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Published Articles

Specifying Static-free Floors

ESD sensitivity and risks for personal safety and electronic equipment

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Specifying Static-free Floors

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Images courtesy Staticworx

SPECIFYING ANY FLOOR REQUIRES A SPECIAL SET OF SKILLS, BUT WHEN IT COMES TO STATIC-CONTROL ENVIRONMENTS, THE CHALLENGES TAKE ON EVEN MORE DRAMATIC PROPORTIONS. ELECTROSTATIC DISCHARGE (ESD) IS A MULTI-BILLION-DOLLAR INDUSTRY PROBLEM AFFECTING MANUFACTURING FACILITIES AND END-USER ENVIRONMENTS THAT USE ELECTRONIC PARTS. PROVIDING THE RIGHT SPECIFICATIONS PRESENTS AN OPPORTUNITY FOR DESIGN/CONSTRUCTION PROFESSIONALS TO HELP PREVENT PERSONAL INJURY, EQUIPMENT FAILURES, PRODUCT RETURNS, AND CRITICAL COMMUNICATION ERRORS.

ESD is the sudden, spontaneous transfer of electric current. Essentially, a charge flows through a spark between two bodies at different electrostatic potentials as they approach one another. A common example is the built-up static electricity from walking on one surface and touching another—sometimes the result is a minor shock, other times it can be permanent damage to expensive electronic equipment.

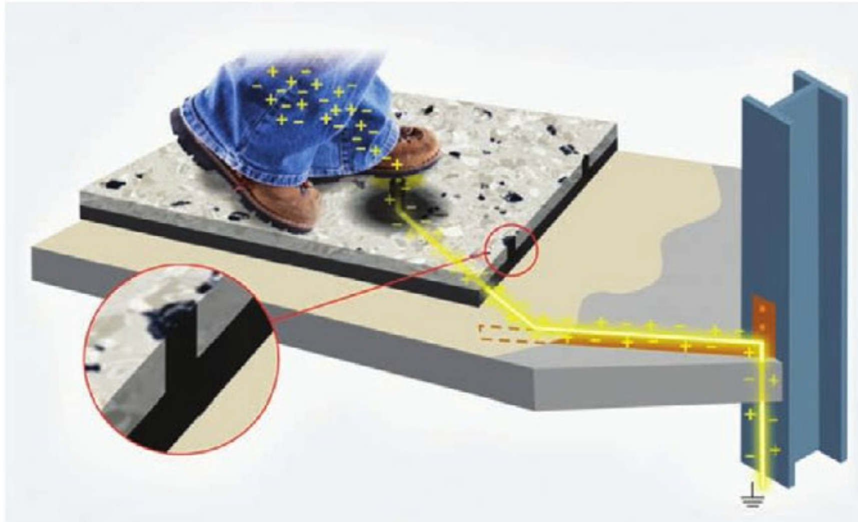
Electrostatic discharge has always presented an invisible and imperceptible threat. While people cannot feel electrostatic charges of up to 3500 V, it may only take 50 V or less to zap telephony equipment, fry circuit boards, and knock out networked computer systems. This occurs when workers walk on a charged surface, touch equipment, and release electrostatic charges trapped in them. Without the right flooring in place, few realize this is a problem until it is too late.

To make matters worse, the ESD problem is intensifying. Electronic devices continue to become smaller and more powerful—this miniaturization reduces the room for on-chip protection, increasing vulnerability to ESD.[1] The result is more environments are at risk if they do not have specialized anti-static, fault-tolerant flooring designed to perform regardless of variables such as controlled footwear, maintenance, and humidity.

On a practical and ethical level, one wants to provide clients with flooring solutions that best meet their needs. However, designers should also protect themselves against costly litigation when things fall short—an increasing concern among industry professionals. In this light, the legal standard of "What are the basics you need to know?" is evolving to become "What else should you have known?"

Timelines of ESD

Through the 1990s, damage to electronic devices from ESD declined as many manufacturers invested in on-chip circuit protection. Unfortunately, these circuit design strategies diminished the electronic equipment's performance—they were eventually eliminated to meet the demand for smaller components. As a result, numerous environments have become more sensitive to levels of static discharge.



How electrostatic discharge (ESD) flooring works.

Preventing the sources of static generation has become a priority for designers at electronics factories, data centers, and mission-critical environments reliant on sophisticated electronic systems. Static discharges cannot occur in a space with flooring that dissipates existing static charges and prevents new ones. Many facility managers view static-free flooring as the most effective means to prevent ESD from ever becoming a problem.

GLOSSARY OF TERMS

AATCC 134: Created by the American Association of Textile Chemists and Colorists, this standard measures the electrostatic propensity of carpets—their tendency to generate a charge. It measures the amount of static generated by a neolyte or leather shoe sole stepping on a carpet surface in a controlled room environment.

ANSI/ESD S20.20-2007, *Protection of Electrical and Electronic Parts, Assemblies, and Equipment in EPAs (ESD Protected Areas):* This standard covers the requirements necessary to design, establish, implement, and maintain an ESD control program to protect electrical equipment susceptible to damage from human body model (HBM) discharges greater than or equal to 100 volts.

