Selecting a Static-control Floor

Matching Products and Environments Through Evidence-based Design

staticWorx®
GroundSafe® ESD Flooring

Choosing the Right ESD Floor

Electrostatic discharge (ESD) is a well-documented, invisible threat to electronic parts, systems, and mission-critical operations. Increasingly smaller electronic devices mean reduced room for on-chip protection and increased vulnerability to ESD. Eliminating the risk of harmful ESD events requires "fault-tolerant" static-control flooring that performs consistently — regardless of variables such as footwear, maintenance, and humidity.

Specifications for a static-control floor should address unique environmental conditions and meet the latest ESD standards; otherwise, you risk damage to equipment, product returns, facility downtime, communication errors, and liability. Using evidence-based design principles, you can match the right product to its post-installation environment.

> ***A Note about Class-0 Electronic Devices***
>
> *The electronics industry has no clear definition for the term Class-0. However, the classification is widely used within the industry to reference ultra-sensitive devices.*
>
> *While most companies are acutely aware of the hazards of ESD (electrostatic discharge), few are aware of best practices for preventing failures of these extremely sensitive devices.*

What's Inside

The information in this guide is based on industry-approved flooring specifications, and the review of hundreds of static-generation tests on all forms of ESD flooring, using multiple test subjects wearing dozens of types of ordinary and ESD footwear — providing a scientific framework for finding customized flooring solutions.

Contents

Are You Grounded?

Static-control Flooring Checklist

When selecting a static-control floor, it's important to understand the basics about static control and ESD flooring. This checklist — as well as the charts on the pages that follow — can help.

❒ **Check your environment.**

Will the floor be installed in a stringently controlled ESD-protected area (EPA) — mandating special ESD footwear? In an environment where static-control footwear is required but not enforced? Or in an end-user environment with no static-control protocols?

❒ **Check which types of footwear will be used.**

Footwear affects the performance of static-control floors. When evaluating static generation, test every type of footwear that may be used, both standard and static control.

❒ **Check conductivity.**

Be sure the floor provides a safe path to ground. Find the "sweet spot" for conductivity (page 6).

❒ **Check body voltage generation.**

Find out how much static will be generated when people walk across the floor, using the ANSI/ESD S97.2 charge generation test (see graph on page 5).

❒ **Check static-control terminology.**

Pay special attention to terms like conductive; static dissipative; Ohms; and static generation. Be aware that certain terms, such as ESD flooring, are generic, so mean very little.

❒ **Check to be sure the floor meets industry standards for static-control flooring.**

- Reference ANSI/ESD S20.20 and IEC 61340-5-1 for electronics manufacturing.
- Refer to Motorola R56 and ATIS-0600321.2015 for mission-critical environments — e.g., data centers or 9-1-1 dispatch centers.
- Use FAA 019f for flight control applications.

❒ **Check for permanent static control.**

The anti-static properties of some static-control floors come from the application of special waxes and sprays that wear off and must be continually reapplied.

❒ **Check short- *and* long-term budgets.**

Consider the initial investment, maintenance, and repair, as well as total life-cycle costs.

❒ **Check durability requirements.**

Will the floor be installed in a high- or low-traffic area? Will soldering equipment or solvents be used? Will heavy loads be moved across the floor? Will forklifts be in use?

❒ **Check aesthetics.**

Will the floor maintain its appearance over time and within its environment?

❒ **Check ergonomics.**

Factor anti-fatigue, sound attenuation, and slip resistance into your decision.

❒ **Check the time allotted for installation.**

Some products require more extensive floor preparation and certain materials are easier to install than others.

❒ **Check the origin of the product.**

Floor tiles produced offshore are often die cut and, as a result, have slight dimensional variations, causing unsightly gaps in the seams.

❒ **Check the warranty.**

Select a manufacturer that warrants ESD performance over the life of the product.

