

ELECTROSTATIC DISCHARGE CONTROL

<u>CONTENTS</u>	<u>PAGE</u>
1. PURPOSE .....	1
2. SCOPE .....	2
3. DEFINITIONS.....	2
4. ESD FUNDAMENTALS .....	3
4.1 Static Electricity.....	3
4.2 Triboelectric Charging .....	3
4.3 Triboelectric Series .....	5
4.4 Material Characteristics .....	5
4.5 Failure Modes.....	6
4.6 Device Sensitivity .....	7
5. ESD CONTROL PRINCIPLES.....	8
5.1 Immunity by Design.....	8
5.2 Reduce Charge Generation .....	8
5.3 Dissipate Charges .....	9
5.4 Protect Products .....	9
6. ESD CONTROL MEASURES .....	9
6.1 Education .....	9
6.2 Tools and Materials .....	10
6.3 Environment.....	15
6.4 Shipping and Receiving.....	16
7. SUMMARY / POLICY.....	17
8. REFERENCES .....	17
9. NON EXCLUSIVE SUPPLIERS .....	18
10. ACKNOWLEDGEMENT .....	18

1.1 Electrostatic discharge (ESD) is considered one of the major causes of defective circuit packs in our network. ESD affects virtually every solid state component in our network, including transistors, integrated circuits and MOS (metal-oxide-silicon) devices. In most cases, the damaging discharge can neither be seen nor felt. The purpose of this practice is to provide an overview of ESD phenomena and how ESD can be controlled in order to improve the performance of our network and to lower operating costs.

1.2 This practice applies to all SBC regions and is intended for all engineering, operations and contract personnel as well as personnel in procurement (i.e. shipping and receiving) who may handle circuit packs as part of their day-to-day responsibilities.

## **2. SCOPE**

2.1 This practice merges documents from Ameritech, Nevada Bell, Pacific Bell, Southern New England Telephone and Southwestern Bell.

2.2 The contents of this practice apply to all employees and contract personnel who come in contact with ESD-sensitive equipment used in any network element (switching, transport, loop, power, etc.) in all locations, including but not limited to central offices, controlled environmental vaults, cabinets and huts (electronic equipment enclosures). The contents also apply to SBC equipment located at customer locations.

2.3 All equipment containing solid state electronic components is considered ESD-sensitive.

2.4 In this practice the term circuit pack is equivalent to terms such as plugs, plug-ins, plug-in units (PIUs), printed wiring boards (PWBs), circuit boards, packs, cards, etc.

2.5 Whenever information contained in these document conflicts with a standard published by an authority having jurisdiction over safety-related practices and procedures (e.g., NEC or OSHA), those published standards shall take precedence over the applicable text of this document.

## **3. DEFINITIONS**

Antistatic - A property of materials that resist triboelectric charging and produce minimal static charge when separated from themselves or other materials. A material's antistatic property is not necessarily correlated with its resistivity.

Anitistatic Solution - A solution that provides a static dissipative coating to material.

Charge - An excess or deficiency of electrons on the surface of a material, measured in coulombs.

Circuit Pack - An assembled printed circuit board with components (resistors, diodes, transistors, integrated circuits, etc.).

Common Point Ground – A system of connecting two or more grounding connectors to the same electrical potential.

Conductive - Material exhibiting a surface resistivity of  $<10^5$  ohms per square or a volume resistivity of  $<10^4$  ohm-cm.

Dissipative - Material exhibiting a surface resistivity of between  $10^5$  and  $10^{12}$  ohms per square or a volume resistivity of between  $10^4$  through  $10^{11}$  ohms-cm.

Electromagnetic Interference (EMI) - An electromagnetic disturbance that degrades the performance of electronic equipment.

Electrostatic Charge - An electric charge at rest.

Electrostatic Discharge (ESD) - The rapid, spontaneous transfer of electrostatic charge induced by a high electrostatic field.

Electrostatic Field - An attractive or repulsive force in space due to the presence of an electric charge.

Electrostatic Shield - A barrier or enclosure that limits the penetration of an electrostatic field.

ESD Sensitive – A device or circuit pack that is sensitive to ESD damage.

Field Induction – The process by which a charge's field establishes a charge in a nearby conductive object without physical contact.

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

Insulative - Material having a surface resistivity  $>10^{12}$  ohms per square or a volume resistivity  $>10^{11}$  ohm-cm.

Ionization - The process by which neutral atoms or molecules acquire a positive or negative charge.

Ionizer - A device designed to generate positive and/or negative air ions.

NO-OX-ID "A" – A general term applied to any one of a number of coatings manufactured by Sanchem (or others) that protect against corrosion and the formation of rust. NO-OX-ID "A" is made especially for electrical applications.

Surface Resistivity - The ratio of DC voltage drop per unit length to the surface current per unit width. It is independent of the size of the square or its dimensional units and is expressed in ohms/square.

