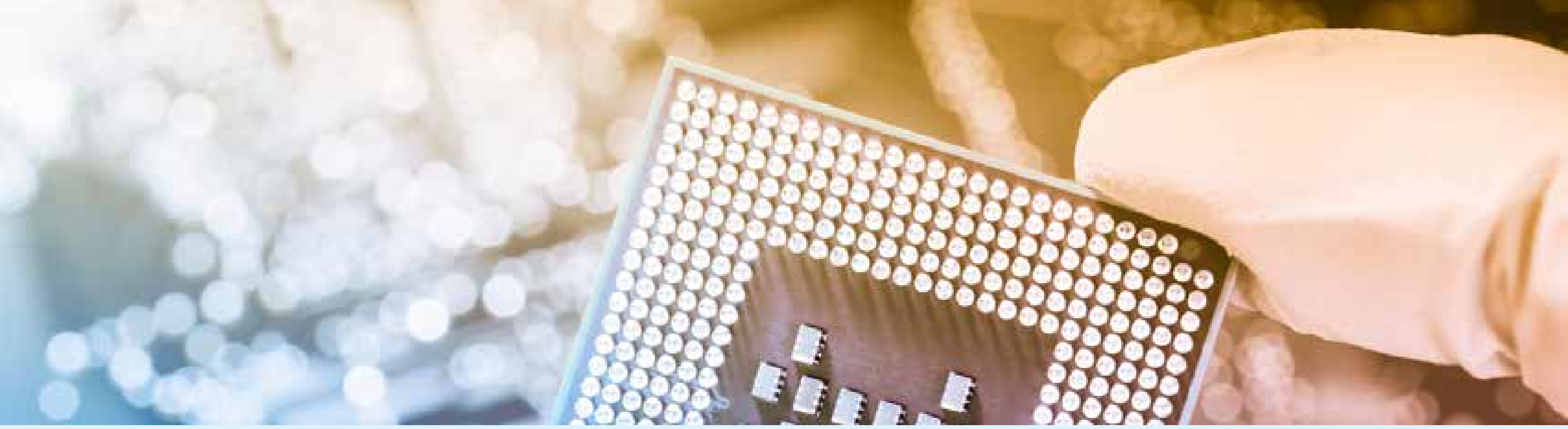
Frequently Asked ESD Questions
Published In the EOS/ESD Association Threshold Newsletter

Index for ESDA's Frequently Asked Questions



Frequently Asked ESD Questions

Published In the EOS/ESD Association Threshold Newsletter

1-Threshold Volume 23, No. 4
July/August 2007

Q. We have heard that cell phones can generate and discharge static electricity. Is this true?

A. The issue surrounding cell phones and operation in hazardous environments, including gas filling stations, seems to have to do with the internal sparks that occur when the back light comes on. There will also be tiny sparks during the activation of the phone pad/keys as well. Therefore it is NOT recommended to use a cell phone when pumping gas.

Nearly all of the fires that have occurred at gas stations have involved people who start the gas flow and get back in the car. When they get back out, they may have generated a static charge on their body, and when they touch the gas nozzle there is a spark. With a correct fuel/air mixture, a fire can occur. People often panic and pull out the nozzle without shutting off the gas and the problem gets bigger. Always touch the body of the car or door frame to discharge your static electricity before touching the gas nozzle.

There is no evidence to suggest that the cell phone operating signal can cause a fire. You do need to be aware that electrical sparks occur inside the phone - especially when the lighted display turns on. You may want to contact the National Fire Protection Association (NFPA) for more information.

2-Threshold Volume 23, No. 5
September/October 2007

Q. Answer this question for me; is there any type of ESD trainer's certification available to teach the fundamentals to our ESD Coordinator?

Also, could you tell me please, when wearing an ESD smock that has long sleeves with snaps at the end, if a person is wearing a ¾ or short-sleeved shirt, can they push the ESD smock sleeve up or roll it up a bit to be comfortable, or should it remain down and snapped? I know that there are smocks available with ¾ and short sleeves so I ask with this in mind wondering if as long as the clothing underneath is not exposed at all, could the ESD smock sleeve be rolled or pushed up?

A. We offer what we call ESD Program Manager Certification. This is a 10- tutorial set that people complete (generally takes two years) followed by an eight-hour written exam. We have offered the test for two years now*. There are a total of 13 Certified ESD Program Managers out there now (out of a group of about 25 or so that attempted the test). Please review the ESD Program Manager information on our website at www.esda.org and click on Certification. If you are interested in getting some training done quickly to get a person started, perhaps one of the consulting companies shown in our Buyer's Guide on the website could offer a custom package for you. There are several that do this all the time.

Generally, companies that use smocks in their ESD Control Program allow the sleeves to be rolled up as long as the street clothing is not exposed. I have seen this written into many ESD Control Program Plans.

3-Threshold Volume 23, No. 6
November/December 2007

Q. I'm trying to decide on either a conductive floor or a static dissipative floor. What would be the pros and cons of each and when would you select one over the other?

A. The decision about which type of floor should be selected depends on your company's ESD process needs. Some things to consider:

1. If the floor is to be used as a primary ground for people, the lower the resistance of the flooring typically translates into lower voltages on personnel. This is especially important if personnel are allowed to carry unprotected products by hand. To meet the requirements of an ANSI/ESD S20.20 based program, personnel must have a resistance to ground of <35 megohms. To meet this requirement with a floor and footwear system, the floor should be on the order of 10 megohms or less to ground. At 35 megohms to ground, personnel will not be able to generate more than 100 volts in most any production situation.

2. The sensitivity of the products that you handle now and in the foreseeable future also have an impact on the flooring choice. If the product is not very sensitive (say over 1,000 volts based on the Human Body Model) then you might not need to have a highly conductive floor. But remember, the floor is a considerable investment and if you have any thought of handling a more sensitive product you might consider grounding of personnel through the floor in the future.

3. If the floor is not used as a primary ground for people, then a static dissipative floor might meet your needs. However, you must provide another means of grounding personnel who handle unprotected (unpackaged) parts, for instance wrist straps.

4-Threshold Volume 24, No. 1
January/February 2008

Q. I have been assigned the task of writing an ESD Control Plan for our company. One question that keeps coming up it what is the best ESD packaging. One of our customers required that we do not use any pink poly bags with their product. So, does that mean that pink bubbles are also not acceptable?

A. The standard ANSI/ESD S541 (S541) – Packaging Materials for ESD Sensitive Items is available for free download on the ESD Association web site at www.esda.org. This important document should help answer all your packaging questions.

Many companies struggle when it comes to specifying packaging in their ESD Control Programs. The company that does not want Pink Poly next to their product may be concerned that the packaging material does not provide shielding or that they are worried about chemical transfers. In order to satisfy your customer, you may need to ask for details as to what their concern might be with regards to this material. From an ESD protection point of view, the use of a Pink Poly type bubble wrap would be fine for intimate contact since the material should be low charging and probably dissipative. Of course, you should qualify the material to make sure that it meets those specifications as listed in S541. Low charging and dissipative plastics have many appropriate uses within a static control program, but they are not the only protection materials needed for transport or storage outside of an ESD Protected Area (EPA). Within an EPA, materials like Pink Poly are encouraged since they are low static generating and dissipative and can reduce the use of conventional plastics that may charge up too much.

Static Shielding rated materials are required for shipment or storage outside of an EPA. This type of protection is afforded by metallized laminate films, wraps and bags, conductive tote boxes or other containers made from conductive plastics and other packaging forms that provide separation from the sensitive items contained in the package. In a properly designed and managed ESD Control program all the materials and sensitive items will be maintained at a low static charge level. The use of low charging and dissipative packaging materials within the EPA helps to reduce charge accumulation within that environment and also limits the charging of parts when used for intimate packaging.

5-Threshold Volume 24, No. 2
March/April 2008

Q. We need some help in understanding the use of a static dissipative floor in our factory.

1. Are there any special controls or requirements needed if the production line uses static dissipative flooring?

2. What are the factors that can contribute to a floor resistance measurement being out of specification?

3. What are the precautions we need to take on the production line when we use static dissipative flooring?

a. Trolley and cart grounding with a drag chain?

b. Do's and Don'ts?

c. Maintenance and cleaning?

4. Any other important information on flooring?

A. Static dissipative and conductive flooring are available in many different forms: tile, epoxy, sheets, carpet, paint and other coatings to name a few. The installation, care and maintenance of these floor systems will vary depending on the type, form and manufacturer/installer. If the floor is going to be used as the primary grounding path for personnel wearing some form of static control footwear or shoe grounding devices, then the floor may need to be conductive to allow personnel to have a resistance to ground of less than 35 megohms (<3.5 x 107 ohms) per the requirements of ANSI/ESD S20.20. In response to the specific questions:

1. The main purpose of a static dissipative or conductive floor is to provide an electrical path to ground for personnel wearing static control footwear and any mobile equipment that is groundable. Equipment may use conductive wheels or other grounding devices such as drag chains. Be aware that drag chains may not make sufficient contact with the floor to provide adequate grounding. Making a resistance to ground measurement from the cart while stationary and while in motion will determine the suitability of the grounding system.

2. If a floor is not installed correctly, it may not function as a ground path very well. When a floor gets dirty, it may not function as a ground path. Measurement of the resistance to ground from various points on the floor surface need to be made (usually quarterly) to make sure the floor is not changing in properties. Choose high traffic areas to monitor the wear characteristics of the floor. Moisture may have an influence on the resistance to ground of some flooring types so it is important to record humidity levels when making resistance measurements to keep track of changes in performance.

3. The main issue for any floor is to make sure it is installed correctly. If there is a lot of moisture in the subfloor (concrete), moisture will extract, causing adhesion problems with the new floor regardless of type. It is important to measure the moisture content of a grade-level concrete sub-floor to make sure the new floor installation will be satisfactory. The installation contractor should provide the moisture testing and guarantee the installation. Too much water in the sub-floor is one of the most frequently reported problems in floor installations.

a. Trolleys and carts need to be grounded when used in an ESD protected area (EPA). The most reliable method is to have at least one conductive wheel on each trolley or cart. Make sure all the shelves are electrically interconnected to the cart or trolley frame and that there is continuity between all parts of the cart. Often, there are plastic inserts that isolate the shelving from the frame. Drag chains may not work very well so it is always best to make resistance to ground measurements to make sure the cart or trolley resistance is within your specification. Some companies install a wire on their carts that allow the carts to be electrically bonded to a common point ground terminal when they are parked at a workstation.

b. Be careful with the use of wax and polishes on the floor. Conventional waxes may ruin the electrical properties of static dissipative or conductive flooring.

c. The flooring manufacturer will specify the appropriate cleaning process for the floor.

4. The main things to be aware of are listed below in summary:

a. Make sure the floor installation has an established ground path (See ANSI/ESD S6.1 – Grounding for guidance).

b. Make sure that the moisture level of the sub-floor is suitable for the installation.

c. Make sure that the floor type selected meets the application requirements (e.g. ability to withstand the traffic).

d. Make sure that the selected flooring meets the electrical requirements that are established.

e.When in doubt, make measurements.

6-Threshold Volume 24, No. 3
May/June 2008

Q. What is the recommended relative humidity that a room should be kept at for ESD purposes?

A. There are no hard and fast rules or specifications regarding humidity for control of static electricity in the current ESD Program Management Standards. Our standard ANSI/ESD S20.20 -2007 (available for free download from www. esda.org) does not specify a humidity range for applications. While it is pretty well understood that humidity plays a role in the ability to generate, store and dissipate static charge, it is also known to be unreliable as a control mechanism. Certainly, static charge generation is far worse at 10% RH than at 90% RH but significant levels can still be generated at 90+% RH.

Your ESD Control Program must be designed to work at the lowest practical level of humidity you can expect in your environment. The northern tier of US states have cold winters (heating up air dries it out and it is difficult and expensive to replace the moisture) and the interior of factories may see very low RH (measurements of <3% in MN inside a factory and technical "0" RH on the north slope of Alaska have been recorded). If you make a statement in your program about maintaining a certain level of humidity and you are an ISO factory or a military contractor, what are you going to do when the humidity drops below the stated level? Close the doors and send everyone home? This has occurred before with some military contractors that had an RH statement in their Procedures. It is best to avoid this costly error by not making a statement about RH control.

A well designed ESD Control Program and good materials will function correctly at very low RH. There are some different rules for pyrotechnics, ordnance and flammable atmospheres so if you are in any of those industries then RH control may be required. The statements above relate to electronics manufacturing industries.

7-Threshold Volume 24, No. 4
July/August 2008

Q. What are the resistance characteristics of conductive packing materials and dissipative packing materials? What is each used for?

2. Do shielding bags require dissipative or conductive characteristics?

3. As we know, there are many requirements of packing materials. Low charging, conductive or dissipative (resistance character), shielding (less 50nJ), decay time (from high potential volt to low potential volt expending time). Are these all of the requirements?

A. The surface of a packaging material that contacts a sensitive part needs to be dissipative. Conductive is not recommended for direct contact with sensitive items. This applies to bag and film types of packaging materials. It is OK to use conductive materials in tote boxes and other rigid containers since most of the time only small areas of the part may contact the conductive surface, and this reduces the risk to a minimum. So both dissipative and conductive materials are fine to use but it is important to know where to use them. Dissipative most often is best inside of an Electrostatic Protected Area (EPA) but Conductive is OK to use as well. Dissipative materials are often low-charging because of additives. Conductive materials generally are not low-charging.

For shielding bags, the inside surface is almost always dissipative and low-charging for contact with the parts. There is a conductive layer in the bag (usually metal) that provides the Electrostatic Shielding property. It does not matter where the conductive layer is in the bag but it should not be on the inside. A dissipative layer is usually over the outside of the bag covering the conductive layer to protect it.

For static shielding bags, as described above, the interior is supposed to be dissipative and low-charging; the metal layer (conductive layer) provides shielding. The measurements required for this type of bag are: Shielding Property - < 50 nJ (good bags are almost always <10 nJ) using ANSI/ESD STM 11.31; The inside surface should be <1 x 10E11 ohms using ANSI/ESD STM 11.11. The outside surface is usually the same as the inside, maybe a little lower in resistance (1 x 10E9 or 1 x 10E10 ohms).

It is technically not correct to use the decay time tests on multilayered materials as the test does not work properly. The most conductive layer controls the test so it is meaningless.

8-Threshold Volume 24, No. 5
September/October 2008

Q. I work for a solvent paint manufacturer. We are having a debate about over-the-counter insoles in ESD shoes. Some say you cannot use over-the counter insoles in ESD shoes, and others say you can. How do I know if over the counter insoles are ok to use?

A. Be careful with standard shoe in-sole inserts from an ESD perspective. ESD shoes generally work by providing an electrically conductive path from the wearer- through their stockings (sweat layer), to the in-sole and then to the outer sole and ultimately to the floor, provided the floor is conductive too. All the standard inserts for shoes are electrically insulating based on the materials that are used. The best way to resolve this issue is to take some electrical measurements. All you really need is a metal plate about 12” x 6”, some wire and a high voltage ohmmeter (megger). A standard Volt-Ohmmeter generally does not have enough voltage output to provide an accurate measurement. Ask an electrician that works in the area about borrowing an appropriate instrument (it needs to measure electrical resistance at a minimum of 10 volts. Up to 100 volts is ok.). Attach a wire to the metal plate and to the positive terminal of the meter. Attach the second lead to the negative (common) terminal of the meter. On the free end of this second wire, attach a metal rod or tube large enough to hold in your hand. Stand with one foot on the metal plate and activate the meter. Do this with and without the shoe in-sole inserts to measure the differences.