Anti-static flooring: The generic term 'anti-static' refers to a condition where static generation is inhibited during contact and separation with a different material. Anti-static, or static-control, flooring can either be static-dissipative or -conductive.

Conductive: This term refers to a material's ability to conduct a charge to ground; usually indicated by an electrical resistance range measured in ohms—a minimum of 2.5×10^4 (25,000 ohms) to a maximum of 1.0×10^6 (1 million ohms).

Conductive flooring: Unlike highly conductive materials such as copper and steel, conductive flooring is actually relatively resistive. Conductive floors like static-dissipative floors are classified based on their electrical resistance to ground measured in ohms of resistance. The resistance to ground of a properly specified, conductive floor is $> 2.5 \times 10^4$ and $<1.0 \times 10^6$ measured per ANSI/ESD STM 7.1. Conductive flooring always meets all three recommended electrical parameters of ANSI/ESD S20.20.

Dissipative tile: Usually composed of carpet, synthetic rubber, or vinyl composition, these floor tiles are used for mitigation of ESD. Static-dissipative tile inherently meets the electrical properties of "static dissipative flooring" without anti-static waxes, finishes, and glazes. These floors are not necessarily anti-static and should be carefully evaluated in applications where special controlled footwear will not be used.

ESD-grade carpet tile: Used to control the accumulation of electrostatic discharge on people, chairs, and tables, these modular floor tiles are made of conductive carpet and a thermoplastic backing, usually manufactured using conductive fibers woven into the carpet face. These tiles are designed to provide an electrical path to ground for the dissipation of unwanted static electricity charges in applications where electronics are stored, manufactured, used, or handled. An ESD-grade flooring material will remain conductive at any relative humidity (RH) level. (Not to be confused with computer-grade or low Kv carpet materials.)

ESD floors: This is a generic, catch-all term for any type of floor covering with anti-static properties. It should not be used in a specification.

Ground: In electrical terms, ground is the safe point of discharge of unwanted static electricity; it represents zero electrical potential. When something is grounded, it is neutral and has no charge. Attaching a conductive floor to ground ensures the static charges will be diverted to the earth through the conductive floor system.

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A resistance-to-ground (RTG) test of conductive vinyl tile using a megohm meter and National Fire Protection Association (NFPA) probes. Note: one probe is on the floor surface and the second probe is placed on the copper ground connection.

Regardless of the environment, some form of static-control flooring can meet almost any space's physical, aesthetic, and ergonomic needs. In fact, facility managers in environments as diverse as semiconductor manufacturing, flight control operations, and casino command centers view static-free flooring as the most effective way to mitigate ESD problems.

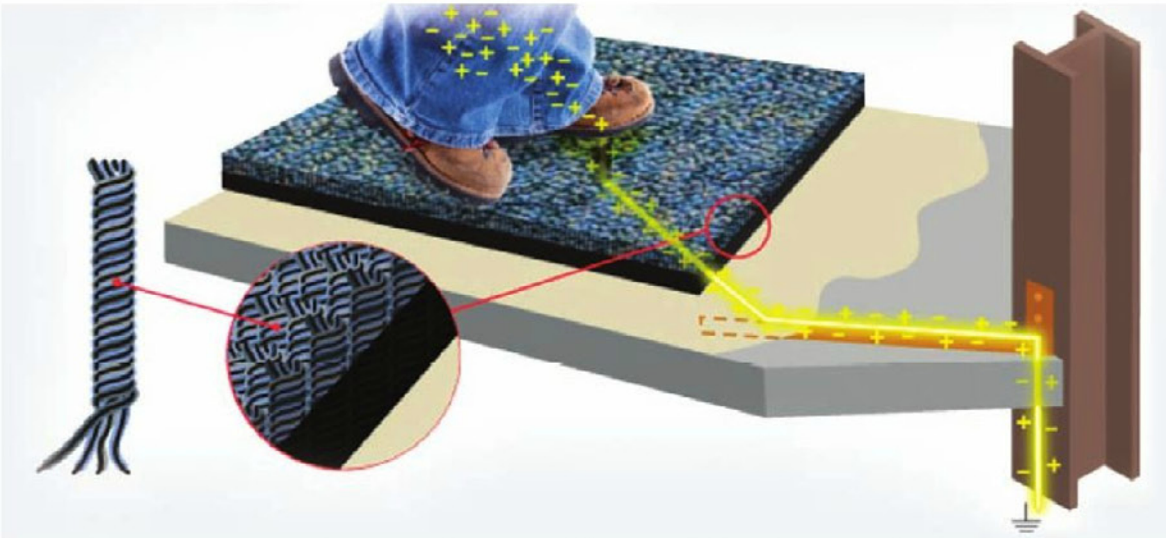
Due diligence

Fortunately, installing the right kind of anti-static floor eliminates the source of ESD problems. Unfortunately, most organizations fail to understand the risks, and most specifiers do not install flooring that meets the latest industry standards. Part of the problem is a disconnect among architects, contractors, flooring distributors, manufacturers, and end users.