Triboelectric Charging – The generation of electrostatic charges when two materials make contact or are rubbed together and then separated.

Volume Resistivity - The ratio of DC voltage drop per unit thickness to the amount of current per unit area passing through the material. It is independent of the volume of the material and is expressed in ohm-length (usually ohm-meter or ohm-centimeter).

## **4. ESD FUNDAMENTALS**

### **4.1 Static Electricity**

Static electricity is defined as an electrical charge caused by an imbalance of electrons on the surface of a material. This imbalance of electrons produces an electric field that is strong enough to be measured and that can have a disruptive influence on nearby objects. This electrical charge may be transferred from one material to another by way of an electrostatic discharge. Electrostatic discharges can destroy a semiconductor device, degrade the electrical characteristics of a semiconductor device, alter normal operation of an electronic system and/or corrupt data transmission. Studies completed in the 1990s concluded that, within the telecommunications industry, an average of 30% of all circuit pack failures were due to electrostatic discharge events.

### **4.2 Triboelectric Charging**

4.2.1 Electrostatic charge is most often created by the contact and separation of two similar or dissimilar materials. This is known as triboelectric charging and involves the transfer of electrons between materials. In Figure 1 below, Material A consists of atoms with equal numbers of protons and



another charged object. However, within the telecommunications environment, triboelectric charging is by far the most prevalent means of electrostatic charging.

4.3.1 The relative amount of triboelectric charging on two materials that have made contact and then separated can be determined from Figure 3. The triboelectric Series is a loose ranking of a material's polarity when triboelectrically charged with another material. The materials at the top of the series will typically have a more positive charge than a material lower in the series and the more separation in the series, the higher the resultant charge will be.

**Figure 3 (Triboelectric Series)**

<b>MATERIAL</b>	<b>RELATIVE CHARGE</b>	
Air	Most Positive	
Human Hands		
Asbestos		
Rabbit Fur		
Acetate		
Glass		
Nylon		
Wool		
Lead		
Silk		
Aluminum		
Paper		Neutral
Cotton		
Steel		
Mylar		
Copper		
Gold		
Polyester		
Acrylic		
PVC (Vinyl)		
Teflon	Most Negative	

**4.4 Material Characteristics**

Virtually all materials, including water and dirt particles in the air, can be triboelectrically charged. How much charge is generated, how quickly it is charged and how the charge is distributed on the material are functions of the materials' electrical characteristics. For static control purposes, materials are categorized as insulative, dissipative or conductive.

4.4.1 An insulative material (or insulator) prevents or limits the flow of electrons across its surface or through its volume. Insulators have an extremely high electrical resistance although a considerable amount of charge can be generated on the surface of an insulator. Because an insulative material does not readily allow the flow of electrons, both positive and negative charges can reside on an insulative surface at the same time, although at different locations. Electrons cannot easily flow across the insulative material's surface and charges may remain in place for a very long time.

4.4.2 A conductive material (or conductor), because it has low electrical resistance, allows electrons to flow easily across its surface or through its volume. When a conductive material becomes charged, the charge (i.e., the deficiency or excess of electrons) will be uniformly distributed across the surface of the material. If a charged conductive material makes contact with a second conductive material, the electrons will transfer between the materials quite easily. If the second conductor is attached to an earth ground point, the electrons will flow to ground and the excess charge on the conductor will be "neutralized." Wrist straps rely on this principle.

4.4.3 Static dissipative materials have electrical resistance between that of insulative and conductive materials. There can be electron flow across or through the dissipative material, but it is controlled by the surface resistance or volume resistance of the material. As with the other two types of materials, charge can be generated triboelectrically on a static dissipative material. However, like the conductive material, the static dissipative material will allow the transfer of charge to ground or to other conductive objects. The transfer of charge from a static dissipative material will generally take longer than from a conductive material of equivalent size. Charge transfers from static dissipative materials are significantly faster than from insulators, and slower than from conductors.

#### 4.5 Failure Modes

ESD damage is usually caused by one of three events: direct electrostatic discharge **to** the device; electrostatic discharge **from** the device or **field induced** discharges. These failures can be catastrophic (immediate and permanent damage to the device or circuit pack) or latent (the device or circuit pack will continue to perform but with decreased operating life).

NOTE: It is important to understand that damaging discharges occur even though there may be no audible or visual effects.

##### 4.5.1 Discharge to the Device

An ESD event can occur when any charged conductor (including the human body) discharges to an electrostatic discharge sensitive device (ESDS). The most common cause of electrostatic damage is the direct transfer of electrostatic charge from the human body or a charged material to the (ESDS) device.

When a person walks across a floor, an electrostatic charge accumulates on the body. Simple contact of a finger to the leads of an ESDS device or assembly allows the body to discharge, possibly causing device damage. A similar discharge can occur from a charged conductive object, such as a metallic tool or fixture.