9-Threshold Volume 24, No. 6
November/December 2008

Q. Could you please help me to understand the relation between EPA & Class 0 level definitions. I understood that there is not a direct relation: - EPAs are areas where we can handle any type of Electrostatic Device Sensitivity (ESDS). In general an EPA is prepared to handle components with 100 V of sensitivity. Class 0 is a sensitivity classification only applied for devices (250 V or less).

Is there any classification for EPAs? I mean, example; EPA class xx is prepared to support ESDS with yyy V of sensitivity.

A. That is a very good question and one that comes up frequently in discussions in the industry today.

Device sensitivity classifications are for device characterization only. The test models used are intended to represent what happens to a component when stressed in a specific way. The HBM (human body model) represents a charged person touching a grounded part. The MM (machine model) represents a component contacting a charged - isolated conductive item in a process and the CDM (charged device model) represents a component becoming charged in a process and then contacting a grounded conductive surface. Field Induced CDM is also a consideration - representing a component being grounded in the presence of an electrical field from a close proximity charged item. All of these things can happen within a process, so understanding the sensitivity to each model is important.

The industry is trying to make the connection between the device test models and the factory control level needed. Class "0" parts have an HBM sensitivity of 250 volts or less as you mention. What this means in the factory is that human handling activities need to be controlled to less than 250 volts. Is there a perfect correlation between device test level and the human voltage spec? No, but what the industry is attempting to do is to control the human factors to as low a level as possible in order to reduce the associated risk to components.

A typical wrist strap system, worn properly with a 1 megohm resistor, will keep personnel grounded at a resistance of between 1 megohm and 35 megohms. At 1 megohm to ground, a person can only generate a few volts on their body even with rapid movement. At 10 megohms to ground a person may generate something like 20-30 volts with rapid movement. At 35 megohms to ground, a person may be able to generate close to 100 volts with rapid movement (such as running in place). You can see a graph of this in the ESD Technology Roadmap available at the ESDA web site (www.esda.org). A properly designed and implemented floor and footwear system will give similar results.

In the modern factory, most of the component handling is done by machine. In automated assembly, all of the conductive parts of the equipment must be grounded in order to avoid MM type damage. It is becoming better understood in the industry that a part designed with 1000 volts HBM protection will have at least 30 volts MM protection automatically (rule of thumb by the Industry Council on Device Stress Level Testing - see White Paper also on the ESDA web site). Isolated conductors must be avoided in any automated handler, but simple point to point resistance measurements will locate isolated conductors in machines.

CDM and Field Induced CDM are major concerns in the industry. Component stress levels to CDM are being discussed at great length in the industry right now. The size of the component package has a lot to do with the stress level - the same actual chip in two different packages will have different stress levels. What needs to be avoided here is the charging of the part in the process. Packaging, including tape and reel, trays, tubes, bags and boxes need to be evaluated for charge generation to avoid undo charging of components. The handling system needs to be evaluated so that every charge generating interaction can be kept to a minimum. Here it can get complicated. S20.20 has a requirement that all process essential insulators in the EPA be <2000 volts at 1 inch measurement (the spacing from most electrical field measurement instruments to the item being measured is 1 inch). If the item has an electrical field measurement of >2000 volts at 1 inch, the item has to be kept 12 inches away from any unprotected components or the charge on the item reduced in some way to bring it below 2000 volts at 1 inch. With all this in mind, a proper EPA will control voltage on personnel to <100 volts (proper grounding), equipment to <30 volts (proper grounding), Field Induced CDM to <100 volts (removal of insulators and control of charge on process essential insulators), and CDM to <100 volts by controlling charge generation on the parts themselves. So is there a relationship between device test levels and EPA? Of course there is. Is it a perfect correlation? No, but the industry is working on it.

10-Threshold Volume 25, No. 1

January/February 2009

Q. A customer has asked if our facilities are certified to class 0 CDM. We are accustomed to class 0 for HBM, so is this the same for CDM?

A. In November 2007, an Open Forum article in Conformity Magazine [1] clarified that a "class 0" designation does not exist for CDM (Charged Device Model), and would not be added to the latest revision of the CDM standard [2] which will be published in 2009. This is because there was not enough data and analysis at the time of the new release.

The increasing use of the term "class 0" to refer to CDM by many users in the industry is being misused and needs proper clarification. The application of the "class 0" term to situations, places and things where it does not apply seems to be "out of control" based on the number of questions being fielded by the ESDA.

The very first acknowledged and accepted use of the term Class X type designation can be traced to the HBM (Human Body Model) standards of the 1980s and the 1990s [3, 4]. The classes all refer to a range of pass/failure voltages for each "class X". The highest and least susceptible class X for the HBM [4] standard is class 3B (> 8000V) and the lowest and most susceptible class X for HBM is class 0 (< 250 V). There are 5 more classes between these 2, all published in the standards.

These classes are device testing (DT) classifications and the users who attempt to use these as a means to classify/certify their facility/factory are simply not in line with the proper use of the terms/designations. It is well established that the ANSI/ESD S20.20 [5] document is the standard which is to be used to certify a factory as an (Electro Static Discharge) ESD controlled facility.

More specifically, the scope of the S2020 standard states that the facility/factory is in compliance when its ESD control program can protect electrical or electronic parts, assemblies and equipment susceptible to ESD damage from Human Body Model (HBM) discharges greater than or equal to 100 volts. S2020 therefore addresses HBM directly, but not CDM (as yet).

Any stated facility/factory certification voltage number must always have a proper reference to HBM or CDM or MM whichever is relevant. Such voltages are simply those measured from the human in the factory or from an existing field regardless of the size of the existing capacitances, resistances or inductances. The DT classification number in the standard for HBM, CDM and MM are based on specific human, device or equipment related capacitance, resistance and inductance, but the existing factory number in S2020 is related to HBM only. There is no real exact correlation between the factory certification numbers and the DT classification numbers. The design engineers know the HBM failure voltage threshold of the device based on testing and Failure Analysis in the ESD and FA Labs. to accepted and established capacitance (100pF) and resistance (1500 ohms) from humans. They also know the failure voltages from devices for CDM and MM, but the factory only knows the voltage/in or voltage/cm based on the existing field where the measurements are made. If we use the term Q=CV or V=Q/ C, we see that the different fields (from the different charges) in the factory could produce the same or a different measured voltage depending on how the capacitances change, but this idea, though not new, needs more data and analyses before it can be applied to the factory and related to a DT CDM class X.

In recent years, many users in the IC industry have attempted to make the "jump" from HBM class 0 (< 250V) to a fictitious CDM class 0 (which does not exist) without the benefit of solid and relevant data from the factory. Users are now applying the term class 0 to CDM, and that is just "wrong". Let's be clear, the CDM standard has No class 0; repeat, No Class 0. The lowest and most susceptible classification for CDM is class 1 (< 125 V). Any attempt by users to relate any CDM class to ESD control in the factory must first be justified using data which is relevant. The industry council is working on this, and is expected to publish a CDM white paper II in 2009.

A factory paper [6] presented at the 2008 symposium in Tucson, presented data and a procedure for measuring fields and voltages in the factory, but the complete "bridge" to DT failure voltages was not made.

It must be remembered that CDM Device testing (DT) relies on the capacitance of the individual device and the capacitance of the testing environment in which the packaged device is being tested. We know the ranges for the capacitance of the devices. Is the capacitance of the factory environment known through which device has to travel? How and what can be accurately measured in the factory? Q? V? Are we stuck with Q and V only? What are the ranges within the factory from factory to factory?

In summary then, it is not established by any standard that a class 0 exists when referring to CDM. Further, it is not yet established that any of the classes in the DT CDM document can be tied directly to the same or any specific voltages in an ESD control factory. ANSI/ESD S20.20 covers HBM class 0, but does not address the CDM issue. There is no correlation established as yet between factory ESD control voltages and DT voltages in the ESD test lab. Class 0 for CDM is fictitious, and should NOT be used in reference to CDM until it is established by a recognized standard body. As of publication, the lowest and most susceptible classification for CDM is class 1 (<125V).

1. Leo G. Henry, November 2007 Conformity ESD Open Forum - "The Charged Device Model", Page 22-23

2. ANSI/ESD STM5.3.1-1999 for the Electrostatic Discharge Sensitivity Testing. Charged Device Model (CDM) -- Component Level

3. MIL-STD 1686C Electrostatic Discharge Control Program For Protection Of Electrical And Electronic Parts, I Assemblies And Equipment (Excluding Electrically Initiated Explosive Devices) Method 57: 25 October 1995

4. ANSI/ESD STM5.1-1998 for the Electrostatic Discharge Sensitivity Testing. Human Body Model (HBM) Component Level.

5. ANSI/ESD S20.20-2007 Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

6. Halperin, S; Gibson, Ron; and Kinnear John, "Process Capability & Transitional Analysis". EOS/ESD Symposium Proceedings, EOS-30, pp 148-157, 2008.

11-Threshold Volume 25, No. 2
March/April 2009

Q. I'm a major worldwide distributor of plastic sheeting (specifically 18 mil PET). For many years I have bought from US suppliers who, in cooperation with our organization, have been able to deliver the specifications and standards of quality required for our clientele.

I have been struggling with developing overseas suppliers and after several years have located a very modern facility and developed a good partnership. They make extremely good material in (almost) every way. However we have discovered one serious problem which we need to resolve before proceeding with full scale production and distribution of their material.

The material arrives with serious blocking issues. We now add modifiers which have mostly alleviated this issue but we are still hampered with static issues. Using handheld measuring devices on material from overseas locations we record a wide range of static from mid hundreds to several thousands, peaking around 10,000 to 12,000V.

We have asked the factory to perform static tests as well and they have come up with the same numbers confirming that the static is present at the point of extrusion and sheeting.

The factory placed ionized air blowers on line, but this has not resolved the issue. We suspect that ionizers need to be installed on line, at the appropriate power and correct polarity to completely neutralize the electrostatic charge. Our US material carries a 200V charge at delivery, an insignificant number.

I need to better understand the difference between ionized air blowers and ionizers, the difference in their capabilities and effectiveness in dealing with this issue, following which I need to determine a suitable brand and product configuration to recommend and install at our overseas facility.

A. I have many years of involvement with wide polymer webs of various formulations. As you are no doubt aware, static electricity generation is a dynamic process - changing at every interface between the web and rollers. The main areas to make sure static levels are reduced are prior to any coating application, immediately after coating, perhaps after curing and for sure prior to wind-up.

I would not suggest the use of blowers as they generally do not provide enough ionization and contribute to movement of debris and other contaminants. For this application, ionizer bars should be placed cross web at a down web distance of approximately 3 to 4 times the roller diameter from the tangent point of the web passing over the roller. Grounded induction type bars will reduce in process static electricity to something less than 5kV in most cases and then a good electrical ionizer bar after that can knock it down to something approaching a few hundred volts - depending on web speed. If a nuclear type ionizer is available - they could reduce it even more. I would try to reduce the voltage to as low as possible right at the wind-up station.

The surface topology of the China made film may be flatter (smoother) than film made elsewhere. That will most certainly contribute to increased static charging and blocking so it is something I would look at right away.

12-Threshold Volume 25, No. 3
May/June 2009

Q. 'I read the ESD roadmap, but I do not understand Figure 8. Does this figure indicate that the voltage on a person's body will be controlled below 50 volts if the person walks across an ESD floor while wearing ESD footwear without wrist straps? I thought it had to be higher than 50 volts. Also, S20.20 defines that items measuring 2,000 volts at one inch should be kept 12 inches away from sensitive items. Does this mean that we can accept items that generate or potentially generate a voltage less than 2,000 volts, and touch devices with HBM sensitivity more than 100 volts?

A. 'Figure 8 in the Roadmap document is only an example of the control that can take place with a good floor and footwear system. If the resistance to ground from the person were lower, peak voltage generated would most likely be lower than shown. If the resistance to ground was higher, the voltage shown would likely be higher than shown. Voltage readings of people can vary depending on the resistance to ground measurements for individual people. An insulating material with a measured electrostatic potential <2,000 measured at one inch, has a small electrical impact on other objects, even if in contact. Studies have been done in support of the Roadmap and IEC as well as the ESD Association documents that show a material with less than 2,000 volts at one inch is a very small risk for susceptible items with a sensitivity greater than 100 volts. As I mentioned, if you have more sensitive items in your process, the 2,000 volt level needs to be reduced. An insulator can only discharge from a small area, even if in contact with a grounded conductor, so the amount of charge transfer is very small. Even though 2,000 volts at 1 inch seems like a lot, it is not viewed as a significant hazard for >100 volt HBM parts. An isolated conductor with an electrical field of 2,000 volts at one inch would be a hazard if allowed to touch a sensitive item since the whole charge would go into the item- that does not happen with an insulator.

13-Threshold Volume 25, No. 4
July/August 2009

Q. I am looking to understand how ESDA's ESD sensitivity level classification for components (HBM, CDM, MM to class 1A etc.) moves from classification of components to implementation of ESD practices. If components are rated to certain classification, is there a standard or document that defines the ESD protection parameters a facility must meet in order to protect components rated to such class?

To give you a little background, I am an electrical engineer for mixed signal ASICs at Sensata Technologies. I have classified our devices (ASICs) according to ESDA standards and now would like to understand how to work with our suppliers so that they offer adequate ESD protection in accordance to the ESDs component classifications. It seems that at a typical supplier facility there is a general ESD program that implements a best practice. Sometimes companies will work with their suppliers to implement additional practices that they deem necessary. But what I would like it to understand is if the suppliers' ESD control plan is adequate for the component ratings that we have identified.

A. This is a very good question and it is one that we are working on in the ESD Association. For the moment, separate device classification from process capability. While you are quite correct that they do not seem to line up, they are really two different items. From process capability, there is only one model with enough standards around it to qualify a line. That is HBM. We can qualify a line by measuring the people in the process. For the most part, if a person's resistance to ground is less than 3.5x10*7 they cannot generate more than 100 volts. If the resistance is greater, then testing can be done with ESD STM 97.2 for footwear/flooring systems. The reason 100 volts was selected in ANSI/ESD S20.20 is that it is an easy number to achieve in any reasonable process without spending more money than a basic program.

The next two models get a little more complicated as there are no standards at this time to measure process capability, only proposals. For Machine Model the 20.20 standard requires grounding of all metal items. If all metal items are grounded, there cannot be any MM type of discharges. While there are not standards to classify this, experience has shown that if this is followed, devices with MM as low as 10 volts can be handled without any problems. If metal parts cannot be grounded, then measurements need to be taken to ensure the metal does not become charged. There are several contact voltmeters that can do this.

