ESD Association Standard Test Method

ANSI/ESD STM3.1-2006

ANSI/ESD STM3.1-2006
Reaffirmation of ANSI/ESD STM3.1-2000

For the Protection of Electrostatic Discharge Susceptible Items -

Ionization

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

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

Ionization

Approved February 26, 2006
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Foreword

The primary method used to limit static charge for the protection of electrostatic discharge susceptible items in the work environment is grounding. However, grounding methods are not effective in removing static charges from the surfaces of non-conductive (insulative) or isolated conductive materials. Air ionization techniques may be employed to reduce these charges. The active parameters in charge neutralization are the conductivities of the air for each polarity. It would be appropriate to measure either the conductivities themselves or the ion concentrations for each polarity. This would determine the ability of the ionized air to neutralize a charge in a given location. (Annex A has been provided as an informative annex on performance of ionizers.)

In practice, these measurements are difficult to make. A more feasible way of evaluating the ability of an ionizer to neutralize a static charge is to directly measure the rate of charge decay. Charges to be neutralized may be located on insulators as well as on isolated conductors. It is difficult to charge an insulator reliably and repeatably. Charge neutralization is more easily evaluated by measuring the rate of decay of the voltage of an isolated conductive plate. The measurement of this decay should not interfere with or change the nature of the actual decay. Four practical methods of air ionization are addressed in this standard test method:

1. Radioactive Emission
2. High Voltage Corona from AC Electric Fields
3. High Voltage Corona from DC Electric Fields
4. Soft X-ray Emission

This standard test method provides test methods and procedures that can be used when evaluating ionization equipment. The objective of the test methods described in this document is to generate meaningful, reproducible data. The test methods are not meant to be a recommendation for any particular ionizer configuration. The wide variety of ionizers, and the environments within which they are used, will often require test methods different from those described in this standard test method. Users of this document should be prepared to adapt the test methods as required to produce meaningful data in their own application of ionizers.

Similarly, the test conditions chosen in this standard test method do not represent a recommendation for acceptable ionizer performance. There is a wide range of item sensitivities to static charge. There is also a wide range of environmental conditions affecting the operation of ionizers. Performance specifications should be agreed between the user and manufacturer of the ionizer in each application. Users of this standard test method should be prepared to establish reasonable performance requirements for their own application of ionizers.

Annex B has been provided as a normative annex to provide a method for measuring capacitance of the charged plate.

The 2006 revision of this document contains various minor changes from the previous standard test method, ANSI/ESD STM3.1-2000. One additional test position was provided for both the vertical and horizontal laminar flow hoods. Test surfaces may now be conductive as well as static dissipative. References have been added to ESD SP3.3, Periodic Verification of Air Ionizers.

This standard was originally designated ANSI/EOS/ESD S3.1-1991 and approved on June 6, 1991. Standard Test Method ANSI/ESD STM3.1-2000 was a revision and redesignation of ANSI/EOS/ESD S3.1-1991 and was approved on February 6, 2000. Standard Test Method ANSI/ESD STM3.1-2006 is a reaffirmation of ANSI/ESD STM3.1-2000 and was approved on February 26, 2006. All documents were prepared by the 3.0 Ionization Subcommittee.

At the time the STM3.1-2006 version was prepared, the 3.0 Ionization Subcommittee had the following members:

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Simco

Arnold Steinman, Vice Chair Ion Systems	David Swenson, TAS Affinity Static Control Consulting	Donn Bellmore Universal Instruments
Eugene Felder Desco Industries, Inc.	Tim Jarrett Guidant Corp.	Vladimir Kraz Credence Technologies
Carl Newberg Microstat Labs / River's Edge Technical Service	Maciej Noras Trek	Dale Parkin IBM
Donald Pritchard Monroe Electronics	Jeff Salisbury Seagate	Julius Turangan Western Digital

At the time the S3.1-1991 version was prepared, the 3.0 Ionization Subcommittee had the following members:

