

ESD Standards: A Review And Update

A definitive look at the evolution of ESD standards, and their increasing importance in today's electronics industry

It's hardly front-page news that change is a dominant force in today's electronics industry. Economic pressures, higher density devices, new technologies, and increasing reliance on out-sourcing are only a few of the indicators of change. When change is accompanied by today's stagnant economy, the double whammy intensifies the pressure to reduce product losses to electrostatic discharge (ESD).

Other than increasing sales dramatically, electrostatic discharge (ESD) control may be the single most profitable opportunity for the industry under today's economic conditions. Independent consultants have found that ESD costs the average electronic manufacturer 4 to 8 percent of total annual corporate revenues, depending on product designs and device sensitivity. With an estimated average negative impact of 6.5 percent of revenues, this means the international electronics industry is losing in excess of \$84 billion (USD) every year based on 1997-2001 production data.¹

As companies face the complex challenge of reducing ESD losses, they look for legitimate ways to evaluate and compare competing brands and types of products. They need objective confirmation that their ESD control program provides effective solutions to their unique ESD problems. Contract manufacturers and OEMs require mutually agreed-upon ESD control programs that reduce duplication of process controls.

That's where ESD standards come into play, playing an ever-increasing role in reducing marketplace confusion in the manufacture, evaluation, and selection of ESD control products and programs. They help define the ESD sensitivity of the products manufactured and used. They help define the

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performance requirements for various ESD control materials, instruments, and tools. They provide guidance in developing programs that effectively address ESD process control. And, as the industry and its needs change, ESD standards also undergo transformation and refinement.

Who Uses Standards And Why?

Who uses ESD standards? The list is quite broad: manufacturers, purchasers, and users of ESD sensitive devices and products; manufacturers and distributors of ESD control products; certification registrars; and third party testers of ESD control products.

Why use ESD standards? The reasons are numerous:

- They help assure consistency of ESD sensitive products and consistency of ESD control products and services
- They provide a means of objective evaluation and comparison among competitive ESD control products
- They help reduce conflicts between users and suppliers of ESD control products
- They help in developing, implementing, auditing, and certifying ESD control programs
- They help reduce confusion in the marketplace.

In the United States, the use of ESD standards continues to be voluntary. However, their use can be written into contracts or purchasing agreements between buyer and seller. In much of the rest of the world, the use of standards, where they exist, is compulsory.

¹ "ESD Control: A Profitable Opportunity in Tight Economic Times", Stephen A. Halperin, *Threshold*, January/February 2003, ESD Association, Rome, NY.

General Types Of Standards

As recently as 1990, there were relatively few reliable ESD standards and many of them were developed for applications other than electronics. In this new century, the landscape has changed significantly with an increasing number of ESD standards developed specifically for the electronics industry.

ESD Association standards can be categorized into four main groups. First, there are those that provide ESD program guidance or requirements, such as *ANSI/ESD S20.20-1999: Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*, *ANSI/ESD S6.1-1999: Grounding — Recommended Practice* and *ANSI/ESD S1.1—1998: Wrist Straps*. These documents are classified as “standards” as they all have specific requirements that must be met.

A second group of documents is called “Standard Test Methods.” These documents contain procedures that can be used to evaluate device sensitivity or ESD control products, materials, or processes. The procedures called out in a standard test method should provide similar test results when tested by two separate labs. Standard test methods include documents such as *ESD STM5.1-2001: Device Testing — Human Body Model (HBM) Component Level* and *ESD STM7.1-2001: Resistive Characterization of Materials—Floor Materials*, to cite just a few.

The third category of documents is called “Standard Practices.” A standard practice contains procedures similar to those found in a standard test method with one difference. The procedure is not sufficiently developed to ensure that two labs will get the same result when the procedure is followed. In many cases, a document is released as a Standard Practice so that industry can

start to use it. The working group that issued the standard practice continues their efforts to make the test method repeatable and reproducible with the goal of eventually elevating the document to a Standard Test Method.