❒ **Check the floor after it has been installed.**

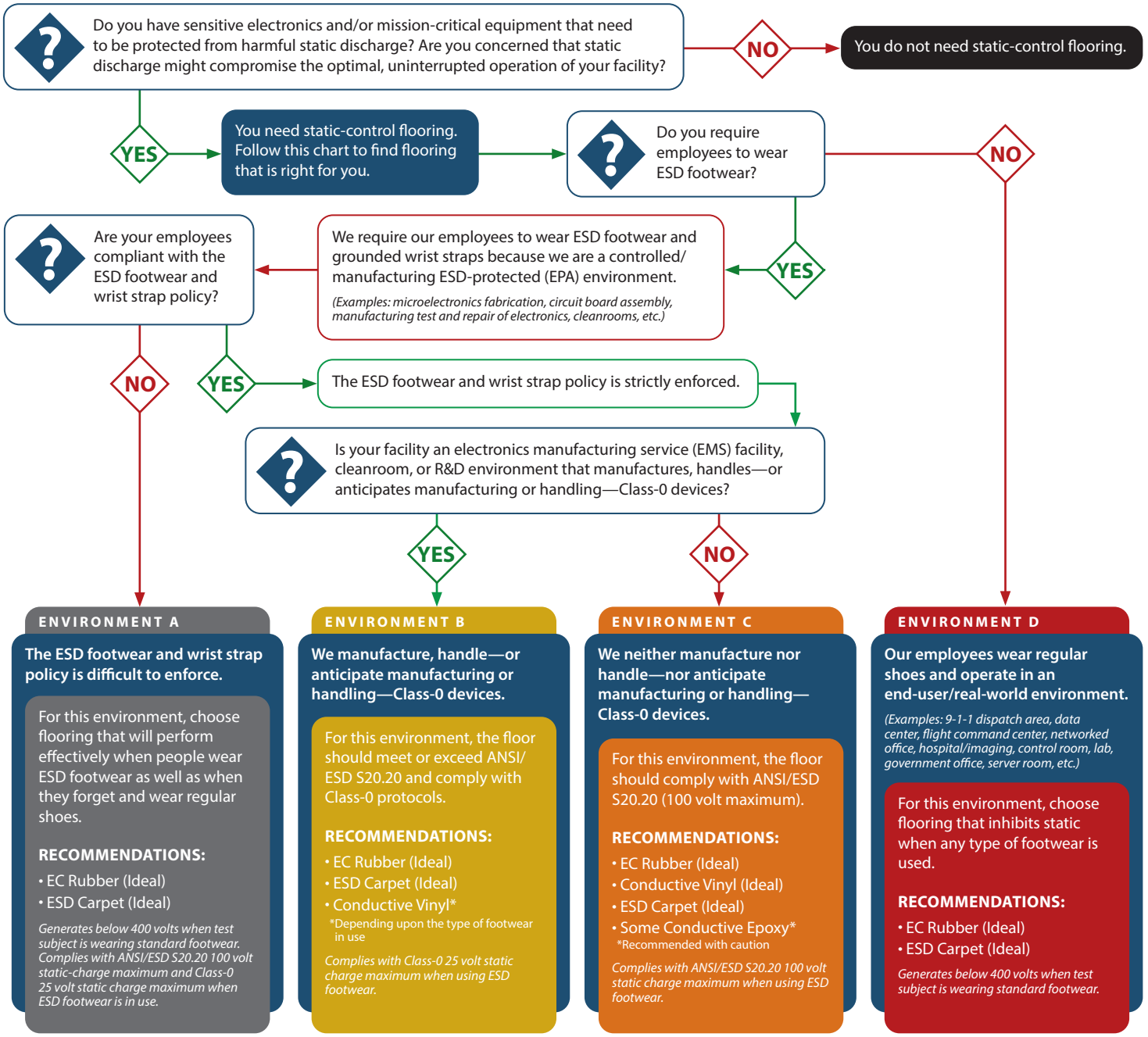
Request a free flooring audit — with written certification that the floor meets static-control parameters.