Joel Weidendorf, Chair
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Arnold Steinman, Vice Chair Ion Systems, Inc.	Ron Gibson, Secretary IBM Canada, Ltd.	Niels Jonassen, Technical Advisor Technical University of Denmark
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Lester Wenger Pinion Corporation	James Horvat (Alt.) U.S. Air Force	Gene Williams Static Control Services, Inc.
Stephen Koehn (Alt.) 3M Company		Howard Meyers Motorola

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1.0 SCOPE, PURPOSE, AND APPLICATION

1.1 Purpose

This document provides test methods and procedures for evaluating and selecting air ionization equipment and systems (ionizers).

1.2 Scope

This standard test method establishes measurement techniques, under specified conditions, to determine offset voltage (ion balance) and discharge (charge neutralization) time for ionizers. This standard test method does not include measurements of electromagnetic interference (EMI), or uses of ionizers in connection with ordnance, flammables, explosive items or electrically initiated explosive devices.

1.3 Application

As contained in this document, the test methods and test conditions may be used by manufacturers of ionizers to provide performance data describing their products. Users of ionizers are urged to modify the test methods and test conditions for their specific application in order to qualify ionizers for use, or to make periodic verifications of ionizer performance (refer to ESD SP3.3, Periodic Verification of Air Ionizers). The user will need to decide the extent of the data required for each application.

2.0 NORMATIVE REFERENCES

The following documents contain provisions that, through reference in this text, constitute provisions of this standard test method. All documents are subject to revision, and parties to agreements based on this standard test method are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

The references listed below are not meant to be inclusive of all that might be applicable to the operation of ionizers. There may be additional local, state, national and international documents that are relevant. Users of this standard test method are encouraged to determine if other regulations and references apply.

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

ESD SP3.3, Standard Practice for Protection of Electrostatic Discharge Susceptible Items – Periodic Verification of Air Ionizers[1]

ESD TR20.20, ESD Handbook[1]

ESD TR3.0-02-05, Selection and Acceptance of Air Ionizers[1]

ANSI/NFPA 70, National Electrical Code[2]

29 CFR 1910.1000, Ozone, (OSHA) Air Contaminants[3]

[1] ESD Association, 7900 Turin Road, Bldg. 3, Rome, NY 13440-2069, (315) 339-6937, www.esda.org
[2] National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, 800-344-3555, www.nfpa.org

29 CFR 1910.95, (OSHA) Occupational Noise Exposure[3]

29 CFR 1910.242 (b), (OSHA) Compressed Air Used For Cleaning[3]

10 CFR 20, (NRC) Standards for Protection against Radiation[3]

21 CFR 1020, (FDA) Performance Standards for Ionizing Radiation Emitting Products[3]

3.0 DEFINITION OF TERMS

The following definitions apply for the purposes of this document in addition to those specified in the ESD Association Glossary of Terms:

Air Conductivity

The ability of air to conduct (pass) an electric current under the influence of an electric field.

Air Ions

Molecular clusters of about ten molecules (water, impurities, etc.) bound by polarization forces to a singly charged oxygen or nitrogen molecule.

Charge Decay

The decrease and/or neutralization of a net electrostatic charge.

Charge Induction

The redistribution of charge in an isolated conductor when placed in an electric field (e.g., from a charged body). NOTE: Momentary grounding of such a conductor would result in its gaining a net charge.

Charged Plate Monitor (CPM)

An instrument used to measure the charge neutralization properties of ionization equipment.

Compressed Gas Ionizer

Ionization devices that can be used to neutralize charged surfaces and/or remove surface particles with pressurized gas. This type of ionizer may be used to ionize the gas within production equipment.

Corona

The production of positive and negative ions by a very localized high electric field. The field is normally established by applying a high voltage to a conductor in the shape of a sharp point or wire.

