



# ESD Compliance

## Common Mistakes When Selecting a Static Control Floor

by David Long

Since the invention of the first microprocessor by Intel in 1971, there has been a steady drive to create smaller, faster and more complex electronic circuitry. According to the Sematech Roadmap for Semiconductors ([www.sematech.org](http://www.sematech.org)), the continued scaling of tiny, lightning-quick electronic devices has, and will continue to, generate significant challenges for designers and, by extension, users of next generation semiconductors. Many of these challenges will involve the need for stringent static control procedures from wafer fabrication facilities all the way through to computer rooms and any space where electronic devices are handled, stored or used.

Ted Dangelmayer, a leading authority on ESD, says “this rapid advance of technology and the associated design constraints are producing devices with ever increasing sensitivity to ESD. A recent benchmarking study of integrated circuit suppliers indicated that ESD will be one of the top three reliability concerns within the next five years and already is with certain products.”

Static discharge is certainly not a new phenomenon to the computer industry. For years static has been documented as a significant contributor to serious problems, including computer freeze-ups, loss of data, dropped phone calls and, in the worst cases, head crashes, failures of semiconductors and

ultimately shutdowns of mission critical operations involving computer and telephony equipment used in military and health and safety applications. Static problems are particularly acute in hospitals, server rooms, 9-1-1 call centers and flight control towers.

And the introduction of the next generation of faster more sensitive components will only elevate these concerns. The combination of the ubiquitous reliance on electronic devices and the increased sensitivity of those devices to static electricity are forcing facilities engineers to reanalyze conventional building materials and design static free environments so static cannot become a problem in the first place.

Over the past 20 years ESD awareness has created an entire industry devoted to producing antistatic and conductive versions of commonplace items such as garments, plastic bins, table covering, chairs as well as floor tiles and carpeting. The good news is that it is now possible to locate and install an antistatic version of almost any building, flooring or upholstery material for a static sensitive work space. The bad news is that selecting the right material can be confusing for the novice and sometimes even for the experienced engineer or architect.

For example, choosing the wrong ESD flooring can be as disastrous as having no static protection at all. Understandably, it is much more expensive to remove and reinstall flooring in an occupied building than it was to install the right floor the first time. In many cases, when the wrong floor is installed it's because the proper homework was not done up front.

A substantial amount of confusion results from a general lack of knowledge about static control specifications and standards combined with confusing and/or contradictory data found on the Internet. Because of the massive amount of both reliable as well as unreliable information available on the web, facility designers often make the same common mistakes when selecting static control flooring materials.

Here are seven common mistakes in choosing the right static control floor, and how to avoid them.

**Mistake #1: Confusion of Static Control Terminology**

There are a number of terms sellers use to describe static control flooring. Although these terms are often used as if they were synonymous, they are not interchangeable. These terms are sometimes used incorrectly in marketing materials. When terms such as conductive, dissipative, ESD and antistatic are used indiscriminately, buyers and sellers become confused.

For example, a conductive floor is not the same thing as a static dissipative floor; each term describes a floor with appreciably different electrical properties. Designating a flooring material as antistatic does not necessarily mean that that floor can be grounded; many (but not all) antistatic materials (such as low Kv carpet) inhibit static generation but lack the necessary conductivity for actual grounding.

These are just two of the more obvious abuses of technical terms. A fundamental understanding of these terms is absolutely necessary before any specification should be written. Referencing one of the numerous ESD industry glossaries should eliminate most of the confusion regarding simple terminology.

In general, most experts agree that conductive flooring offers distinct advantages over static dissipative flooring. This fact should become obvious through a careful reading of the ESD Associations' document *ANSI/ESD S20.20*, which can be downloaded for free at [www.esda.org](http://www.esda.org). *S20.20* recommends a flooring footwear total system resistance of no greater than 35 megohms. This total resistance would be difficult to achieve if the flooring material, by itself, measured in the upper range of static dissipative (a material can measure as high as 1000 megohms and still be characterized as static dissipative).

Additionally, if a conductive floor also exhibits antistatic properties, it will usually meet or exceed almost any static control requirement for body voltage generation.

