Selecting a Static-control Floor

Matching Products and Environments Through Evidence-based Design
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.

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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 $1.0 \times 10^9$.

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.

Body Voltage Generated with Different Types of Footwear

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.

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.
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.

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

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

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

**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

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

### Physical Properties and Maintenance

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

## Ergonomics and Environmental Factors

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


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


AATCC 134 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 $1.0 \times 10^6$.

**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 $1.0 \times 10^6$. 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 $2.5 \times 10^4$.

**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 $1.0 \times 10^6$ and less than or equal to $1.0 \times 10^9$ ohms. ($1.0 \times 10^6$ 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).