Flooring manufacturers and distributors know about flooring, and ESD specialists know about static prevention, but neither has much communication with the other. This puts specifiers in a bind because the information they receive from flooring professionals is usually inconsistent with that from static-control providers. Even with the best of intentions, most specifiers do not know where to turn.

Another issue hindering communication is the technical jargon—terms that are particularly confusing because they are not always used in the same way. For example, some static-dissipative tile might be marketed as an 'anti-static flooring solution,' but may not meet the needs of most applications unless polished with three to five coats of special anti-static waxes.

As another example, many specifications are written based on a resistance range; however, what happens if the range is so broad it includes an ineffective portion? Research has shown floors measuring in the upper half of the static-dissipative range often lack the ability to adequately drain static charges.[2] If a floor is specified as just having to be "static-dissipative," the specification allows for



Conductive fibers are over-engineered to withstand punishment in high-traffic areas without fracturing or losing conductivity. They are linked from the surface to a ground plane below the carpeting. The fibers' capacitive capabilities are coupled with carbon to ensure conductivity at a safe and controlled rate of dissipation. Specially formulated adhesives also play a role in reaching the chosen ground.

both the effective and ineffective portions of the range. This means the client could end up with a floor that meets the spec, but still does not prevent ESD problems.

The point is electrostatic-discharge protection is a very specialized industry—without understanding of terminology, specifiers and facility managers cannot tell if they are specifying the proper floor.

To firm up one's vocabulary, it is important to pay special attention to terms like those found in the glossary. Due to the liabilities associated with a catastrophic ESD event, specifiers should also have some knowledge about electricity, grounding, and the associated standards and test methods.

Flooring types

Before recommending the best flooring solutions, it is important to study the environment and test for special ESD concerns, including variables like footwear, humidity, and environmental factors. In some projects, one particular product will be preferred; in others, a combination of products will form the ESD floor plan. In any event, it is essential to have a thorough understanding of the products (*i.e.* rubber, vinyl, carpeting, and epoxy).

The product descriptions in the following paragraphs are meant to be general, with specific attributes varying between providers. In this light, the most important variable in the flooring selection process may be to partner with a reputable manufacturer. It is also critical to review application charts in deciding what solutions will work best.

ESD rubber

Independent research from MIT Lincoln Laboratories recently recognized the latest generation of electrically conductive (EC) rubber flooring as having the most effective static protection for any application. It is the only fault-tolerant flooring suitable for Class-0 applications (a working definition of Class 0 is any component that fails under 200 V for the Human Body Model or Charged Device Model). EC rubber is also the only static-resistant product that works regardless of footwear.

While people cannot feel electrostatic charges of up to 3500 V, it may only take 50 V or less to zap telephony equipment, fry circuit boards, and knock out networked computer systems. Few realize this is a problem until it is too late.

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Insulative: The property of 'insulation,' which applies to normal footwear, refers to a material's ability to store as opposed to conduct. An insulator is the opposite of a conductor. In the case of carpet construction, all fibers are insulators unless a conductive coating is applied to the external perimeter of the fibers. Insulated fibers will both generate and store static electricity; they cannot be grounded.

Low-kV computer grade: "Low-kV" is a synonym for anti-static or computer-grade carpet. It will not generate as much static electricity as standard carpet, and reduces the associated shock hazards. The typical human threshold for feeling a static zap is 3.5 kV, or 3500 volts.

NFPA 99, *Standard for Healthcare Facilities*: Created by the National Fire Protection Association, this standard provides a test methodology for measuring the conductivity of flooring and other surfaces. It was originally designed in the 1960s for use in hospital operating rooms that used explosive gases for anesthesia.

Ohm: Ohms are the SI units of electrical resistance, defined to be the electrical resistance between two points of a conductor when a constant potential difference applied between these points produces a current of one ampere. The resistance in ohms is numerically equal to the magnitude of the potential difference. One 'Meg' equals 1 million ohms or 1.0×10^6—the maximum electrical resistance level for a conductive flooring specification. The lowest end of the range is 25,000 Ohms or 2.5×10^4—anything less is considered an electrical shock hazard.

Path to ground: The electrical link between a conductive material and the earth.

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

Resilient flooring: A type of flooring designed to be durable, resistant to stains and water, and comfortable to stand on. Resilient flooring resists penetration by water, making it less likely than textile-based flooring to become a breeding ground for mold and mildew. Resilient flooring withstands heavy foot traffic. The materials used to make resilient flooring resist scuffing and damage from rolling furniture, dollies, or pallet jacks that are dragged across the floor. Rubber flooring is also slip-resistant, making it an ideal solution for wet applications in manufacturing facilities.

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

Static-dissipative flooring: These floors are defined by a property called electrical resistance (measured in ohms). The important parameter for describing a floor is the static-control flooring resistance to ground or path to ground. To meet the qualification of static-dissipative, a floor must have an electrical resistance to ground of $> 1 \times 10^6$ (one million ohms) and $<1 \times 10^9$. **CS**

Measuring resistance between points (RTT) on an 'ESD-grade' carpet tile using two NFPA probes. (Note extreme low resistance 7.9 E 03 = 7900 ohms. NFPA 99 minimum resistance is 25,000 ohms.)