Some of the more important key terms are:

<i>ESD</i>	<i>Walking Body Voltage</i>
<i>Conductive</i>	<i>ANSI/ESD S 7.1</i>
<i>Static Dissipative</i>	<i>ANSI/ESD S 97.1</i>
<i>Antistatic</i>	<i>ANSI/ESD S 97.2</i>
<i>Ground</i>	<i>Minimum resistance</i>
<i>Triboelectric Series</i>	<i>Heel strap</i>
<i>Static Generation</i>	<i>Computer Grade flooring</i>
<i>Tribocharging</i>	<i>IBM Burroughs standard</i>
<i>ANSI/ESD S20.20</i>	<i>ATCC 134 test</i>
<i>Resistance</i>	<i>Humidity Dependence</i>
<i>Resistance to Ground</i>	

*Therefore, DO familiarize yourself with basic static control terminology and specifications.*

**Mistake #2: Not Understanding Internet Hype**

The Internet is only as good as the researcher doing the research. Many people assume that, if it's published on the web, it must be true. Remember that any individual can publish anything on their own web site, whether the information is correct or not. An objective web site should always present both advantages and disadvantages of the various flooring solutions. After all, no ESD flooring product is perfect or universally applicable for every application.

Watch out for hyperbole and repeated platitudes. Question information that describes products that have infinite conductivity, that offers "lifetime" performance, or that states that any property will last "forever." Beware of any buying sources or companies that do not support claims with objective references to standardized test methods that count, quantify, qualify, differentiate or somehow identify performance parameters by some objective universally accepted scale or longitudinal performance criteria.

In short, if a claim seems inconsistent and too good to be true, it probably is.

Specifications are meaningless unless they are derived from respected, reliable, objective sources. Data should be scrutinized and cross-checked. In the case of ESD flooring, tests referencing ESD Association standards should always be available from an independent test lab. The two most important ESD standards for flooring are:

- *ESD STM 97.1-1999 Floor Materials and Footwear—Resistance Measurement in Combination With a Person.* As previously stated, an upper resistance limit of 35 megohms is recommended by the authors of this document. This information should be included on any specification sheet. Stating that the flooring material will meet ANSI/ESD S20.20 is not an adequate claim. ANSI/ESD S20.20 is a process document and not a test standard.

- *ESD STM 97.2-1999 Floor Materials and Footwear—Voltage Measurement in Combination With a Person.* No ESD flooring material should allow the generation of more than 100 volts when tested in conjunction with a human body wearing controlled (conductive) footwear. When evaluating flooring for mission critical applications, test results should also include testing involving various conventional footwear (athletic shoes, work boots, leather shoes etc.), since most mission critical spaces do not mandate or monitor the type of footwear worn.

When evaluating performance data, the results of independent lab reports should always be viewed as more credible than descriptive performance claims printed on sales literature. The same is true for articles or web site editorials that offer opinions and comparisons. When evaluating technical information, look for articles that originally appeared in respected industry journals. Unlike website sales editorials, published articles must pass some form of editorial review before they are published.

*So, DO look for independent test reports and ESD articles published by respected trade journals or industry associations, including this publication, [www.neena.org](http://www.neena.org), and [www.esda.org](http://www.esda.org).*

**Mistake #3: Using an Unfamiliar Supplier or Contractor**  
Some buyers believe they can save money or gain technical advantages by hiring a flooring installer from out of town. This path is often chosen with the belief that a static control company knows more about flooring installations than a flooring contractor when in fact the opposite is actually the case. Most general contractors would disagree with hiring an Internet contractor for any number of reasons. Other than simple grounding and the use of conductive adhesives, there is no difference between installing conventional flooring and static control flooring. In this 21<sup>st</sup> century litigious society, does it actually make sense to use a contractor with no regional office or local representation in the area of the installation? What happens if there are problems after the original job has been completed? Who will handle ongoing repairs and repairs?

Very few flooring installations are complete after the last tile is placed or the grounding strips are bonded to building steel. Often, tiles are damaged during the moving of equipment and they must be reinstalled. The certification of electrical properties should not be finalized for at least several days after the installation is complete when the floor or adhesive is fully cured. If an out-of-the-area installer is used, who will handle warranty work?

And what about insurance? It makes little sense to use a contractor who employs out-of-state workers; in some states it is acceptable for contractors to hire laborers who are not bonded and have no worker's compensation insurance. What happens if those workers are injured on the job? Other states, including West Virginia, California and Arizona, will not permit construction labor by unregistered out-of-state contractors.

As with any other scope in construction, it usually makes sense to keep things as local as possible. No cost savings from hiring out-of-town labor could possibly compensate for damages from one accidental liability claim filed by an employee who has fallen because of loose floor tiles. According to the American insurance industry, slips and falls on flooring cost over ten thousand dollars per claim and cost the insurance industry billions of dollars every year.