##### 4.5.2 Discharge from the Device

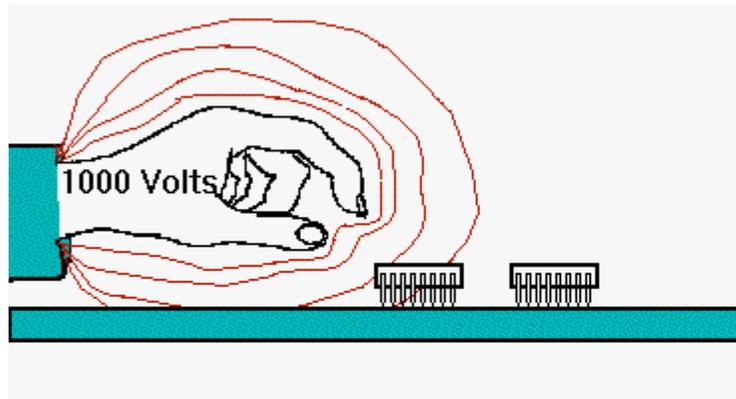
The transfer of charge from an ESD sensitive device is also an ESD event. When circuit packs or individual devices are handled without proper control measures, a charge will accumulate on the circuit pack or device. If it then contacts another conductive surface, a rapid discharge occurs from the device to the conductive object. Although the duration of the discharge is very short--often less than one nanosecond--the peak current can reach 10 amperes or more.

##### 4.5.3 Field Induced Discharges

Another event that can directly or indirectly damage devices is termed Field Induction. Whenever any object, such as the hand in Figure 4, becomes electrostatically charged, there is an electrostatic field associated with that charge. If an ESDS device is placed in that electrostatic field, a charge may be induced on the device. If the device is then momentarily grounded while within the electrostatic field, a transfer of charge from the device occurs.

NOTE: It is possible to damage a device even though no physical contact has been made.

**Figure 4 (Electrostatic Induction)**



#### 4.6 Device Sensitivity

Damage to an ESDS device by the ESD event is determined by the device's ability to dissipate the energy of the discharge and / or withstand the voltage levels involved. This is known as device "ESD sensitivity". Test procedures based on the models of ESD events help define the sensitivity of components to ESD. Some devices may be more readily damaged by discharges occurring within automated equipment, while others may be more prone to damage from handling by personnel.

Many electronic components are susceptible to ESD damage at relatively low voltage levels. Some are susceptible to damage at less than 100 volts and most disk drive components have sensitivities below 10 volts. Current trends in product design are to pack more and more circuitry into the same small space (semiconductor traces less than 1 micron) while at the same time lowering logic levels (2 volts and less) and increasing operating rates (100Mbps and higher). The very characteristics that make these devices so attractive (small size, low operating voltages and high operating speed) is also what makes them so susceptible to ESD.

**Figure 5 (Semiconductor Device Sensitivity)**

Device Type	Range of Sensitivity (volts)
Film Resistors	300 - 3000
CMOS	200 - 3000
Operational Amplifier	190 - 2500
Transistors	140 - 7000

EPROM	100 – 2500
VMOS	30 – 1800
MOSFET	10 – 100

**5.0 ESD CONTROL PRINCIPLES**

The potential for harmful electrostatic discharge exists throughout a product’s lifecycle. Beginning with the manufacturing process and continuing through the testing, shipping, receiving, installation, operation and maintenance processes, the potential for ESD damage is present. Despite the broad exposure to ESD events for both components and systems, the control of damaging ESD events can be accomplished by focusing on just four basic principles: Immunity by Design, Reduce Charge Generation, Dissipate Charges and Protect Products.

Through our policies and procedures, SBC addresses all four principles although the majority of our day-to-day efforts are focused on dissipation of charges and protection of products.

**5.1 Immunity by Design**

The control of ESD begins with the manufacturer’s design of solid state components and electronic systems. Manufacture’s can improve the robustness of their products by selection of less static sensitive devices (see Figure 5) and by providing protection on devices, boards, assemblies and systems. SBC has the least influence over this ESD control measure but we do make considerable effort to evaluate products for compliance with our standards for ESD immunity.

5.1.1 SBC document TP76200MP provides the requirements and objectives to be met by manufactures for equipment intended for use in our network. These requirements include testing for ESD immunity, product labeling to alert users that the equipment is ESD sensitive and product maintenance documentation that addresses ESD mitigation and dissipation.

**5.2 Reduce Charge Generation**

The second principal of control is to eliminate or reduce the generation and accumulation of electrostatic charge. The concept is basic – if there is no charge then there will be no discharge. This is done by reducing static generating processes and materials and by keeping materials at the same electrostatic potential. Minimizing contact of materials that are at the opposite ends of the Triboelectric Series in Figure 3, selection of flooring and work surface material can all help reduce static generation. Maintaining objective levels of humidity (nominally 30%) will also serve to minimize the generation of static charges (see Figure 6 below).