From CDM it becomes even more complicated. There are two items that you must take into account. The first and easiest is to remove all insulators that are not required in the process and ensure that the insulators that are required do not pose a threat. 20.20 suggests that the threat level be set at 2000 v/in for insulators. If you can follow that, then you can control CDM due to insulators down to 250 volt level or lower. In IBM we have used this technique to handle product down to 50 v CDM. The last part and the most difficult is to ensure that parts do not become charged before placement or testing or packaged. That measurement is more difficult and there are no standards on it. We recommend that you review the paper on process capability that was presented at the EOS/ESD Symposium in September 2008 for more detail. We hope this helps.

14-Threshold Volume 25, No. 5
September/October 2009

Q. In ANSI/ESD S20.20 2007 there is a limit of 2000 volts/in. What this is stating is that if insulators measure less than 2000 v/in then they are NOT considered a threat and no action needs to be taken. 2000 volts/in is the limit even for contact. The problem is most of our customers are using 100V as the control limit to audit our workstation. If the e-field from the package material, the machine cover or even an ESD smock is higher than 100V, they say it is not ESD S20.20 compliant and we are required to take action to bring it down. But honestly speaking, it is hard to control all to <100V. My belief is that what most people do not understand is that 100 volts on a person is not the same as 100 volts on an insulator. While a person can discharge their voltage to the part, an insulator can only induce a voltage on a part. I noticed that the E-field control limit in IEC61340-5-1 is also 2000V. In JEDEC625-A the control limit is changed to 1000V. My question is that for ESD sensitive devices which are sensitive to 100 volts or higher HBM, why the e-field control limit is 2000V or 1000V but not 100V. How can I say it is not a threat if e-filed is <2000V or <1000V even for contact? Is there any test or experiment that can show it is not a risk for 100V HBM or higher device? Is there any article that can be shared? Is there any further study conducted by ESDA that <2000V is not a risk even for contact? As most of our customers have a misunderstanding for 100V HBM, I'd like to get your comments so that I can persuade them.

A. You are correct in your interpretation of the insulator threat level in ANSI/ESD S20.20 - 2007. The threat level is defined as 2000 volts/in for insulators. The number was generated by studies done by North America (Celestica and the US Air force) and by studies done in Europe. The important point to note is that 100 volts on a person is different from 100 volts on an insulator. A person with 100 volts can discharge the entire energy into the device. An insulator does not have a potential but can only generate a field. So the proper term that an insulator can have is 100 volts/in. This level is a field and cannot be discharged into a device. What an insulator does is induce a voltage on an ungrounded device and if the device is grounded within the field, a discharge could occur. However a field of 100 volts/in cannot induce a potential on a device that is damaging. The field must be much higher to be able to set up a damaging event. In fact, the studies show that insulators need to have a large uniform charge across the surface (very unlikely) and must be very close (less than 1/8 of an inch) to become problems. Fields of 2000 v/in did not cause problems unless the insulator was a large uniform material almost in contact with the device. For a typical insulator, the field generated had to be in excess of 10,000 v/in before problems occurred.

15-Threshold Volume 25, No. 6
November/December 2009

Q. We drilled several copper rods 8 feet down into the ground (clean earth) to connect our ESD workstations throughout production. I would like to know, how do I test the "rod itself" to verify that it can provide the ESD protection expected?

A. The ESD Association Standard, ANSI/ESD S6.1 - Grounding, recommends the use of the equipment grounding conductor - third wire ground of the electrical system - for the ESD ground. What you have installed would be considered a "Supplemental Ground" per the United States Electrical Code - NFPA70. The Supplemental Ground needs to be electrically interconnected (bonded) to the equipment grounding conductor, and the electrical resistance between the Supplemental Ground rods (in your case) and the electrical system needs to be less than 25 ohms, when measured with an appropriate tester. The tester needs to have an output voltage of at least 100 volts to make the resistance measurement. You could make the measurement at 500 volts as well. The instrument normally used for this measurement is generically called a Megger or Insulation Tester (usually carried by Electricians). Attach one lead of the tester to an installed ground rod and the other lead from the tester to a ground connection in the electrical system (any ground point at any outlet). You should have a measurable continuity - if you don't, it is necessary to add a bonding wire between the ground rod system and the electrical ground, preferably at the ground buss at a main service entrance (power panel). Again, you need to have <25 ohms between the ground systems. It is not a good idea to use a completely isolated grounding system (supplemental ground) for your ESD ground since that particular ground can be at a very different electrical potential (voltage) than the electrical system ground that is used with powered equipment within your work areas (soldering irons, test equipment etc.). As long as the grounding systems are bonded together, then it is OK to use the supplemental ground for your ESD ground, but generally it is not considered necessary to provide the supplemental ground in the first place. In addition, do not use isolated grounds (as used for computers and other sensitive electronic equipment - the ones with orange receptacles and a green triangle) for the ESD ground as they are meant to have reduced electrical noise on the ground line for that type of equipment. You may need some assistance to ascertain whether or not your supplemental ground is correct. For that, please see our Buyer's Guide for Consultants to find someone who can do these measurements.

16-Threshold Volume 26, No. 1
January/February 2010

Q. I have a customer that wants us to measure our compressed air for static. How can I measure air?

A. Thank you for the question. We normally do not see or measure static charges in compressed air if it is clean. If it is dirty or contaminated, the contaminate can build up a charge. How to measure it is another issue. As the charge would be the result of contaminate movement in the compressed air, blowing the air against an isolated conductive plate and then measuring the plate with a field meter may be one way to measure the charge of the air, however it would only be the charge transfer being measured. Discharging the air against a charge plate monitor while "floating" may also show a charge transfer if the air is charged.

17-Threshold Volume 26, No. 2
March/April 2010

Q. We are a manufacturer of ESD flooring. Recently, we supplied one of our contractors with a ESD flooring material that was installed properly. ESD readings were taken and were in the 10E7 to 10E8 range, as required. Our testing procedure has always been to use our 701 Megohmeter, place the 5 pound contacts firmly on the floor about 3-4' apart, and take the readings while holding the contacts. Our customer is questioning the need to apply any pressure when taking these readings. When not applying some pressure, the readings are more erratic, causing the customer's concern about the efficiency of the ESD floor. Is there anything in EOS/ ESD Association Test procedures that addresses this specific issue?

A. ANSI/ESD S7.1 describes the ESD Association standard test methods for flooring resistance measurements. It can be used for laboratory testing (samples prior to installation), acceptance testing (after installation) and periodic verification (method also appears in ESD TR-53 - Compliance Verification). The 701 instrument with 2 each 5 lb., 2.5 inch diameter electrodes is suitable for making the Acceptance and Periodic Verification measurements. It is not suitable for making Laboratory level testing as it is an open circuit instrument (measurement voltage drops off as indicated resistance increases). A laboratory grade instrument applies a constant or steady voltage across the measurement range (the 100 volts applied does not drop off). The 5lb. weight of the contact electrode is meant to be the entire force applied during the measurement. The contact area and weight of the electrode is representative of the ball of the foot of a person standing flatfooted on the floor. The method was originally established in NFPA 56A which is now NFPA 99 - the standard on Health Care Facilities. The methodology was originally established for measuring the electrical resistance of hospital operating room flooring. Applying additional pressure to the contact electrodes is not described in the standards. If more weight were desired, the electrodes would have been made heavier. By applying more force to the electrodes, the soft face (Shore A 70 durometer hardness) will deform a bit more and make better contact with the floor surface - but this defeats the purpose of having a standard size and weight electrode. Whoever told you to press harder on the electrodes was in error. What is suggested in this case is to use a laboratory grade instrument for making the floor resistance measurements. In the case of disagreement between the installer and the floor owner, a laboratory grade instrument measurement takes precedence.

18-Threshold Volume 26, No. 3
May/June 2010

Q. I think I am an unusual customer for the ESD association coming as I am from a healthcare setting. I am the manager for a hyperbaric oxygen (HBO) service. We use ESD personnel grounding devices to ground our patients during HBO treatment as static control is a critical element of fire safety in a compressed oxygen environment.

Traditionally we have used the metal wrist straps, but it seems the fabric wrist straps with metal wire woven in are becoming more prevalent and are starting to show up in the HBO world. I am confident that the effectiveness of the commercially available fabric wrist straps has been formally studied and evaluated based on their widespread use/availability in the electronics world, but I am having a hard time convincing my peers that a research study comparing the effectiveness of the metal wrist straps to the fabric ones is reinventing the wheel. Can you point me to any existing studies/data which equivocate the effectiveness of these two kinds of wrist straps?

A. There have been numerous studies done by the manufacturers of wrist straps over the years. However, none have been published for peer review (that we recall). The Standard for wrist straps (ANSI/ESD S1.1- Wrist Straps) dictates the performance parameters so as long as the wrist strap assembly meets those requirements, how they are constructed does not matter.

Almost all of the fabric bands used in the electronics world contain some form of metallic elements in the stretch weave (coatings on the fibers or metal filaments woven into fiber bundles) so it would be prudent to understand the risk of particles or fibers coming off from fabric bands. Also, the fabric bands do wear out and frankly are not meant to be shared amongst users. You only need to look at the fabric weave of a used fabric band under low power microscope to see the accumulation of skin debris.

Wrist straps are generally considered a piece of clothing and at that should be provided for individual users. Fabric bands can be washed - do not use chlorine bleach as that will destroy most metallic fibers used in these bands. Metal wrist strap bands can probably be sterilized in conventional equipment, but probably not suitable for fabric bands.

Wrist straps are meant to provide a reasonably low resistance path to ground. By the Standards, the maximum resistance of a person to ground wearing a wrist strap is 35 megohms (3.5 x 10E7 ohms). A properly fitted wrist strap - regardless of material type will almost always meet that requirement although there are some people that have extremely high skin resistance. Often, the maximum resistance to ground will be on the order of 10 megohms down to 1 megohm depending on an individual's skin characteristics. So, electrically there should be no significant issue in using fabric wrist strap bands in your medical application. There could be other cost or mechanical or biological reasons to not use them. You would have to make those determinations. You may find benefit in having more in depth discussions with a consultant in this field. You may find a suitable consultant in our Buyer's Guide on the ESD Association Web site - www.esda.org.

19-Threshold Volume 26, No. 4
July/August 2010

Q. We follow the manufactures recommendations for the cleaning of ESD garments and they show no signs of wear or other damage and they are under the manufactures maximum number of launderings. Is it required that they be tested for proper resistance after each laundering? I have a copy of ANSI/ESD S20.20-2007 but not ANSI/ESD STM2.1-1997, which I think only describes the methods for testing of ESD garments.

A. There are two directions you can go with this. If you have specified in your ESD control plan that garments are used as part of your ESD Program, then ANSI/ESD S20.20 requires a resistance measurement be made to verify the integrity of the garment system. You should obtain a copy of ANSI/ESD STM2.1 to understand how the test should be done. The garments should have gone through some kind of qualification procedure initially, then compliance verification testing done after that. You don't have to test every garment after laundering, but a statistical sample should be taken on a regular basis. Some users ask the laundry service to test a set number or percentage of the laundered garments each time. Some pull garments on a quarterly basis and test them randomly. Personally, I have done this and found problems after a short while in my facility, we negotiated a warranty exchange and were able to get some new garments at a significantly reduced cost. The other direction you can go is to realize that garments are an optional element in ANSI/ESD S20.20. If you don't mention them in your ESD Control plan, you don't need to do anything with them. Many companies are taking this approach. They still want garments for a variety of reasons, but don't want to qualify and test them. ANSI/ESD S20.20 allows you to do this by simply not making them part of your ESD Control Plan. This may be preempted by your customers requirements though - you will have to determine that for your specific process/application.

20-Threshold Volume 26, No. 5
September/October 2010

Q. Does the ESD Association have any white papers covering the use of wireless wrist straps? A number of our field service providers use them and I would like to point them to industry papers to show them how ineffective they are.

A. Cordless or wireless wrist straps have been marketed for many years. They are supposed to work based on the concepts of induction and corona discharge. While there may be some merit for high voltage applications, there is little application in conventional electronic assembly or service operations. The onset of induction to create corona ionization is approximately 3.5 kV to 7 kV depending on the shape of the object (sharp points are required). There may be some cordless wrist straps that may maintain a person at the 3.5 to 7 kV level but that has little value where the risk of damage may be as low as 100 volts. We do not know of any published papers on the subject at this point in time.

Work is underway in several places on free-standing corona discharge systems but the physics involved does not allow the potential to be less than 3- 3.5 kV. For many areas of concern that may be adequate to mitigate problems (e.g. fire initiation, personnel shock) but certainly not for electronics.

21-Threshold Volume 26, No. 6
November/December 2010

Q. We have conductive flooring and a conductive chair with a drag chain; operators wear ESD smocks and foot straps. Does the operator require a wrist strap at the bench? Is this ESD safe? I am thinking that if the operator has their feet on the rung of the chair this is still not safe, however others believe the operator would be grounded to the floor via the chair. Since the operator does not have direct skin contact to the chair (clothing barrier) I am thinking this is still not acceptable.

A. Thank you for your question. According to ANSI/ESDS20.20, personnel that handle ESD sensitive devices must be grounded through the use of a wrist strap assembly or by using static control footwear when standing on a grounded ESD floor or ESD floor mat. Furthermore, if personnel are seated when handling ESD sensitive devices the only option for grounding personnel is a grounded or equipotentially bonded wrist strap system. The scenario that you describe is technically not an option for grounding your personnel. However, ANSI/ESD S20.20 does allow users to modify any technical requirement as long as there is sound rationale along with a technical justification that is documented in the ESD Control Program Plan. If you want to ground your employees through an ESD chair that is sitting on an ESD floor there are some technical issues that will need to be investigated:

1. System resistance from the employee's hand to ground while seated. ANSI/ESD STM 97.1 describes how that measurement is made for personnel that are standing on a static control floor while wearing static control footwear. You will have to modify the procedure slightly to measure your personnel as they are sitting on the ESD chair. You should be targeting for limits of less than 3.5x107 Ohms. Note: In order to properly make these measurements they must be done at the lowest relative humidity that you would expect to see in your facility as this will represent the worst case resistance readings.

2. No matter what resistance reading is obtained you should also perform the charge generation test listed in ANSI/ESD STM 97.2. This test method would have to be modified as well for your situation. It is suggested that the procedure would record a person's body voltage while they are sitting on the ESD chair and making motions similar to the type of "while seated" movements that would be involved in their daily work. The voltage levels should be less than 100 volts. Again, this test should be conducted at the lowest relative humidity that you would expect to see in your facility. Even if the resistance readings are less than 3.5x107 Ohms and the voltage generation readings are less than 100 volts there are still concerns that you must address:

1. How reliable is the connection from the person to the chair? If you rely on the shoes being in contact with the chair's foot ring it will be difficult for an operator to "remember" to keep their feet firmly in place. If you are using the smock to make the connection between the person and the chair, you have concerns here as well. Is the person's skin continually in contact with the garment fabric and how does the garment reliably contact the chair – is the connection via the seatback or does the operator need to be sitting on the smock such that the garment is between the chair seat cushion and his body. How do you ensure that this happens reliably?