Flooring Selector Guide

Footwear and static-control flooring work together to control charge generation. This decision tree can help you find the flooring options that are most compatible with your environment. Recommendations are based on electrical resistance, measured in ohms, and charge generation, measured in volts.

Static-control floors should meet ESD performance standards for both resistance and walking body voltage generation. The information presented in this chart assumes that the floor under consideration meets industry standards for electrical resistance — less than or equal to 1.0 x 10^9.

All types of footwear — regular and ESD — affect the performance of a static-control floor. It is therefore recommended that you obtain a report from an independent ESD-flooring laboratory, showing performance results, tested with the subject wearing regular shoes (e.g., with rubber, leather, and/or plastic soles), as well as different types of ESD footwear (e.g., heel straps, toe straps, and static-control shoes).



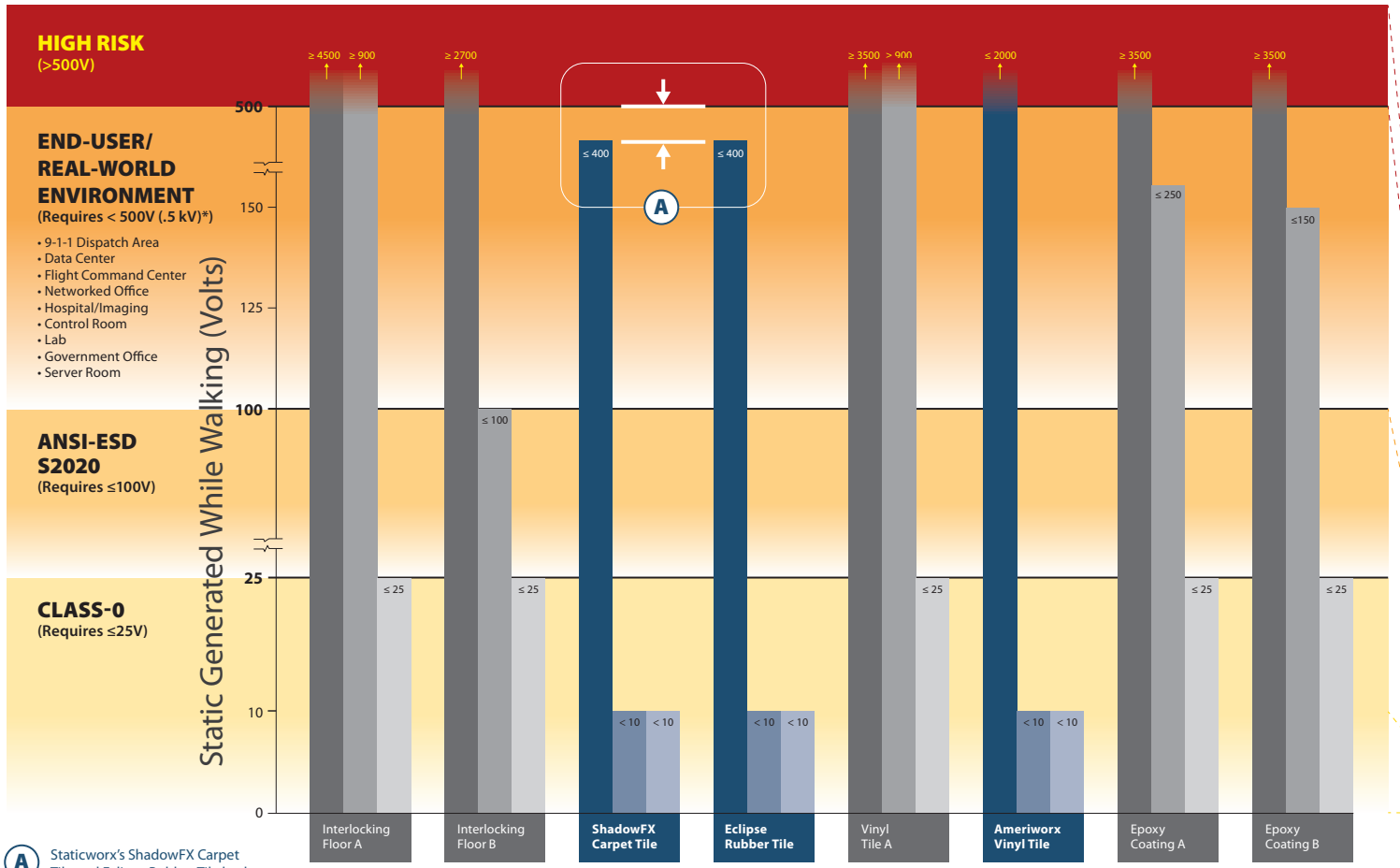
What is Body Voltage Static Generation?