**Figure 6 (Triboelectric Charge Levels)**

Typical Electrostatic Voltage Levels (volts)			
Activity	At Relative Humidity (%)		
	10	40	55
Walking across carpet	35,000	15,000	7,500
Walking across vinyl tile	12,000	5,000	3,000
Worker at bench	6,000	800	400

Remove bubble pack from PWB	26,000	20,000	7,000
Rise from urethane foam chair	18,000	8,000	1,500

### 5.3 Dissipate Charges

Since it is unlikely that we will successfully eliminate the generation of all electrostatic charge, the third principal of control is to safely dissipate those charges that remain. For example, workers who “carry” a charge into the work environment can rid themselves of that charge by attaching a wrist strap and plugging it into an ESD ground jack. For some material such as plastic or other materials that are not good conductors, an antistatic spray can be used under controlled conditions to dissipate electrostatic charges. For larger areas, treatment of workstation or equipment space with air ionization can be effective in neutralizing charges.

### 5.4 Protect Products

The last principle of ESD control is to protect our circuit packs so that, when discharges do occur, the discharges do not reach susceptible parts and assemblies. This is accomplished in two ways. First by packaging circuit packs and other components in proper static dissipative or static-shielding packaging materials, the packaging material will shield the products from static discharge. Secondly, by providing a proper ground (personnel and workstation) during handling of sensitive components and circuit packs, potential charges can be eliminated and any discharges that do occur can be safely dissipated.

## 6.0 ESD CONTROL MEASURES

### 6.1 Education

Education and awareness are the most crucial aspects of ESD control. In fact, many consider the biggest challenge to controlling ESD damage is to convince those who can make a difference that ESD damage is real.

6.1.1 Perhaps because of the relative large physical size of a typical circuit pack, some find it hard to believe that damage can occur simply by touching a circuit pack. Since there is no audible or visual reinforcement when an ESD event occurs, there is no association between cause and effect. However, microchips within the circuit pack are constructed of conductive and insulative material that may be a single micron or less in width (a human hair is approximately 50 microns in diameter). Keeping in mind that electronic circuit components can be damaged by as little as 30 volts (Figure 5) and that voltage levels generated by everyday activities can exceed 15,000 volts (Figure 6), it is clear to see why our network components are vulnerable to ESD damage.

6.1.2 As integrated circuit packages continue to get more and more dense (as many as 1,000,000 transistors on a single chip), we can expect that semiconductor devices and circuit packs will become even more susceptible to ESD damage. Fortunately, with a modest investment in ESD control measures, ESD losses can be minimized with a resultant improvement in network reliability and reduced operating cost.

6.1.3 All affected employees and contractors shall receive training on the principles and control of ESD. At least three training videos are available on ESD: "Pacific Bell Looks At Electrostatic Discharge", Ameritech's "Zap: Avoiding Electrostatic Discharge" and Telcordia's "Electrostatic Discharge and The Central Office". The SBC Center for Learning (<http://cfl.sbc.com/>) offers an 8 hour, self-paced course on electrostatic discharge (course number 1000964). In addition, virtually every vendor-provided maintenance course includes a section on ESD and static sensitive equipment procedures.

### 6.2 Tools and Material

Various tools and material are available to implement an effective ESD control program including:

- Wrist Straps
- Test Equipment
- Fixed Workstation
- Portable Workstation
- Common Point Ground
- Labels, Signs and Posters
- Packaging
- Storage

### 6.2.1 Wrist Straps

A wrist strap is considered the “first line of defense” against the effects of electrostatic discharge and is the most cost-effective ESD counter-measure available. Always moving and moving things around us, people cause more ESD-related damage and problems than any other source. When used appropriately, the wrist strap can keep personnel voltages low thereby avoiding one of the most potent sources of ESD accumulation in the work environment - a charged human body. The purpose of a wrist strap is to safely drain body charges and to safely keep the body at or near ground potential.

6.2.1.1 Employees handling unprotected circuit packs should be issued their own approved wrist strap and it shall be worn at all times and connected to a known ground point when handling a circuit pack that is being placed or removed from service or is otherwise not in its protective container. Wrist straps shall also be worn during any installation or maintenance activity when contact with equipment is required (e.g., plugging in a Craft Interface Device, adjusting panel controls, or making backplane connections).

6.2.1.2 To maintain continuity between the wearer's skin and the wrist strap ground point, the band of the wrist trap should be properly adjusted to maintain continuity with the wearer's skin.

6.2.1.3 Spare wrist straps should be available to provide a quick replacement for wrist straps that fail the daily test routine (see section 5.2.2)

6.2.1.4 Approved ESD heel straps and footwear may be used in areas where the use of wrist straps is deemed impracticable.