Finally, the last category of standards documents includes “Advisories” and “Technical Reports.” These types of documents are used to provide educational information to potential users. A good example is *TR20.20*. This document is a companion publication to *ANSI/ESD S20.20-1999* and provides detailed, background information on the requirements of the standard as well as a wealth of information on ESD control issues.

Who Are The Primary Standards Developers?

Although there are a number of organizations such as IEST, IDEMA, and JEDEC involved in ESD standards development, the ESD Association has

become the focal point for the development of ESD standards in recent years. An ANSI-accredited standards development organization, the Association is charged with the development of ESD standards and test methods. The Association also represents the United States on the International Electrotechnical Commission's Technical Committee 101-Electrostatics. The ESD Association has published 27 standards documents and 16 technical reports covering material and program requirements, electrostatic sensitivity, and test methodology for evaluating ESD control materials and products.

Traditionally, the U.S. military spearheaded the development of specific standards and specifications with regard to ESD control in the United States. Today, however, U.S. military agencies are taking a less proactive approach, relying on commercially developed standards

rather than developing standards themselves.

The international community, led by the International Electrotechnical Commission (IEC), has also taken an active role in standards development. Europe's CENELEC has issued a European electrostatic standard, *EN61340-5-1 Protection of Electronic Devices From Electrostatic Phenomena – General Requirements*, that was adopted as a European Norm.

Trends In Standards Development: Organizational Cooperation

Perhaps one of the more intriguing trends in ESD standards development has been the increasing organizational cooperation between various groups. One such cooperative effort occurred between the ESD Association and the U.S. Department of Defense, which resulted in the Association preparing *ANSI/ESD S20.20*, a standard that has been adopted by the Department of

Defense as a successor to MIL-STD-1686.

Similarly, the ESD Association recently completed work on a new packaging standard as a replacement for EIA 541-1988. The new document, *ANSI/ESD S541-2003: Packaging Materials for ESD Sensitive Items*, was approved as a full standard in February of 2003.

Internationally, European standards development organizations and the ESD Association have developed working relationships that result in an expanded review of proposed documents, greater input, and closer harmonization of standards that impact the international electronics community. The IEC and the ESD Association are now working together to more closely align and harmonize the IEC and European standards with S20.20.

For users of ESD standards, this increased cooperation will have a significant impact. First, we should see

standards that are technically improved due to broader input. Second, we should see fewer conflicts between different standards. Finally, we should see less duplication of effort.

Trends In Standards Development: New And Updated Documents

A second major trend in standards development is the continuing process of creating new standards and the fine-tuning of existing standards to meet the technological advances and changing needs of the industry.

The Advent of S20.20

Perhaps the key standards document to be introduced into the ESD marketplace in recent years is *ANSI/ESD S20.20-1999: Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*. Designed to help answer the questions “How do I convince my customers my ESD control program adequately protects the products I provide them?” and “How do I demonstrate that a single ESD control program will work for all of my customers?” *ANSI/ESD S20.20-1999* outlines the basic requirements necessary to design, establish, implement, and maintain an ESD control program. The standard itself provides broad program guidance while allowing the user the flexibility to develop a specific, individualized program within the framework of S20.20.

What makes S20.20 unique is that programs developed and based on it are third-party auditable. Using S20.20 as a program guideline, a manufacturer not only has a means for developing and implementing a program that meets its specific needs, but also has an ISO-level certifiable program that can demonstrate to their customers that they have a functioning ESD program in place. Contract manufacturers who faced a myriad of differing control programs to satisfy their customers’ varying requirements have the opportunity to implement a single auditable program.

The ESD Association announced the

ESD Association Documents

The ESD Association issues four distinct types of standards documents:

Standard: A precise statement of a set of requirements to be satisfied by a material, product, system or process that also specifies the procedures for determining whether each of the requirements is satisfied.

Standard Test Method: 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 yields a reproducible test result.

Standard Practice: A procedure for performing one or more operations or functions that may or may not yield a test result. Note: If a test result is obtained, it may not be reproducible between labs.

Technical Report: A collection of technical data or test results published as an informational reference on a specific material, product, system, or process.