This product group meets all domestic and international industry standards, including:

- National Fire Protection Agency (NFPA) 99, *Healthcare Facilities*;
- American National Standards Institute/Electrostatic Discharge Association (ANSI/ESD) S20/20-07, *Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)*;[3]
- ANSI/ESD STM 97.1-2006, *Floor Materials and Footwear: Resistance Measurement in Combination with a Person*;
- ANSI/ESD STM 97.2-2006, *Floor Materials and Footwear: Voltage Measurement in Combination with a Person*;
- U.S. Department of Defense (DOD) 4145.26-M, *DOD Contractors' Safety Manual for Ammunition and Explosives*; and
- National Aeronautics and Space Administration (NASA)-grade cleanroom requirements.

Additionally, it is free of halogens, polyvinyl chloride (PVC), lead, phthalates, and asbestos.

Among other attributes, EC rubber is designed to last forever, can withstand heavy loads, and never needs conductive wax. Ergonomically, rubber is a better anti-fatigue floor than either epoxy or vinyl, and, like carpet, dampens noise. As it is less porous than vinyl, it is also easier to clean, wash, and maintain.

EC rubber is becoming a preferred option in electronics manufacturing facilities, and cleanrooms. It is also highly recommended for data and call centers, computer labs, R&D

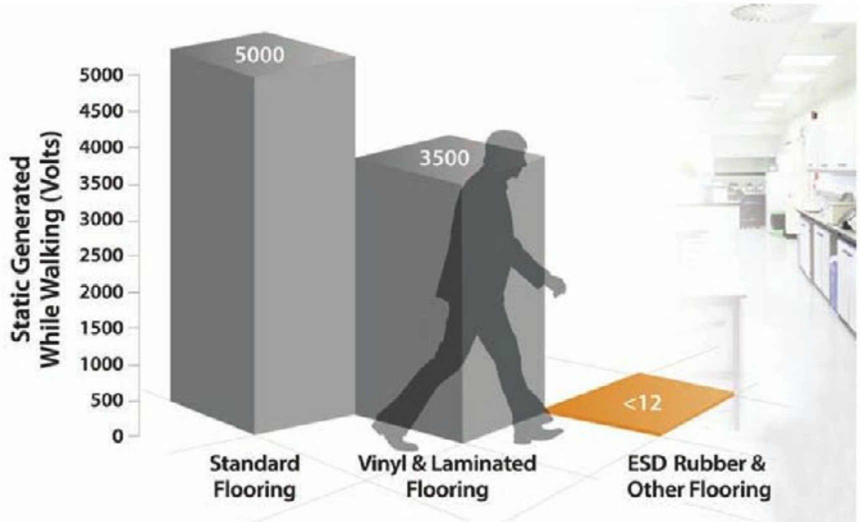
labs, hospitals, and other mission-critical environments with zero tolerance for static. In Class-0 ESD environments, the use of EC rubber, combined with controlled footwear, also eliminates the need for wrist straps for mobile personnel.

Though its installed cost is the highest among the various options, the total expense of ownership for rubber is low because it is durable and inexpensive to maintain. Nevertheless, despite its many advantages and value, the initial cost may be perceived as prohibitive.

It is important to ensure the selected rubber is 'conductive' and not 'static-dissipative,' as the latter's resistive properties exceed the recommended system resistance (*i.e.* less than 35 megohms) parameters of industry standards like ANSI/ESD S20.20-2007.

ESD carpeting

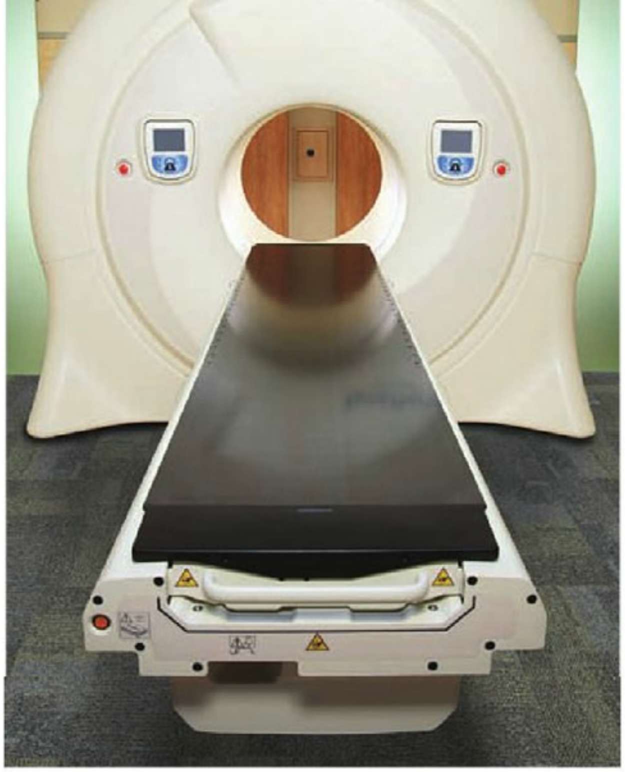
At one time, carpet manufacturers believed they could solve ESD problems if they could simply prevent people from getting shocks when they walked across the carpeted floor.