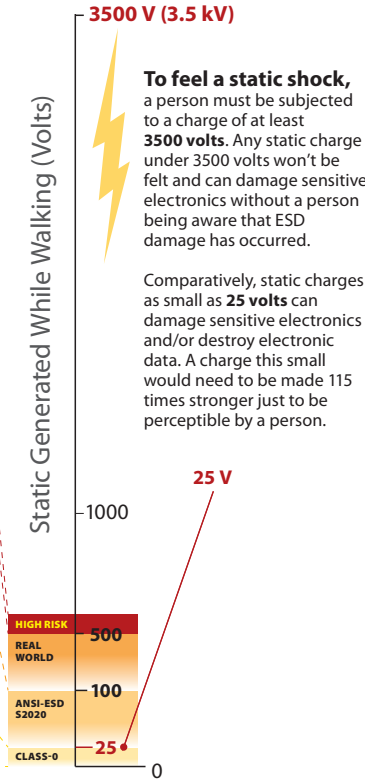
Walking body voltage tests evaluate the flooring system. Using a charge plate monitor, the test measures static generated when a person walks across the floor, wearing a particular type of footwear — regular shoes, or static-control heel straps, toe straps, or ESD shoes. Because different shoes generate different amounts of static, the test is typically repeated, with the subject wearing various types of regular shoes and static-control footwear.

Electrical resistance tests — which ESD flooring must also pass — evaluate only the floor's path to ground.

Walking — or the friction that occurs when a foot touches and separates from the floor — generates static. These static charges accumulate on the human body and discharge to the first object the person touches, potentially damaging electronic components or systems.

Body Voltage Generated with Different Types of Footwear





To feel a static shock, a person must be subjected to a charge of at least **3500 volts**. Any static charge under 3500 volts won't be felt and can damage sensitive electronics without a person being aware that ESD damage has occurred.

Comparatively, static charges as small as **25 volts** can damage sensitive electronics and/or destroy electronic data. A charge this small would need to be made 115 times stronger just to be perceptible by a person.

Walking body voltage tests conducted by Fowler Associates, in their independent ESD-testing lab.

**ASHRAE has established a body voltage maximum of 500 volts (.5 kV) for service operations. The ASHRAE study was conducted at the University of Missouri, Science and Technology, Rolla, MO, U.S.A. under the guidance of Dr. David Pommerenke.*

Ⓐ Staticworx's ShadowFX Carpet Tile and Eclipse Rubber Tile both test well below the 500V high risk zone, providing a safe buffer and allowing workers in End-user/ Real-world Environments to safely wear regular, everyday footwear.

Flooring Used With Different Footwear

Flooring type with regular footwear	Flooring type with ESD heel strap	Flooring type with ESD shoes	Staticworx flooring with regular footwear	Staticworx flooring with ESD heel strap	Staticworx flooring with ESD shoes

Resistance Requirements by Environment

Resistance requirements, based on the latest ESD standards, depend upon your environment and footwear. Use the chart below to determine the most compatible flooring materials for your environment.