[3] CFR (Code of Federal Regulations) U.S. Government Printing Office, 732 N. Capitol Street NW, Washington, DC 20401, 866-512-1800, http://bookstore.gpo.gov

Decay Rate

The decrease of charge or voltage per unit time.

Discharge Time

The time necessary for a voltage (due to an electrostatic charge) to decay from an initial value to some arbitrarily chosen final value.

Emitter

A conducting sharp object, usually a needle or wire, which will cause a corona discharge when kept at a high potential.

Horizontal Laminar Flow

Non-turbulent airflow in a horizontal direction.

Ion Balance (*See* Offset Voltage)

Ionizer

A device that is designed to generate positive and/or negative air ions.

Isolated Conductor

A non-grounded conductor.

Laminar Flow Hood Ionization

These devices or systems provide local area ionization coverage in vertical or horizontal laminar flow hoods or benches.

Offset Voltage

The observed voltage on the isolated conductive plate of a charged plate monitor (CPM) that has been placed in an ionized environment.

Peak Offset Voltage

For pulsed ionizers, the maximum value of the offset voltage for each polarity, as the ionizer cycles between positive and negative ion outputs.

Room Ionization

Ionization systems that provide large area coverage with air ions.

Worksurface Ionization (formerly Tabletop Ionization)

Ionization devices or systems used to control static charges at a workstation. NOTE: This type includes benchtop ionizers, overhead worksurface ionizers and laminar flow hood ionizers.

Vertical Laminar Flow

Non-turbulent airflow in a vertical direction.

4.0 SAFETY REQUIREMENTS

In addition to the safety issues mentioned in this section, there may be local, state, national and international safety standards or regulations that affect the operation of ionizers. Users of this standard test method should determine if such requirements will apply to their installation of ionizers.

4.1 Personnel Safety

4.1.1 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 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 may come into contact with electrical sources.

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

4.2 Electrical

In the case of high-voltage ionizers with exposed emitters, the corona points or wires should be peak current limited to applicable safety requirements for the installation.

4.3 Ozone

The OSHA limit, as defined by 29 CFR 1910.1000, shall not be exceeded. If ozone-sensitive components are in the vicinity of an ionizer, the manufacturer should provide information and/or evaluation suggestions for the situation.

4.4 Radioactive

The manufacturer is required to obtain a license from the Nuclear Regulatory Commission (NRC) or the NRC Agreement State in which the equipment is manufactured. The manufacturer and user shall meet all requirements of 10 CFR 20 and any other applicable government regulations.

4.5 X-ray

The manufacturer and user shall meet all requirements of 21 CFR 1020 and any other applicable government regulations. Typically, state and local government agencies will require the device to be registered at its use location. X-ray devices should be installed in such a way that prevents accidental exposure to personnel. Typically this will include some type of enclosure for the X-ray device and electrical interlocking to turn the X-ray device off when the enclosure is opened.

4.6 Installation

Installation should conform to applicable electrical, mechanical and safety codes, as well as individual facility standards. Some equipment, such as compressed gas guns and nozzles may have to meet other requirements such as 29 CFR 1910.95 for noise exposure and 29 CFR 1910.242 for personnel safety with compressed gas devices. Installation techniques should also be applicable to the particular environment in which the ionizer is to be installed (e.g., cleanrooms).

5.0 TEST EQUIPMENT

5.1 The instrument recommended by this standard test method to make performance measurements on air ionization equipment is the CPM (refer to Figure 1). The conductive plate shall be 15 cm by 15 cm (6 inches by 6 inches) with a minimum capacitance of 15 pF when mounted in the test fixture without electrical hookups. The total capacitance of the test circuit, with plate, shall be 20 pF ± 2 pF (refer to Annex B). The instrument recommended by this standard test method may also be used for the periodic verification of air ionizers (refer to ESD SP3.3, Periodic Verification of Air Ionizers).

5.2 There shall be no objects, grounded or otherwise, closer than Dimension "A" of the conductive plate except the supporting insulators or plate voltage contacts, as shown in Figure 2 (refer to Annex B).