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ANSI/ESD S1.1—1998: Wrist Straps

This document establishes test methods for evaluating the electrical and mechanical characteristics of wrist straps. It includes improved test methods and performance limits for evaluation, acceptance, and functional testing of wrist straps.

ANSI/ESD STM2.1—1997: Garments

This Standard Test Method provides test methods for measuring the electrical resistance of garments used to control electrostatic discharge. It covers procedures for measuring sleeve-to-sleeve and point-to-point resistance.

ANSI/ESD STM3.1-2000: Ionization

Test methods and procedures for evaluating and selecting air ionization equipment and systems are covered in this standard. The document establishes measurement techniques to determine ion balance and charge neutralization time for ionizers.

ESD SP3.3-2000: Periodic Verification of Air Ionizers

This Standard Practice provides test methods and procedures for periodic verification of the performance of air ionization equipment and systems (ionizers).

ANSI/ESD S4.1-1997: Worksurfaces – Resistance Measurements

This Standard establishes test methods for measuring the electrical resistance of worksurface materials used at workstations for protection of ESD susceptible items. It includes methods for evaluating and selecting materials.

ANSI/ESD STM4.2-1998: ESD Protective Worksurfaces - Charge Dissipation Characteristics

This Standard Test Method provides a test method to measure the electrostatic charge dissipation characteristics of worksurfaces used for ESD control.

ESD STM5.1-2001 Electrostatic Discharge Sensitivity Testing — Human Body Model (HBM) Component Level

This Standard Test Method updates and revises an existing Standard. It establishes a procedure for testing, evaluating and classifying the ESD sensitivity of components to the defined Human Body Model (HBM).

ANSI/ESD STM5.2-1999: Electrostatic Discharge Sensitivity Testing — Machine Model (MM) Component Level

This Standard establishes a test procedure for evaluating the ESD sensitivity of components to a defined Machine Model (MM). It also provides a system of classifying the sensitivity of these components.

ANSI/ESD STM5.3.1-1999: Charged Device Model (CDM)-Component Level

This Standard Test Method establishes the procedures for testing, evaluating, and classifying the ESD sensitivity components to a defined charged device model.

ANSI/ESD S6.1-1999: Grounding — Recommended Practice

This Standard recommends the parameters, procedures, and types of materials needed to establish an ESD grounding system for the protection of electronic hardware from ESD damage.

ESD STM 7.1-2001: Resistive Characterization of Materials — Floor Materials

Measurement of the electrical resistance of various floor materials such as floor coverings, mats, and floor finishes is covered in this document.

ANSI/EOS/ESD S8.1-1993: Symbols — ESD Awareness

Three types of ESD awareness symbols are established by this document. The first one is to be used on a device or assembly to indicate that it is susceptible to electrostatic charge. The second is to be used on items and materials intended to provide electrostatic protection. The third symbol indicates the common point ground.

ANSI/ESD STM 9.1-2001: Footwear — Resistive Characterization

This Standard defines a test method for measuring the electrical resistance of shoes used for ESD control in the electronics environment. A companion document covering foot grounders is in the draft stage.

ESD SP10.1-2000: Automated Handling Equipment (AHE)

This Standard Practice provides procedures for evaluating the electrostatic environment associated with automated handling equipment.

ESD STM 11.11-2001: Surface Resistance Measurement of Static Dissipative Planar Materials

This Standard defines a direct current test method for measuring electrical resistance of static

dissipative planar materials used in packaging of ESD sensitive devices and components.

ANSI/ESD STM11.12-2000: Volume Resistance Measurement of Static Dissipative Planar Materials
This Standard Test Method provides test methods for measuring the volume resistance of static dissipative planar materials used in the packaging of ESD sensitive devices and components.

ANSI/ESD STM11.31-2001: Bags
This Standard provides a method for testing and determining the shielding capabilities of electrostatic shielding bags.

ANSI/ESD STM12.1-1997: Seating-Resistive Measurement
This Standard provides test methods for measuring the electrical resistance of seating used to control ESD.

ESD STM13.1-2000: Electrical Soldering/Desoldering Hand Tools
This Standard Test Method provides electric soldering/desoldering hand tool test methods for measuring the electrical leakage and tip to ground reference point resistance and provides parameters for EOS safe soldering operation.