Static charge generation with controlled footwear.

By preventing static buildup on the people who touched the components, the reasoning was damage to computer equipment would be reduced. To an extent, they succeeded in meeting their goal. By using anti-static additives or tufting the carpet with yarns containing carbon cores, static shocks were blocked.

However, because the carbon bi-components were insulated from the exterior surface of the carpet and lacked contact points, their static-dissipative properties were rendered ineffective.



Carpet tiles must be suitable for mission-critical environments like MRI suites.

The resulting products, while ideal for residential and general commercial use, did not meet the standards required by the electronics industry for the manufacturing and handling of electronic components.

ESD carpet has come a long way since the days of the so-called 'computer-grade' products. Today, in the tufting process, conductive fibers can be woven into the yarn bundle, creating an almost infinite number of contact points, providing a fast and reliable path to ground. Thanks to heavier denier conductive fiber, the new generation of ESD carpets can also withstand physical punishment in high-traffic areas.

Since they are easy to install and remove, carpet tiles are a popular choice among facility managers. Carpet tiles are installed with clean, fast-drying release adhesives, and can be placed directly over old vinyl tile or uneven concrete, which lowers installation costs. If the carpet is accidentally damaged, the area can be easily replaced without special tools or even new adhesive.

However, carpet can also have its disadvantages. It is not well-suited to accommodate heavy loads such as forklifts and pallet jacks; it is also difficult to roll carts or systems on wheels over carpet. Further, carpeting has low resistance to chemicals and solvents, and it can be difficult to find small electronic parts when they are dropped on it.

The biggest challenge with carpet is finding one that has permanent static-control performance while still meeting the safety requirements for a floor that can be used around operational computers and electrical appliances. Some carpet tiles, often generically described as 'ESD-grade,' contain yarns too conductive on the surface to be fit for use in public or uncontrolled environments like call centers and offices.

GROUNDING STARTS HERE

1. Account for all types of footwear when evaluating anti-static properties of the floor. Most flooring brochures state performance parameters based on the use of special anti-static footwear.
2. Do not specify based on terms like 'static-dissipative' or 'conductive.' Specify based on actual ohms range.
3. Ensure floor can be used near operational electrical equipment. (Visit www.allaboutcircuits.com/vol_1/chpt_3/4.html for help in calculating leakage current at various resistance and voltage conditions.)
4. Require conductive adhesive for all tile installations. Standard non-conductive adhesives are acceptable for sheet flooring when the flooring material is produced with a conductive bottom surface.
5. The specification should contain upper limit for body voltage generation:
   - ANSI/ESD S97.2—ideal upper limits;
   - Mission Critical (MC)—should not exceed 1000 V;
   - EPA—cannot exceed 100 V; and
   - Class 0 ESD—should not exceed 25 V.
6. State resistance-to-ground (RTG) values using ANSI/ESD S7.1-2005 test methods.
7. Specification should account for margin for error. This author suggests specifying an uninstalled (*i.e.* RTG) resistance range between 100,000 and 10,000,000 ohms.
8. State "electrical properties must be independent and not rely upon temperature, humidity, or any surface additives, waxes, finishes, polishes, or sprays."
9. Require post-installation verification using a calibrated ohm meter. Floor must measure above 25,000 ohms to meet NFPA 99 resistive parameters in the installed condition. Upper limit should measure below 35 million ohms to easily address ANSI/ESD S20.20-2007 system resistance parameters.
10. State the floor must comply with Table 2, Section 8.2, on page 1 of ANSI/ESD S20.20-2007 for EPA applications.
11. For EPAs, specify system resistance limit of less than 3.5 X 10 E7 per test method ANSI/ESD S97.1.
12. Require a post-installation certification that will include testing resistive properties per ANSI/ESD S7.1-2005 between surface points (RTT) and point to ground (RTG). Tests will include measuring two points on the same surface of selected tiles. (For best practices, electrical properties should be warranted for the life of the floor.)
13. Require a grounding frequency of one ground connection per 93 m^2 (1000 sf) and at least one per room or installation area.
14. Specify a maximum of 25 ohms resistance between auxiliary ground and building ground conductor.