5.3 The isolated conductive plate, when charged to the desired test voltage, shall not discharge more than 10% of the test voltage within five minutes, in the absence of ionization.

5.4 The voltage on the plate shall be monitored in such a way that the system conforms to Sections 5.1, 5.2 and 5.3. The response time of the monitoring device shall be sufficient to accurately measure changing plate voltages.

5.5 The voltage source used to charge the plate should be current limited so as to meet the requirements of Section 4.1.

6.0 SPECIFIC REQUIREMENTS FOR EQUIPMENT CATEGORIES

For the types of ionization equipment listed in Sections 6.1, 6.2, 6.3 and 6.4, the following specific requirements apply:

a) **Discharge Time Test** - The conductive plate of the test fixture shall be charged to an initial test voltage and allowed to discharge to 10% of the initial test voltage. The time required shall be monitored and recorded for both polarities of initial charge. This time is referred to as the discharge time (refer to Section 5.1 and Figure 1).

b) **Offset Voltage Test** - The conductive plate shall be momentarily grounded to remove any residual charges and to verify zero of the monitoring device. The plate is then monitored within the ionized environment, per the procedure described for each equipment category. The resulting observed voltage is referred to as the offset voltage.

c) **Locations** - The discharge time and offset voltage should be measured for each test location described in the test location figures (see Table 1).

d) **Same Conditions** - Discharge time and offset voltage shall be measured under the same conditions without any equipment adjustments. If ionizers from different categories are to be compared, the same test voltages shall be used for all tests.

e) **Peak Offset Voltage** - In the case of pulsed ionizers, offset voltage should be measured and reported in peak values using the test equipment described in Section 5.1.

f) **Other Parameters** - Application specific parameters such as humidity, temperature, air velocity, etc., should be recorded.

Table 1. Test Setups and Test Locations

Equipment Category	Figure References	Number of Test Locations	Offset Voltage Measurement Time Interval	Charged Plate Initial Voltage
Room Ionization				
Grids, AC	3	2	1 – 5 min	1000
Bars, Pulsed & DC	3	2	1 – 5 min	1000
Single Polarity Emitter	4	3	1 – 5 min	1000
Dual DC Line	5	3	1 – 5 min	1000
Pulsed DC Emitter	6	2	1 – 5 min	1000
Laminar Flow Hood				
Vertical	7 and 8	8	1 – 5 min	1000
Horizontal	9 and 10	6	1 – 5 min	1000
Worksurface Ionization				
Benchtop	11 and 12	12	1 – 5 min	1000
Overhead	13 and 14	12	1 – 5 min	1000
Compressed Gas Ionization				
Guns and Nozzles	15	1	10 sec – 1 min	1000

6.1 Room Ionization

6.1.1 The area around the charged plate monitor should be cleared for a horizontal distance of 5 feet in all directions. The ionization system should be operated for a minimum of 30 minutes to stabilize conditions in the test area.

6.1.2 During the test, the test technician should be grounded and stand outside the 5-foot cleared area.

6.1.3 Discharge Time from a 1,000 volt initial voltage to a 100 volt final voltage shall be measured for both positive (+) and negative (-) polarities.

6.1.4 The air velocity at the test location should be recorded.

6.1.5 Measurements should be taken with the charged plate monitor at a distance of 5 feet from the ionizer under test. Since installed ionizer heights may vary, a consistent measurement height should be selected for the evaluation of different systems. This height and the ionizer mounting height shall be recorded in the test results.

6.1.6 The minimum number of test locations is determined by the type of system. (See Table 1 and refer to Figures 3 through 6.)

6.1.7 Discharge Time as described in 6(a) should be measured at each test location.

6.1.8 Offset voltage as described in 6(b) and 6(e) should be determined at each test location. Offset voltage shall be measured after a period of at least 1 minute to allow the reading to stabilize (5 minutes maximum).