Often, Internet contractors get hired because confused buyers view ESD flooring installation as some kind of black art. ESD floors are no more difficult to install than ceramic flooring or regular carpet and tile! In many cases, larger electronics companies actually utilize members of their own in-house facilities department for ESD flooring installation. Grounding is simple, new carbon-free conductive adhesives are easy to spread and clean-up is usually done with soap and water. A local contractor is someone who can be relied upon because he or she is interested in obtaining all of their customer's flooring business, not just in a one shot deal involving a few thousand feet of conductive tile.

*Therefore, DO ask flooring manufacturers for names of local, approved and experienced installers. If they can't confidently recommend one, find a different manufacturer.*



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**Mistake #4: Failing to Carefully Evaluate Suppliers and Their Warranties**

Warranties are only as good as the financial backbone of the warrantor (and sometimes their supplier as well). A “lifetime” warranty will be useless if the supplier is out of business a few years after the floor is installed. What happens if, at that point, the floor begins delaminating or losing conductivity? Although asking for references seems like a good idea, references are only as good as the objectivity and experience level of the company or individual providing the reference. As with evaluating a job applicant, due diligence could save a lot of money downstream. When evaluating a supplier’s integrity, look for the following:

- **Ask if the flooring turer is a GSA contract holder:** The GSA requires significant product testing and supplier evaluation before approving a manufacturer. Any reputable flooring manufacturer will list at least some of their products with the GSA.
- **Ask how many years'zr gt lgepeg the supplier has:** A supplier with many successful years of ezr gt lgepeg may qhgt 'c'o qtg'tqdwuy cttcp\ ONqqlht 'c'htgvo g" warranty y j lej hau stqpi value.
- **Conduct a credit check:** A credit check of a prospective supplier through Dun & Bradstreet or other credit evaluation source will reveal a supplier’s financial status and their years of service. A company with less than a million dollars in sales may have the best price but they may also be a poor choice for the purchase of a product that could cost two to three times their annual sales, particularly if an operational facility must be shut down if the job encounters problems.
- **Find out if the supplier can be bonded:** Insurance companies will only provide bonds to contractors with solid financial and performance history. The contractor’s bond rate compared with other contractors will usually reveal hidden information that will not be revealed from a simple reference check.

The best insurance against future problems is not a long-term warranty but a detailed evaluation of both the product and the contractor under consideration. In the case of static control flooring, always request that the electrical testing be done after accelerated life testing from chair caster rolling. Recent research has shown that some ESD flooring products fail electrical testing after sustained exposure to rolling chair casters. When evaluating a project reference, look for old installations. Most customers are happy when their floor is new – it is important to measure satisfaction levels two to three years later.

*DO thoroughly evaluate your supplier and ask for and get objective test reports from reliable sources such as independent labs and unbiased third party sources.*

**Mistake #5: Failing to Investigate Sub-floor Conditions**

Often, ESD flooring failures are the direct result of problematic yet correctable site conditions, such as contaminated concrete and moisture vapor drive. In fact, moisture is the single biggest threat to any ESD flooring installation. Concrete and moisture problems are detected easily by pulling core samples and performing ASTM moisture tests. These tests can be arranged by the flooring manufacturer and should be performed in conjunction with a local certified contractor. Often, contaminated slabs can be rectified by double shot-blasting. Moisture problems can be alleviated by installing moisture barriers or by installing an inexpensive moisture-resistant portable sub-floor such as SmartDeck.

Before getting a firm price from any flooring contractor the following questions should be answered:

- What is the condition of the subfloor? Will the floor need to be leveled or patched? Will cracks need to be filled?
- Is the concrete ready to be used? New (green) concrete takes 90 days to cure. Because of its high water content, adhesives will not adhere to green, hydrated concrete without installing the proper type of curing compound or base coat.
- Will the floor need a moisture barrier or a special moisture-mitigating curing compound? Both can be expensive.
- Is there a vapor barrier? According to the Rubber Institute, moisture levels should be no higher than 3 lb per 1000 sq ft per 24 hours. Calcium chloride (CaCl) testing, the standard test used to measure moisture, can give an incomplete picture because moisture varies according to fluctuating environmental conditions and variations in subterranean activities related to water table, drainage, and aquifer. Costs of vapor barriers must be taken into account. Most floors perform poorly or even fail when laid over a subfloor with vapor problems.
- Perform ASTM-F-1869 – Standard Test Method for Measuring Moisture Vapor Rate of Concrete Subfloor Using Anhydrous Calcium Chloride: The maximum allowed transmission rate is 3 pounds per 1000 square feet per 1,000 square feet.
- Perform ASTM F-2170 – Standard Test Method for Determining Relative Humidity in concrete Floor Slabs Using In Situ Probes: This will show the relative humidity of the concrete slab over time. The maximum relative humidity should be below 80%.
- Perform ASTM-D4263 – Plastic Sheet Test: This is a visual test that may provide an indication of the presence of moisture.