22-Threshold Volume 27, No. 1
January/February 2011

Q. In the newly published HBM standard ANSI/ESDA/JEDEC JS- 001-2010, page 3 mentioned a phenomenon of "step stress test hardening" as follows: step stress test hardening: This occurs when a component subjected to increasing ESD voltage stresses is able to withstand higher stress levels than a similar component not previously stressed. For example: a component may fail at 1000 volts if subjected to a single stress, but fail at 3000 volts if stressed incrementally from 250 volts.

1. Could you please help to explain this kind of phenomenon?

2. According to our experience, it seems HBM by step stress will get lower pass voltage than only zap specific HBM voltage. Why is our result different from yours?

A. This phenomenon of step stress test hardening (SSTH) is not unique to the ANSI/ESDA/JEDEC JS-001 2010 HBM standard, and it is not the result of any new procedures or requirement in the joint document. It is also defined in other ESD documents. As you will recall, the SSTH is in the definition section, and in section 6.2, it clearly states that three new components may be used at each voltage level or pin combination if desired. This will eliminate any step-stress hardening effects, and reduce the possibility of early failure due to cumulative stress.

The situation in which step stressing produces lower failure levels is certainly easier to explain based on the idea of wear-out from repeated stress. If either stress hardening or lower failure voltage due to step stressing occurs, then it certainly depends on the details of the integrated circuit being tested, both in terms of the circuit design and the technology used for the integrated circuit in question. The authors of ANSI/ESDA/JEDEC JS-001-2010 included this definition and a discussion of step stress hardening in the document, to help users who might see this effect on their product. Without this note in the document users seeing this effect for the first time could easily spend considerable time trying to fix an HBM simulator problem that was not really there, when the problem was a property of the circuit being tested. It is also wise, especially when dealing with a new technology or design style, to look for the possibility of stress hardening to ensure that HBM results reported are an accurate representation of the ESD properties of the product tested.

23-Threshold Volume 27, No. 2
March/April 2011

Q. We have a HiPot test station setup on an ESD worksurface. We are experiencing breakdowns in some of our Hall effect sensors due to a high inrush voltage measured with a scope. Hooking the ground to the body of this particular black anodized motor casing and the positive lead of the HiPot to the motor A,B,C windings (which we twist together for the test) we then apply 500 volts AC. Intermittently we get a surge of voltage which we believe is damaging the hall sensors. We have placed the device under test on an insulated platform and they pass the test but breakdown when on the ESD mat. I have contacted numerous HiPot Manufacturers and talked with their engineers and they are telling me not to test on the ESD mat, because the ESD mat is conductive. They are recommending we use an isolated platform for the test.

Here is my question, if we are to have a truly ESD safe area, would we not be defeating the purpose of the ESD safe workstation theory to have an isolated area to do this Hi- Pot test?

A. Thank you for your important question. HiPot testing is one of the areas where personal safety has to take precedence over ESD control.

The other people you have talked to have given you correct information. It is NOT recommended to use ESD control materials in or around these types of test areas where personnel may be exposed to open voltage sources. The other aspect of having a dissipative or conductive mat in the area is the problem you have experienced. The resistive coupling between the tester and the product under test through a ground plane (formed by the ESD control mat) is setting up for current flow through the product under test. That is most likely why you are seeing failures. You need to provide ESD protection for the product going into the test up to the point where you make the connections for the HiPot test. For circuit boards this may mean shunts across the edge connector, shielding bags for transport etc. Often personnel will be grounded while setting up the test but when the test is actually being conducted, they should be disconnected from ground for safety purposes.

24-Threshold Volume 27, No. 3
May/June 2011

Q. I'm looking for some guidance regarding the use of ESD flooring. My questions are:

• Between static dissipative or static conductive, is one considered better than the other?

• How is it determined which product is more appropriate for a given use?

• Are there protocols associated with either type? (Footwear grounding, straps, etc?)

• Is there an ideal surface resistance range that covers a majority of projects?

• What are the advantages and disadvantages between rubber and vinyl?

A. These are fairly often asked questions. There are lots of choices in flooring materials today; you do need to be careful in the selection since it is an expensive purchase. For those that want to use the floor as either the main grounding path for personnel or as a back-up in an ANSI/ESD S20.20 compliant or certified facility, the combination of floor and footwear becomes the primary quantity to measure. In the current release of S20.20 (2007) two methods are used to qualify the floor and footwear system. In the first, the resistance to ground from a person, through their footwear while standing on the floor, has to be less than 35 megohms (<3.5 x 10E7 ohms). If the floor and footwear combination is greater than 35 megohms but the floor resistance to ground is less than 1 gigohm (<1 x 10E9 ohms) then a walking test according to ANSI/ESD STM97.2 must be used to qualify the floor and footwear combination. The result of the walking test must be less than 100 volts (or other user defined value).

In order to have a combined floor and footwear resistance of <35 megohms the floor itself has to be just about 10 megohms or less to ground. This means that in almost every case, a conductive range floor is needed. The vast majority of floors being installed today are considered conductive and are in the range of 2.5 x 10E5 ohms to 1 x 10E6 ohms when measured according to ANSI/ESD S7.1 (soon to be STM7.1 without significant content change). A 1 megohm floor +/- 10% would be considered ideal by most today.

We cannot get into details regarding features and advantages of the various materials but it can be stated that there are both vinyl and rubber based flooring materials that will meet the requirements for grounding of personnel as stated above. There are also vinyl and rubber materials that will not meet the requirements as stated above so it is necessary to thoroughly review product literature before purchase.

25-Threshold Volume 27, No. 4
July/August 2011

Q. I was wondering if you know of any good papers discussing the various ordnance ESD test standards, such as MIL-STD-464, MIL-DTL-32659, MILSTD- 1576, etc.? I'm working on what our ordnance has been tested to and what it should be tested to. Given there are conflicting standards and specifications in existence, I was wondering if anyone has addressed them in the past, or is working on streamlining them? None seem to be representative of anything "real" (i.e., what represents the various test circuits, such as Human Body Model, Machine Model, etc., and where is the engineering to justify them?).

A. You raise a number of interesting questions. Unfortunately, we do not know of a concerted effort to try to resolve these and other related questions with regards to ESD type test methods as related to energetics.

The ESD Association is certainly in a good position to assist in this area and actually has some responsibility in that regard since we are an ANSI affiliate with responsibility for all areas of electrostatics. We are in the preliminary stages of working with the Military to better harmonize the Human Body Model test method for ESD susceptible components. The ESD Association and JEDEC have a joint working group that has released a harmonized HBM document and that has caught the attention of the US Military. Updating Mil STD 883 is certainly within the realm of possibility, as the responsible people are in communication with the Joint Working Group.

The HBM test method, regardless of form, is not exactly appropriate for energetics but some of the concepts may apply. The standards and test methods you referenced apply some of the same techniques as used in HBM testing and the IEC61000-4-2 test procedures. It is probably time (actually way past time) to get a group together to discuss the needs of your part of the industry. What is needed are people from your industry to get together and determine what it is that you want to do. The ESD Association can then assist in providing expertise in designing test methods, establishing risk criteria, and even hosting meetings. Without people from your industry participating, nothing will happen as we do not have a sufficient base of experts and affected parties involved at this time.

If you or someone else would like to take the lead in organizing a Working Group to deal with the ESD sensitivity testing of energetics, please contact the ESD Association Headquarters (315-339-6937) and talk to Christina Earl – Standards Program manager. She will help you get into contact with the correct volunteers from our standards organization.

26-Threshold Volume 27, No. 5
September/October 2011

Q. Does the ESD association have any guidelines, specifications, or recommendations about how frequently ESD verification should occur at an electronics manufacturing facility? We do not wish to over or under verify the equipment at our facility when scheduling ESD verification of our equipment. Please advise.

A. The frequency at which compliance verification tests should be done is highly dependent on the specific applications and facilities. As a result, there are no specific frequency requirements stated in the primary standards (ANSI/ESD S20.20-2007 and ESD TR53-01-06). As a general guideline, items which are likely to drift or change their performance such as wrist straps, ground wires and ionizers may require more frequent testing than more robust items such as lightly used dissipative mats. Ultimately, as in other process measurements, the frequency of measurement should be adjusted based on data and criticality. These judgments should be made by the plant ESD Program Manager in consultation with the appropriate engineering and operations personnel. One way to do this is to test all the items using an initial plan that errs on the side of frequent testing and as data is collected, modify the test intervals accordingly. So maybe start once a week for a set time period. If there are no issues, expand to once a month, then once a quarter and so on. If the worksurfaces are fairly clean, not moved around much you could define them to be tested once a month or once a quarter. It really depends on how much risk you want to take based on you process. If you move the benches around every other day and have to disconnect them from ground, you may want to test them more often. If you use daily wear wrist strap/or heel straps you should test them every day. They can be put on incorrectly or break. But if you use shoes and you have a lot of history of reliable usage, maybe once a month is enough.

27-Threshold Volume 27, No. 6
November/December 2011

Q. What are your thoughts on the use of regular Scotch tape for sealing static dissipative ESD bags? I am developing an ESD process and this question came up in one of our review meetings and we could not fully support saying YES or NO.

A. Normal office tape should not be recommended for use in sealing bags. The plain tape you mention is often used in classes and by consultants to demonstrate static charge generation. A typical roll of plain office tape will produce electrical field values of 8kV to 12kV at 1 inch when a piece is unrolled quickly. That does not sound like something that should be used in an ESD protected area. That being said, it most certainly should not be used on static dissipative bags since these types of materials do not provide any level of electrical field shielding. You probably could get away with sealing static discharge shielding bags (metallize film) or most moisture barrier type bags since they have a metal layer to provide shielding and the electrical field from the charged tape would be attenuated on the outside surface of the bag. However, the simple answer to your question would be No, not a good idea.

Your ESD control areas should be evaluated for insulators and only process essential insulators allowed. A process essential insulator could include tape but to meet the requirements you would have to ensure that the electrical field was less than 2,000 volts at 1 inch as a starting point. For close proximity to ESD susceptible items, the field strength should be lower. You would be much better off using a low-charging tape or labels made for sealing bags.

28-Threshold Volume 28, No. 1
January/February 2012

Q. I have a question about Tip-to-Ground Resistance testing. I have inventoried all our soldering equipment and done testing to see if they meet ESD requirements. I used the resistance testing procedures from the ESD Association. I am checking soldering irons, desoldering irons and air knifes. I have some equipment that is failing or not getting a reading at all. On most of the air knifes I cannot get a resistance reading; it reads open. On some of the desoldering irons, my resistance readings are above the 2 ohm max limit (8 and 9 ohms). Should I be doing this test on air knifes? Any suggestions on what I need to do to get these items within specs? What is your recommendation on how often I should be checking these? I was going to try and change the tips on these and see if that helps.

A. A considerable amount of work is going on within our Standards Working Group on Hand-Tools regarding this area. Changing tool tips of out of spec tools is generally a good idea since corrosion tends to build up and cause higher than normal resistance readings. Thorough cleaning of threads for screw-in tips is necessary to ensure good electrical contact between parts. We have not looked at air knives at this point but perhaps they should actually follow the same idea as other hand-tools. If there is any contact between an air knife and a sensitive item then the air knife should have the same requirements as any other contacting item, but that may be a very high resistance. Some standards regarding hand-tools have a resistance to ground from the part of the tool that contacts something of concern as less than 10E9 ohms. This of course is very different than soldering/desoldering equipment which has very low tip to ground resistance requirements due to the applied voltage. You may not be able to measure the high resistance with the same instrument or set-up that you use for soldering equipment. At the higher allowed resistance, you can only make an accurate measurement with a higher voltage resistance meter such as used for measuring floors or worksurfaces at 100 volts.

29-Threshold Volume 28, No. 2
March/April 2012

Q. Looking at the S20.20-2007, I don't see that there is a requirement to "log" the readings when we check the ESD worksurfaces or floors. However some of our customers say that it's required that we have documented logs that show what the readings were. Our internal procedure that is based on the S20.20 only requires that we test and indicate a Pass/Fail and then sign a certificate sticker indicating acceptance. Is there a requirement that we log the readings for our worksurfaces and floors?

A. In the ESDA documents pertaining to the establishment and maintenance of an ESD Control Program (ANSI ESD S20.20- 2007, ESD TR20.20-2008, and ESD TR53-01-06) there is no requirement of logging specific measurements although there is a requirement to document the measurements of all the technical elements used in your program in your Compliance Verification Plan - as described in paragraph 7.3 of S20.20. These documents allow the flexibility to establish the plan that works for your situation and is acceptable to your customers. Since you have a Pass/Fail criteria established against some set of parameters, it would be advisable to maintain a paper or computer based log book or record to show when the testing was done and by whom.

In addition to this, however, there are facility certifications that are available through ISO 9000 Certification Bodies. Your ESD control program plan documentation must describe how you record compliance verification testing which includes the test methods you use (based on ESD Association or equivalent methods), the test equipment used (must be applicable to the test method), and who has done the measurements (have they received appropriate training to do the measurements). Your compliance verification records then become evidence that you can show your customers that you have your ESD control program is well established and performing within your own specifications. This eliminates a lot of discussion between you and your customers.

30-Threshold Volume 28, No. 3
May/June 2012

Q. ANSI/ESD S20.20-2007 does not provide any requirements regarding humidity and temperature control as did ANSI/ESD S20.20-1999. Is there any reason why this requirement had been taken out, or is this covered under another standard? A) In the new release of ANSI/ESD S20.20, humidity has been removed as a requirement because the ESD Control Program technical elements that you use in your Plan must be designed to function at the lowest level of humidity that you will experience in your work environment. Establishing and maintaining a range of moderate humidity does very little in terms of providing protection from static charge generation and accumulation. Flooring, footwear, worksurfaces, personal grounding devices, garments, packaging and most other static control items (technical elements in S20.20) need testing by their manufacturer at 12+/- 3% RH to make sure they maintain their functional specifications at low humidity. While there certainly are differences in charge generation between 30% and 70% RH, it is just not enough to rely upon for electrostatic protection. In addition, much of the world has difficulty in maintaining this level of humidity inside of buildings during winter and other dry months. Placing a specification on humidity in your operation can lead to great difficulty when it comes to compliance verification. If the humidity goes out of specification, you may have to cease production until it can be brought back into range or else you risk being out of compliance from an ISO9000 or ANSI/ESD S20.20 certification standpoint.

31-Threshold Volume 28, No. 4
July/August 2012

Q. I have the book, ESD From A to Z - Electrostatic Discharge Control for Electronics by John M. Koyler and Donald E. Watson. In section 3.6.5.2.2., Voltage and resistance differential from commercial power ground on page 61, the book said that "Static ground, measured at the distribution wire (3.6.5.2.3 and Fig.1), shall not differ from commercial power ground by more than 5V (9dc or rms) or by more than 25 ohms." I am just wondering where 5V and 25 Ohms come from and any special reasons?

A. The voltage difference between ground systems - e.g., the equipment grounding conductor (3rd wire ground in a North American electrical system) and an auxiliary or supplemental ground (building frame is an example) needs to be low. At the time of the writing of the book you referenced, 5 volts would have been more than adequate for an electrostatic control grounding system. Today and into the future, 5 volts may be on the high side for some very sensitive devices. The 25 ohms of resistance value comes from the National Electrical Code - NFPA 70. The measured resistance between auxiliary ground and the equipment grounding conductor must be less than 25 ohms to meet the Code. It would be best in very sensitive environments to have a lower resistance between systems to ensure that the momentary potential difference is maintained very low (that is where the <5 volts comes into play).