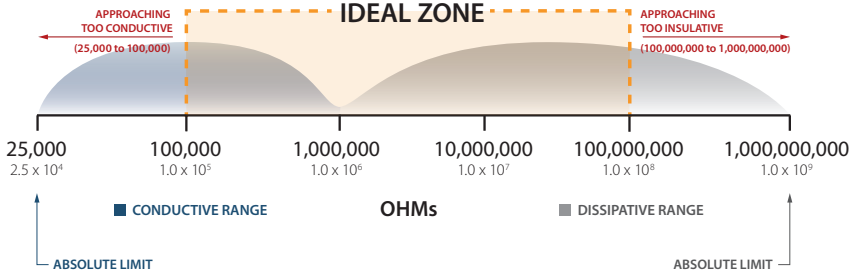
Category	Class-0	Controlled Environments (ANSI/ESD S20.20)	End-User/Real-World (Data Centers, 9-1-1 Dispatch Operations, etc.)	
Maximum allowable resistance	25,000 - ≤ 10^9 ohms	25,000 - ≤ 10^9 ohms	10^6 - 10^9 ohms	
Environment	Controlled/manufacturing ESD-protected areas (EPA) that handle ultra-sensitive devices or will in the future	Controlled/manufacturing ESD-protected areas (EPA) that are not Class-0	Mission-critical areas that require ESD protection regardless of footwear	
Applications	electronics manufacturing service (EMS) facilities cleanrooms R&D environments microelectronics	microelectronics fabrication circuit board assembly manufacturing test and repair of electronics, etc.	9-1-1 dispatch areas data centers flight command centers networked offices hospital/imaging	control rooms labs government offices server rooms, etc.
Flooring options with regular footwear	N/A: Regular footwear prohibited; must use ESD footwear	N/A: Regular footwear prohibited; must use ESD footwear	EC Rubber ESD Carpet	
Flooring options with ESD footwear or heel straps	EC Rubber ESD Carpet Conductive Vinyl	EC Rubber ESD Carpet Conductive Vinyl Generation 3 Epoxy Coatings GroundLock Interlocking Conductive Flooring	EC Rubber ESD Carpet Conductive Vinyl Static-dissipative Vinyl Tile Conductive Epoxy Coatings	Static-dissipative Epoxy Coatings Plastic Interlocking Conductive Flooring GroundLock Interlocking Flooring

Testing a Floor's Electrical Resistance

Electrical resistance tests use an ohm meter to predict the speed at which an ESD floor will discharge electricity, allowing the charge to pass from the floor's surface to ground.

If resistance is too low, electrical currents can cut across the floor, posing a safety hazard. If it's too high, static will discharge too slowly, rendering the floor ineffective.

Your "Sweet Spot" for Conductivity



All Staticworx static-control flooring tests within the safe range (sweet spot) shown above.

Comparing Types of Flooring

Static-control Properties

Category	ESD Carpet Tile	ESD Solid Vinyl Tile *(Conductive)*	ESD Epoxy GEN2 / GEN3	GroundLock Interlocking Flooring	ESD Rubber
Inhibits static with ordinary footwear; per ASHRAE, the upper limit for the environment is 500 V maximum	Yes: < 400 V maximum	No: > 3500 V	No: > 3500 V / No: > 3500 V	No: > 3500 V	Yes: < 400 V maximum
Meets standard ANSI/ESD S20.20 for electrical resistance	Yes, when using any ESD footwear	Yes, when using any ESD footwear	Yes, depending on type of ESD footwear / Yes	Yes, when using ESD footwear	Yes, when using any ESD footwear
Class-0 qualified	Yes, depending on type of ESD footwear	Yes, depending on type of ESD footwear	No / Yes	No	Yes, when using any ESD footwear

Caution

Static-control interlocking flooring, vinyl, high pressure laminate, and some epoxy will not inhibit static charges without the use of ESD footwear. Persons wearing standard footwear—depending upon shoes, humidity and other factors—can generate over 3.5 kV while walking on these four materials (see chart on walking body voltage, page 5).