CS

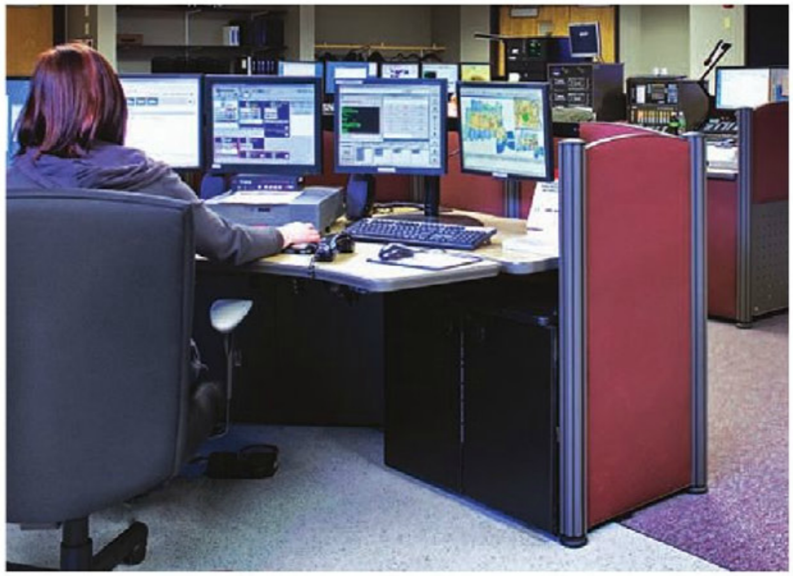
Telecommunication facility ground standards (such as Alliance for Telecommunications Industry Solutions [ATIS] 0600321, *Electrical Protection for Network Operator-type Equipment Positions*) specifically exclude these highly conductive carpeting. Specifiers can avoid this safety liability issue by requiring the carpet resistance between any two points (RTT) to never measure below 1 million ohms. The author is also aware of at least one carpet tile that addresses the excessive conductivity issue; this sort of product would be recommended for mission-critical applications.

ESD vinyl

Vinyl tile was the first ESD flooring material. Invented in the 1940s, the most suitable products are solid vinyl tiles (SVTs). Properly maintained SVT is attractive and can give a facility a 'hospital look' of cleanliness and shine. Many facility managers favor vinyl floors because the material is relatively inexpensive, simple to repair, and capable of handling heavy rolling loads.

Aware of the need to contain cleaning costs, some vinyl manufacturers have developed no-wax ESD solid vinyl floors that, unlike less expensive static-dissipative vinyl composition tiles (VCTs), do not require periodic wax or polish treatments to eliminate static. Most manufacturers recommend cleaning methods that steer clear of finishes, polishes, or waxes. Since the properties of SVT are the same throughout the full thickness of the tile, high-speed buffing—what maintenance professionals call 'burnishing'—is most often recommended for cleaning.

It is now possible to install certain conductive SVT in occupied spaces over old floors like VCT and epoxy. The use of conductive, dry adhesives and fast-drying pressure-sensitive adhesives that are also low in volatile organic compounds (VOCs) now enables some of the ESD tile to be installed atop most types of old floors.



Call and emergency dispatch centers need to protect their powered equipment, as well as the safety of their employees.

To avoid gaps between seams, it is important to ensure the vinyl tiles will not shrink from plasticizer migration. Before buying any vinyl tile, the supplier should be asked:

- where the products were manufactured;
- whether they will be free of heavy metals, dioctyl phthalate (DOP), and bis(2-ethylhexyl)phthalate (DEHP) plasticizers; and
- if they meet all standards for squareness and electrical properties.

ESD epoxy

Easily installed and maintained, epoxy has matured to become a durable, high-quality ESD flooring option. Along with the solid-colored coatings typically used in parking garages and aircraft hangars, the new breed of epoxies is available in patterns as well as in multiple colors and textures. The use of multiple layers of conductive materials as part of the coating's overall thickness provides redundant paths to ground. This means, when installed properly, epoxies are highly effective in meeting most ESD standards.

In facilities where constant heavy loads and high traffic are the norm, epoxies can be a very practical flooring material. To identify the best-looking, most durable product for its facility, EMC Corp. (Franklin, Massachusetts) performed a product durability test on several flooring materials and products. As part of the test, EMC rolled 2268-kg (5000-lb) computers throughout the manufacturing area. The only flooring material not destroyed was a self-leveling, 2-mm (80-mil) thick conductive epoxy, mixed with quartz aggregate.

However, the upside of epoxy is also its downside. The floor is ruggedly hard and unforgiving; it is easily scratched, difficult to repair, slippery, and allows sound to echo throughout a facility. Further, epoxy will not prevent static without the rigid employment of special static-control footwear. This means if the users of a space are wearing normal shoes, static-control epoxy floors generate almost the same amount of static as their non-static-control counterparts.

In addition to ergonomic considerations, facilities managers should understand the color of an epoxy floor is not 100 percent stable. Over time and exposure to ultraviolet (UV) rays, epoxy has been known to yellow or haze. Another problem with epoxy is one does not know for sure what it will look like until after the floor is installed and fully cured.