The ESDA Grounding Standard ANSI/ESD S6.1 also uses the <25 ohms value but does not discuss voltage as resistance is easier to measure in the system and ultimately controls the voltage. If two grounding systems are present at a workstation, they need to be electrically bonded together (with <25 ohms) to keep the potential as low as possible between the major elements of the work station and ESD control items and the electrical system ground (equipment grounding conductor).

32-Threshold Volume 28, No. 5
September/October 2012

Q. The ESD documents ANSI/ESD S20.20, ESD TR20.20, and TR53 provide a good in-sight into methods of measuring ESD facility parameters and suggested range of achievable values. In some cases the values differ between documents. In some cases the values are defined as what the user specifies. We are updating our QA Procedures and want to be specific about the measured values or ranges of values for the various ESD parameters for a qualified ESD work station such as work surface to ground resistance, common ground point to earth ground resistance, and many more. Is there a document which you can recommend that defines specific required values for the workstation ESD protective parameters? Secondly, many of the new test equipment are inside a non-conductive case. Using them in an ESD protective environment presents a problem. Is there a method such as a spray, etc., to provide an acceptable conductive coating or other solution?

A. ANSI/ESD S20.20 is the standard that defines product qualification and compliance verification requirements. The values in this standard will override any other values in individual standards. For packaging, the values given in ANSI/ESD S541 are the values required. These two standards should be used to derive requirements for your products unless there are additional customer requirements or very sensitive devices that you are dealing with. For values that are not listed or defined as user defined, there are no test methods or limits that have been established for the industry. Some insight on how to develop these numbers can be found in TR20.20 which is a companion document for ANSI/ESD S20.20.

For the second part of your question, there are products on the market that will reduce the fields of insulative parts of tools. The ESD Association does not recommend any products. However by using ANSI/ESD S20.20 and the insulative requirements, as long as the product you evaluate, keeps process required insulators that are closer than 12 inches less than 2000 volts per inch, the requirement of ANSI/ESD S20.20 are satisfied.

33-Threshold Volume 28, No. 6
November/December 2012

Q. The current ANSI/ESDS- 20.20-2007 standard is silent on what humidity requirements must be met to mitigate the risk of ESD damage. Although other standards like JSTD- 001 require ESD protection to be verified if the humidity drops below 30%, no such requirement exists in the 20.20 standard. Will future revision to the 20.20 standard address humidity requirements? If not, why not? What does ESDA recommend for humidity limits for ESD protection? If humidity drops below 30%, what does ESDA recommend be done to verify proper function of ESD controls?

A. Humidity levels are not addressed in ANSI/ESD S20.20 since humidity control is not a reliable method to control static electricity in most manufacturing environments. Certainly it is well known that some electrostatic phenomena are influenced by changes in humidity but relying on humidity in any given process is not an effective solution. All of the materials used in an ESD control program plan, according to ANSI/ESD S20.20 or IEC61340-5- 1, are evaluated at 12% RH at nominal 23C or the lowest level of humidity that is expected in the process environment. The ESD control program must be set up to work effectively at the lowest humidity level that may occur in the area. Trying to maintain a level of elevated humidity is very costly and you would still have to establish a properly outfitted ESD control program with appropriate ESD control materials that work in your processes. The range specified in old standards - mostly military - was 30-60%. This level has been shown to only offer minimal improvement in mitigation of static charge generation and dissipation.

This level does not significantly reduce the risk of electrostatic charge and discharge in most process environments. Using proper grounding and bonding techniques for personnel and equipment are not affected by humidity, proper packaging is not affected by humidity and process essential insulators still will generate significant charges at 30-60% RH, so other mitigation techniques are still needed. Should you required assistance in setting up an ESD control program, you may need to contact one of the consultants listed on our Buyer's Guide for help. Many of them have significant years of experience in this area that could help you directly. http://esda.org/members/buyers_guide.cfm

34-Threshold Volume 29, No. 1
January/February 2013

Q. I am trying to find out why it is not advisable to use just a untreated concrete floor as ESD flooring. The floor has been measured and is under the 35 meg limit set within ANSI 20.20.

A. While it may be true that a concrete floor measures an acceptable conductivity at a point in time that will not guarantee that any future measurements will be within the tolerances. Concrete is porous and does absorb moisture. What this means is the conductivity measurement is subject to change depending on the humidity. Furthermore, due to its porous nature, as time goes on various substances are absorbed into the concrete; this will cause the conductivity to change as well. Another concern is that the conductivity may vary widely locally so while the overall conductivity may measure in an acceptable range, this means that there may be local areas where the conductivity is too low. This is exacerbated by the porous nature of concrete that will be affected by what is absorbed into the floor over time. In conclusion, not treating the concrete floor will mean that the conductivity of the floor will likely not remain stable. Concrete is not designed to have a consistent conductivity. If you use a concrete floor you would need sufficient data to demonstrate that the floor is meeting its ESD purpose. You would have to make resistance and walking voltage measurements more often and in more places than is usual for an intentionally ESD-safe floor.

Q. What is the resistance range for floors in an explosive area? Is there any real difference in static decay from 1.5E05 to 5.0E06? Can the answers be supported by any documentation?

A. An ESD floor works by allowing efficient static decay AND minimizing triboelectric charging during walking. When all other things are equal, yes the static decay is better at the lower value. However, since this is only part of the floor function and explosives areas require a conservative approach to performance, it is more important for you to conduct walking voltage tests as described in ANSI/ESD STM97.2 and/or AATCC134. These tests should be conducted with the footwear being used. This test is preferred since it addresses directly the main risk. ANSI/ESD S20.20 requires a maximum of 100 volts using the 97.2 method. In the explosives area you may want to be more conservative. You are certainly free to choose a lower voltage for your local standard. Some have chosen values as low as 10 volts. It should be noted that choosing a low voltage will limit your flooring/footwear choices.

35-Threshold Volume 29, No. 2
March/April 2013

Q. Would headphones to a personal device such as MP3 player, phone, etc., create static? If you are working at a company with electronics, sitting at your bench with a ground strap on, wouldn't that discharge the static, if any, coming from the headphones? Is there any info explaining these questions?

A. Generally speaking, "personal devices" would by themselves generate static electricity. However, the plastic housings can be charged by rubbing against clothing and other materials. Since this charge would usually be isolated from the person, a ground strap would not dissipate the charge. The headphones may be a path for equalization between the person and the device but this is not guaranteed, it would depend on the product and headphone design. At the very least, the devices themselves should be kept well away from sensitive product. They should be classified for this purpose as "static generators" and then the "12 inch rule" in ANSI/ESD S20.20 would apply

Q. If I have a part that has been in contact with pink poly foam, how can I "decontaminate" my part for possible surfactant contamination?

A. The best way to remove contamination from the pink poly surfactants is to use IPA (isopropyl alcohol). The 70% mix is sufficient. I suspect from your inquiry that you already know that pink poly is prone to producing this type of contamination and thus is not suitable for storage for long periods of time and that direct contact should be avoided.

36-Threshold Volume 29, No. 3
May/June 2013

Q. Recent audits at Electronic Assembly Manufactures conducted by Missile Defense Agency (MDA) revealed a new behavior in our supply chain. Some of our suppliers are citing the ANSI/ESD S20.20 that there are no requirements to use smocks in ESD designated areas regardless of ESD class of parts or electronic assemblies being handled or in close proximity. The ANSI standard is silent on the use of smocks. Was it the committee's intention not to require the use of smocks in ESD areas? Can you expound on the committee's expectation (requirement) with respect to protection of product from personnel clothing and how this was conveyed to the industry in the standard? In addition, some suppliers were found to use smocks in lunch, bathroom, and other areas which may degrade or contaminate the smocks. Lastly, some suppliers did not have smock test, monitoring, or cleaning processes to ensure smocks remain effective while in use. The above practices are not deemed acceptable, but we have no standard to cite, just known best practices. We welcome your thoughts.

A. It is the intent of the ANSI/ESD S20.20 Standard to provide the basis for an ESD control program. There are certain requirements listed along with a number of options for implementing the requirements. It is expected that the users of the S20.20 Standard (just like the users of MIL STD 1686) develop their own written ESD Control Program Plan and define the necessary ESD control technical elements that are required to meet their defined Plan. If a company sees some necessity for using an ESD control garment, then they are expected to list them. S20.20 actually has stated requirements for garments, if the organization chooses to use garments. However, it is necessary to understand that S20.20 does not consider garments as a hard requirement. Effective ESD control programs have been implemented in many places without the use of an ESD control rated garment. How garments are used and worn, where they are worn, and how they are tested need to be defined in the organization's ESD Control Program Plan. Then, if they are in violation of what they have stated, they should be cited for being out of compliance. If an organization is using ESD control garments, they need to determine how and where they will be worn and how often to clean and test. It would seem from the way your question is stated that the organizations (suppliers) do not have a properly defined ESD Control Program Plan and that is what they should be cited on first. They would need to have their Plan well thought out, detailed properly and inserted into their Quality Management System. There are numerous consultants listed in our Buyer's Guide that have considerable experience in preparing ESD Control Program Plans that some of your suppliers seem to need. As mentioned, the use of smocks is not considered mandatory unless specifically identified in an organization's ESD Control Program Plan. As mentioned above, the reason they are not mandated is that experience has shown that a very effective ESD control program can be designed and maintained without the use of smocks. If smocks and other ESD control garments are listed, then there are requirements to show how they were qualified for use, how they are tested, how they are cleaned, where they are required for use and not to be used. You could contact some of the consultants listed in the Buyer's Guide to get opinions on your questions. You might also find it useful to attend some of the ESD Association meetings to meet some of the experts in person. Our next meeting will be in St. Louis in June. Information is on our web site. Of particular importance is the Symposium in September. You might find it useful to participate in the Tutorial program where you can receive much more detailed information.

37-Threshold Volume 29, No. 4
July/August 2013

Q. Hand tools- if the tools are not ESD rated is it acceptable to:

A. Instruct the operator to neutralize the tools with ESD spray daily i.e., Staticide and to keep the tools at a minimum of 12 inches away from the work at hand.

B. Supply the station with an Ionizer?

A. Both strategies m staticide will become compromised quickly after only a few uses since it rubs off easily. Also keep in mind that tools which are designed to touch product (e.g., tweezers) should have dissipative tips (not the handles) if possible or care should be taken to control voltage and that is where the ionizer would come in.

Q. If we tie a common point ground to the electrical ground at a work station do we need to have a 1 megohm resistor installed or can direct be acceptable?

What about racks through a 1 megohm resistor or direct?

A. The 1 megohm resistor is NOT necessary in either case. The only place this resistor is required is for wrist straps where the purpose is to limit current that might flow through a person. The resistor is NOT an ESD protective element.

Q. Is the following statement true or necessary in an ESD control program?

"To probe test points of an ESD device or assembly, touch the probes to ground first".

A. The important thing is that the probes and the device are at the same potential or as close as possible. If the device is sitting on a grounded worksurface and has a path to ground, this is achievable. Of course if you are making a measurement the voltage on the probes will be determined by the instrument.

Q. Can power supplies, oscilloscopes etc., be used on the ESD workstation?

A. Yes. The only minor complication is that grounded equipment on a worksurface may interfere with the verification that the surface is properly grounded. It is therefore suggested, if practical, to verify the ESD ground path with the other equipment removed from the surface.

38-Threshold Volume 29, No. 5
September/October 2013

Q. S4.1 states: 8.0 RESISTANCE GUIDELINES Due to a wide variety of applications for worksurfaces, specific requirements that could be broadly applied are difficult to determine. However, the following set of guidelines can be used as a starting point for establishing local requirements for the resistance of worksurfaces:

- Resistance-to-groundable point 1 x 10^6 to 1 x 10^9 ohms

- Resistance from point to point ≥ 1 megohm TR20.20 Handbook states:

(I'm assuming this is for qualification testing of material) Testing: The standard for testing the electrical

resistance of worksurface materials is ANSI/ESD S4.1. The test method is designed to operate in the range of 1.0 x 10^5 ohms to 1.0 x 10^11 ohms and Periodic Verification Testing Periodic testing of worksurfaces is included in the evaluation of the workstation as defined in ESD TR53. (<10^9 ohms with no lower limit) So there is definitely some confusion on my part to grasp this concept with essentially three different values/ranges for measuring a worksurface. So if testing the worksurface material for qualification purposes allows the material to measure up to 1.0 x 10^11 why would TR53 limit the value to <1.0 x 10^9?

I'm assuming the lower limit of 10^6 set in S4.1 is to help with CDM mitigation. One other issue that we ran into was an ICT tester that required the use of a "blocker plate". Since the fixture was used for different assemblies which are slightly modified from each other the blocker plate would prevent certain pins from making contact to the assemblies. Of course the material of the blocker plate needs to be insulative to prevent from shorting these blocked pins to each other. Since the DUT sits directly on the blocker plate (worksurface?) this negates the possibility of meeting the above requirements. The only way that I can qualify the fixture while the blocker plate is on it, then, is to measure the static field of the blocker plate, right? Since this becomes a "necessary insulator" I need to make sure the static field is less than 2,000v/in. I suppose that we can also topically treat the top side of the blocker plate to help minimize charge generation.

A. While there may appear to be some confusion when comparing the documents and values that you have highlighted, understanding the purpose for the documents and proper use of the values clarifies this question. First, it is important to understand the Purpose and Scope of ANSI/ESD S4.1 as well as the intent of Section 8.0 Resistance Guidelines. The Purpose of the document is to provide "test methods for evaluating and selecting work surface materials." The Scope further adds that the Standard defines "accurate and repeatable measurement techniques." Thus it is not the intent of the document to provide resistance limits for qualifying work surfaces but rather methods for measuring them. This is consistent with what is stated in 8.0 Resistance Guidelines when it states that "specific requirements that could be broadly applied are difficult to determine." The values given in that section are given only as a "starting point for establishing local requirements." In fact, the resistance to ground values are the same values as are given in the Glossary (ADV1.0-2012) for "dissipative floor material." Again, this is only a starting point and the actual values will need to be established by the individual company or lab in compliance with their ESD control plan.

39-Threshold Volume 29, No. 6
November/December 2013

Q. Our company has a product that has a drag chain for grounding and is moved remotely using four drive motors/ wheels. Our customer wants us to test the drag chain. Is it the same to clip on the chain and chassis directly or should I use the metal plate on the floor and clip on to the chassis method (similar to STM12.1-2006).

A. The answer to this depends on what your customer really wants to know. The most important measurement to make here is to ensure that the cart/drag chain system is providing an adequate path to ground. This is best verified by the mobile equipment test in TR53-2006. In this test you treat the cart like a worksurface and use a 5 lb electrode on the surface where sensitive products may be placed and measure its resistance to a reference ground electrode as specified in ANSI/ESD S6.1 (usually the green wire ground). ANSI/ESD S20.20 sets the requirement for this measurement as <10e9 ohms. It is a good idea to set an internal requirement based on your measurements. For example if the typical value for this measurement is 10e7 you should set your internal requirement at 10e8. This way you will catch problems before they are serious. Drag chain effectiveness while change over time. This measurement will include the floor. My suggestion is that in reporting the measurements you might consider reporting the resistivity of the floor or measurement surface as well. This would help prevent a discrepancy if the customer decides to verify the measurements provided by your company. If the customer is interested in a more detailed analysis of the cart/chain system, then you could make the measurements similar to those in ANSI/ESD STM12.1 as you have suggested. You use the same 5 lb electrode placement on the worksurface but the other lead would be clipped to the drag chain or to a metal sheet placed under it.