For more comprehensive product information, visit staticworx.com/esd-flooring

Life Cycle Costs

Category	ESD Carpet Tile	ESD Solid Vinyl Tile *(Conductive)*	ESD Epoxy GEN2 / GEN3	GroundLock Interlocking Flooring	ESD Rubber
Total cost of ownership (includes material, installation, and ongoing maintenance)	Low	Moderate	Low / Low to moderate	Low	Lowest
Cost of material	Low to moderate	Lowest	Low / Moderate	Highest	Moderate to high
Installation	Easiest and fastest	Easy and fast	Difficult	Easy	Moderate and fast
Cost of maintenance	Low to moderate	Moderate	Low *Note: shine cannot be restored once surface is scratched*	Low	Lowest

Comparing Types of Flooring *(continued)*

Physical Properties and Maintenance

Category	ESD Carpet Tile	ESD Solid Vinyl Tile *(Conductive)*	ESD Epoxy GEN2 / GEN3	GroundLock Interlocking Flooring	ESD Rubber
Long-term appearance	Good to excellent	Excellent: surface scratches can be removed by abrasive buffing	Fair: degrades over time, scratches cannot be removed	Excellent: surface scratches can be removed by abrasive buffing	Excellent
Wear layer	n/a	No: wear layer is consistent throughout the thickness of the floor	Yes: top only / Full thickness	Wear is consistent throughout the thickness of the floor	No: wear is consistent throughout the thickness of the floor
Color throughout thickness (helps hide scratches)	n/a	Yes	No / Yes	Yes	Yes
Color consistency for projects of any size	Yes	Yes	Yes	Yes	Yes
Durability	Good to excellent	Excellent	Excellent: micro scratches cannot be repaired	Excellent	Excellent
Handles/withstands heavy rolling loads	Fair	Excellent	Excellent	Good	Good
PSI	n/a	2500 - < 3000	> 3000	2500	600 - 800
Ease of rolling	Fair	Excellent	Excellent	Excellent	Good to excellent
Maintenance	Vacuum and wet extraction	Sweep, damp mop, and buff	Sweep and damp mop	Sweep and damp mop	Sweep, damp mop
Chemical resistance	Fair	Superior	Superior	Superior	Superior
Ease of repair	Easiest	Easy	Most difficult: time consuming	Easiest	Moderate

Comparing Types of Flooring *(continued)*

Ergonomics and Environmental Factors

Category	ESD Carpet Tile	ESD Solid Vinyl Tile *(Conductive)*	ESD Epoxy GEN2 / GEN3	GroundLock Interlocking Flooring	ESD Rubber
Ease of finding small parts	Fair	Easy	Easy	Easy	Easy
Slip resistance	> 0.6 Meets or exceeds ADA guidelines	> 0.6 Meets or exceeds ADA guidelines	0.5 Depending on texture	0.5 – 0.6	> 0.6 Meets or exceeds ADA guidelines
Sound absorption	Excellent	Poor to fair 4 dB	Not sound resistant	Poor to fair	Excellent 5 – 19 dB
Anti-fatiguing	Excellent	No	No	No	Good
VOC compliant	Yes	Yes FloorScore certified	Yes	Yes	Yes GREENGUARD certified
Halogen free – no chlorine or other corrosive gases in fire	Yes	No	Yes	No	Yes
Contributes toward LEED credits	Yes	Yes	Yes	Yes	Yes

Industry Standards and Test Methods

Industry standards and test methods provide verifiable metrics to help manufacturers, suppliers, and customers objectively determine the quality and performance of ESD flooring materials. Adherence ensures that everyone uses the same parameters to manufacture and evaluate static-control products, reducing confusion in the marketplace.

ESD Standards

ANSI/ESD S20.20 - 2014 ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

IEC 61340-5-1:2007 IECEE.ORG: Electrostatics — Part 5-1: Protection of electronic devices from electrostatic phenomena. The European equivalent to ANSI/ESD S20.20.