*Regardless of previous experience, DO test and evaluate every sub-floor properly before flooring is installed, and never ignore defects or marginal moisture vapor readings.*

### Mistake #6: Not Understanding Total Cost of Ownership

The initial material and installation costs are only part of the total cost of owning an ESD floor. When evaluating an ESD floor, designers often forget to consider the cost to repair and maintain the floor under consideration. Every floor, whether standard or ESD, requires some kind of maintenance and repair. Over five years, these maintenance and repair costs can significantly raise the cost of the floor.

- Vinyl floors are the costliest and most difficult to maintain. Beware of any claims that describe vinyl floors with special factory glazes that never need to be waxed. If there was really such a thing as a no wax, low-maintenance vinyl floor, grocery stores and shopping malls would be buying them. Never needs wax usually means always needs buffing. Regular buffing is just as costly as waxing.
- Carpet requires periodic vacuuming and yearly wet or dry extraction. Broadloom carpet is much more difficult to repair and replace than carpet tile. All carpet is vulnerable to chemical spills and solder spills.
- Epoxy floors need regular washing and gouges are very difficult to repair and match to existing areas. It is usually difficult to repair epoxy floors in occupied spaces due to the three day process of installation and drying. Epoxies are usually sensitive to ultraviolet exposure. The color will soften and fade in well lit areas.
- Rubber is not porous so it will not capture dirt, but it still needs occasional scrubbing with a single disc machine or it will become dull.
- Certain conductive adhesives dry right away, while others take 24 to 72 hours to fully cure; curing times can impact repairs considerably.

It is imperative to know and understand exactly what maintenance people will encounter before purchasing an ESD floor. The way the floor is maintained will directly impact its ability to eliminate static electricity. A good starting point for evaluating the true cost of ownership of any conductive epoxy or ESD tile is AT&T's landmark study of 18 different ESD floors (available online at [www.staticworx.com](http://www.staticworx.com)). This exhaustive in-factory evaluation was conducted over a period two years by AT&T engineers.

*DO consider the long-term costs of repairing and maintaining your ESD floor.*

### Mistake #7: Specifying the Wrong Product for the Application

Every static control flooring application presents some unique challenge. For example, 9-1-1 call centers and FAA flight towers rely heavily on the use of sensitive electronic equipment that is extremely vulnerable to static electricity. A static event could cripple their mission-critical operation, jeopardizing public safety and security. Designers of these 24/7 mission-critical spaces do not hesitate in specifying some form of static control flooring.

Unfortunately, it is easy to select the wrong floor for these applications, particularly in cases where the supplier is unclear about the capabilities and deficiencies of a particular ESD floor. In fact, many static control flooring materials (conductive vinyl, HPL, LAN carpet and computer-grade carpet, for example) are often incorrectly specified for these applications because real world testing has revealed that these materials do not and cannot possibly eliminate static in these types of spaces. Research has demonstrated that certain types of rubber and conductive carpet are the best ESD flooring solutions for mission critical spaces, since both rubber and conductive carpet inhibit static generation on moving personnel regardless of footwear.

### Conclusion

Mission-critical applications require flooring that is capable of both grounding static and preventing the accumulation of static in the first place. Because static is an invisible phenomenon, it is impossible to know, until a computer crashes or some other event occurs, that the floor is not working properly to eliminate static. To preemptively solve static problems in a mission-critical environment, the conductive floor must be groundable, antistatic and must also provide some ESD mitigation with or without the use of conductive shoes. Therefore, floors should be evaluated based upon body voltage generation testing involving both controlled and uncontrolled footwear using ESD STM 97.2 methodology.

*DO remember that applications differ in their static-protective requirements. Be sure that the floor you select is the right floor for your application. If you're not sure, ask a static control expert for help.*

Idiosyncratic and constantly changing requirements of technology businesses challenge the expertise of even the most capable building professionals. Technical ESD specialists should be enlisted to help decipher and explain ESD terminology and jargon. Supplier references should be checked carefully. Make sure that the ESD flooring is the right one for your application. As previously discussed, flooring that performs well with conductive footwear (like conductive vinyl) may offer little to no static protection in mission critical spaces that do not utilize heel straps or conductive shoes.

Results are best when the people who will actually occupy and maintain the space are also involved in the final ESD flooring selection. Sufficient technical resources exist to prevent the selection of the wrong ESD flooring material. Left alone, in the hands of design and build construction specialists, black-and-white factors like low price and speed of installation will always prevail over more important criteria like performance, appearance, and cost of ownership. □

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