Other factors affecting flooring applications

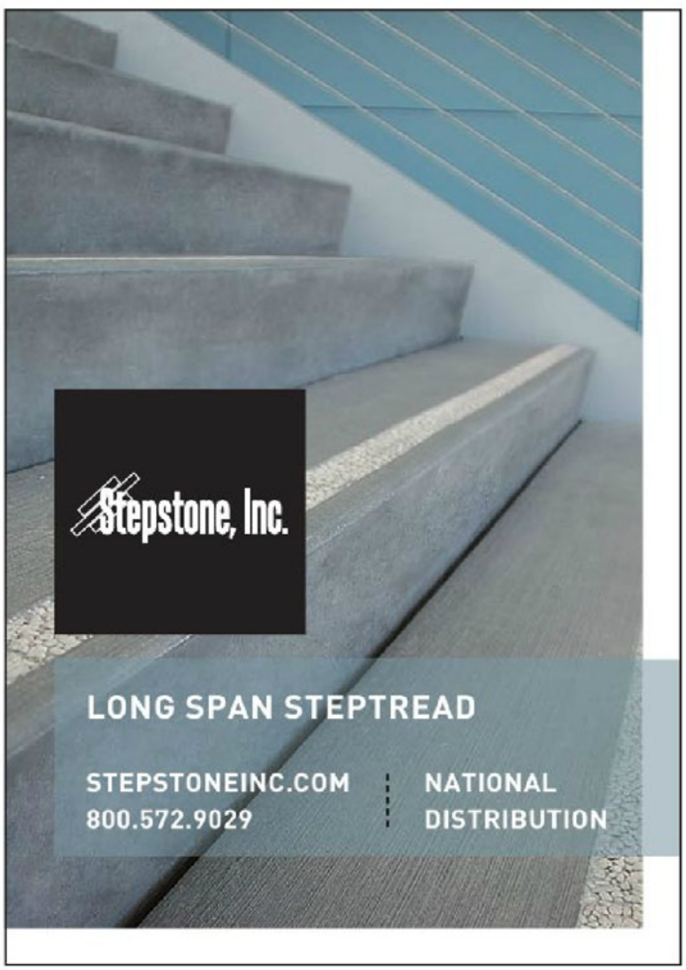
Before product selection and installation, it is essential to assess two different environments that require static-control flooring: the real world and electronic manufacturing plants.

The real world includes mission-critical environments like computer rooms, data centers, 911 dispatch centers, and magnetic resonance imaging (MRI) suites. All these operations rely on the uninterrupted use of sophisticated electronic equipment, and are free of static-control protocols like wearing wrist straps and specially grounded footwear.

Since the floor is the only line of defense against the generation of static on employees, it must inhibit charges and be fault-tolerant—that is, possess the ability to continue operation even when equipment fails. In these environments, there is little clarity on performance criteria, and this can get specifiers in trouble when they receive requests for 'anti-static flooring.' Most of the specification sheets from flooring manufacturers do not reveal what will happen under conditions involving people wearing ordinary footwear.

A typical manufacturer's spec sheet will publish static generation test measurements obtained in a walking test in controlled laboratory conditions using static-control shoes in tandem with a grounded floor (ANSI/ESD S97.2). The other common test references how much charge is generated on a subject wearing test-specific shoe sole covers composed of neolite and leather (*i.e.* American Association of Textile Chemists and Colorists [AATCC] 134, *Electrostatic Propensity of Carpets*). However, neither test method sheds light on the implications for real-world environments.

Independent research consultants like Dangelmayer Associates and *The ESD Journal* have determined EC rubber will likely inhibit static charges on people wearing most types of shoes. At the same time, they have proven static-control options like epoxies, high-pressure laminates, and vinyl (conductive or dissipative) generate significant charges with people wearing most standard footwear. In other words, these materials, regardless of conductivity and



SPECIFIERS' CHECKLIST

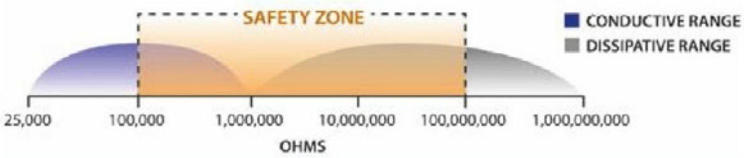
- Only conductive and static-dissipative floors can be grounded. Standard flooring installed with ground strips or conductive adhesive will not offer any static protection.
- Always reference grounding standards appropriate for the space:
  - ANSI/ESD for electronics handling and manufacturing;
  - ATIS 0600321 and Motorola R56 for telecommunications applications;
  - FAA 019e for flight control areas; and
  - DOD 4145.26-M for explosives handling.
- An effective static-control floor can be verified with an ohm meter to determine the electrical resistance of the material. If the material does not pass the ohm meter test, it cannot be grounded.
- Conductive floors should never require any anti-static sprays or waxes to enhance or maintain performance. The conductivity should be achieved by the actual permanent physical composition of the material.
- The floor should reduce static electricity regardless of relative humidity (RH). Ask the supplier specifically about performance in very dry conditions.
- In real-world conditions, the floor must inhibit static buildup without special conductive shoes or shoe straps. When in doubt, ask for independent test data verifying this property. The data should be compiled from an installed floor and not from a lab test of new flooring.
- Never assume a 'shock-free' environment means 'static-free.' A shock-free environment only means static charges are below 3500 V.
- Do homework upfront. It is much more costly to remove an ineffective floor and replace it than to do it right the first time. Any mission-critical space is only as secure as its Achilles' heel.
- Even if the present electronics are immune to static, if they are eventually upgraded or replaced with state-of-the-art equipment, then static will be a problem. As with any potential security breach, it is always best to plan ahead. **CS**

grounding, are static-generating antagonists under these conditions.