Having said this, there are important considerations for drag chains. They do not perform as reliably as conductive casters. It would be best to qualify a specific vendor of a chain that works and to not allow local purchasing decided on the basis of lowest cost. The length of chain in contact with the floor should ideally be about 18” though many use as little as 6”. The best deployment of chains is diagonally between opposite corners of the cart. It is also advisable to add a visual inspection to your compliance verification process to check if the chains are in fact present as specified. This is especially true if you have a large number of carts in operation and it is impractical to make measurements frequently.

Q. We need to move our workstations on the test floor often due to test loading needs. As such, the workstations have wheels on them to facilitate this. Once the workstation has been moved to the new location, the workstation would reside there for a few days or 1 to 2 weeks before relocation again. We currently connect a ground wire to the workstation after relocation. However, as the workstation is relocated often, there are many challenges to ground the workstation after each move... such as unconnected ground wire, extra costs etc. Can we classify the workstations as moveable workstations? Can the workstations be grounded via a drag chain only?

A. Even for carts, drag chains have been shown to be unreliable. Conductive casters are better but could be expensive. Even then they would not meet requirements as specified in ANSI/ESD S6.1. If your workstations have a standardized method and hardware for grounding it will reduce errors due to frequent connect/ disconnect. If you want to deviate from this, say for S20.20 certification, you would need to demonstrate and document that your substitute system is equally robust and reliable. Thus, the best way to handle the situation is to standardize your procedure so that it is easy to inspect and verify.

40-Threshold Volume 30, No. 1
January/February 2014

Q. What should an ESD safe floor read in a production area where electronics assembly takes place?

A. Requirements for an ESD safe footwear/ flooring system are given in ANSI/ESD S20.20-2007. Footwear and flooring are put together because they comprise a system that keeps electrostatic charging levels on people to an acceptably safe level. S20.20 is available as a free download from the ESDA website (www. esda. org). The answer to your question depends on how your footwear/ flooring was qualified. The following is paraphrased from S20.20, Section 8.2 Personnel Grounding. When a footwear/flooring system is used, one of the two following conditions shall be met:

A. The total resistance of the system (from the person, through the footwear and flooring to ground) shall be less than 3.5 x 10e7 ohms (using the test method described in ANSI/ESD STM97.1).

B. The total resistance of the system (from the person, through the footwear and flooring to ground) shall be less than 1.0 x 10e9 ohms (again using ANSI/ESD STM97.1) AND walking voltages must be less than 100 volts when tested using ANSI/ESD STM97.2. These requirements apply to the Product Qualification of the footwear/ flooring systems. S20.20 also requires Compliance Verification of the footwear and flooring. When condition A above applies, the footwear and flooring shall each have resistances less than 3.5 x 10e7 ohms when measured using the corresponding test methods described in ESD TR53. When condition B applies, the resistances must be less than 1.0 x 10e9 ohms using the same TR53 tests.

Q. I recently purchased the ESD handbook and had some questions related to ESD testing of flooring. The questions are:

1) In the flooring section of TR53 (page 16), the document mentions that if the resistance is less than 1 x 10e6 ohms, then continue testing. But, if the resistance is greater than this, switch the meter to 100V and continue testing. It's not clear when testing is supposed to stop.

2) Table 2 in the S20.20 document lists 3.5 x 10e7 ohms as the required limit, but why isn't this referenced in TR53? It seems that there's a disconnect between these documents. Should I assume that as long as we're below this limit in Table 2, the test passed, regardless of the information in question 1 above?

A. The voltage level versus measured resistance discussion is actually unrelated to the number of tests required. All of the ESDA's resistance measurements use a 1.0 x 10e6 ohm cutoff to switch the applied voltage from 10 volts to 100 volts. This is simply an issue related to the ability of meters to accurately measure current in higher resistance materials. The resistance measurement procedure is to set the meter to 10 volts and make a measurement. If the indicated resistance is less than 1.0 x 10e6 ohms, record the value after 5 seconds and continue with the next measurement. If the indicated resistance is equal to or greater than 1.0 x 10e6 ohms, set the meter to 100 volts and make a measurement. Record the value after 15 seconds or when the measurement has stabilized. If switching the test voltage to 100 volts results in a resistance reading of less than 1.0 x 10e6 ohms, then the reading made with the 100 volt test voltage is used. How many tests you conduct depends on the size and continuity of the area. TR53 doesn't have specific required test limits, as it's really just a test method document. I would suggest you start with a minimum of 5 measurements per every 5000 square feet or 5 measurements within a continuous area. This can be reduced as you collect data that indicates that your floor is consistent. TR53 does recommend that some of those measurements be made in high traffic areas to ensure worn areas stay within specification. The response given is a service to industry; the ESDA is not responsible for content. The users of this information need to determine the suitability of the response.

41-Threshold Volume 30, No. 2
March/April 2014

Q. I am getting ready to complete a gap analysis between our current ESD program and ANSI/ESD S20.20 to prepare for certification, I have some questions that I need clarification on in order to be best prepared:

1. Do I need to serialize the many hundreds (possibly into the thousands) of carts used here and test every one of them, or can I pull a sample every (x) amount of time and record the results?

2. Do I need to test every smock every (X) amount of time or can I pull a sample and record the results?

3. Is it a requirement to have constant monitoring at every bench?

4. Must the site have a certified program manager or can someone like me (Electronic Engineer) be the coordinator?

A. ANSI/ESD S20.20 is looking to instill a reasonable process control program for ESD controls. As such, it leaves things open with respect to how you choose to control your process. So regarding the first two questions, that is entirely up to you, an assessor (whether a 3rd party, or even a customer) would be looking for control - in other words, if you can show that you have a process to evaluate carts, garments etc. on a reasonable basis depending on the criticality of a failure, you would be covered. Regarding question #3: I'm assuming by "constant monitoring" you mean a continuous wrist strap/ worksurface monitoring system such as that provided by many ESD control product suppliers, then no. ANSI/ESD S20.20 only requires that the operators be properly grounded when handling ESD sensitive items, and that they be handled at a properly configured ESD-safe work area. Your compliance verification process defines how those items are to be verified so that they are working.

Question #4: No, the ESD Coordinator does not have to be certified. That person just has to be recognized by management and in the ESD Control Plan. Having the training in place that would allow the person to be certified would make his/her job easier, but it is not required.

Q. I have heard that the ANSI/ESD S20.20 standard is being updated to include more detail with regards to product qualification in the EPA. What information do you have on this upcoming change? Is this update going into effect in the next few months?

A. We expect the standard to be released within the next 4 months; however there will be a phase-in period for all changes for companies that have certification through a Certification Body. There will be more information and guidance in the document regarding product qualification. As long as you have done some form of qualification of the items you use for ESD control (evaluation of vendor data sheets or testing of the products either internally or through a 3rd party laboratory), you should be in good shape.

42-Threshold Volume 30, No. 3
May/June 2014

Q. I work for a company that provides soldering robots. A customer has asked us to provide a certificate proving that the machine is ESD certified. I'm not even sure where to begin.

A. This is not a common question but we expect it will be one asked more often from now on. We imagine that the customer is interested in knowing how safe the soldering robot is, as it relates to charging or discharging to their products, during manufacture. The ESDA has a soldering iron test procedure that is used to evaluate normal (hand-held) soldering and de-soldering equipment that could certainly be used to evaluate the soldering robot. Basically, you would measure the voltage present on the actual part of the robot that would touch the product being manufactured. You might want to obtain a copy of the test method and study it to determine if you can make it work for your equipment.

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

There are also test procedures established for CE marking that would evaluate the equipment in terms of ESD susceptibility and radiated emissions within the IEC61000 series of standards. There may be something in those documents that may be useful as well.

43-Threshold Volume 30, No. 4
July/August 2014

Q. I am in the process of space renovation and would like to provide our architects with the correct specification which specifically addresses ESD flooring. The missing link that I am in search of relates to the actual methods which are utilized to bond and verify the ESD flooring connection to earth. Please provide any expertise and standards that I may find helpful.

A. Thank you for your inquiry. It is a very good idea to get an understanding of the floor and grounding installation before the actual work begins. The electrical system ground is the preferred grounding system. Often, a buss bar is installed that is bonded to the electrical equipment grounding conductor (3rd wire - green wire/ green wire yellow stripe) for connection to the actual floor grounding system. Generally, the floor tile is installed with a conductive epoxy adhesive with copper foil strips that extend up a wall or a copper foil tape grid pattern that is on the subfloor that interconnects the tiles with extensions that extend up the wall. The copper foil is then bonded to the buss bar or the electrical system in whatever manner is selected. You should probably have a look at our ANSI/ESD S7.1 - Flooring and ANSI/ ESD S6.1 - Grounding documents for guidance and assistance in this area. The actual floor installation is dependent on the floor manufacturer so whomever is selected should be brought into the process early. The main criteria that you have to determine is the electrical resistance range that you want for the finished floor. There are different opinions on this depending on what the floor is intended to do for your ESD control program. It is more common today to specify a conductive floor - 5 x 10E4<RTG<1 x 10E6 ohms as this level provides better control of static on walking personnel and faster decay times. The dissipative range for flooring goes from 1 x 10E6 to <1 x 10E9 ohms. The upper end of the range is much slower in dissipation rate so that has to be considered in your decision making process. If you need more detail, you may want to have a discussion with one or more of the consultants listed in our Buyer's Guide on the web site. Several of them have considerable experience in making flooring decisions.

44-Threshold Volume 30, No. 5
September/October 2014

Q. ANSI/ESD S20.20 section 7.3, "Compliance Verification Plan" requires us to confirm that we are meeting requirements, but doesn't explicitly state what to do when we find a noncompliance. Our customer would like an explicit requirement to not only correct noncompliances, but also examine and address the potential risk to product as a result of the noncompliance.

A. The requirement that you suggest is really part of a Quality Management System (QMS). The various committees that have written and modified the standard made the decision that 20.20 would not add to or modify the requirement of a QMS system but instead work within the QMS system that was already implemented within the site. For example, ISO 9001 - 2008 section 8.5.2 calls for Corrective Action:

• The organization shall take action to eliminate the causes of nonconformities in order to prevent recurrence.

• Corrective actions shall be appropriate to the effects of the nonconformities encountered.

• A documented procedure shall be established to define requirements for;

a) reviewing nonconformities (including customer complaints)

b) determining the causes of nonconformities

c) evaluating the need for action to ensure that nonconformities do not recur

d) determining and implementing action needed

e) records of the results of action taken

f) reviewing the effectiveness of the corrective action taken

In effect if a site has a certified QMS system in place this should be addressed. Now if we specifically added a section that required this, what would happen if the process required a once a quarter measurement on a worksurface. During the compliance verification program, if the worksurface was not in compliance then technically the process owner would have to take a risk assessment on all product that was on that worksurface. This implies a way to trace all products which some companies have and some don't.

45-Threshold Volume 30, No. 6
November/December 2014

Q. I see a new spec in the ANSI/ESD S20.20 - 2014, section 8.3.1, that requires insulators greater than 125 volts/inch and less than one inch of distance need to be moved or ionized. Is there a white paper or some information to help me better understand the reasoning behind this so I can make the necessary adjustments at our facility?

A. The reason behind this change is the claim of protecting to 200V CDM model. If the CDM model is considered, a conductor much bigger than the device is placed down with a very thin insulator on top. Next the device is placed on top of that and each pin is discharged to determine the CDM withstand of the device. ANSI-ESD S20.20-2014 now claims that a 200V CDM device can be handled. What this implies is that an insulator, that is in intimate contact with the device, must not generate a field greater than 200V/in. Since field meters tend to be widely used for this measurement and can be very inaccurate, it was decided by the 20.20 working group to keep the field number to 125V/in to ensure protection.

Q. What is the required flooring limit for ANSI-ESD S20.20-2014; and what are 2014 limits in Table 2?

A. ANSI/ESD S20.20 - 2014 is now released and can be downloaded from the ESD Association website. The requirements for flooring/footwear system requires a body voltage test according to ANSI/ESD STM 97.2. as well as resistance according to ANSI/ESD STM 97.1. The 20.20 requirement is for body voltage with the selected footwear and floor to generate less than 100 volts on any peak. The current 97.1 and 97.2 test methods can be used to fulfill these requirements.

http://www.esda.org/Documents.html#s2020

46-Threshold Volume 31, No. 1
January/February 2015

Q. Our question is about the test method for wrist strap bending life. We are curious about the weight hanging approach. Should it be hanged without any supporting fixture? Is there any improper points? How can we improve?

A. The main idea is to have the cord go through a 120 degree cycle relative to the ground cord termination end with a weight of 1 pound (453.6 grams) attached to the cord. The cord can be guided so that the whole cord does not swing around causing extra strain on the connection. It appears that you are guiding the cord with the rollers just above the weights so as long as they do not catch or hold the cord it should be fine. If you test coil cords, make sure the weights are attached to the straight part of the cord and not into the coils since that would cause oscillation (bouncing).

Follow up questions:

Q. After the test, if we find the cord jacket or coil broken, but the cord resistance is within the limit, should the test be passed?

A. The rules for judging failure include any breaks in the strain relief, even if the electrical resistance is still OK. We understand that the coil cord is difficult to test. Just make sure the weight is on the straight section and guided by the rollers and that is about the best you can do.

Additional follow up questions:

After discussing with our engineers, we still have some doubts about the wrist strap bending life test. They are as follows:

Q1. We use a fixture to fix one end of the ground cord to the rocker plate, will that be OK?

Q2. A weight of one pound is for the whole ground cord, but now we just test the straight parts of the ground cord, which means the strain relief or the coil and other parts are nearly not under stress. Should the coil be tested? If our test includes the coil, can the weight be placed on the ground or just hanging in the air (cause bouncing, hard to control)?

Q3. In the standard, a ground cord failure is defined by 2 conditions (R>1.25megohms or visual mechanical failure of the jacket or coil), the latter condition is hard to detect and our current test excludes the coil. Should our test include the coil?

For clarification:

A1. yes it is fine to use the fixture to hold the end of the ground cord as indicated. The strain relief must be free to move through 120 degrees angle.

A2. only put the weight on the straight part of the cord. If it is on the coil cord there will be too much bouncing. You are only measuring the life of the strain relief in this test, not the cord.

A3. as above, the strain relief may start to show fatigue and cracks. That is usually the first sign of failure even before there is any electrical change.

Making sure the weights do not bounce is the main thing - the weight may sway side to side, this can be controled with the rollers if desired.

47-Threshold Volume 31, No. 2
March/April 2015

I would like to ask some questions relating to ANSI/ESD S20.20 version 2014.