ANSI/ESD S20.20-1999: Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
This Standard provides administrative, technical requirements and guidance for establishing, implementing and maintaining an ESD Control Program.

ANSI/ESD STM97.1-1999: Floor Materials and Footwear – Resistance Measurement in Combination with a Person
This Standard Test Method provides for measuring the electrical resistance of floor materials, footwear and personnel together, as a system.

ANSI/ESD STM97.2-1999: Floor Materials and Footwear - Voltage Measurement in Combination with a Person
This Standard Test Method provides for measuring the electrostatic voltage on a person in combination with floor materials and footwear, as a system.

ESD S541-2003: Packaging Materials for ESD Sensitive Items
This is a new standard that defines the packaging properties needed to protect electrostatic discharge susceptible (ESDS) electronic items through all phases of production, transport and storage. The document discusses application requirements and references the testing methods for evaluating packaging and packaging materials for those properties.

ESD Association Advisory Documents

Advisory Documents are not Standards, but provide general information for the industry or additional information to aid in better understanding of Association Standards.

ESD ADV1.0-1994: Glossary of Terms
Definitions and explanations of various terms used in Association Standards and documents are covered in this Advisory. It also includes other terms commonly used in the ESD industry.

ESD ADV3.2-1995: Selection and Acceptance of Air Ionizers

This Advisory document provides end users with guidelines for creating a performance specification for selecting air ionization systems. It reviews four types of air ionizers and discusses applications, test method references, and general design, performance and safety requirements.

ESD ADV11.2-1995: Triboelectric Charge Accumulation Testing

The complex phenomenon of triboelectric charging is discussed in this Advisory. It covers the theory and effects of tribocharging. It reviews procedures and problems associated with various test methods that are often used to evaluate triboelectrification characteristics.

ESD ADV53.1-1995: ESD Protective Workstations

This Advisory document defines the minimum requirements for a basic ESD protective workstation used in ESD sensitive areas. It provides a test method for evaluating and monitoring workstations.

ESD TR 20.20: ESD Handbook

New handbook provides detailed guidance for implementing an ESD control program in accordance with ANSI/ESD S20.20.

Sources of Standards

ESD standards are available from the following sources:

- ESD Association, 7900 Turin Road, Building 3, Rome, NY 13440. Phone: 315-339-6937. Fax: 315-339-6793. Web Site: <http://www.esda.org>
- International Electrotechnical Commission, 3, rue de Varembe, Case postale 131, 1211 Geneva 20, Switzerland. Fax: 41-22-919-0300. Web Site: <http://www.iec.ch/>
- Military Standards, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

mechanism for a third-party facility audit based on S20.20 in the Fall of 2000. The S20.20 facility certification program is similar to ISO 9000, with certified registrars independently assessing a company's ESD control program and issuing a formal S20.20 certification. This assessment of a company's ESD control program can be performed in conjunction with a company's ISO 9000 audit or as a separate audit.

Other Standards Documents

In addition to the recent release of *ANSI/ESD S541*, the ESD Association continues to work on updating existing documents as necessary as well as developing new ones to meet industry needs. Standards covering floor materials, footwear, static dissipative planar materials, bags, and HBM testing were reviewed and updated in 2001. The Association recently released draft standards covering Foot Grounders, ESD Simulators, Transmission Line Pulse Testing, Socketed Device Model and Transient Latch-up Testing.

Summary

As the electronics industry continues to face technological advances, the propagation and fine-tuning of ESD standards to meet these advances will result in an increase in the technical references that will help improve ESD control programs. There will be recommendations and procedures to help set up effective programs. There will be test methods and specifications to help users of ESD control materials evaluate and select products that are applicable to their specific needs. And there will be guidelines for vendors of ESD products and materials to help them develop products that meet the real needs of their customers. ■

About The ESD Association

With more than 2000 members throughout the world, the ESD Association is the largest industry group dedicated to advancing the theory and the practice of ESD avoidance. Readers can learn more about the Association and its work at its web site at www.esda.org. Special thanks to Michael Brandt for his assistance in preparing this article.