6.2.1.5 An alligator clip may be attached to the plug of a wrist strap for use in locations where a ground jack is not readily available and where a known ground point is available.

### 6.2.2 Test Equipment

#### 6.2.2.1 Wrist Strap Tester

6.2.2.1.1. All wristband and heel strap assemblies shall be tested each day the devices are used and shall be replaced when found defective. A “Go/No-Go” type wrist strap or heel strap tester using LEDs and an audible tone should be used to test the integrity of the wristband and cord system. The tester should be available at a location that facilitates daily testing of wrist straps. For more information on wrist strap testers, refer to Telcordia's GR-1418-CORE Generic Requirements for Wrist Strap Testers.

6.2.2.1.2 When a wrist strap assembly is tested, the band shall first be properly adjusted to the wrist. Then the cord should be moved from side to side and subjected to a slight pulling stress to expose intermittent failures.

NOTE: In the absence of a wrist strap tester, the wrist strap assembly can be tested with a volt-ohm meter (VOM). The reading should be between 0.75 and 1.2 megohms.

#### 6.2.2.2 Electrostatic Field Meter

Electrostatic field meters are used regularly to conduct audits in order to determine representative charge levels within the work environment. One of the more important uses of an electrostatic field meter may be as an educational tool to demonstrate to new employees what levels of static charge exist on their body and within the workplace.

### 6.2.2.3 Ionization Tester

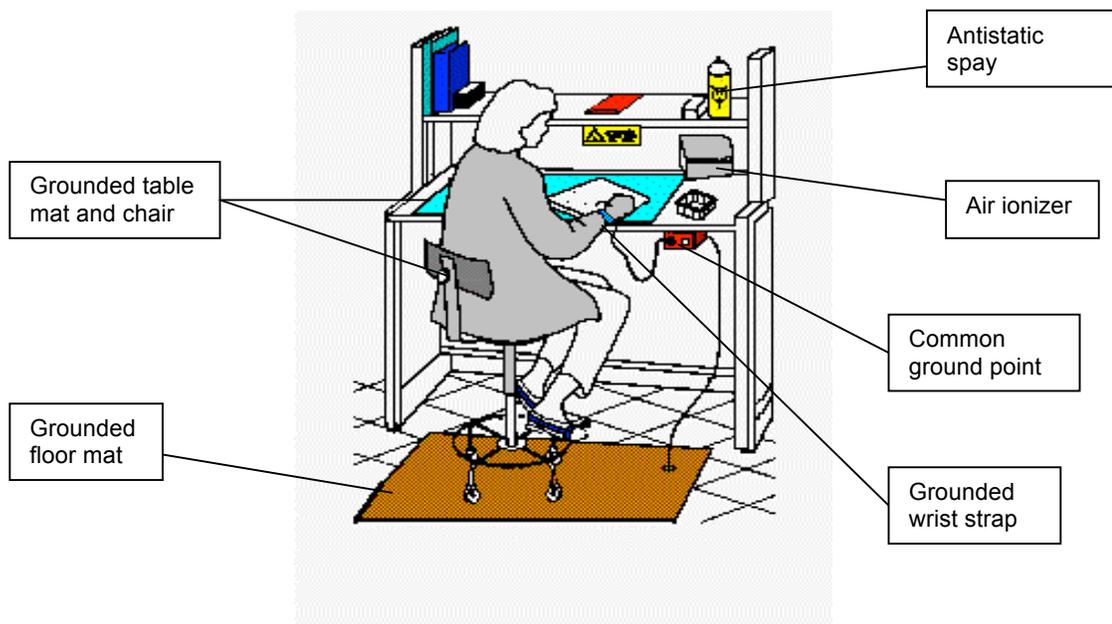
Ionization testers are most often used in and around fixed workstations that have ionization systems. The testers verify that charges are being emitted and they check for balance between positive and negative ions.

### 6.2.3 Fixed Workstation

6.2.3.1 Components of a fixed workstation may include a grounded workbench, a chair with conductive casters, a grounded work surface (mat) made of dissipative material, a grounded floor mat made of dissipative material, wrist straps, heel straps, common point ground, air ionizer, static dissipative containers and static shield containers.

6.2.3.2 A fixed, antistatic workstation (Figure 7) makes it easier to perform repetitive operations like setting circuit pack options on a large number of circuit packs or preparing a large number of circuit packs for shipment.

**Figure 7 (Fixed Workstation)**



### 6.2.4 Portable Work Station

A portable antistatic workstation (field service kit) is required for maintenance and repair at all equipment locations including the central office, a controlled environmental vault, a field cabinet or hut. The minimum requirements for a portable workstation include a wrist strap, a grounded dissipative mat and a common ground point. The use of a static dissipative mat provides a discharge path for all conductive objects placed on it (such as circuit packs, tote boxes, bags, tools, etc.).