Q1. In the scope, 200 volts CDM & 35 volts on isolated conductors are added. What is the intention to add them? Why are both of them determined on the value of 200 volts and 35 volts, respectively?

Q2. As defined in clause 8.3.1, "If the field measured on the process required insulator is greater than 125 volts/inch and the process required insulator is less than 2.5 cm (1 inch) from the ESDS item, steps shall be taken to either A)… or B)…", is there any relation between 125 volts/inch in here and 200V CDM in scope? If there is ESDS items whose sensitivity level is lower than CDM 200 volts (e.g., 100 volts) to be handled, which additional control elements or adjusted limits should be required?

A. Yes, there is a relationship to the 125 volts/inch and 200V CDM. The CDM testing itself uses a large charging plane to determine the CDM withstand of the device. If there was a large infinite insulator and a device was placed on it and there was a ground connection made, in theory with a 125 volts/inch limit a device with a 125 withstand CDM voltage would still be safe. If there was a device that was less than 200V CDM then the process would need to be evaluated to see what specific steps the device would be at risk at and there may be a need to adjust the field requirements in this case. It really depends on the process and if there are any insulators that may cause a problem.

Q3. For 8.3.2 Isolated Conductors, which should be considered as isolated conductors in practical electronic manufacturing processes; could you provide more examples? Is an electrical screwdriver a typical isolated conductor while the tip cannot be grounded stably in 10 ohm the same as a soldering iron?

A. It is more than just isolated conductors. It is an isolated conductor that comes into contact with an ESDS device. So while a screwdriver may be isolated it may not come into contact with an ESDS device. Typical isolated conductors that come into contact would be the contact pins in an in circuit tester, a probe that cannot be grounded, or tweezers with insulated handles. In reality, there should not be too many isolated conductors that come into contact with ESDS. Also, when the new checklist comes out, this will only result in an observation for a while as it may require new equipment or a survey of the process. This is also a qualification issue, not something that would be part of compliance verification.

Q4. For production qualification of shielding bag, the test method defined in ANSI/ESD STM11.31-2012 as well as test equipment and criteria (<50 nj) is seldom used in current practice. Is there alternative method as well as criteria?

A. There is no alternative method at this time. This is the only way to measure the effectiveness of the buried metal layer of a bag. There are many manufacturers that provide this information as part of the product data sheet.

Q5. For the walking test, is it accepted to put the hand on the metal panel of the CPM instead of a Hand Held Electrode in test?

A. Putting a hand on a CPM would be acceptable.

48-Threshold Volume 31, No. 3
May/June 2015

Q. We have an OEM who manufacturers assemblies such as chassis or drawers that contain ESD sensitive parts. These drawers are encased in either an aluminum or steel enclosure, painted gray or clear anodized having external connectors. The ESD sensitive components can either be mounted on plug-in circuit cards or otherwise can be mounted directly on the chassis The OEM maintains that the drawers do not need to be handled as ESD sensitive because the metal case acts like a faraday shield thus protecting any ESD sensitive part from damage.

This does not appear to be a valid position since the metal case is not grounded. Additionally, if folks are working on the drawer unless the drawer is grounded and that wrist straps are worn, an ESD event could damage parts. The OEM indicates they have a process conforming to S20.20.

Any feedback you can provide on the above would be appreciated.

A. While the metal drawers may act like a Faraday Cage when they are fully enclosed without being grounded, the concern may be more related to the coatings over the metal drawers. There should be an evaluation of the charge generation characteristics of these metal parts. Additionally, since grounding may not be present, the ability of the system to drain a charge from conductive or dissipative items inserted may be questionable. If a person wearing a wrist strap is handling susceptible items inside the drawer, they should be bonded to the drawer to equalize any potentials between themselves and the drawer before actually touching parts. This would assure minimal potential difference between the person and the drawer.

49-Threshold Volume 31, No. 4
July/August 2015

Q. Please clarify/confirm my understanding, regarding "p.8.3.1 Insulators" within the new revision of ANSI/ESD S20.20:2014. It is stated that "If the field measured on the process required insulator is greater than 2000 volts/inch…". As I understand the idea of measurement is defined as electric field between two parallel charged plates (like in capacitor) – isn't it? So when distance between plates increased – field energy decreased proportionally (not with square of distance), am I right? I mean, when I measure insulator's surface from 2.5cm (1in) and get i.e. 500V/m, and then re-measured from 5cm (2in-doubled distance), the device should show 250V/m – correct?"

A. "The field measurement is based on the instrumentation that is typically used. The instruments that are used today are typically a field meter or an electrostatic non contacting voltmeter. Both of which report the measurements as field measurements, typically in volts/in. The field meters are calibrated to measure a field at a specific distance, typically one inch. To understand the measurement, you need to understand your meter. So with the field meter, you take the measurement at the specified distance and then determine if the process required insulator is a threat or not. The meter cannot be used to measure the field twice the distance as it is not calibrated to do that measurement. An electrostatic non contacting voltmeter is similar but there is a minimum distance from the spot to be measured. Again if you move the meter too far the measurement is not accurate. The requirement in 20.20 is based on the typical measurement technique in the industry. So to evaluate an insulator, measure as per the meter and then take the appropriate action."

Q2. "Thank you for explanation. I understand that the issue is directly correlated to the instrument. It's obvious to me, that when the requirement was created, it had to have a real measurement, which is based on physics. Can you just confirm my understanding of standard requirement – if it's based on field mill induction principle and (when talking about reasonable distance like 1inch or 1cm) the field energy changes proportionally when the distance changes?"

A2. "The limits were based on a study where a 100 volt sensitive part and a metal plate was placed in a field created by a large plate and a small ball. The discharge current was then measured from the plate and the part was discharged to while in the field. The study showed that you needed a very large plate and a very high field to create a problem. Note - actual failures from the part and the discharge current from the plate only showed failures when the field generated was greater than 20,000 v/in with the source less than 3 inches from the plate or part. A guardband of 10 was used for the field and a distance of 12 in. (In the study a large plate with 25,000 v/ in 12 inches away could not generate any discharge current or damage the part.

50-Threshold Volume 31, No. 5
September/October 2015

Q. I was just wondering if you have any information with regard to someone working in an ESD production environment that has a prosthetic leg?

This is a new one for me but have just ran across it with a temporary employee. Obviously a heel strap fails on that side. We can keep him attached with a wrist strap but it is not ideal since it is a standing job.

A. This is not the first time it has come up. You may want to get a little creative here since you said the job requires standing. Shoe straps could be worn on both feet with the one on the natural foot attached conventionally. On the prosthetic leg, the long strip could go up the leg with some kind of extension such as a wrist strap ground wire. Several wrist straps could be interconnected end to end to form a strap that would fit around the upper part of the leg where it would be in skin contact. Alternatively, you could procure some of the pads used for EKG and have the person apply them to their waist. These generally have a 4mm snap connection that would attach readily to a wrist strap ground cord. This way you would have a shoe strap on both feet which is the best situation. One installed normally on the normal shoe and foot and the other making skin contact with another part of the body.

Q. I am looking for information on the effectiveness of ESD smocks when the wearer is not grounded. Can you suggest any sources?

A. ESD rated garments, those with conductive threads in the cloth, must be grounded for use otherwise they can be considered an isolated conductor and become a potential discharge hazard. Fortunately, if a person is grounded through some other means such as a floor and footwear system or they are wearing a wrist strap attached to ground they more than likely will ground the garment. In order to provide full suppression of charges on underlying clothing the external ESD garment has to be grounded. If the wearer is not grounded and is wearing an ESD garment with conductive threads, the threads can become charged and become a direct discharge source.

The applications using ESD rated garments with conductive threads must be evaluated to ensure the person and the garment are grounded. The best idea is to make resistance measurements from the person to ground and the garment to ground just to verify that the person and the garment are electrically bonded together. Groundable static control garments, those with a snap or other feature that allow the connection of a grounding wire can be measured like a wrist strap and the procedure is shown in our document ANSI/ESD STM2.1.

51-Threshold Volume 31, No. 6
November/December 2015

Q. I have a question about microfiber cloths for cleaning electronics. They are not defined to my knowledge in regards to generating static. The static requirement being <125V/Inch, our company ordered new "antistatic wipes". When tested to this criteria they pass (barely). My question is, because these clothes will be in direct contact with the PCB for cleaning, shouldn't they be measured to that extent? When the cloth touches the meter with a grounded person, the meter will spike and hold that charge. Is this acceptable or is there a way to get around this?

A. The cleaning cloths should really be evaluated in two ways and perhaps a third:

1. Does the cloth create a separation of charge on whatever it is you are wiping?

2. Does the cloth dissipate a charge when it is grounded? (such as being held in the hand of a grounded person)

3. It might be useful to measure the surface resistance of the cloth (but if they are dissipative you will see the end result in evaluation 2 above).

If the cloth is low charging as advertised by the manufacturer (so called "antistatic" if they are using the term correctly), then the separated charge on the cloth should be low - less than 125 volts measured at 1 inch with a hand held electrostatic field meter. If the cloth is >125 volts at 1 inch then it is likely that it is not truly low charging and should be discussed with the manufacturer.

If the cloth dissipates the charge when held in the hand of a grounded person or when it is laid on a grounded surface for a few seconds and then picked up and measured again with the hand-held electrostatic field meter, then it could be considered at least dissipative. A dissipative cloth should have measurable surface resistance of < 1 x 10E11 ohms for sure and it would be better if < 1 x 10E9 ohms when measured with a procedure such as our ANSI/ESD STM11.11 (Surface Resistance).

Therefore, if the cloth has too high a residual charge resulting in an electric field >125 volts at 1 inch and that charge does not readily decay (under 2 seconds), then it should not be considered static safe unless you have established a higher threshold.

52-Threshold Volume 32, No. 1
January/February 2016

Q. This question is related to section 8.3 in the 20.20 2014 standard. The first paragraph says:

"Handling of ESDS items, parts, assemblies and equipment without ESD protective covering or packaging shall be performed while in an EPA. The EPA shall have clearly identified boundaries."

Our program had been setup to require any transport of ESDS items to be in an ESD shielding bag, tube, tray or tote with no provision for whether the transport was done within an EPA. This has lead to questions/debate over whether it's OK to grab a populated PCBA at the end of SMT line inspection station and walk the length of the reflow oven to place it at the workstation pre-reflow. If following the letter of our process, it would not be acceptable to move a board from one work station to another 6' away within the same EPA. You can see our problem here. We have established no practical guidelines.

Our floors are conductive tile and floor personnel are required to wear ESD smocks and 2 heel straps (tested daily).

So the question is - If we are transporting ESDS items via walking within an EPA, can the standard be interpreted to allow for that?

A. If you define the EPA as the entire floor and can show that the total system resistance from a person's hand to ground is less than 1.0xE9 ohms AND do a walking test to show that the voltage generated by a person walking is less than 100 volts, yes you can just carry the ESDS item within your EPA without any packaging.

Sometimes with heel straps it is difficult not to spike over 100 volts. In this case, I would measure the voltage of the person doing this specific task to see if it can be documented that this operation is low risk. I would then put that into a tailoring statement for this operation.

If you have a good floor and depending on your heel straps you may be fine. If you do have spikes over 100 volts, check out sole grounders (they cover the entire sole of the shoe) or look into shoes.

53-Threshold Volume 32, No. 2
March/April 2016

Q. At the manufacturing facility I work at workers wear ESD wrist straps when handling PCBAs.

However, they are also wearing polyurethane coated cut-resistant gloves. How does this effect ESD? Does it make it worse/better/no effect?

Should they be wearing ESD safe gloves?

A. Thank you for your inquiry to the ESD Association. We would suggest making some resistance measurements of people wearing the gloves in question. The generic wrist strap test described in ESD TR53 or the standard ANSI/ESD S1.1 - Wrist Straps, could be used for this. The person would wear a wrist strap per normal practice. Put on the gloves in question and hold an electrode (metal cylinder as shown in the test procedures), connect the metal cylinder to an appropriate ohmmeter and connect the wrist strap ground cord to the other terminal of the ohmmeter. Generally this would be done at 30 volts or less but if you have an open circuit tester for floors or worksurfaces you could use that as well at 10 volts or 100 volts as the current will be limited. Compare the results while wearing the gloves to results without the gloves. If the results with the gloves are < 1 x 10E9 ohms you can consider the person grounded and probably not causing much of a problem while handling your parts. You may be above your ESD control program resistance to ground value (perhaps 35 megohms or 3.5 x 10E7 ohms) but you could insert a tailoring statement allowing the gloves for safety reasons since you can show low risk to parts. You may want to back up the risk assessment by making electric field measurements on the parts after handling them with the gloves worn just to make sure you are not triboelectrically charging the parts above your preset limits (maybe 100 volts/inch as in most plans).

54-Threshold Volume 32, No. 3
May/June 2016

Q. We have a powered hand held tool that the manufacture will not provide conductive, dissipative and insulative range specifications of the different components that are exposed on the outside.

Can the STM 11.13 be used to take measurements since it is point to point and that there is no planar surfaces large enough to take measurements?

A. The STM11.13 2-point probe should be able to make good contact with the surface of the tools you are trying to measure and allow you to make resistance measurements. Make sure the tool is held in a stable position so the 2-point probe does not move around while you are pressing down. Generally, the results you obtain correlate well to the concentric ring measurement of larger planar surfaces.

Q. Will the STM11.13 describe in detail how to go about this measurement in distance, etc? I'm assuming that there is a formula that needs to be calculated in order to equate to what the larger surface probes (or concentric rings) and its distance that the standards require to be able to classify if the material is Conductive, Dissipative or Insulative. My understanding would be that the greater the distance the larger the resistance will be.

Examples of some of the items I will be measuring is a .121" O.D. flexible plastic tubing and .310 OD plastic protruding the surface about .025".

A. The STM11.13 probe dimension is fixed - .125 inch diameter contact electrodes spaced .125 inch from edges of the two electrodes. Therefore center to center the electrode spacing is 0.25 inch. It would appear from your description that this probe may be too large for your application. There is no direct calculation to convert the point to point measurement with surface resistance obtained with the concentric ring. The values obtained with the concentric ring and the 2-point probe are in simple resistance, based on the electrode spacing. The concentric ring resistance value can be converted to surface resistivity by multiplying the values obtained by a factor of 10 (converts ohms to ohms/square). This conversion does not apply to the 2-point probe. You are correct that the resistance will change with probe spacing changes.

It will be difficult to obtain resistance measurements on the samples you described. You may have to configure your own probes out of pogo-pins or other metal pins that have a flat contact surface. You need to have some contact surface area and the best you may be able to do is determine that the pieces have SOME level of resistance in the dissipative (or conductive) range. However, it will be difficult to precisely say what the surface resistance value actually is for these items.

You might also consider a charge decay type test. For this you would use a charge plate monitor (CPM as used to measure the decay rate of an ionized air blower). Even a hand-held electrostatic field meter with an isolated plate that you can charge up (portable ionizer tester) could be used. Charge up the plate of the CPM or portable unit to some level (generally 1,000 volts) then touch the plate with the item you want to test while holding it in the hand of a grounded person and observe whether or not the plate dissipates. Any material with a reasonable surface resistance will dissipate the plate. Obviously the faster the discharge the more conductive the material. This is a useful technique often used by the consultants and practitioners of the ESD art when resistance is hard to measure.