In mission-critical areas, static-control carpeting offers excellent static mitigation properties. Research has shown carpet tiles manufactured with conductive yarns, conductive pre-coats, and special backing will inhibit static generation on people wearing standard or static-control footwear.

However, there is a caveat: Some carpet yarns are too conductive and could put people in danger if they were to come in contact with AC-line voltages from servers and data storage equipment. In fact, the manufacturing process of ESD carpet produces significant variations in conductivity, with resistive properties varying from less than 10,000 to more than 100,000,000 ohms within the same batch of carpet tile. The first number is below the lowest resistance limits allowed by NFPA 99 for safety; the second is indicative of a material that will not drain static as fast as it is generated.

Figure 1



Any time static-control carpet is considered, it would be prudent to specify a safe resistance range that offers some margin for error at both ends of the spectrum. The material cannot be too conductive, but it should still be effective in mitigating ESD.

As far as specifiers are concerned, it is imperative to identify material with consistent electrical properties for both safety and static mitigation performance—and ultimately to preclude liability.

Any time static-control carpet is considered, it would be prudent to specify a safe resistance range that offers some margin for error at both ends of the spectrum. The material cannot be too conductive, but it should still be effective in mitigating ESD. This author suggests quantitatively specifying a material resistance range above 100,000 and less than 100,000,000 ohms—the 'sweet spot' illustrated in Figure 1.

Before specifying any carpet, the material should be thoroughly tested for resistance to ground, as well as resistance between two surface points on the same tile. The logic behind requiring two tests is to weed out overly conductive, unsafe materials. Regardless of lab tests or information on a manufacturer's specification sheet, the supplier should certify the resistive properties of the floor after installation and before it is turned over to the owner. This is particularly important because an acceptable resistance range is different in an electronics manufacturing facility than in a 911 call center.

When dealing with the world of electronic manufacturing, international standards require use of specialized footwear, packaging, and wrist straps. However, these standards are not easily enforced, and workers are often lax. The upshot is in the static-free manufacturing world, as well as end-user environments, it is best to strive for maximum static protection.

Standards and certification

Many methods and industry standards have led to the creation of standardized technical specifications that match flooring application requirements. As noted, electronics manufacturers require anyone handling static sensitive parts to follow rigorous grounding protocols.

The electronics industry designates spaces where grounding is necessary as electrostatic protected areas (EPAs). Grounding protocols used in EPAs are outlined in ANSI/ESD S20.20-2007, but this standard offers little instructional value for controlling static in real-world environments like data centers, call centers, and healthcare facilities.

A close reading of ANSI/ESD 20.20-2007 should eliminate the argument over whether 'static-dissipative' or 'conductive' flooring is better suited for static-control flooring. The requirements summary section, in Table 2,

ADDITIONAL **INFORMATION**

Author

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Abstract

This article provides a comprehensive overview of static-control flooring applications, grounding considerations, key standards, and test methods referenced in a specification. It focuses on how to compare performance characteristics and properly match a floor's electrical properties with the space's static mitigation requirements. This article emphasizes the important balance between effectively eliminating static charges through grounded flooring with the need to guarantee electrical safety for space occupants.

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Section 8.2, sensibly encourages material selection based on multiple variables and several test standards, and not based on choosing a broad range of resistance designated as 'conductive' or 'static-dissipative.' Instead, the standard calls for specific numerical values. This is also the way an architectural specification should characterize materials with electrical properties.

ANSI/ESD S20.20-2007 requires that no person have the ability to develop a body voltage in excess of 100 V. Body voltage is measured using test method ANSI/ESD S97.2. In theory, it should not be possible for persons to generate more than 100 V if they are part of a system resistance measuring below 35 megohms. However, there are several circumstances where this assumption has proven invalid.

Conclusion

It is important to ensure the floor specified meets or exceeds the standards mentioned throughout this article. However, post-installation certification is also important. Most facility managers do not know whether they comply with anti-static flooring standards—and they may be at risk if they are non-compliant.

Ideally, facilities should ensure that they are protecting worksites on three levels: personal safety, static-control performance, and environmental health. To ensure flooring meets electrical safety specifications after installation, some manufacturers offer audits.

Meanwhile, specifiers should recognize the ESD flooring industry will continue to grow, presenting significant challenges and opportunities at the same time. In this arena, education will remain the most powerful tool. In the final analysis, all industry professionals should be working toward the same goal—providing the best flooring options for clients. To realize this outcome, the entire project team needs to appreciate what is at risk and begin to speak the same language. **CS**

Circuit-board manufacturing areas often combine specialized carpeting and vinyl tile products.

Notes

[1] This is known as "Moore's Law." Intel Corp.'s co-founder Gordon Moore predicted the number of transistors on a chip will double about every two years.

[2] See David E. Swenson et al's "Resistance to Ground and Tribocharging of Personnel, as Influenced by Relative Humidity" from the 1995 *EOS/ESD Symposium Proceedings.*

[3] This can be downloaded at no cost at www.esda.org.