6.2 Laminar Flow Hood Ionization

6.2.1 The test should be performed on a surface that does not contain obstructions to airflow. Unless otherwise specified, the test surface should be static dissipative or conductive and properly grounded.

6.2.2 The test technician should be properly grounded.

6.2.3 Discharge Time from a 1,000 volt initial voltage to a 100 volt final voltage shall be measured for both positive (+) and negative (-) polarities.

6.2.4 The air velocity at test location TP4, as shown in Figures 7 or 9, should be recorded.

6.2.5 For a vertical laminar flow hood, the test setup is shown in Figures 7 and 8. Data should be taken at test positions TP1 through TP8 as shown in Figure 7.

6.2.6 For a horizontal laminar flow hood, the test setup is shown in Figures 9 and 10. Data should be taken at test positions TP1 through TP6 as shown in Figure 9.

6.2.7 Discharge time as described in 6(a) should be measured at each test location.

6.2.8 Offset voltage as described in 6(b) and 6(e) should be determined at each test location. Offset voltage shall be measured after a period of at least 1 minute, or as necessary to allow the reading to stabilize (5 minutes maximum).

6.3 Worksurface Ionization

6.3.1 The test should be performed on a surface that does not contain obstructions to airflow. Unless otherwise specified the test surface should be static dissipative or conductive and properly grounded.

6.3.2 The test technician should be properly grounded.

6.3.3 Discharge Time from a 1,000 volt initial voltage to a 100 volt final voltage shall be measured for both positive (+) and negative (-) polarities.

6.3.4 The unit should be measured with the heater off, if so equipped. The unit should be tested with any filters in place if so equipped. Measurements should be made at both minimum and maximum airflows for units with variable airflow. The air velocity should be measured and included in the test results. End users should test ionizers with the same configuration of operating heaters and filters that they intend to use.

6.3.5 For benchtop units, the ionizer should be placed as shown in Figures 11 and 12. Airflow should be directed at test location TP2 and measured at test locations TP2 and TP5. The charged plate monitor shall face the ionizer. Measurements with the charged plate monitor should be made at test locations TP1 through TP12 as shown in Figure 11.

6.3.6 For overhead units, the ionizer should be placed as shown in Figures 13 and 14. Airflow should be measured at test locations TP5 and TP8. Measurements with the charged plate monitor should be made at test locations TP1 through TP12 as shown in Figure 13.

6.3.7 Discharge time as described in 6(a) should be measured at each test location.

6.3.8 Offset voltage as described in 6(b) and 6(e) should be determined at each test location. Offset voltage shall be measured after a period of at least 1 minute, or as necessary to allow the reading to stabilize (5 minutes maximum).

6.4 Compressed Gas Ionizers – Guns and Nozzles

6.4.1 The test should be performed on a surface that does not contain obstructions to airflow. Unless otherwise specified, the test surface should be static dissipative or conductive and properly grounded.