### 6.2.5 Common Point Ground

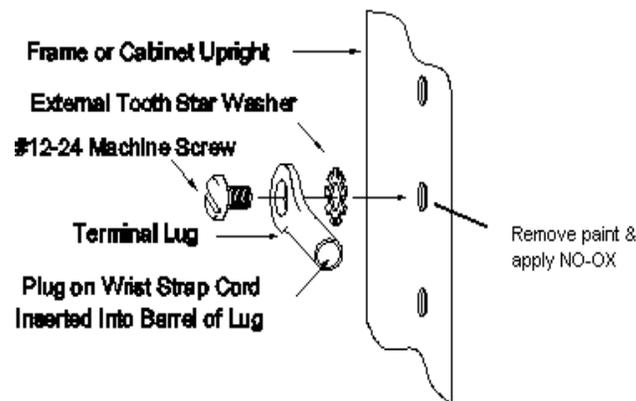
6.2.5.1 All locations where unprotected circuit packs may be handled shall be equipped with a means to ground wrist straps or similar devices that require a connection to ground. This includes all network equipment locations, fixed or portable workstations, storage cabinets and all shipping and receiving points.

6.2.5.2 The preferred wrist strap connection point is a ground jack. However, in the absence of a ground jack, an alligator clip may be adopted to the wrist strap or similar device for connection to a known ground point on the equipment bay. Most unpainted screws, nuts, bolts or equipment mounting plates will serve as an effective ground point.

Note: An ESD ground jack mounted on the equipment **shelf** does not always offer an effective ground and may cause equipment errors. Some areas have experienced equipment malfunctions when plugging wrist straps into **shelf** ground jacks. There is speculation that the EMI field produced as a result of an ESD event (plugging a wrist strap into a jack) may disrupt circuit packs that are installed near the **shelf** ground jack. This does not occur when a **frame** jack is used, perhaps because of the greater distance of the frame jacks from the circuit packs and because the frame itself acts as an EMI shield. **Until more information becomes available, frame ground jacks should be used instead of shelf ground jacks.**

6.2.5.3 A ring type terminal lug or banana jack can be installed in existing equipment that has not been factory-equipped with a ground point jack. Figure 8 illustrates an uninsulated crimp type connector for a #8 AWG wire that has a ring tongue with a 1/4" mounting hole. It is secured to a frame or cabinet using a #12-24 screw in an equipment mounting hole in the upright. An external tooth lock washer shall be placed between the terminal and the mounting surface. As usual, remove paint or other coatings from the frame or cabinet, install a thin coat of NO-OX-ID "A" and tighten the lug assembly. The banana plug on the wrist strap cord can then be inserted into the barrel of the connector.

**Figure 8 (Ground Jack Assembly)**



6.2.5.4 A common ground point shall be used for all grounding conductors (wrist straps, work mats, floor mats, etc.) at an antistatic workstation.

#### 6.2.6 Labels, Signs and Posters

6.2.6.1 All frame and cabinet wrist strap ground points shall be labeled. The label should read "ESD Common Point Ground" or otherwise identify the connection as the ESD ground point. Figure 9 is the industry approved Ground Point label.

**Figure 9 (ESD Wrist Strap Ground Point)**



6.2.6.2 Figure 10 shows the universal ESD susceptibility symbol indicating the presence of static sensitive devices, assemblies or systems. This symbol appears on labels and signs to alert personnel of the need for special handling of equipment. Figure 11 shows the universal symbol indicating protection to ESD sensitive devices. This symbol can be used to identify tools, material and equipment that are specifically designed to provide ESD protection.

6.2.6.3 The use of ESD signs, labels and posters is encouraged to promote ESD awareness. These are available through a number of companies that specialize in ESD-related products.

**Figure 10 (ESD Susceptible Symbol)**



**Figure 11 (ESD Protection Symbol)**



### 6.2.7 Packaging

As stated in Section 4.5, ESD damage is usually caused by one of three failure modes. Packaging material is designed to protect circuit packs from one or all of these failure modes. In addition, packaging may also provide protection against physical damage and moisture. There are a wide variety of packaging materials available that provide protection against one or more all of the ESD failure modes. It is important to be familiar with the general properties, construction characteristics and applications of these packages.

**6.2.7.1 Conductive bags / containers** are constructed of conductive material that will dissipate a charge very fast. However, without the addition of antistatic material, the charge may be transferred through the volume of the material to the circuit pack instead of around the material to ground. Conductive containers provide a small measure of protection (30%) against field induced discharges.

"Black Poly" is an example of a conductive bag. Conductive containers are not recommended unless used in conjunction with other static protective material.

