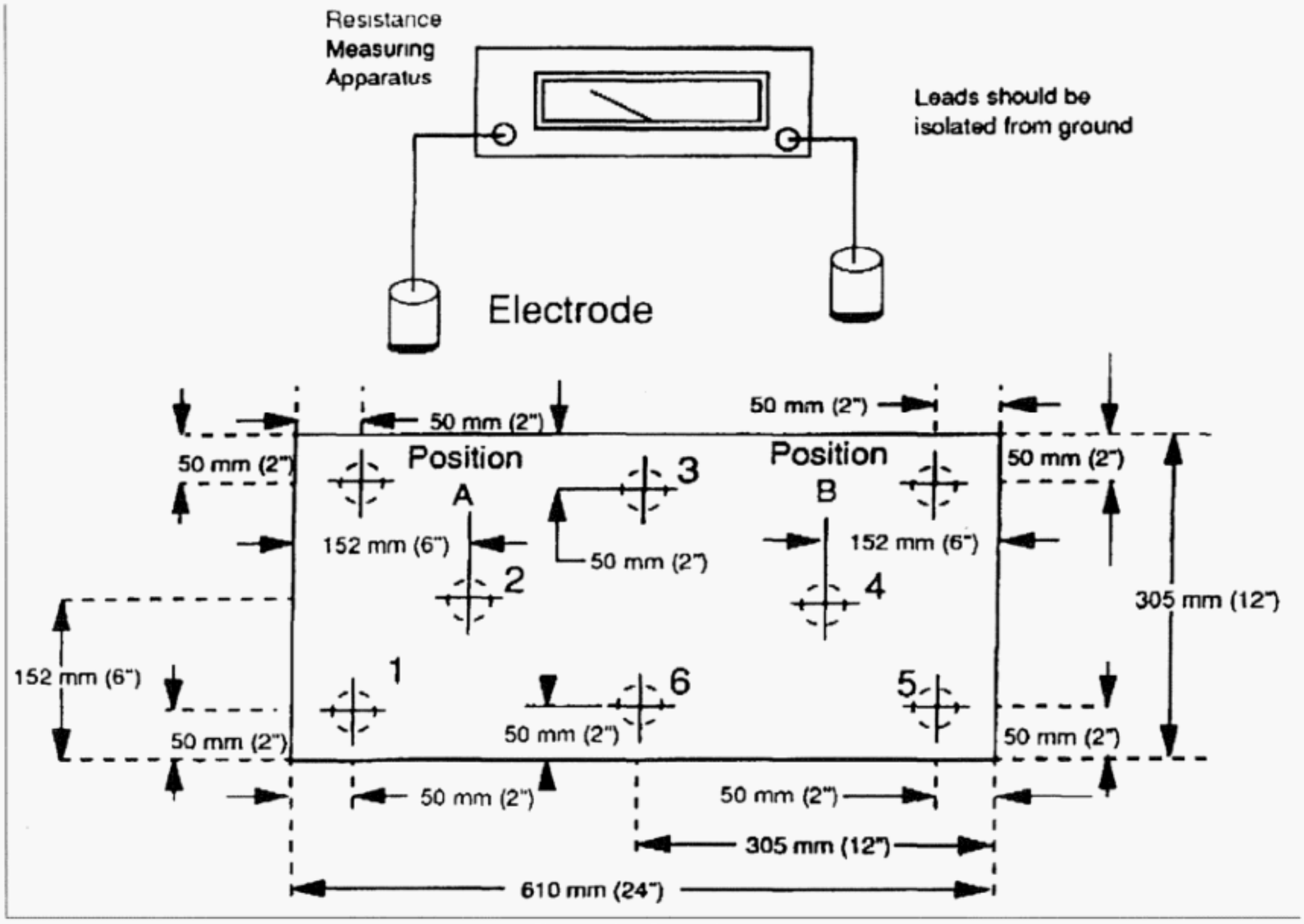
6.4 Alternate Test Conditions

Alternate conditions required for specific situations may be used for this test. If conditions other than those specified in this test method are used, they shall be reported.



Sample Specimen

Figure 1 -- Resistance to Groundable Point Measurement
Laboratory Evaluation



Sample Specimen

Figure 2 – Point-to-Point Resistance Measurement Laboratory Evaluation

7.0 SAMPLE FLOORING RESISTANCE TEST RECORD

Measurement	R to G Check (√)	P to P Check (√)	Resistance (Ohms) Magnitude x Exponent	Pass	Fail
1.			XE		
2.			XE		
3.			XE		
4.			XE		
5.			XE		
6.			XE		
7.			XE		
8.			XE		
9.			XE		
10.			XE		
11.			XE		
12.			XE		
13.			XE		
14.			XE		
15.			XE		

Reporting:	
Date:	
1. Average	
2. Median	
3. Maximum	
4. Minimum	
5. Number of Observations	

Notes:

8.0 BIBLIOGRAPHY

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American Society for Testing and Materials,

ASTM F150-98, Standard Test Method for Electrical Resistance of Conductive Resilient Flooring

National Fire Protection Association,

ANSI/NFPA 99-1993, Health Care Facilities

IICUC S001-1991, Standard Reference Guide for Professional On-Location Cleaning of Installed Textile Floor Covering Materials

APPENDIX A

In addition to electrical or electrostatic properties, other factors may be important in the selection, application, installation, or performance of a floor material. Chemical resistance, durability, humidity dependency, maintenance, and footwear may directly or indirectly affect the ESD performance of the selected material. The importance of these factors and others is strongly dependent on the specific installation, and the type of products and devices being handled.

The resistance of 1×10^6 ohms is historically a used number to define the point where the conductive range becomes dissipative for flooring. The difference in the actual ESD properties of the floor is negligible between 5.0×10^5 and 5.0×10^6. Therefore the slight variations at 1.0×10^6 have negligible effects on ESD properties. Based on variation in instrumentation and other conditions materials that test close to or at 1.0×10^6 may be classified in either the conductive or dissipative range.

Performance should be monitored to assure that correct maintenance procedures are being followed.

The data obtained under this standard test method should be analyzed by the end user in a manner consistent with their performance specifications for the materials being tested.