6.4.2 The test technician should be properly grounded.

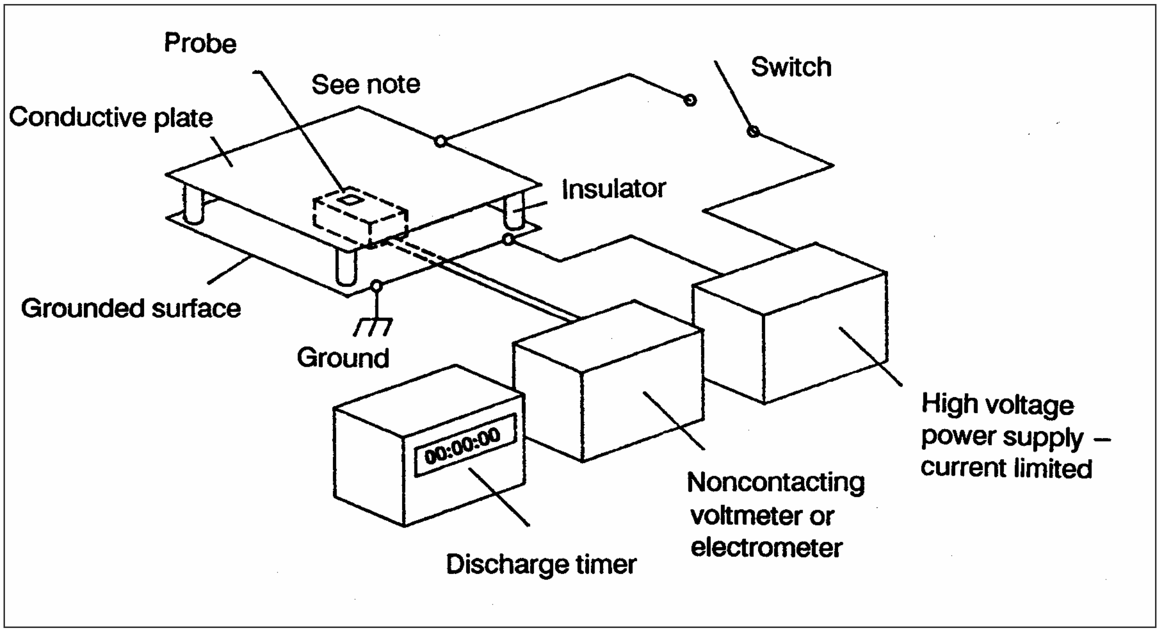
6.4.3 Discharge Time from a 1,000 volt initial voltage to a 100 volt final voltage shall be measured for both positive (+) and negative (-) polarities.

6.4.4 Unless otherwise specified, the input pressure should be 30 psig. End users should test compressed gas ionizers in the same configuration of input pressure and distance that they intend to use.

6.4.5 The tests should be performed using the test setup shown in Figure 15.

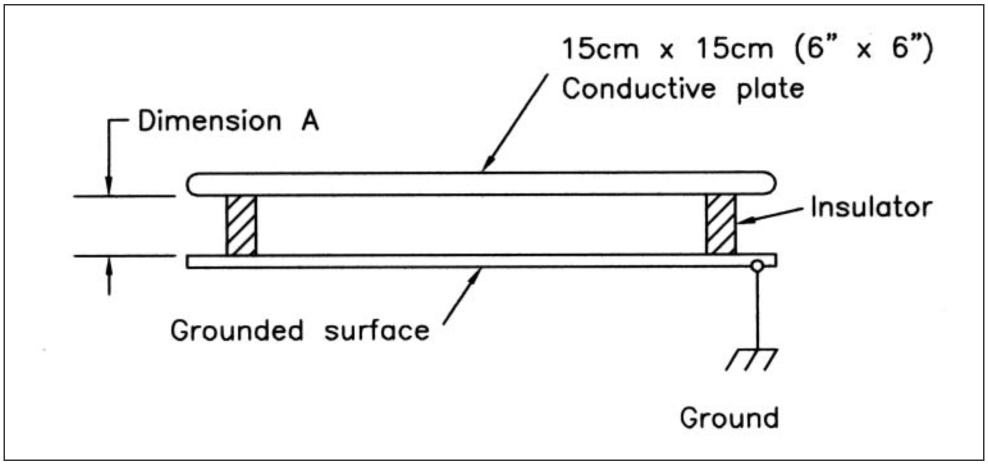
6.4.6 Discharge Time as described in 6(a) should be measured at the test location.

6.4.7 Offset voltage as described in 6(b) and 6(e) should be determined at the test location. Offset Voltage shall be measured after a period of at least 10 seconds or as necessary to allow the reading to stabilize (1 minute maximum).



NOTE: See Figure 2.

Figure 1: Charged Plate Monitor Components



NOTE: Grounded surface should be ≥ 15 cm (6 inches) square.

Figure 2: Charged Plate Detail