**6.2.7.2 Dissipative bags / containers** are made of dissipative material that allow any accumulated charges to flow across the surface and through the body of the material when grounded. Because the semi-conductive property is inherent in the material, it does not wear off over time. Most dissipative bags also have antistatic properties that prevent triboelectric charging. This combination provides protection against discharge to the device and from the device but not from field induced discharges where it is only 10 % effective. "Pink Poly" is an example of a dissipative bag. Dissipative containers are useful for packaging items (e.g., printed material, hardware, etc.) that will be placed in close proximity to static sensitive items.

**6.2.7.3 Static shielding bags / containers** have conductive, dissipative and antistatic layers that provides protection against discharges to and from the circuit pack as well as from field induced discharges (97% effective). **This is the preferred packaging for circuit packs.**

**6.2.7.4** Replacement circuit packs should remain in their original container until placed in service by a technician wearing a grounded wrist strap. When a circuit pack is removed from an equipment shelf, bank, module, etc., it shall immediately be placed in antistatic package or on a grounded work mat. A circuit pack should not be removed from its container except for installation into equipment or for maintenance (setting option switches, etc.) at an antistatic workstation. Equipment suppliers can provide specific information about the type of static protection provided by their packaging.

**6.2.7.5** The effectiveness of antistatic and static shielding bags / containers will diminish over time. Check with individual manufacturers for the expected useful life.

### 6.2.8 Storage

**6.2.8.1** For the purposes of this document, "storage" refers to cabinets or shelving that are intended to hold multiple circuit packs for an extended period of time. Antistatic transport cases (bins, tote boxes, etc.) may hold multiple circuit packs but are intended for transport and should not be used for storage.

**6.2.8.2** Circuit packs that are stored in central office space shall be packaged in static shielding containers and placed in grounded metal cabinets. Cabinets should be connected to the CO ground system with a #6AWG bond. Unlike equipment frames, it is permissible to "daisy chain" these connections or to use angle iron. Refer to BSP 800-068-151 dated June 1998 for anchoring and grounding details. As usual, all paint shall be removed from the metallic contact areas and NO-OX-ID "A" applied to the connection area.

Note: Some storage cabinets associated with Northern Telecom DMS-100F switches are installed in the switch's isolated ground plane. These cabinets

are insulated from walls, floors, etc., and are grounded via a connection to the switch's framework ground system.

## 6.3 Environment

### 6.3.1 Flooring

6.3.1.1 Floor Finish – Static dissipative floor treatments for vinyl flooring have proven to be an effective tool for treatment of chronic static problems. Due to the higher cost (versus standard floor treatment products) and the temporary nature of the solution, floor treatments should only be considered in extreme circumstances.

6.3.1.2 Antistatic Carpeting - Antistatic carpet does provide a level of ESD control and is recommended in areas such as operator position locations. However, carpets tend to contain dirt and other particulates that can harm electronic equipment. For this reason, carpeting is not suitable for a central office environment.

### 6.3.2 Humidity

In a humid environment, moisture absorbed on the surface of an object will provide a leakage path to ground resulting in a low static potential. In dry conditions, such as a heated building in wintertime or in a naturally arid climate, the leakage rate no longer equals the rate of static generation and large static potentials can result. Figure 6 shows the effect of relative humidity on static generation. Higher humidity has less effect on materials like Teflon that do not absorb moisture. Central offices are generally kept at between 20% and 55% relative humidity.

### 6.3.3 Air Filtration

Central office environments should incorporate air filtration with an ASHRAE dust spot rating of 65% or better. The minimum ventilation rate is 0.25 air changes per hour or 15 cfm per person, whichever is greater. Air filtration, can help maintain humidity levels as well as minimize triboelectric charging due to particles in the air.

### 6.3.4 Air Ionization

Ionizers neutralize a charge on the surface of a material by blowing air filled with equal numbers of negative and positive ions across the material. Materials (usually insulative materials) that must stay within the area of a fixed workstation and that are neither conductive nor readily connected to ground should be treated with air ionization. Air ionizers are generally intended to treat a single small area (such as a workstation).

NOTE: Some air ionizers produce ozone as a by-product. If so, ozone production must be within the OSHA allowance of less than 0.1 parts per million.

### 6.3.5 Antistatic solution

An antistatic solution or spray can be used to prevent static charge generation on materials that are not antistatic. While sprays or wipes may help mitigate a static problem, they do not have sufficient conductivity to act as a ground for personnel or other items. These sprays and wipes are unsuitable substitutes for wrist or heel straps in any area where static control measures are required. Antistatic solutions should be applied according to the manufacturer guidelines and must never be applied to energized parts or assemblies.

## 6.4 Shipping and Receiving

6.4.1 ESD control procedures begin when we take possession of circuit packs or other ESD sensitive products and do not end until ownership passes to another party. This usually means that the first and last group to have an impact on the effectiveness of our ESD control procedures is our warehouse personnel.