DOD 4145.26-M Safety standards for DoD and private industry ammunition and explosives (AE) operations; and facilities performing AE work or AE services under DoD contracts, subcontracts, purchase orders, or other procurement methods.

Mil STD 1686 (converted to ANSI/ESD S20.20) is the parent document for all ESD Association standards and is the main reference for Auditing an ESD Control Program.

FAA STD 019f Standard for Lightning Protection, Grounding, Bonding and Shielding Requirements.

Motorola R56 Public Safety and Telecommunications standards and guidelines for the installation of equipment, infrastructure, and facilities for communications centers. Commercial standard for network-operated dispatch operations—e.g., 9-1-1 call centers.

ATIS-0600321 Telecommunications industry standard for installations where personnel are required to access a computer terminal keyboard while continually wearing a headset.

IBM Data Center Recommendations: IBM-recommended guidelines to minimize static-electricity buildup in a data center.

NFPA 99 establishes criteria for health care services or systems based on risk to patients, staff, or visitors in health care facilities to minimize the hazards of fire, explosion, and electricity.

ESDA Electronics Industry Standard Test Methods (STM)

ANSI/ESD STM7.1-2013 Tests resistive characterization of flooring materials.

ANSI/ESD STM97.1-2015 Measures the electrical system resistance of floor materials in combination with persons wearing static-control footwear.

ANSI/ESD STM97.2-2016 Measures the voltage on a person in combination with floor materials and static control footwear, shoes or other devices.

ASTM F150-06(2013) Tests electrical resistance of resilient flooring.

AATCC 134 Electrostatic Propensity of Carpets. Standard carpet industry test, uses laboratory simulation to assess static generation when a person walks across the carpet.

ESD Standards by Application

ANSI/ESD S20.20 – 2014

ESD Association Standard: Provides guidelines to protect electrical and electronic parts, assemblies and equipment from electrostatic discharge.

- **Handles Class-0**
  ANSI 20.20 (< 20 volts) — in addition to compliance with Class-0 protocols
- **Does Not Handle Class-0**
  ANSI 20.20 (100 volt maximum)

IEC 61340-5-1:2007 IECEE.ORG

The European equivalent to ANSI/ESD S20.20.

See ANSI 20.20 - 2014 (above)

Applications

- Electronics Manufacturing
- Microelectronics Fabrication
- Circuit Boards Assembly
- Electronics Test and Repair
- Cleanroom
- R& D
- Computer Manufacturing
- Military Base Electronics

FAA STD 019f

Standard for lightning protection, grounding, bonding and shielding requirements.

MOTOROLA R56

Public safety and telecommunications standards and guidelines for the installation of equipment, infrastructure, and facilities for communications centers.

ATIS-0600321

Telecommunications industry standard for applications where people access a computer keyboard while continually wearing a headset.

Applications

- All network-operator dispatch operations—e.g. 9-1-1 call centers
- Mission-critical Call Centers
- Communications Centers
- Networked Offices
- Government Mission-critical Areas
- Control Rooms
- Flight Towers
- All FAA/flight support areas (and 019e designation)

DOD 4145.26-M

Safety standards for Department of Defense and private industry ammunition and explosives (AE) operations.

Applications

- Defense Contractors
- Facilities performing AE work
- AE Services
- Companies Covered Under DoD

NFPA 99 National Fire Protection Association–Defunct Standard for Conductive Flooring

Establishes criteria for health care services to minimize the hazards of fire, explosion, and electricity.

In 2015, all references to conductive flooring were removed from this standard.

Applications

No longer valid

Mil STD 1686 (converted to ANSI/ESD S20.20)

The parent document for all ESD Association standards and is the main reference for Auditing an ESD Control Program.