55-Threshold Volume 32, No. 4
July/August 2016

Q. Is there a new specification which covers the requirements for the Walking Test for S20.20_2014?

A: There is a requirement to determine the voltage on personnel in an electrostatic protected area meeting the requirements of ANSI/ESD S20.20-2014. The requirement appears in Table 2 - Personnel Grounding Requirement - Footwear/Flooring System. Both a resistance to ground specification according to STM97.1 and peak voltage according to STM97.2 must be met in order to qualify the program, if a footwear/flooring system is in use for personnel grounding.

The ANSI/ESD STM97.2 describes a walking voltage test method that requires measuring the voltage on a person while walking in a defined pattern.

Basically, the person walks in the defined pattern for at least 12 step cycles and the average of the 5 peak voltage points used to determine the footwear /floor walking voltage. The average has to be < 100 volts to qualify for a basic S20.20 program. Well designed footwear/flooring systems result in average voltage levels of <10 volts, often as low as a few volts.

56-Threshold Volume 32, No. 5
September/October 2016

Q. I have a few questions pertaining to ANSI/ESD S20.20-2014 and welcome any feedback received.

1) 8.3.1 - Is there a difference between “personal items” and personal effects?

Is wearing earbuds/headphones in an EPA a violation of ANSI/ESD S20.20-2014?

2) 8.3.2 - If the personal effects (ear buds, jewelry, watches, etc) are less than 35 volts, can they be allowed/authorized for use in an EPA?

3) 6.3 - Does the tailored document/decision have to be technically justified and with rationale?

What exactly proves rationale and technical justifications?

Is that done with authorization from/through ANSI?

A. At the time of writing, personal items were considered items that were placed on a workstation that should not be there. This is a general requirement and does not cover specific items. Earbuds for example if allowed would have to be evaluated to see if there was a threat. If they are made of dissipative or conductive materials, then they would be grounded through the person while wearing them. If they are insulative then they must be kept 12 in away from ESDS items or need to be under 2000 v/in. So while the letter of the law may be to remove them entirely, you can evaluate them if you want.

The 35 volt rule only applies to isolated conductors that come into contact with ESDS items. Any metallic jewelry will be grounded by the person while worn, so it is not isolated. If it is isolated, then it would have to come into contact with the ESDS before there were any reason to evaluate it.

Any item that is tailored, needs to have technical justification and rational. The amount of information will depend on the reason for tailoring and what is getting tailored. If something is getting tailored as it could lead to an unsafe working environment, such as grounding a person while working on high voltage, then not much more information is needed. If you are going to ground people through chairs while seated instead of using a wrist strap, then there must be data to show that it can be done, the voltage on a person does not go above 100 volts and there needs to be a way to ensure continuing compliance. Most programs do not have any tailoring in them.

57-Threshold Volume 32, No. 6
November/December 2016

Q. I am new to the ESD world and looking to get input regarding a few things. First, in reference to a standard ESD workstation, why do I need to have an ESD worksurface if I plan on using an ESD protective mat on top of that worksurface? Second, how do I test whether or not an ESD station is doing its job properly and directing all current to the ground?

A. Thank you for your question and welcome to the fascinating world of ESD. We encourage you to look for ways that EOS/ESD Association, Inc. can assist in your education. We offer many online courses and face to face classes at our annual symposium and regional events.

A typical work bench used for electrostatic control has an electrically dissipative top surface. These surfaces are hard and often cold to work on and do not offer any cushion if you are dealing with fragile items. Many users will install a soft mat on top to make the work more comfortable and provide a cushion for their products. The bench is generally grounded to maintain a static free area and the mat may be grounded by separate grounding wire or in some cases may actually be grounded through contact to the dissipative table top.

Measurements are described in our standard test method documents and broadly described in our Technical Report TR53. The worksurface standard - ANSI/ESD S4.1 (will become Standard Test Method- STM4.1 in the next revision) is used for evaluation of worksurfaces prior to purchase and after installation. The measurements are point-to-point across the worksurface and point to groundable point (mat surface to ground snap normally provided on these mats). The workbench with a dissipative or conductive surface is also measured in the same way. A 5 lb., 2.5 inch diameter electrode with a conductive contact area is defined in the testing documents. The resistance between two of the electrodes placed on the surface is measured with an ohmmeter like instrument with 10 volts and 100 volts measurement voltage. The 10 volts setting is used for resistances less than 1 x 10E6 ohms and the 100 volts range is used for measurements greater than or equal to 1 x 10E6 ohms. Typical workbench surfaces are in the 10E8 to just below 10E9 ohms range (although some are conductive) and the typical soft mat surface is 10E7 to just below 10E9 ohms. The TR53 document shows how to make measurements of installed workstations and table mats.

Over the years, studies and papers have shown that resistance levels of <1 x 10E9 ohms are adequate for most applications. The resistance may be lower - in fact all the way to “0” ohms for some applications (Stainless Steel benches often used in clean rooms). However, care must be taken when using worksurfaces with resistance to ground of less than about 5 x 10E5 ohms as the discharge path for items placed on those surfaces could lead to higher than desired discharge currents.

You may have already discovered our 6 part fundamentals series on the web site under the banner “About ESD”. www.esda.org/about-esd/esd-fundamentals/ If not, please see that series as it will help bring you up to speed.

58-Threshold Volume 33, No. 1
January/February 2017

Q. I have a technical question about static discharge with plastics/insulators. If a plastic has a positive static charge around 2,000 volts how can that static transfer to an ESD sensitive component? I know plastics/insulators can only be neutralized by using an ionizer so I wonder how the charge would actually go to an ESD sensitive component and potentially cause damage it.

A. Thank you for your question, it is surprising that this is not asked (this way) more often as it is important to the understanding of electrostatics. Several of our tutorials cover this quite well. First of all, since the plain plastics you refer to are (probably) an insulator, electrons do not move easily across or through an insulator. When you measure a piece of plastic with an electrostatic field meter and obtain a value of 2,000 volts, you are actually measuring the electric field that is integrated across a field of view that is about 6 inches in diameter. This is not the same as a surface electrical potential since the separated charges (positive or negative polarities representing missing or excess electrons respectively on the surface) are not free to move on the surface of an insulator. If you had an isolated piece of conductive material, perhaps a piece of metal, that was charged to 2,000 volts, you would also measure 2,000 volts with your electrostatic field meter. The difference is that the conductive material can discharge all of the charge by contact with ground or to some other conductor at a different potential. Remember, a conductor allows the flow of electrons.

When a charged insulator (your piece of plastic) contacts something, little if any charge is transferred. True, a small amount of charge may move from the exact point of contact but the entire piece cannot and will not discharge. A piece of metal or other conductor will discharge all of the potential. There is very little risk for contact with a charged insulator at reasonable charging levels, say under 5kV.

The greatest issue for an insulator that is charged in a process area is the electric field. When some sensitive item, such as an electronic device, is brought into the presence of an electric field, it will become polarized, depending on the strength of the electric field at the exposure distance. If the part is grounded while in the electric field, electrons will flow to or from the part (depending on polarity). This is a discharge. When the ground is removed and the part moves out of the electric field, the part will actually be holding a charge and if it contacts ground again, the conductive portions of the part will discharge all at once. This is called induction charging and is very dangerous in processes. This is also discussed in many of our tutorials.

We may suggest that you try to take a few of the on-line tutorials as they could help with your understanding of this complex subject (Electric Fields, Packaging Principles for the Program Manager and others). If you need something else, let us know.

59-Threshold Volume 33, No. 2
March/April 2017

Q. 8.3.1 Insulators

All nonessential insulators such as coffee cups, food wrappers and personal items shall be removed from the EPA.

The ESD program shall include a plan for handling process-required insulators in order to mitigate field-induced CDM damage.

Can you define field-induced?

Since this only addresses CDM damage, are process required insulators such as in process documentation, product packaging, and other things that are just a part of how we work acceptable to be present in the EPA?

A. Electric field induction occurs when a conductive item is brought into an electric field and then grounded while in the electric field. A charge will be transferred from ground to compensate for the intensity of the electric field at the exact location. The transfer of charge to and from ground represents a discharge to or from the conductor. If the conductor is then isolated from ground again, as often occurs in automated processes, the conductor will trap a charge. When the conductor is grounded again, a second discharge occurs. This type of event is discussed in numerous tutorials that are offered by the ESDA.

Any insulator that you consider process essential needs to be evaluated while in the process to ensure that the electric field from the insulator is within the established limits and within what you have established as the risk, at the location where sensitive items are present. The values and distances are stated in ANSI/ESD S20.20.

The measurement of the electric field is most often done with electric field meters but it is important to understand the limitations of the measurements and how to interpret them. These considerations are also discussed in numerous tutorials. It is possible to measure the induced charge on isolated conductors using a contact electrostatic voltmeter which is a new class of instrument. This is now one of the best ways to determine what is actually happening in regards to induction in the actual process.

You may want to have a more in-depth discussion with some of the consultants listed in our Buyer's Guide as many of them have considerable experience in this area.

60-Threshold Volume 33, No. 3
May/June 2017

I am trying to ensure that my ESD chairs are working per the ANSI/ESD STM12.1-2013 standard.

The required test conditions:

a) According to the standard, Page 3, we are to clean the casters and groundable points with a mixture of 70% alcohol and 30% water.

b) The test is to be in conducted in low humidity 12 +/- 3% RH and a preconditioning of 48 hours.

c) We are also to have a planar surface with a surface resistivity of greater than 1.0 X 1012 ohms/square.

Here are my Questions:

Q1. We paid thousands of dollars for a humidity system to keep the RH up to 40%-45% during the winter months. Now I need to find a place to have each chair (quantity of about 85) sit for 48 hours prior to the test? How do other companies comply to this that may have hundreds of chairs?

Q2. Should the chair read as a dead short, i.e. 105 or 106?

Q3. Does the chair need to have ESD wheels or the drag chain or both?

Q4. If a person sitting in an ESD chair, holding the resistance bar in their hand connected to the meter and the other connection connected to the weight on the ESD floor is tested; should they read a direct short like 105 or a dissipative reading like 107 -108?

Q5. Is it possible to sit in an ESD chair that has passed the prescribed test and have low readings such as 105 or 106 and NOT wear a wrist strap?

Response

Purpose:

ANSI/STM12.1-2013, is a test method for measuring the electrical resistance of seating used for controlling electrostatic charge.

The purpose of the STM is to provide measurement methods for the qualification of seating prior to installation or application.

Sample Size:

The required specimen (sample) size required for qualification of ESD Seating, shall be (3) three specimens. Each specimen shall be configured in the manner in which it will be used in the intended application.

Product Qualification:

Product qualification results for ESD control items are collected by the end user via one of three methods;

1) Manufacturer's product specification review (e.g., technical data sheet). A statement by the manufacturer that their product has been tested either internally or externally per the conditions of STM12.1; meeting a given resistance range or limit(s).

2) Independent laboratory evaluation (e.g., third party evaluation). Most commonly either the manufacturer or the end user commissions an independent party to evaluate the ESD control item per the required standard. Data collected is provided to the requesting party. Manufacturer's typically will use this data for publication in their technical data sheets.

3) Internal laboratory evaluations (e.g., end user evaluation). The least common of all product qualification options. Here the end user evaluates the ESD control item per the required standard. For many ESD control items this requires the use of controlled environmental conditions, typically 12% RH and 50% RH at 23°C.

For situations where the controlled environmental conditions can not be achieved, (i.e., 12% RH, 23°C), a manufacturer, independent laboratory or internal laboratory may still evaluate seating per STM12.1. The alternative environmental test conditions shall be collected and reported as part of the modified qualification data. The end user is responsible for evaluating the use of the alternative environmental conditions to ensure their minimum humidity conditions are represented.

As a practical use, the end user should perform qualification testing at the worst case environmental conditions that they experience in their factory location(s).

For your specific situation. If your humidity control levels maintain a minimum of 40% RH, it is acceptable to qualify your chairs at this worst case RH level.

A2. Should the chair read as a dead short, i.e. 105 or 106?

Resistance point-to-point and/or resistance point to ground values will vary dependent on the specific type of seating as well as the point(s), i.e. seat coverings and groundable points, from which the measurements are taken.

Typical ESD seating includes both chairs and stools, coverings (e.g., cloth, metal, plastic, etc.) and groundable connection points (e.g., metal glides, rubber or plastic casters, etc.) for seating surfaces are manufacturer dependent and as a result the resistance values will vary.

ESD control program requirements for seating are defined by the end user. For compliance to industry standards such as ANSI/ESD S20.20-2014, resistance values of less than 1x109 ohms are required.

A3. Does the chair need to have ESD wheels or the drag chain or both?

There are no requirements for seating item groundable points given per ANSI/ESD STM12.1. A seat may be connected to ground via various methods, e.g., casters (wheels), drag chains, glides, etc. typically seating is considered a level two technical element. I.e, the seating is typically grounded via the seats' groundable point(s) through an ESD flooring system. However, it would also be acceptable to to directly connect, i.e., hard wire, the seating directly to ground (level one technical element).

Reliability of the various grounding methods will vary.

The end user should perform qualification testing that simulates their end use conditions.

A4. If a person sitting in an ESD chair, holding the resistance bar in their hand connected to the meter and the other connection connected to the weight on the ESD floor is tested; should they read a direct short like 105 or a dissipative reading like 107 -108?

There is no industry defined standard test method using the conditions described above. When evaluating an ESD chair in combination with a person in this manner, one must consider all series resistance paths. In this case, the connection of the person and the hand held electrode (resistance bar) to the ESD floor. There are many items that could and will influence this resistance value.

1. Is the person directly connected to ground via a wrist strap system?

2. Is the person wearing some type of glove?

3. Is the person wearing some type of ESD garment? Is that garment connected to ground? How does the garment material connect electrically to the chair?

4. What type of outer clothing material is the person wearing? How is it connected to the chair?

For this reason, evaluation of seating using this method is not an acceptable means of determining whether or not seating in combination with a person will provide adequate protection for ESD sensitive devices.

ESD control programs such as ANSI/ESD S20.20-2014, require that all personnel while seated be connected to ground via a wrist strap system.

A5. Is it possible to sit in an ESD chair that has passed the prescribed test and have low readings such as 105 or 106 and NOT wear a wrist strap?

Similar to the question above. Evaluation of a person's resistance to ground in combination with a person is not a reliable method. The end user must determine the reliability of this personnel grounding combination, as well as the impact to their ESD sensitive device handling procedures.

While it is not recommended to ground personnel via a chair system, there are very rare cases where manufacturers' have demonstrated through alternate methods (i.e. voltage in combination with a person), that a system consisting of an ESD chair, with conductive casters and personnel wearing groundable static control garments, while seated, connected to ground via conductive ESD flooring, for given humidity conditions, meet their ESD requirements.

Again use of this method is not recommended. A wrist strap system is a much more reliable method, that maintains a body voltage on personnel significantly less than could ever be achieved via personnel connected to ground via seating and an ESD floor.

For chairs to be an acceptable method of grounding, one must demonstrate that the body voltage on their personnel is reliably controlled to limits below the ESD failure threshold(s) of the sensitive devices they are handling.