6.4.2 All the procedures outlined in this practice also apply to warehouse personnel with the exception that circuit packs **packaged in static shielding containers** may be stored on open, ungrounded shelves instead of in closed and grounded storage cabinets.

## **7.0 SUMMARY / POLICY**

For convenience, key requirements for effective ESD control are repeated below:

1. A properly grounded wrist strap shall be worn whenever a circuit pack is being handled outside its protective container. This also applies to handling circuit packs that are presumed to be defective.
2. Circuit packs should be handled by the edges only. Avoid touching components or conductors.
3. Spare wrist straps should be kept on hand for ready replacement of defective wrist straps
4. Wrist straps shall be tested every day they are used.
5. Circuit packs should be stored in their original containers and kept in a grounded metal cabinet or vendor-designated storage area.
6. Circuit packs shall be transported in a static dissipative or static shielded container.
7. All employees and contractors who handle circuit packs shall receive training in ESD control
8. Appropriate ESD control tools and materials will be made available at all required work locations.
9. Static generating material should not be allowed in areas where circuit packs are handled.
10. Employees shall be informed of ESD phenomenon and understand what constitutes a static hazard in the work place.
11. Employees and contractors who work with circuit packs shall be given ESD control training.
12. Employees and contractors who handle, transport, store, or test circuit packs shall observe recognized ESD precautions.
13. ESD awareness shall be maintained in all equipment areas.
14. To the maximum degree practical, static-generating material shall not be allowed in areas where circuit packs are handled.

## **8.0 REFERENCES**

The documents listed below contain material relevant to ESD control in a telecommunications environment. Many of the Telecordia documents are available on the APEX web site:  
<http://apex.sbc.com/>

ANSI/EOS/ESD S 11.11 EOS/ESD Association Standard for the Protection of Electrostatic Discharge Susceptible Items - Surface Resistance Measurement of Static Dissipative Planar Materials

ANSI/ESD S11.31-94, ESD Shielding Materials - Bags

ANSI/EIA 541-88, Packaging Material Standards for ESD Sensitive Items

ANSI/ESD-S20.20-1999, Development of an Electrostatic Discharge Control Program

ANSI T1.308 - 1996, American National Standard on Central Office Equipment - Electrostatic Discharge Requirements, American National Standards Institute.

ANSI T1.321-1995 (R2000), Electrical Protection for Network Operator - Type Equipment Positions

BR 010-170-005, Electrostatic Discharge, Issue 3, June 1996, Telcordia

BR 635-300-550, Electrostatic Discharge Outside Plant, Issue 1, December 1985, Telcordia

BR 876-320-100, Electrical Protection for Headset Positions, Issue 1, December 1993, Telcordia

Electrostatic Discharge Control Handbook, Issue 3, 1989, AT&T

IEC Standard Electromagnetic Compatibility For Industrial-Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements, Publication 801-2, International Electrotechnical Commission (IEC), 1991-04

TR-NWT-000870, Electrostatic Discharge Control in the Manufacture of Telecommunications Equipment, Issue 1, February 1991, Telcordia

GR 1089, Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunications Equipment, Issue 2, December 1997 with Revision 1, February 1999, Telcordia

GR 1418-CORE, Generic Requirements for Wrist Strap Testers, Issue 1, July 1994, Telcordia

GR 1419-CORE, Generic Requirements for ESD Protective Workstations, Issue 1, December 1995, Telcordia

GR 1421-CORE, Generic Requirements for ESD - Protective Circuit Pack Containers, Issue 2, June 1995, Telcordia

GR 1422-CORE, Generic Requirements for ESD Controlling Wrist Straps, Issue 1, July 1994, Telcordia

GR 1423-CORE, ESD Floor Finishes, Issue 1, December 1994, Telcordia

GR 1424-CORE, ESD Floor Covering and Carpets, Issue 1, February 1995, Telcordia

GR 2925-CORE, Generic Requirements for ESD Chairs and Carts, December 1996, Telcordia

GR 2971-CORE, Generic Requirements for ESD Signs, Symbols, and Awareness, December 1997, Telcordia

GR2972, Generic Requirements for ESD Protective Tapes and Adhesive, December 1997, Telcordia

## **9. NON EXCLUSIVE SUPPLIERS**

There are no existing supplier contracts in place for the purchase of ESD tools and materials. The following suppliers offer some or all of the most widely used items.

<b>Company</b>	<b>URL</b>	<b>Phone Number</b>
Desco	Desco.com	909-598-2753
Botron Company	Botron.com	623-582-6700
Correct Products	Correctproducts.com	972-690-6645
ESD Systems	Esdsystems.com	508-485-7390
Static Control	Staticcontrol.com	800-356-2728

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Semtronics	Semtronics.com	714-799-9810
3M	3M.com	800-665-7862
Legge Systems	Leggesystems.com	800-345-3443

**10. ACKNOWLEDGEMENT**

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