Applications

Anyone auditing an ESD program

IBM Data Center Recommendations

IBM-recommended guidelines to minimize static-electricity buildup in a data centers. Safety recommendation: minimum floor resistance >150,000 ohms (1.5×10^5).

Applications

- Data Centers
- Server Rooms

ESD Test Methods

ANSI/ESD STM7.1-2013
Tests resistive properties of flooring materials.

ANSI/ESD STM97.1-2015
Measures the electrical system resistance of floor materials in combination with persons wearing static-control footwear.

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Electrostatic Propensity of Carpets. Standard carpet industry test, uses laboratory simulation to assess static generation when a person walks across the carpet.

Key Terms

Anti-Stat, Agent

A substance that is topically applied to a material to render the material surface static-dissipative or less susceptible to triboelectric charging.

Anti-static Flooring

An anti-static floor will not generate a charge (measured in volts)—this property is unrelated to electrical resistance, measured in ohms.

Conductive Flooring

A floor material that has a resistance to ground of equal to or less than 1.0×10^6.

Electrical Resistance

Electrical resistance, expressed in ohms, predicts how quickly a charge on the surface of the floor will discharge to ground.

Electrostatic Charge/Static Electricity

An electric charge at rest.

Electrostatic Discharge

The rapid, spontaneous transfer of electrostatic charge induced by a high electrostatic field.

ESD Floor

A generic descriptor for a floor used to control the accumulation of electrostatic discharge on people.

Ground

A conducting connection, intentional or accidental, between an electrical circuit or equipment and the earth or conducting body that serves in place of the earth.

Mission Critical

Any operation that cannot tolerate intervention, compromise, or shutdown. Mission-critical environments usually support health, safety, security, and human welfare.

Ohms

Ohms are units of electrical resistance between two points. "One Meg-ohm" equals 1 million ohms or 1.0×10^6. The exponent 6 refers to the number of zeroes after the 1 — generally considered the maximum electrical resistance level for a conductive flooring specification. The lowest end of the range is 25,000 ohms, represented as 2.5×10^4.

Static-control Floor

(*See ESD Floor).*

Static-control Footwear

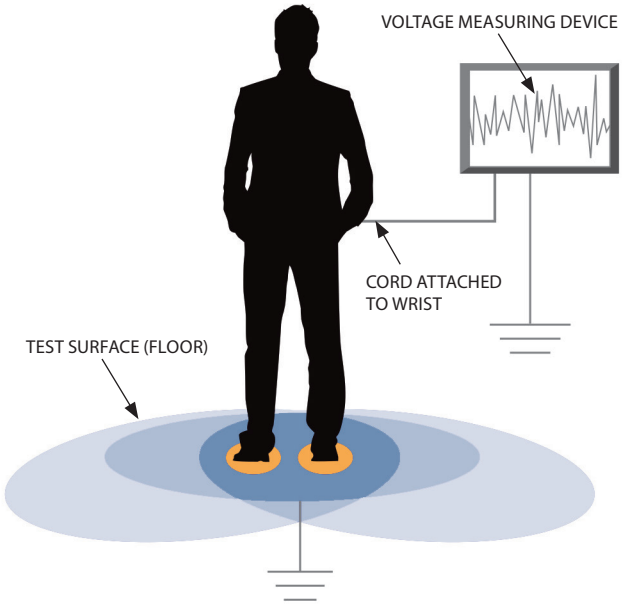
Devices connected to human feet — such as static-control shoes, foot straps, toe grounders, or booties — that provide a path to ground, when used in conjunction with a static-control floor, floor finish, or floor mat.

Static-dissipative Flooring

Floor material that has a resistance to ground greater than 1.0×10^6 and less than or equal to 1.0×10^9 ohms. (1.0×10^6 equals 1,000,000 ohms.)

Walking Body Voltage

The static charge, in volts, generated by a person walking across the floor. Static charges that accumulate on the body discharge to the first object the person touches, potentially damaging or disrupting sensitive electronics *(see illustration at right).*



Walking Body Voltage Testing

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